

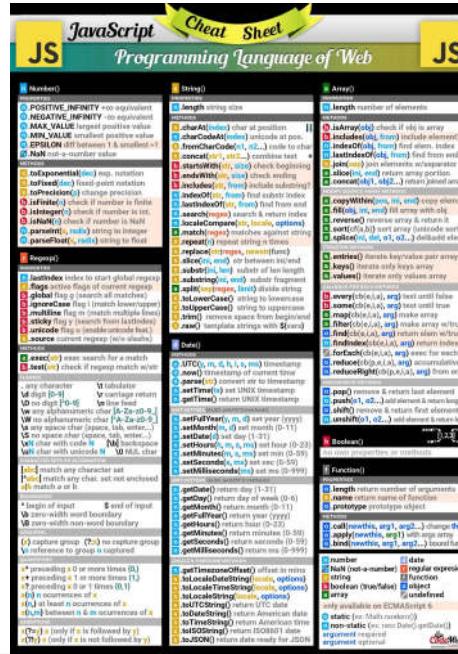
# JavaScript (basics)

"The" language of the Web

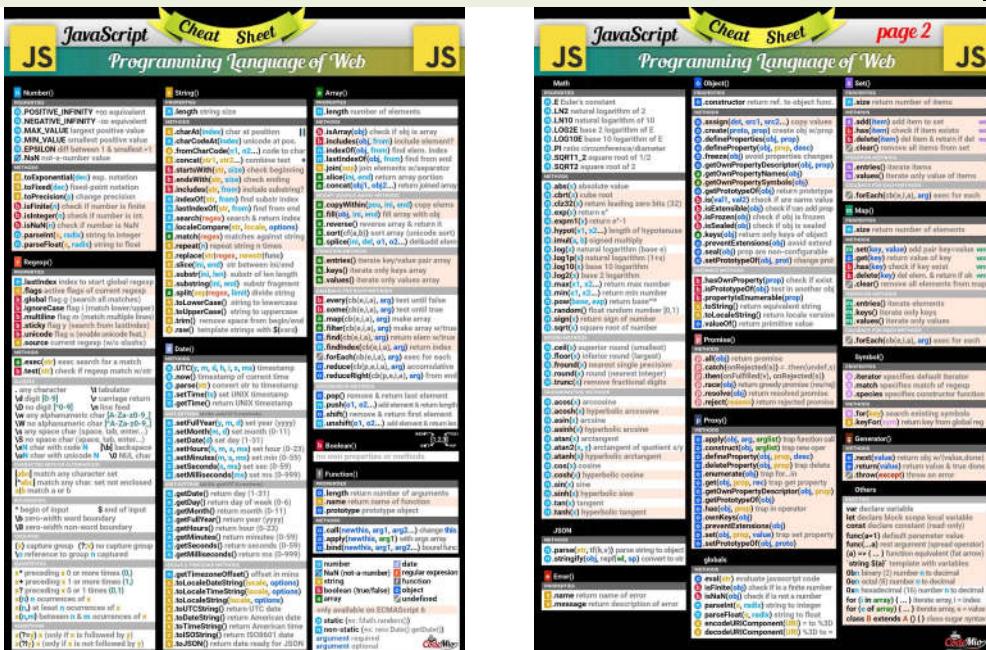
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# Goal

- Learn JavaScript as a language
- Understand the specific semantics and programming patterns
  - We assume a programming knowledge in other languages
- Updated to ES6 (2015) language features
- Supported by server-side (`Node.js`) and client-side (browsers) run-time environments
  - More recent language additions also supported (through *transpiling*)

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# Outline

- What is JavaScript?
- History and versions
- Language structure
- Types, variables
- Expressions
- Control structures
- Arrays
- Strings

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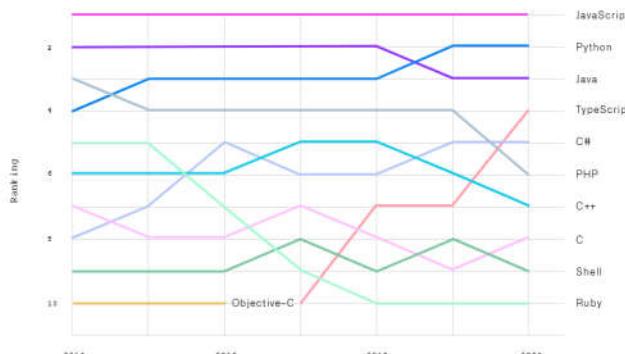
JavaScript – The language of the Web

## WHAT IS JAVASCRIPT?

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// The languages that dominated  
Top languages over the years



source: <https://octoverse.github.com/#top-languages>

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# JavaScript

- JavaScript (JS) is a programming language
- It is currently the only programming language that a browser can execute natively...
- ... and it also runs on a computer, like other programming languages (thanks to Node.js)
- It has **nothing** to do with Java
  - named that way for *marketing reasons*, only
- The first version was written in 10 days (!)
  - several fundamental language decisions were made because of company politics and not technical reasons!

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## HISTORY AND VERSIONS

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## JAVASCRIPT VERSIONS

10 yrs

Main target

ES9,  
ES10,  
...

- ▶ **JAVASCRIPT (December 4th 1995)** Netscape and Sun press release
- ▶ **ECMAScript Standard Editions:** <https://www.ecma-international.org/ecma-262/>
- ▶ **ES1 (June 1997)** Object-based, Scripting, Relaxed syntax, Prototypes
- ▶ **ES2 (June 1998)** Editorial changes for ISO 16262
- ▶ **ES3 (December 1999)** Regexp, Try/Catch, Do-While, String methods
- ▶ **ES5 (December 2009)** Strict mode, JSON, .bind, Object mts, Array mts
- ▶ **ES5.1 (June 2011)** Editorial changes for ISO 16262:2011
- ▶ **ES6 (June 2015)** Classes, Modules, Arrow Fs, Generators, Const/Let, Destructuring, Template Literals, Promise, Proxy, Symbol, Reflect
  - Also: ES2015
- ▶ **ES7 (June 2016)** Exponentiation operator (\*\*), Array Includes
  - Also: ES2016
- ▶ **ES8 (June 2017)** Async Fs, Shared Memory & Atomics
  - Also: ES2017



Brendan Eich

<https://www.slideshare.net/RafaelCasusoRomate/javascript-editions-es7-es8-and-es9-vs-v8>

## JavaScript versions

- ECMAScript (also called ES) is the official name of JavaScript (JS) standard
- ES6, ES2015, ES2016 etc. are implementations of the standard
- All browsers used to run ECMAScript 3
- ES5, and ES2015 (=ES6) were huge versions of JavaScript
- Then, yearly release cycles started
  - By the committee behind JS: TC39, backed by Mozilla, Google, Facebook, Apple, Microsoft, Intel, PayPal, SalesForce, etc.
- **ES2015 (=ES6) is covered in this course**

# Official ECMA standard (formal and unreadable)



The screenshot shows the official ECMA-262 specification page. At the top right is the ECMA International logo. Below it, the title "ECMA-262, 10<sup>th</sup> edition, June 2019" and "ECMAScript® 2019 Language Specification" are displayed. To the left is a sidebar titled "TABLE OF CONTENTS" containing a detailed list of chapters from 1 to 29. The main content area includes sections for "Contributing to this Specification" (with links to GitHub repository, issues, pull requests, and tests), "Community" (with names like Brian Terlson, TC39, Bradley Kuhn, and Jordan Rethond), and an "Introduction". A blue button at the bottom left of the main content area contains the URL <https://www.ecma-international.org/ecma-262/>. A green circular badge in the bottom right corner of the slide contains the number 11.

## JavaScript Engines

- V8 (Chrome V8) by Google
  - used in Chrome/Chromium, Node.js and Microsoft Edge
- SpiderMonkey by Mozilla Foundation
  - Used in Firefox/Gecko
- ChakraCore by Microsoft
  - it was used in Edge
- JavaScriptCore by Apple
  - used in Safari



The footer of the slide contains the URL "Applicazioni Web I - Web Applications I - 2022/2023" and a green circular badge containing the number 12.

# Standard vs. Implementation (in browsers)



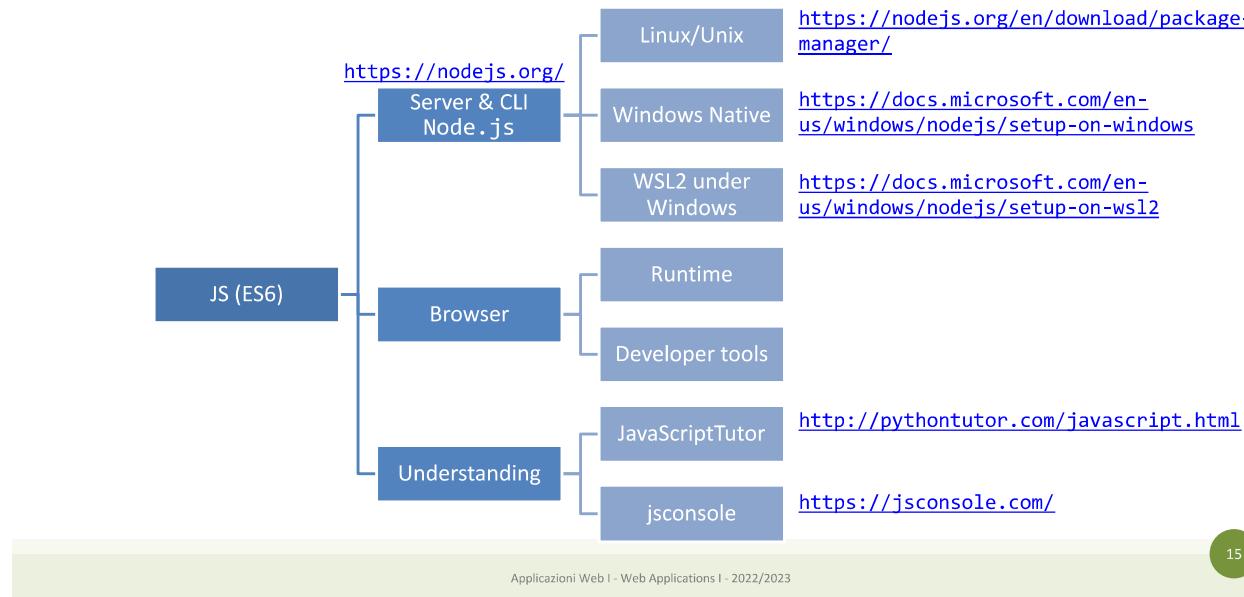
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## JS Compatibility

- JS is *backwards-compatible*
  - once something is accepted as valid JS, there will not be a future change to the language that causes that code to become invalid JS
  - TC39 members: "we don't break the web!"
- JS is not forwards-compatible
  - new additions to the language will not run in an older JS engine and may crash the program
- **strict mode** was introduced to disable very old (and dangerous) semantics
- Supporting multiple versions is achieved by:
  - *Transpiling* – Babel (<https://babeljs.io>) converts from newer JS syntax to an equivalent older syntax
  - *Polyfilling* – user- (or library-)defined functions and methods that "fill" the lack of a feature by implementing the newest available one

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# JS Execution Environments



## JavaScriptTutor

Write code in **JavaScript ES6** (drag lower right corner to resize code editor)

```
1 let nome = "Fulvio";
2 let cognome = "Corino";
3
4 function hello(c, n) {
5   n = n || "sig."
6   const saluto = n + " " + c;
7   return saluto;
8 }
9
10 let s1 = hello(cognome, nome);
11 let s2 = hello(nome);
12
13 let nome2 = [...nome];
14 let cognome2 = [...cognome]
```

line that just executed

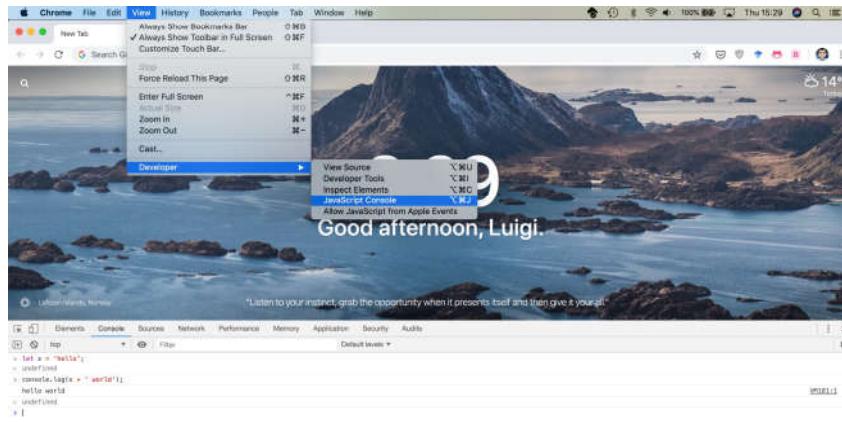
next line to execute

<< First < Prev Next > Last >>

Done running (16 steps)

<http://pythontutor.com/javascript.html>

# Browser and JS console



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## LANGUAGE STRUCTURE

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# Lexical structure

- One File = One JS program
  - Each file is loaded independently and
  - Different files/programs may communicate through *global state*
  - The “module” mechanism extends that (provides state sharing in a clean way)
- The file is entirely *parsed*, and then *executed* from top to bottom
- Relies on a *standard library*
  - and many additional *APIs* provided by the execution environment

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## Lexical structure

```
> let ööö = 'appalled'  
> ööö  
'appalled'
```

- JavaScript is written in Unicode (do not abuse), so it also supports non-latin characters for names and strings
  - even emoji
- Semicolons (;) are not mandatory (automatically inserted)
- Case sensitive
- Comments as in C /\*...\*/ and //
- Literals and identifiers (start with letter, \$, \_)
- Some reserved words
- C-like syntax

```
> let x = '😊';  
< undefined  
> console.log(x);  
😊
```

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# Semicolon ( ; )

- Argument of debate in the JS community
- JS inserts them as needed
  - When next line starts with code that breaks the current one
  - When the next line starts with }
  - When there is return, break, throw, continue on its own line
- Be careful that forgetting semicolon can lead to unexpected behavior
  - A newline does not automatically insert a semicolon: if the next line starts with ( or [ , it is interpreted as function call or array access
- We will **loosely** follow the Google style guide, so we will always insert semicolons after each statement
  - <https://google.github.io/styleguide/jsguide.html>

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## Strict Mode

```
// first line of file
"use strict" ;
// always!!
```

- Directive introduced in ES5: `"use strict"` ;
  - Compatible with older version (it is just a string)
- Code is executed in *strict mode*
  - This fixes some important language deficiencies and provides stronger error checking and security
  - Examples:
    - fixes mistakes that make it difficult for JavaScript engines to perform optimizations: strict mode code can sometimes be made to run faster than identical code that's not strict mode
    - eliminates some JavaScript silent errors by changing them to throw errors
    - functions invoked as functions and not as methods of an object have `this` undefined
    - cannot define 2 or more properties or function parameters with the same name
    - no octal literals (base 8, starting with 0)
    - ...

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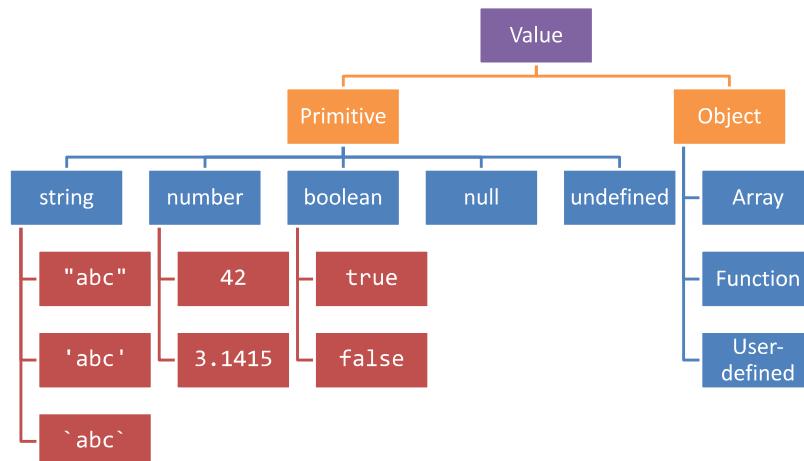
## TYPES AND VARIABLES

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### Values and Types

Values have types.  
Variables don't.



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# Boolean, true-truthy, false-falsy, comparisons

- 'boolean' type with literal values: `true`, `false`

- When converting to boolean

- The following values are 'falsy'

- `0`, `-0`, `NaN`, `undefined`, `null`, `''` (empty string)

- Every other value is 'truthy'

- `3`, `'false'`, `[]` (empty array), `{}` (empty object)

```
> Boolean(3)
true
> Boolean('')
false
> Boolean(' ')
true
```

- Booleans and Comparisons

- `a == b` // convert types and compare results

- `a === b` // inhibit automatic type conversion and compare results

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# Number

- No distinction between integers and reals
- Automatic conversions according to the operation
- There is also a distinct type "BigInt" (*ES11, July 2020*)
  - an arbitrary-precision integer, can represent  $2^{53}$  numbers
  - `123456789n`
  - With suffix '`n`'

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# Special values

- **undefined**: variable declared but not initialized
  - Detect with: `typeof variable === 'undefined'`
  - `void x` always returns undefined
- **null**: an empty value
- Null and Undefined are called *nullish values*
- **NaN (Not a Number)**
  - It is actually a number
  - Invalid output from arithmetic operation or parse operation

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# Variables

- Variables are *pure references*: they refer to a *value*
- The same variable may refer to different values (even of different types) at different times
- Declaring a variable:
  - `let`
  - `const`
  - `var`

```
> v = 7 ;  
7  
> v = 'hi' ;  
'hi'
```

```
> let a = 5  
> const b = 6  
> var c = 7  
> a = 8  
8  
> b = 9  
Thrown:  
TypeError: Assignment to  
constant variable.  
> c = 10  
10
```

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# Variable declarations

Declarator	Can reassign?	Can re-declare?	Scope	Hoisting *	Note
<b>let</b>	Yes	No	Enclosing block {...}	No	<i>Preferred</i>
<b>const</b>	No §	No	Enclosing block {...}	No	<i>Preferred</i>
<b>var</b>	Yes	Yes	Enclosing function, or global	Yes, to beginning of function or file	<i>Legacy, beware its quirks, try not to use</i>
None (implicit)	Yes	N/A	Global	Yes	<i>Forbidden in strict mode</i>

§ Prevents reassignment (a=2), does not prevent changing the value of the referred object (a.b=2)

\* Hoisting = “lifting up” the definition of a variable (not the initialization!) to the top of the current scope (e.g., the file or the function)

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## Scope

```
"use strict" ;  
  
let a = 1 ;  
const b = 2 ;  
let c = true ;  
  
let a = 5 ; // SyntaxError: Identifier 'a' has already been declared
```

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# Scope

Typically, you don't  
create a new scope in  
this way!

```
"use strict" ;  
  
let a = 1 ;  
const b = 2 ;  
let c = true ;  
  
{ // creating a new scope...  
    let a = 5 ;  
    console.log(a) ;  
}  
  
console.log(a) ;
```

Each {} is called a **block**. 'let' and 'const' variables are *block-scoped*.

They exist only in their defined and inner scopes.

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## Scope and Hoisting

```
"use strict" ;  
  
function example(x) {  
    var c ; // hoisted  
    let a = 1 ;  
  
    console.log(a) ; // 1  
    console.log(b) ; // ReferenceError: b is not defined  
    console.log(c) ; // undefined  
  
    if( x>1 ) {  
        let b = a+1 ;  
        var c = a*2 ;  
    }  
  
    console.log(a) ; // 1  
    console.log(b) ; // ReferenceError: b is not defined  
    console.log(c) ; // 2  
}  
  
example(2) ;
```

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JavaScript: The Definitive Guide, 7th Edition  
Chapter 2. Types, Values, and Variables  
Chapter 3. Expressions and Operators

Mozilla Developer Network  
JavaScript Guide » Expressions and operators

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## EXPRESSIONS

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## Operators

- Assignment operators
- Comparison operators
- Arithmetic operators
- Bitwise operators
- Logical operators
- String operators
- Conditional (ternary) operator
- Comma operator
- Unary operators
- Relational operators



Full reference and operator precedence:  
[https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Operator\\_Precedence#Table](https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Operator_Precedence#Table)

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# Assignment

- `let variable = expression ;` // declaration with initialization
- `variable = expression ;` // reassignment

Name	Shorthand operator	Meaning
Assignment	<code>x = y</code>	<code>x = y</code>
Addition assignment	<code>x += y</code>	<code>x = x + y</code>
Subtraction assignment	<code>x -= y</code>	<code>x = x - y</code>
Multiplication assignment	<code>x *= y</code>	<code>x = x * y</code>
Division assignment	<code>x /= y</code>	<code>x = x / y</code>
Remainder assignment	<code>x %= y</code>	<code>x = x % y</code>
Exponentiation assignment <small>⚠️</small>	<code>x **= y</code>	<code>x = x ** y</code>
Left shift assignment	<code>x &lt;= y</code>	<code>x = x &lt;&lt; y</code>
Right shift assignment	<code>x &gt;= y</code>	<code>x = x &gt;&gt; y</code>
Unsigned right shift assignment	<code>x &gt;&gt;= y</code>	<code>x = x &gt;&gt;&gt; y</code>
Bitwise AND assignment	<code>x &amp;= y</code>	<code>x = x &amp; y</code>
Bitwise XOR assignment	<code>x ^= y</code>	<code>x = x ^ y</code>
Bitwise OR assignment	<code>x  = y</code>	<code>x = x   y</code>

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# Comparison operators



Operator	Description	Examples returning true
Equal ( <code>==</code> )	Returns <code>true</code> if the operands are equal.	<code>3 == var1</code> <code>'3' == var1</code> <code>3 == '3'</code>
Not equal ( <code>!=</code> )	Returns <code>true</code> if the operands are not equal.	<code>var1 != 4</code> <code>var2 != "3"</code>
Strict equal ( <code>===</code> )	Returns <code>true</code> if the operands are equal and of the same type. See also <code>Object.is</code> and sameness in JS.	<code>3 === var1</code>
Strict not equal ( <code>!==</code> )	Returns <code>true</code> if the operands are of the same type but not equal, or are of different type	<code>var1 !== "3"</code> <code>3 !== '3'</code>
Greater than ( <code>&gt;</code> )	Returns <code>true</code> if the left operand is greater than the right operand.	<code>var2 &gt; var1</code> <code>"12" &gt; 2</code>
Greater than or equal ( <code>&gt;=</code> )	Returns <code>true</code> if the left operand is greater than or equal to the right operand.	<code>var2 &gt;= var1</code> <code>var1 &gt;= 3</code>
Less than ( <code>&lt;</code> )	Returns <code>true</code> if the left operand is less than the right operand.	<code>var1 &lt; var2</code> <code>"2" &lt; 12</code>
Less than or equal ( <code>&lt;=</code> )	Returns <code>true</code> if the left operand is less than or equal to the right operand	<code>var1 &lt;= var2</code> <code>var2 &lt;= 5</code>

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# Comparing Objects

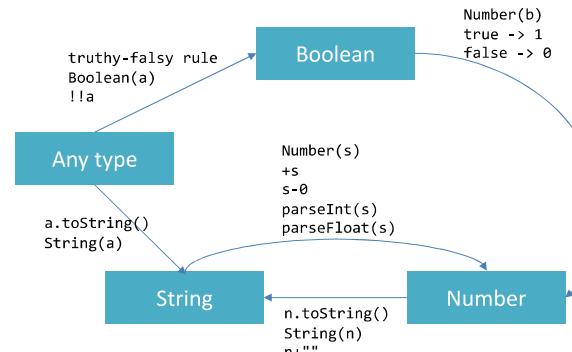
- Comparison between objects with `==` or `===` compares the *references* to objects
  - True only if they are *the same object*
  - False if they are *identical objects*
- Comparison with `< > <= >=` first converts the object (into a Number, or more likely a String), and then compares the values
  - It works, but may be unpredictable, depending on the string format

```
> a={x:1}  
{ x: 1 }  
  
> b={x:1}  
{ x: 1 }  
  
> a====b  
false  
  
> a==b  
false
```

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# Automatic Type Conversions

- JS tries to apply type conversions between primitive types, before applying operators
- Some language constructs may be used to “force” the desired conversions
- Using `==` applies conversions
- Using `===` prevents conversions



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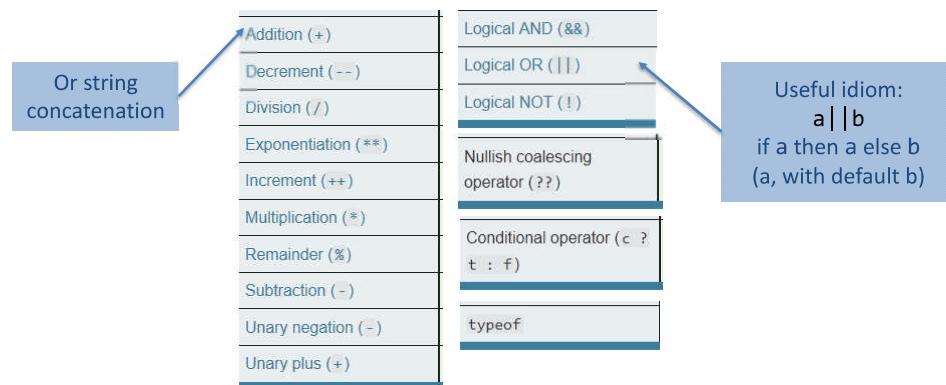
# Logical operators

Operator	Usage	Description
Logical AND ( <code>&amp;&amp;</code> )	<code>expr1 &amp;&amp; expr2</code>	Returns <code>expr1</code> if it can be converted to <code>true</code> ; otherwise, returns <code>expr2</code> . Thus, when used with Boolean values, <code>&amp;&amp;</code> returns <code>true</code> if both operands are true; otherwise, returns <code>false</code> .
Logical OR ( <code>  </code> )	<code>expr1    expr2</code>	Returns <code>expr1</code> if it can be converted to <code>true</code> ; otherwise, returns <code>expr2</code> . Thus, when used with Boolean values, <code>  </code> returns <code>true</code> if either operand is true; if both are false, returns <code>false</code> .
Logical NOT ( <code>!</code> )	<code>!expr</code>	Returns <code>false</code> if its single operand that can be converted to <code>true</code> ; otherwise, returns <code>true</code> .

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# Common operators



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# Mathematical functions (Math global object)

- **Constants:** Math.E, Math.LN10, Math.LN2, Math.LOG10E, Math.LOG2E, Math.PI, Math.SQRT1\_2, Math.SQRT2
- **Functions:** Math.abs(), Math.acos(), Math.acosh(), Math.asin(), Math.asinh(), Math.atan(), Math.atan2(), Math.atanh(), Math.cbrt(), Math.ceil(), Math.clz32(), Math.cos(), Math.cosh(), Math.exp(), Math.expm1(), Math.floor(), Math.fround(), Math.hypot(), Math.imul(), Math.log(), Math.log10(), Math.log1p(), Math.log2(), Math.max(), Math.min(), Math.pow(), Math.random(), Math.round(), Math.sign(), Math.sin(), Math.sinh(), Math.sqrt(), Math.tan(), Math.tanh(), Math.trunc()

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JavaScript: The Definitive Guide, 7th Edition  
Chapter 4. Statements

Mozilla Developer Network  
[JavaScript Guide » Control Flow and Error Handling](#)  
[JavaScript Guide » Loops and Iteration](#)

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## CONTROL STRUCTURES

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## Conditional statements

```
if (condition) {  
    statement_1;  
} else {  
    statement_2;  
}
```

```
if (condition_1) {  
    statement_1;  
} else if (condition_2) {  
    statement_2;  
} else if (condition_n) {  
    statement_n;  
} else {  
    statement_last;  
}
```

```
switch (expression) {  
    case label_1:  
        statements_1  
        [break];  
    case label_2:  
        statements_2  
        [break];  
    ...  
    default:  
        statements_def  
        [break];  
}
```

May also be a string

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## Loop statements

```
for ([initialExpression]; [condition]; [incrementExpression]) {  
    statement ;  
}
```

Usually declares loop variable

```
do {  
    statement ;  
} while (condition);
```

May use break; or  
continue;

```
while (condition) {  
    statement ;  
}
```

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## Special 'for' statements

```
for (variable in object) {
    statement ;
}
```

- Iterates the variable over all the enumerable **properties** of an **object**
- Do not use** to traverse an array (use numerical indexes, or for-of)

```
for( let a in {x: 0, y:3}) {
    console.log(a) ;
}
```

x  
y

```
for (variable of iterable) {
    statement ;
}
```

- Iterates the variable over all values of an *iterable object* (including Array, Map, Set, string, arguments ...)
- Returns the *values*, not the keys

```
for( let a of [4,7]) {
    console.log(a) ;
}
```

4  
7

```
for( let a of "hi" ) {
    console.log(a) ;
}
```

h  
i

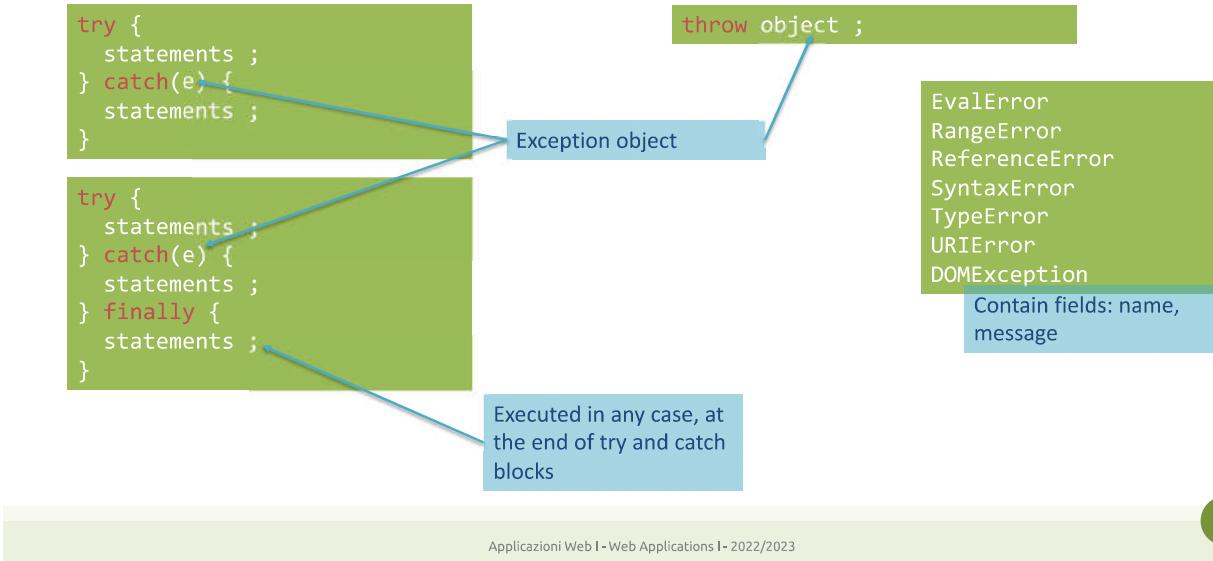
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## Other iteration methods

- Functional programming (strongly supported by JS) allows other methods to iterate over a collection (or any iterable object)
  - a.forEach()
  - a.map()
- They will be analyzed later

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# Exception handling



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JavaScript: The Definitive Guide, 7th Edition  
Chapter 6. Arrays

Mozilla Developer Network  
JavaScript Guide » Indexed Collections

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## ARRAYS

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# Arrays

- Rich of functionalities
- Elements do not need to be of the same type
- Simplest syntax: [ ]
- Property .length
- Distinguish between methods that:
  - Modify the array (**in-place**)
  - Return a **new** array

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## Creating an array

```
let v = [] ;
```

Elements are indexed at positions 0...length-1

Do not access elements outside range

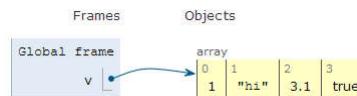
```
let v = [1, 2, 3] ;
```

```
let v = Array.of(1, 2, 3) ;
```



```
let v = [1, "hi", 3.1, true];
```

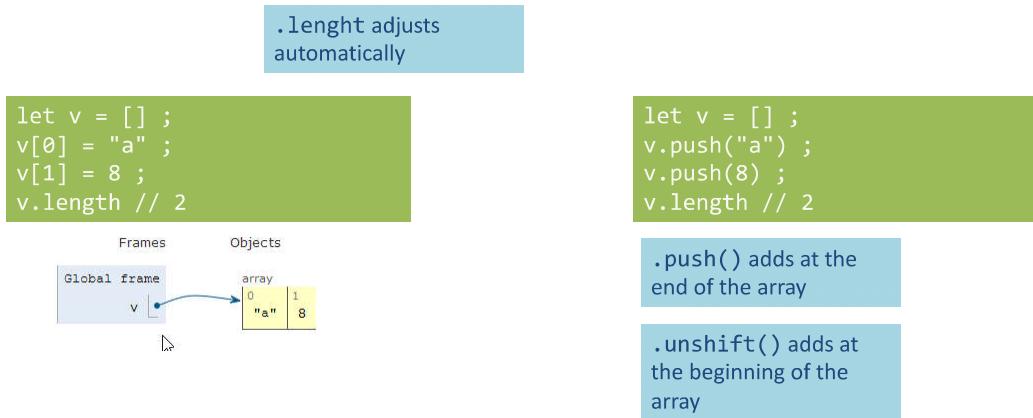
```
let v = Array.of(1, "hi",  
3.1, true) ;
```



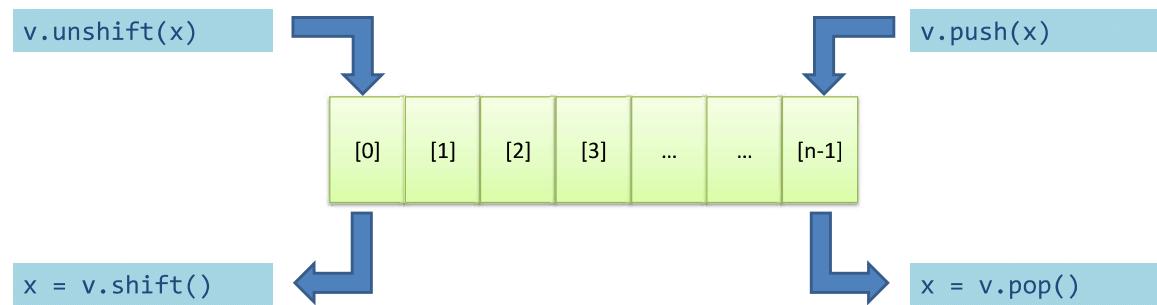
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## Adding elements



## Adding and Removing from arrays (in-place)



# Copying arrays

```
let v = [] ;  
v[0] = "a" ;  
v[1] = 8 ;  
  
let alias = v ;  
alias[1] = 5 ;
```

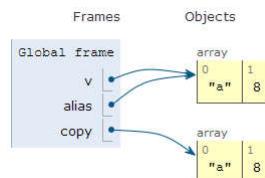
```
> console.log(v); ?  
[ 'a', 5 ]  
undefined  
> console.log(alias);  
[ 'a', 5 ]  
undefined
```

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# Copying arrays

```
let v = [] ;  
v[0] = "a" ;  
v[1] = 8 ;  
  
let alias = v ;  
let copy = Array.from(v) ;
```



Array.from creates a  
shallow copy

Creates an array from  
any iterable object

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# Iterating over Arrays

Preferred

Functional style – later

- Iterators: `for ... of`, `for (..; ..; ..)`
- Iterators: `forEach(f)`
  - f is a function that processes the element
- Iterators: `every(f)`, `some(f)`
  - f is a function that returns true or false
- Iterators that return a new array: `map(f)`, `filter(f)`
  - f works on the element of the array passed as parameter
- Reduce: exec a callback function on all items to progressively compute a result

# Main array methods

- `.concat()`
  - joins two or more arrays and returns a **new** array.
- `.join(delimiter = ',')`
  - joins all elements of an array into a (**new**) string.
- `.slice(start_index, upto_index)`
  - extracts a section of an array and returns a **new** array.
- `.splice(index, count_to_remove, addElement1, addElement2, ...)`
  - removes elements from an array and (optionally) replaces them, **in place**
- `.reverse()`
  - transposes the elements of an array, **in place**
- `.sort()`
  - sorts the elements of an array **in place**
- `.indexOf(searchElement[, fromIndex])`
  - searches the array for searchElement and returns the **index** of the first match
- `.lastIndexOf(searchElement[, fromIndex])`
  - like indexOf, but starts at the end
- `.includes(valueToFind[, fromIndex])`
  - search for a certain value among its entries, returning true or false

## Destructuring assignment

- Value of the right-hand side of equal signal are extracted and stored in the variables on the left

```
let [x,y] = [1,2];
[x,y] = [y,x]; // swap

var foo = ['one', 'two', 'three'];
var [one, two, three] = foo;
```

- Useful especially with passing and returning values from functions

```
let [x,y] = toCartesian(r,theta);
```

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## Spread operator (3 dots: ...)

- Expands an iterable object in its parts, when the syntax requires a comma-separated list of elements

```
let [x, ...y] = [1,2,3,4]; // we obtain y == [2,3,4]
```

```
const parts = ['shoulders', 'knees'];
const lyrics = ['head', ...parts, 'and', 'toes']; // ["head", "shoulders",
"knees", "and", "toes"]
```

- Works on the left- and right-hand side of the assignment

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# Curiosity

- Copy by value:
  - `const b = Array.from(a)`
- Can be emulated by
  - `const b = Array.of(...a)`
  - `const b = [...a]`

Frequent  
idiom

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JavaScript: The Definitive Guide, 7th Edition  
Chapter 2. Types, Values, and Variables

Mozilla Developer Network  
JavaScript Guide » Text Formatting

JavaScript – The language of the Web

## STRINGS

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# Strings in JS

- A string is an **immutable** ordered sequence of Unicode<sup>(\*)</sup> characters
- The **length** of a string is the number of characters it contains (not bytes)
- JavaScript's strings use zero-based indexing
  - The empty string is the string of length 0
- JavaScript does not have a special type that represents a single character (use length-1 strings).
- String literals may be defined with ' abc ' or "abc"
  - Note: when dealing with JSON parsing, only " " can be correctly parsed

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## String operations

- All operations always return **new** strings
  - Consequence of immutability
- `s[3]`: indexing
- `s1 + s2`: concatenation
- `s.length`: number of characters
  - Note: `.length`, not `.length()`

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# String methods

Method	Description
<code>charAt</code> , <code>charCodeAt</code> , <code>codePointAt</code>	Return the character or character code at the specified position in string.
<code>indexOf</code> , <code>lastIndexOf</code>	Return the position of specified substring in the string or last position of specified substring, respectively.
<code>startsWith</code> , <code>endsWith</code> , <code>includes</code>	Returns whether or not the string starts, ends or contains a specified string.
<code>concat</code>	Combines the text of two strings and returns a new string.
<code>fromCharCode</code> , <code>fromCodePoint</code>	Constructs a string from the specified sequence of Unicode values. This is a method of the String class, not a String instance.
<code>split</code>	Splits a <code>String</code> object into an array of strings by separating the string into substrings.
<code>slice</code>	Extracts a section of a string and returns a new string.
<code>substring</code> , <code>substr</code>	Return the specified subset of the string, either by specifying the start and end indexes or the start index and a length.
<code>match</code> , <code>matchAll</code> , <code>replace</code> , <code>search</code>	Work with regular expressions.
<code>toLowerCase</code> , <code>toUpperCase</code>	Return the string in all lowercase or all uppercase, respectively.
<code>normalize</code>	Returns the Unicode Normalization Form of the calling string value.
<code>repeat</code>	Returns a string consisting of the elements of the object repeated the given times.
<code>trim</code>	Trims whitespace from the beginning and end of the string.

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## Unicode issues

- Strings are a sequence of 16-bit Unicode ‘code units’
  - Fine for all Unicode characters from 0000 to FFFF
  - Characters (‘graphemes’) from 010000 to 10FFFF are represented by *a pair of code units* (and they occupy 2 index positions)
  - Therefore, not all string methods work well with Unicode characters above FFFF (e.g., emojis, flags, ...)
- For more details: <https://dmitripavlutin.com/what-every-javascript-developer-should-know-about-unicode/>

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# Template literals

- Strings included in `backticks` can embed expressions delimited by `{}$`
- The **value** of the expression is *interpolated* into the string

```
let name = "Bill";
let greeting = `Hello ${ name }.`;
// greeting == "Hello Bill."
```

- Very useful and quick for string formatting
- Template literals may also span multiple lines

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