

## “The” language of the Web

Luigi De Russis

# Enrico Masala

JavaScript

Cheat Sheet

Programming Language of Web

JS

<b>Number()</b>	
<b>PROPERTIES</b>	
<b>POSITIVE_INFINITY</b> +∞ equivalent	
<b>NEGATIVE_INFINITY</b> -∞ equivalent	
<b>MAX_VALUE</b> largest positive value	
<b>MIN_VALUE</b> smallest positive value	
<b>EPSILON</b> diff between 1 & smallest >1	
<b>NaN</b> not-a-number value	
<b>METHODS</b>	
<b>toExponential(dec)</b> exp. notation	
<b>toFixed(dec)</b> fixed-point notation	
<b>toPrecision(p)</b> change precision	
<b>isFinite(n)</b> check if number is finite	
<b>isInteger(n)</b> check if number is int	
<b>isNaN(n)</b> check if number is NaN	
<b>parseFloat(s, radix)</b> string to integer	
<b>parseFloat(s, radix)</b> string to float	

<b>RegExp()</b>	
<b>PROPERTIES</b>	
<b>lastIndex</b> index to start global regexp	
<b>flags</b> active flags of current regexp	
<b>global</b> flag g (search all matches)	
<b>ignoreCase</b> flag i (match lower/upper)	
<b>multiline</b> flag m (match multiple lines)	
<b>sticky</b> flag y (search from lastIndex)	
<b>unicode</b> flag u (enable unicode feat.)	
<b>source</b> current regexp (w/o slashes)	
<b>METHODS</b>	
<b>exec(str)</b> exec search for a match	
<b>test(str)</b> check if regexp match w/str	

<b>CLASSES</b>	
<b>\.</b> any character	<b>\t</b> tabulator
<b>\d</b> digit [0-9]	<b>\r</b> carriage return
<b>\n</b> digit [0-9]	<b>\n</b> line feed
<b>\w</b> any alphanumeric char [A-Za-z0-9_]	
<b>\W</b> no alphanumeric char [^A-Za-z0-9_]	
<b>\s</b> any space char (space, tab, enter...)	
<b>\S</b> no space char (space, tab, enter...)	
<b>\N</b> char with code <b>N</b> [ <b>\b</b> backspace	
<b>\N</b> char with unicode <b>N</b> [ <b>\u</b> NUL char	
<b>CHARACTER SETS OR ALTERNATION</b>	
<b>[abc]</b> match any character set	
<b>[^abc]</b> match any char. not enclosed	
<b>a b</b> match a or b	

<b>BOUNDARIES</b>	
<b>^</b> begin of input	<b>\$</b> end of input
<b>\b</b> zero-width word boundary	
<b>\B</b> zero-width non-word boundary	

<b>GROUPING</b>	
<b>(x)</b> capture group ( <b>?x</b> ) no capture group	
<b> </b> reference to group <b>n</b> captured	

<b>QUANTIFIERS</b>	
<b>*</b> preceding x 0 or more times {0,}	
<b>+</b> preceding x 1 or more times {1,}	
<b>?</b> preceding x 0 or 1 times {0,1}	
<b>{n}</b> n occurrences of x	
<b>{n,m}</b> at least n occurrences of x	
<b>{n,m}</b> between n & m occurrences of x	

<b>ASSERTIONS</b>	
<b>?(?=x)</b> x only if x is followed by y	
<b>?(!=x)</b> x only if x is not followed by y	

<b>String()</b>	
<b>PROPERTIES</b>	
<b>length</b> string size	
<b>METHODS</b>	
<b>charAt(index)</b> char at position	
<b>charCodeAt(index)</b> unicode at pos.	
<b>fromCharCode(n1, n2,...)</b> code to char	
<b>concat(str1, str2,...)</b> combine text	
<b>startsWith(str, size)</b> check beginning	
<b>endsWith(str, size)</b> check ending	
<b>includes(str, from)</b> include substring?	
<b>indexOf(str, from)</b> find substr index	
<b>lastIndexOf(str, from)</b> find from end	
<b>search(regex)</b> search & return index	
<b>localeCompare(str, locale, options)</b>	
<b>match(regex)</b> matches against string	
<b>repeat(n)</b> repeat string n times	
<b>replace(str regex, newstr func)</b>	
<b>slice(ini, end)</b> str between ini/end	
<b>substr(ini, len)</b> substr of len length	
<b>substring(ini, end)</b> substr fragment	
<b>split(separator, limit)</b> divide string	
<b>toLowerCase()</b> string to lowercase	
<b>toUpperCase()</b> string to uppercase	
<b>trim()</b> remove space from begin/end	
<b>raw()</b> template strings with \${vars}	

<b>Date()</b>	
<b>METHODS</b>	
<b>UTC(y, m, d, h, i, s, ms)</b> timestamp	
<b>now()</b> timestamp of current time	
<b>parse(str)</b> convert str to timestamp	
<b>setTime(ts)</b> set UNIX timestamp	
<b>getTime()</b> return UNIX timestamp	

<b>UNIT SETTERS (ALSO .setUTC methods)</b>	
<b>setFullYear(y, m, d)</b> set year (yyyy)	
<b>setMonth(m, d)</b> set month (0-11)	
<b>setDate(d)</b> set day (1-31)	
<b>setHours(h, m, s, ms)</b> set hour (0-23)	
<b>setMinutes(m, s, ms)</b> set min (0-59)	
<b>setSeconds(s, ms)</b> set sec (0-59)	
<b>setMilliseconds(ms)</b> set ms (0-999)	

<b>UNIT GETTERS (ALSO .getUTC methods)</b>	
<b>getDate()</b> return day (1-31)	
<b>getDay()</b> return day of week (0-6)	
<b>getMonth()</b> return month (0-11)	
<b>getFullYear()</b> return year (yyyy)	
<b>getHours()</b> return hour (0-23)	
<b>getMinutes()</b> return minutes (0-59)	
<b>getSeconds()</b> return seconds (0-59)	
<b>getMilliseconds()</b> return ms (0-999)	

<b>LOCAL &amp; TIMEZONE METHODS</b>	
<b>getTimezoneOffset()</b> offset in mins	
<b>toLocaleDateString(locale, options)</b>	
<b>toLocaleTimeString(locale, options)</b>	
<b>toLocaleString(locale, options)</b>	
<b>toUTCString()</b> return UTC date	
<b>toDateString()</b> return American date	
<b>toString()</b> return ISO8601 date	
<b>toISOString()</b> return ISO8601 time	
<b>JSON()</b> return date ready for JSON	

<b>Array()</b>	
<b>PROPERTIES</b>	
<b>length</b> number of elements	
<b>METHODS</b>	
<b>isArray(obj)</b> check if obj is array	
<b>includes(obj, from)</b> include element?	
<b>indexOf(obj, from)</b> find elem. index	
<b>lastIndexOf(obj, from)</b>	



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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*)

# Outline

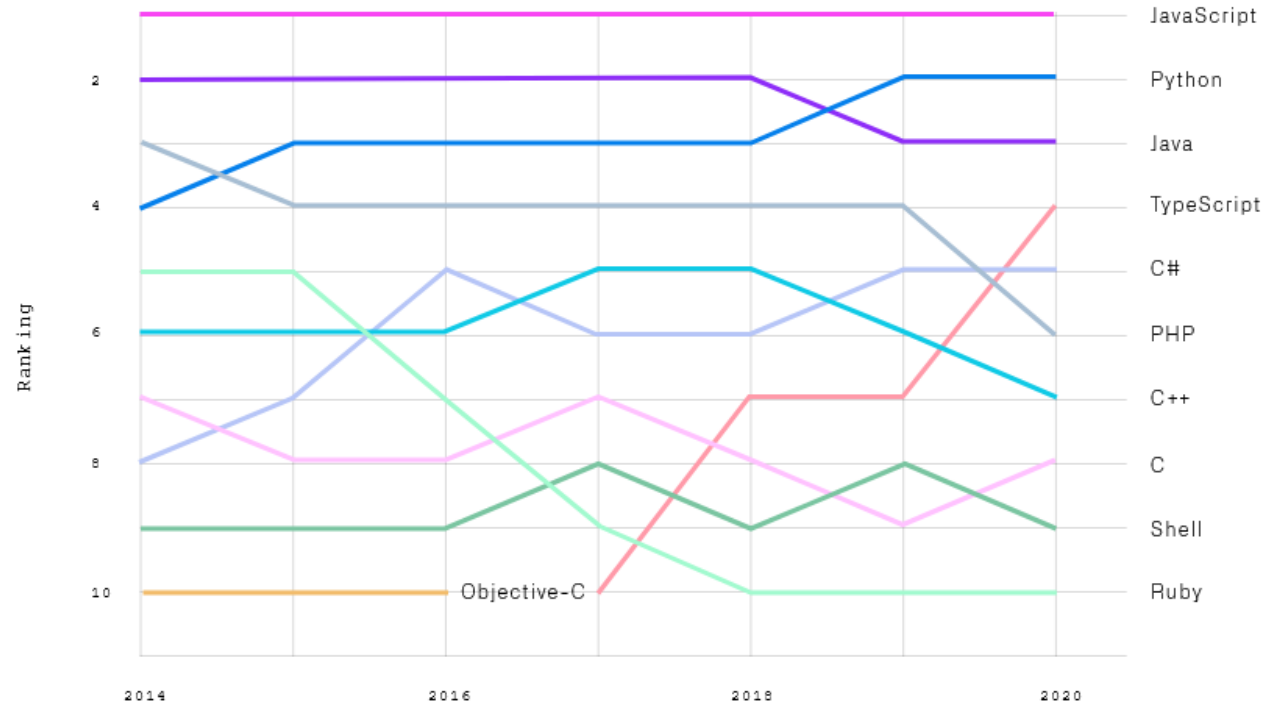
- What is JavaScript?
- History and versions
- Language structure
- Types, variables
- Expressions
- Control structures
- Arrays
- Strings

JavaScript – The language of the Web

# WHAT IS JAVASCRIPT?

// The languages that dominated

## Top languages over the years



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

# JavaScript

- JavaScript (JS) is a programming language
- It is currently the only programming language that a browser can execute natively...
- ... and it also run 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!



JavaScript – The language of the Web


# HISTORY AND VERSIONS



# JAVASCRIPT VERSIONS



Brendan Eich

- ▶ **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
- ▶ **ES7 (June 2016)** Exponentiation operator (\*\*) and Array Includes
- ▶ **ES8 (June 2017)** Async Fs, Shared Memory & Atomics

Also: ES2015

Also: ES2016

Also: ES2017

10  
yrs

Main  
target

ES9,  
ES10,  
...

# 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 displays the official ECMA-262 website. On the left is a 'TABLE OF CONTENTS' sidebar with a search bar at the top. The table lists sections from 'Introduction' to 'H Copyright & Software License'. The main content area features the ECMA International logo, the title 'ECMA-262, 10<sup>th</sup> edition, June 2019 ECMAScript® 2019 Language Specification', and a 'Contributing to this Specification' section. This section includes links to the GitHub repository, issues, pull requests, and test suite, as well as a list of editors and community links. Below this is an 'Introduction' section.

Search...

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**ecma**  
INTERNATIONAL

**ECMA-262, 10<sup>th</sup> edition, June 2019**  
**ECMAScript® 2019 Language Specification**

**Contributing to this Specification**

This specification is developed on GitHub with the help of the ECMAScript community. There are a number of ways to contribute to the development of this specification:

GitHub Repository: <https://github.com/tc39/ecma262>  
Issues: [All Issues](#), [File a New Issue](#)  
Pull Requests: [All Pull Requests](#), [Create a New Pull Request](#)  
Test Suite: [Test262](#)  
Editors:

- Brian Terlson (@bterlson)
- Bradley Farias (@bradleymeck)
- Jordan Harband (@ljharb)

Community:

- Mailing list: [es-discuss](#)
- IRC: [#tc39](#) on [freenode](#)

Refer to the [colophon](#) for more information on how this document is created.

**Introduction**

<https://www.ecma-international.org/ecma-262/>

# 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

# Standard vs. Implementation (in browsers)

## Browser compatibility

[Update compatibility data on GitHub](#)

		Desktop						Mobile					
		Chrome	Edge	Firefox	Internet Explorer	Opera	Safari	Android webview	Chrome for Android	Firefox for Android	Opera for Android	Safari on iOS	Samsung Internet
FetchEvent	⚠	40	Yes	44 ★	No	27	No	40	40	44	27	No	4.0
FetchEvent() constructor	⚠	40	Yes	44 ★	No	27	No	40	40	44	27	No	4.0
client	⚠ ⚠ ⚠	42	?	44	No	27	No	42	44	No	?	No	4.0
clientId	⚠	49	?	45 ★	No	36	No	49	49	45	36	No	5.0
isReload	⚠	45	17	44 ★	No	32	No	45	45	44	32	No	5.0
navigationPreload	⚠	59	?	?	No	46	No	59	59	?	43	No	7.0
preloadResponse	⚠	59	18	?	No	46	No	59	59	?	43	No	7.0
replacesClientId		No	18	65	No	No	No	No	No	65	No	No	No
request	⚠	Yes	?	44	No	Yes	No	Yes	Yes	?	Yes	No	Yes
respondWith	⚠	42 ★	?	59 ★	No	29	No	42 ★	42 ★	?	29	No	4.0
resultingClientId		72	18	65	No	60	No	72	72	65	50	No	No
targetClientId		?	?	?	No	?	No	?	?	?	?	No	?

What are we missing?

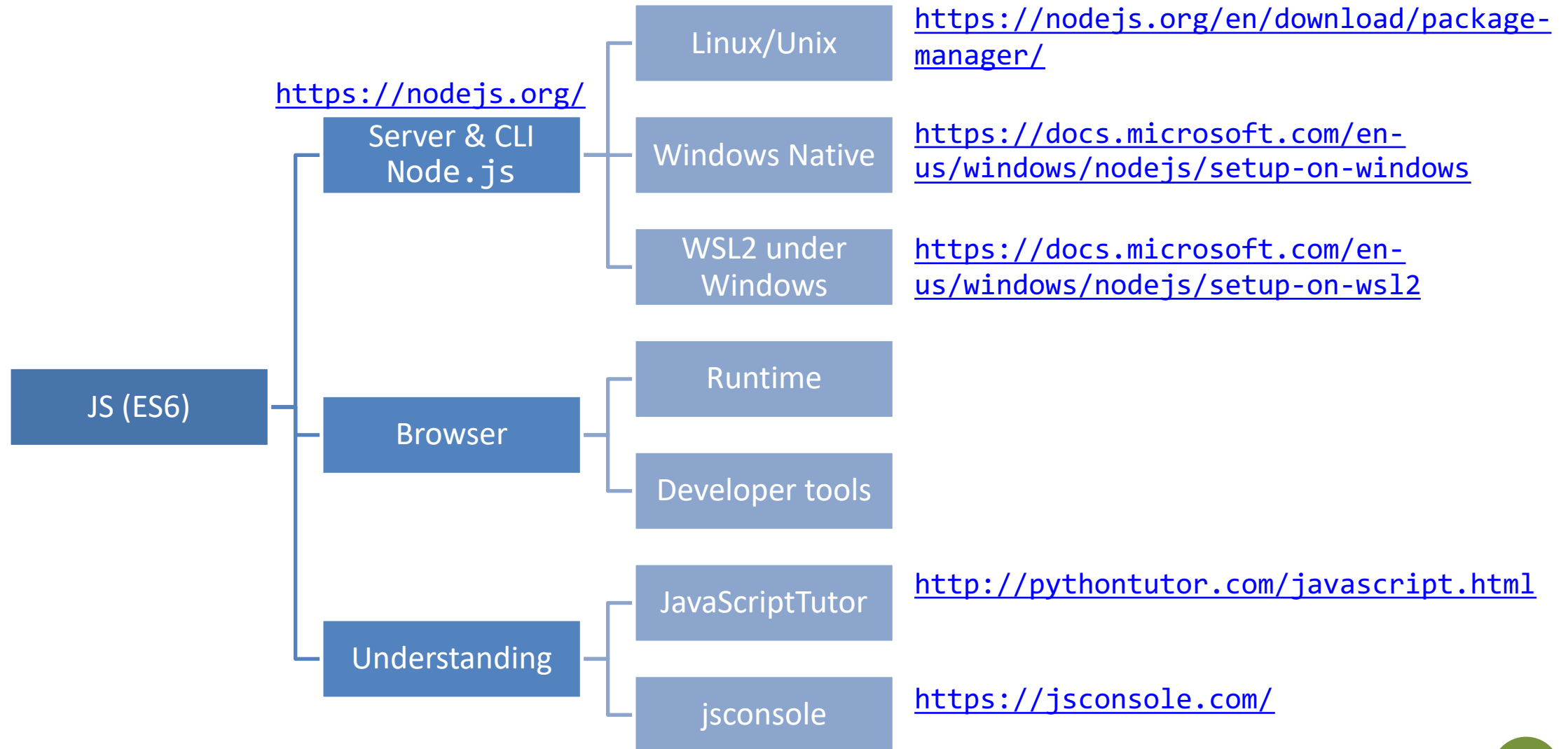
- Full support
- Compatibility unknown
- Non-standard. Expect poor cross-browser support.
- See implementation notes.
- No support
- Experimental. Expect behavior to change in the future.
- Deprecated. Not for use in new websites.



# 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

# JS Execution Environments



# JavaScriptTutor

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

```
1 let nome = "Fulvio" ;
2 let cognome = "Corno" ;
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)

Frames

Global frame	
hello	
nome	"Fulvio"
cognome	"Corno"
s1	"Fulvio Corno"
s2	"sig. Fulvio"
nome2	
cognome2	

Objects

```
function hello(c, n) {
  n = n || "sig."
  const saluto = n + " " + c ;
  return saluto ;
}
```

array

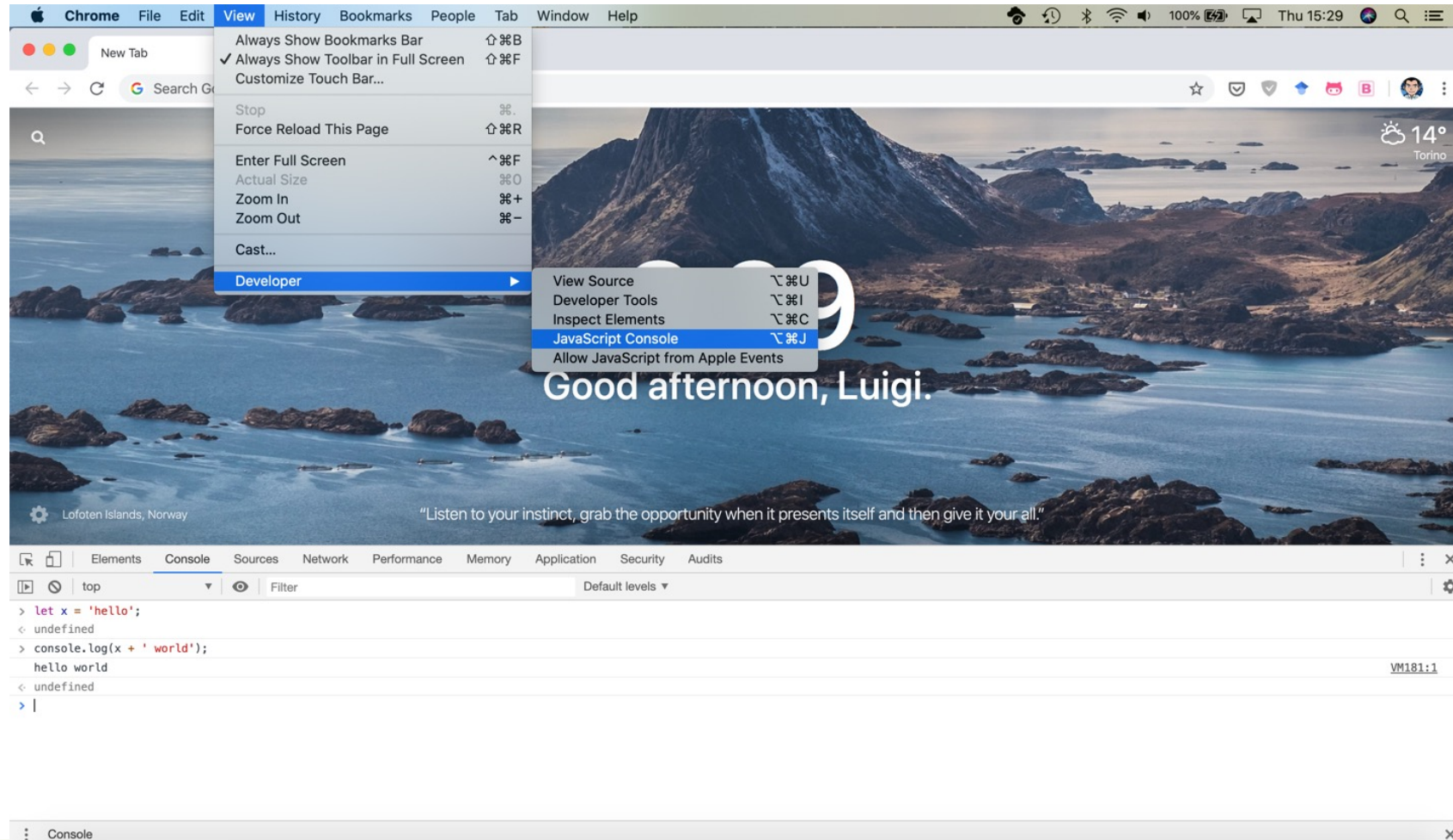
0	1	2	3	4	5
"F"	"u"	"l"	"v"	"i"	"o"

array

0	1	2	3	4
"C"	"o"	"r"	"n"	"o"

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

# Browser and JS console



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# LANGUAGE STRUCTURE



# 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

# 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);  
😱
```

# 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>

# 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)
    - ...



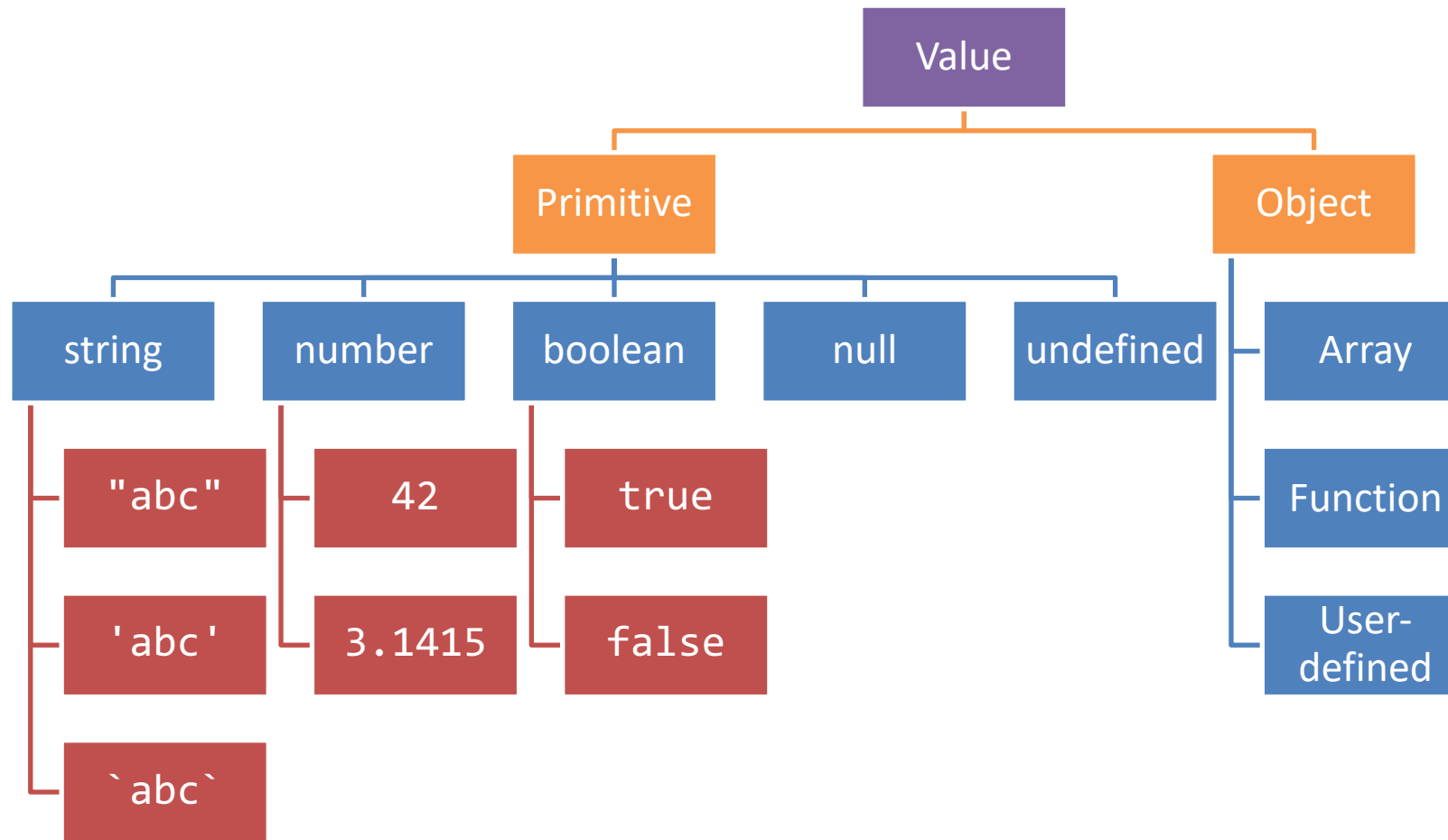
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# **TYPES AND VARIABLES**



# Values and Types

*Values have types.  
Variables don't.*



# 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)

- Booleans and Comparisons

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

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

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

# 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'

# 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

# 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
```



# Variable declarations

Declarator	Can reassign?	Can re-declare?	Scope	Hoisting *	Note
<b>let</b>	Yes	No	Enclosing block {...}	No	<b><i>Preferred</i></b>
<b>const</b>	No §	No	Enclosing block {...}	No	<b><i>Preferred</i></b>
<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)

# Scope

```
"use strict" ;
```

```
let a = 1 ;
```

```
const b = 2 ;
```

```
let c = true ;
```

```
let a = 5 ; // SyntaxError: Identifier 'a' has already been declared
```

# 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.

# Scope and Hoisting


```
"use strict" ;

function example(x) {
  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) ;
```





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

JavaScript – The language of the Web

# EXPRESSIONS

# 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)

# 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 	<code>x **= y</code>	<code>x = x ** y</code>
Left shift assignment	<code>x &lt;&lt;= y</code>	<code>x = x &lt;&lt; y</code>
Right shift assignment	<code>x &gt;&gt;= y</code>	<code>x = x &gt;&gt; y</code>
Unsigned right shift assignment	<code>x &gt;&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>



# Comparison operators



Operator	Description	Examples returning true
Equal (==)	Returns <code>true</code> if the operands are equal.	<code>3 == var1</code> <code>"3" == var1</code>  <code>3 == '3'</code>
Not equal (!=)	Returns <code>true</code> if the operands are not equal.	<code>var1 != 4</code> <code>var2 != "3"</code>
Strict equal (===)	Returns <code>true</code> if the operands are equal and of the same type. See also <a href="#">Object.is</a> and <a href="#">sameness in JS</a> .	<code>3 === var1</code>
Strict not equal (!==)	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 (>)	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 (>=)	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 (<)	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 (<=)	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>

# 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 }
```

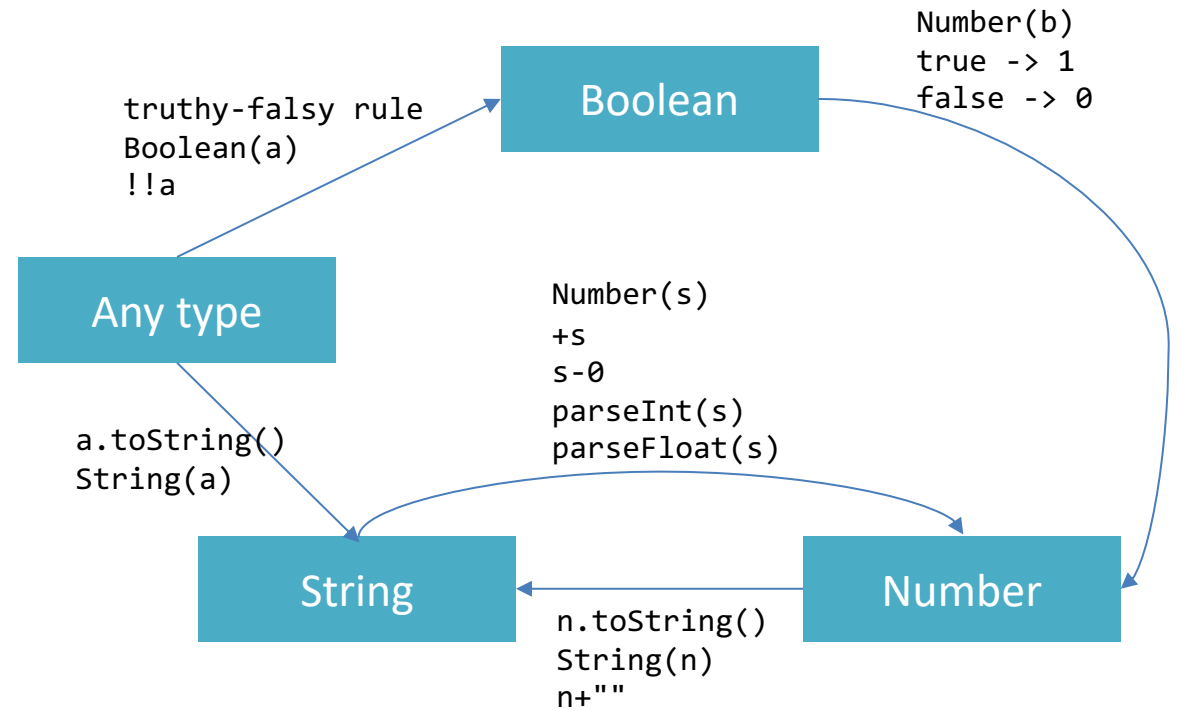
```
> b={x:1}  
{ x: 1 }
```

```
> a===b  
false
```

```
> a==b  
false
```

# 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



# 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>false</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> .

# Common operators

Or string  
concatenation

Addition (+)

Decrement (--)

Division (/)

Exponentiation (\*\*)

Increment (++)

Multiplication (\*)

Remainder (%)

Subtraction (-)

Unary negation (-)

Unary plus (+)

Logical AND (&&)

Logical OR (||)

Logical NOT (!)

Nullish coalescing  
operator (??)

Conditional operator (c ?  
t : f)

typeof

Useful idiom:  
**a || b**  
if a then a else b  
(a, with default b)

# 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()`



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

# Conditional statements

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

if truthy (beware!)

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


May also be a string

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



# Loop statements

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



Usually declares loop variable

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

May use break; or continue;

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

# 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

# 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

# Exception handling

```
try {  
  statements ;  
} catch(e) {  
  statements ;  
}
```

```
throw object ;
```

Exception object

```
try {  
  statements ;  
} catch(e) {  
  statements ;  
} finally {  
  statements ;  
}
```

Executed in any case, at  
the end of try and catch  
blocks

EvalError  
RangeError  
ReferenceError  
SyntaxError  
TypeError  
URIError  
DOMException

Contain fields: name,  
message



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

Mozilla Developer Network  
JavaScript Guide » Indexed Collections

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# ARRAYS

# 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

# Creating an array

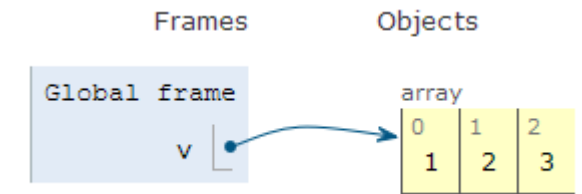
```
let v = [] ;
```

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

Do not access elements outside range

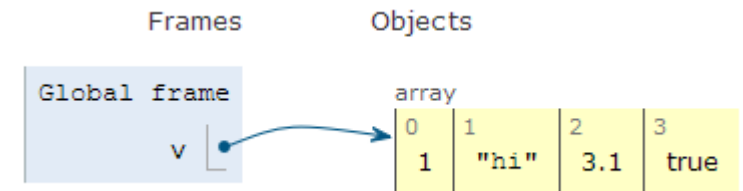
```
let v = [1, 2, 3] ;
```

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



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

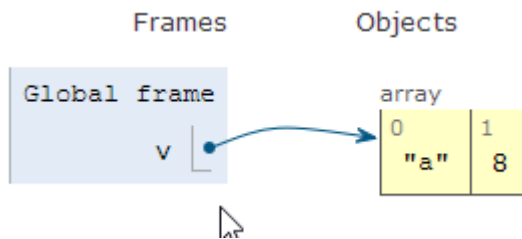
```
let v = Array.of(1, "hi", 3.1, true) ;
```



# Adding elements

`.length` adjusts automatically

```
let v = [] ;  
v[0] = "a" ;  
v[1] = 8 ;  
v.length // 2
```



```
let v = [] ;  
v.push("a") ;  
v.push(8) ;  
v.length // 2
```

`.push()` adds at the end of the array

`.unshift()` adds at the beginning of the array



# Adding and Removing from arrays (in-place)

`v.unshift(x)`

`v.push(x)`



`x = v.shift()`

`x = v.pop()`

# Copying arrays

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

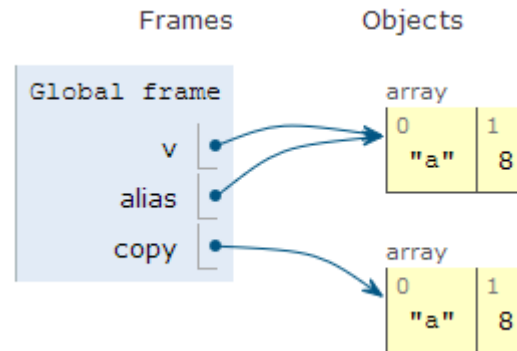
```
> console.log(v);  
[ 'a', 5 ]  
undefined  
> console.log(alias);  
[ 'a', 5 ]  
undefined
```

# 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



# Iterating over Arrays

Preferred

- 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

Functional style – later

# 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 sign 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);
```

# 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

# Curiosity

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

Frequent  
idiom





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

Mozilla Developer Network  
JavaScript Guide » Text Formatting

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# STRINGS

# 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

# 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()`~~

# 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.

# 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/>

# 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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