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2022

JavaScript (basics)

“The” language of the Web

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JS

JavaScript

Cheat Sheet

JS

Programming Language of Web

Number()

PROPERTIES

- .POSITIVE_INFINITY** +∞ equivalent
- .NEGATIVE_INFINITY** -∞ equivalent
- .MAX_VALUE** largest positive value
- .MIN_VALUE** smallest positive value
- .EPSILON** diff between 1 & smallest >1
- .NaN** not-a-number value

METHODS

- .toExponential(*dec*)** exp. notation
- .toFixed(*dec*)** fixed-point notation
- .toPrecision(*n*)** change precision
- .isFinite(*n*)** check if number is finite
- .isInteger(*n*)** check if number is int.
- .isNaN(*n*)** check if number is NaN
- .parseInt(*s*, *radix*)** string to integer
- .parseFloat(*s*, *radix*)** string to float

Regex()

PROPERTIES

- .lastIndex** index to start global regexp
- .flags** active flags of current regexp
- .global** flag g (search all matches)
- .ignoreCase** flag i (match lower/upper)
- .multiline** flag m (match multiple lines)
- .sticky** flag y (search from lastIndex)
- .unicode** flag u (enable unicode feat.)
- .source** current regexp (w/o slashes)

METHODS

- .exec(*str*)** exec search for a match
- .test(*str*)** check if regexp match w/str

CLASSES

- .** any character
- \d** digit [0-9]
- \D** no digit [^0-9]
- \w** any alphanumeric char [A-Za-z0-9_]
- \W** no alphanumeric char [^A-Za-z0-9_]
- \s** any space char (space, tab, enter...)
- \S** no space char (space, tab, enter...)
- \xN** char with code N
- \uN** char with unicode N
- \0** NUL char

CHARACTER SETS OR ALTERNATION

- [abc]** match any character set
- [^abc]** match any char. set not enclosed
- a|b** match a or b

BOUNDARIES

- ^** begin of input
- \$** end of input
- \b** zero-width word boundary
- \B** zero-width non-word boundary

GROUPING

- (x)** capture group
- (?:x)** no capture group
- \n** reference to group n captured

QUANTIFIERS

- *** preceding x 0 or more times {0,}
- +** preceding x 1 or more times {1,}
- ?** preceding x 0 or 1 times {0,1}
- {n}** n occurrences of x
- {n,}** at least n occurrences of x
- {n,m}** between n & m occurrences of x

ASSERTIONS

- x(=y)** x (only if x is followed by y)
- x(!y)** x (only if x is not followed by y)

String()

PROPERTIES

- .length** string size

METHODS

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

Date()

METHODS

- .UTC(*y*, *m*, *d*, *h*, *i*, *s*, *ms*)** timestamp
- .now()** timestamp of current time
- .parse(*str*)** convert str to timestamp
- .setTime(*ts*)** set UNIX timestamp
- .getTime()** return UNIX timestamp

UNIT SETTERS (ALSO .setUTC() methods)

- .setFullYear(*y*, *m*, *d*)** set year (yyyy)
- .setMonth(*m*, *d*)** set month (0-11)
- .setDate(*d*)** set day (1-31)
- .setHours(*h*, *m*, *s*, *ms*)** set hour (0-23)
- .setMinutes(*m*, *s*, *ms*)** set min (0-59)
- .setSeconds(*s*, *ms*)** set sec (0-59)
- .setMilliseconds(*ms*)** set ms (0-999)

UNIT GETTERS (ALSO .getUTC() methods)

- .getDate()** return day (1-31)
- .getDay()** return day of week (0-6)
- .getMonth()** return month (0-11)
- .getFullYear()** return year (yyyy)
- .getHours()** return hour (0-23)
- .getMinutes()** return minutes (0-59)
- .getSeconds()** return seconds (0-59)
- .getMilliseconds()** return ms (0-999)

LOCAL & TIMEZONE METHODS

- .getTimezoneOffset()** offset in mins
- .toLocaleDateString(*locale*, *options*)**
- .toLocaleTimeString(*locale*, *options*)**
- .toLocaleString(*locale*, *options*)**
- .toISOString()** return UTC date
- .toString()** return American date
- .toISOString()** return ISO8601 date
- .toJSON()** return date ready for JSON

Array()

PROPERTIES

- .length** number of elements

METHODS

- .isArray(*obj*)** check if obj is array
- .includes(*obj*, *from*)** include element?
- .indexOf(*obj*, *from*)** find elem. index
- .lastIndexOf(*obj*, *from*)** find from end
- .join(*sep*)** join elements w/separator
- .slice(*ini*, *end*)** return array portion
- .concat(*obj1*, *obj2*...)** return joined array

MODIFY SOURCE ARRAY METHODS

- .copyWithin(*pos*, *ini*, *end*)** copy elems
- .fill(*obj*, *ini*, *end*)** fill array with obj
- .reverse()** reverse array & return it
- .sort(*cf(a,b)*)** sort array (unicode sort)
- .splice(*ini*, *del*, *o1*, *o2*...)** del&add elem

ITERATION METHODS

- .entries()** iterate key/value pair array
- .keys()** iterate only keys array
- .values()** iterate only values array

CALLBACK FOR EACH METHODS

- .every(*cb(e,i,a)*, *arg*)** test until false
- .some(*cb(e,i,a)*, *arg*)** test until true
- .map(*cb(e,i,a)*, *arg*)** make array
- .filter(*cb(e,i,a)*, *arg*)** make array w/true
- .find(*cb(e,i,a)*, *arg*)** return elem w/true
- .findIndex(*cb(e,i,a)*, *arg*)** return index
- .forEach(*cb(e,i,a)*, *arg*)** exec for each
- .reduce(*cb(p,e,i,a)*, *arg*)** accumulative
- .reduceRight(*cb(p,e,i,a)*, *arg*)** from end

ADD/REMOVE METHODS

- .pop()** remove & return last element
- .push(*o1*, *o2*...)** add element & return length
- .shift()** remove & return first element
- .unshift(*o1*, *o2*...)** add element & return len

Boolean()

no own properties or methods

Function()

PROPERTIES

- .length** return number of arguments
- .name** return name of function
- .prototype** prototype object

METHODS

- .call(*newthis*, *arg1*, *arg2*...)** change this
- .apply(*newthis*, *arg1*)** with args array
- .bind(*newthis*, *arg1*, *arg2*...)** bound func

number

- NaN** (not-a-number)
- string**
- boolean** (true/false)
- array**

date


- regular expression**
- function**
- object**
- undefined**

only available on ECMAScript 6

- static** (ex: Math.random())
- non-static** (ex: new Date().getDate())

argument required

argument optional

 Politecnico di Torino

Applicazioni Web I - Web Applications I - 2021/2022

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Number() PROPERTIES ① POSITIVE_INFINITY +∞ equivalent ① NEGATIVE_INFINITY -∞ equivalent ① MAX_VALUE largest positive value ① MIN_VALUE smallest positive value ① EPSILON diff between 1 & smallest >1 ① NaN not-a-number value METHODS ① toExponential(dec) exp. notation ① toFixed(dec) fixed-point notation ① toPrecision(p) change precision ① isFinite(n) check if number is finite ① isInteger(n) check if number is int. ① isNaN(n) check if number is NaN ① parseFloat(s, radix) string to integer ① parseFloat(s, radix) string to float	String() PROPERTIES ① .length string size METHODS ① .charAt(index) char at position [i] ① .charCodeAt(index) unicode at pos. ① .fromCharCode(n1, n2...) code to char ① .concat(str1, str2...) combine text + ① .startsWith(str, size) check beginning ① .endsWith(str, size) check ending ① .includes(str, from) include substring? ① .indexOf(str, from) find substr index ① .lastIndexOf(str, from) find from end ① .search(regex) search & return index ① .localeCompare(str, locale, options) ① .match(regex) matches against string ① .repeat(n) repeat string n times ① .replace(str/regex, newstr/func) ① .slice(ini, end) str between ini/end ① .substr(ini, len) substr of len length ① .substring(ini, end) substr fragment ① .toLowerCase() string to lowercase ① .toUpperCase() string to uppercase ① .trim() remove space from begin/end ① .raw() template strings with \${vars}	Array() PROPERTIES ① .length number of elements METHODS ① .isArray(obj) check if obj is array ① .includes(obj, from) include element? ① .indexOf(obj, from) find elem. index ① .lastIndexOf(obj, from) find from end ① .join(sep) join elements w/separator ① .slice(ini, end) return array portion ① .concat(obj1, obj2...) return joined array MODIFY SOURCE ARRAY METHODS ① .copyWithin(pos, ini, end) copy elems ① .fill(obj, ini, end) fill array with obj ① .reverse() reverse array & return it ① .sort(cmp(a,b)) sort array (unicode sort) ① .splice(ini, del, o1, o2...) del&add elem ITERATION METHODS ① .entries() iterate key/value pair array ① .keys() iterate only keys array ① .values() iterate only values array CALLBACK FOR EACH METHODS ① .every(cb(e,i,a), arg) test until false ① .some(cb(e,i,a), arg) test until true ① .map(cb(e,i,a), arg) make array ① .filter(cb(e,i,a), arg) make array w/true ① .find(cb(e,i,a), arg) return elem w/true ① .findIndex(cb(e,i,a), arg) return index ① .forEach(cb(e,i,a), arg) exec for each ① .reduce(cb(p,e,i,a), arg) accumulative ① .reduceRight(cb(p,e,i,a), arg) from end ADD/REMOVE METHODS ① .pop() remove & return last element ① .push(o1, o2...) add element & return length ① .shift() remove & return first element ① .unshift(o1, o2...) add element & return len
Regex() PROPERTIES ① .lastIndex index to start global regexp ① .flags active flags of current regexp ① .global flag g (search all matches) ① .ignoreCase flag i (match lower/upper) ① .multiline flag m (match multiple lines) ① .sticky flag y (search from lastIndex) ① .unicode flag u (enable unicode feat.) ① .source current regexp (w/o slashes) METHODS ① .exec(str) exec search for a match ① .test(str) check if regexp match w/str CLASSES ① .any character \t tabulator ① .digit [0-9] \r carriage return ① .no digit [^0-9] \n line feed ① .any alphanumeric char [A-Za-z0-9_] ① .no alphanumeric char [^A-Za-z0-9_] ① .any space char (space, tab, enter...) ① .no space char (space, tab, enter...) ① .char with code N \b backspace ① .char with unicode N \0 NUL char CHARACTER SETS OR ALTERNATION ① [abc] match any character set ① [^abc] match any char. set not enclosed ① a b match a or b BOUNDARIES ① ^ begin of input \$ end of input ① \b zero-width word boundary ① \B zero-width non-word boundary GROUPING ① (x) capture group (?x) no capture group ① \n reference to group n captured QUANTIFIERS ① * preceding x 0 or more times {0,} ① + preceding x 1 or more times {1,} ① ? preceding x 0 or 1 times {0,1} ① {n} n occurrences of x ① {n,} at least n occurrences of x ① {n,m} between n & m occurrences of x ASSERTIONS ① x(=?y) x (only if x is followed by y) ① x(?!y) x (only if x is not followed by y)	Date() METHODS ① .UTC(y, m, d, h, i, s, ms) timestamp ① .now() timestamp of current time ① .parse(str) convert str to timestamp ① .setTime(ts) set UNIX timestamp ① .getTime() return UNIX timestamp UNIT SETTERS (ALSO .setUTC() methods) ① .setFullYear(y, m, d) set year (yyyy) ① .setMonth(m, d) set month (0-11) ① .setDate(d) set day (1-31) ① .setHours(h, m, s, ms) set hour (0-23) ① .setMinutes(m, s, ms) set min (0-59) ① .setSeconds(s, ms) set sec (0-59) ① .setMilliseconds(ms) set ms (0-999) UNIT GETTERS (ALSO .getUTC() methods) ① .getDate() return day (1-31) ① .getDay() return day of week (0-6) ① .getMonth() return month (0-11) ① .getFullYear() return year (yyyy) ① .getHours() return hour (0-23) ① .getMinutes() return minutes (0-59) ① .getSeconds() return seconds (0-59) ① .getMilliseconds() return ms (0-999) LOCALE & TIMEZONE METHODS ① .getTimezoneOffset() offset in mins ① .toLocaleDateString(locale, options) ① .toLocaleTimeString(locale, options) ① .toLocaleString(locale, options) ① .toUTCString() return UTC date ① .toString() return American date ① .toTimeString() return American time ① .toISOString() return ISO8601 date ① .toJSON() return date ready for JSON	Boolean() no own properties or methods Function() PROPERTIES ① .length return number of arguments ① .name return name of function ① .prototype prototype object METHODS ① .call(newthis, arg1, arg2...) change this ① .apply(newthis, arg1) with args array ① .bind(newthis, arg1, arg2...) bound func ① .number ① NaN (not-a-number) ① .string ① .boolean (true/false) ① .array only available on ECMAScript 6 ① .static (ex: Math.random()) ① .non-static (ex: new Date().getDate()) argument required argument optional

Math PROPERTIES ① .E Euler's constant ① .LN2 natural logarithm of 2 ① .LN10 natural logarithm of 10 ① .LOG2E base 2 logarithm of E ① .LOG10E base 10 logarithm of E ① .PI ratio circumference/diameter ① .SQRT1_2 square root of 1/2 ① .SQRT2 square root of 2 METHODS ① .abs(x) absolute value ① .cbrt(x) cube root ① .clz32(x) return leading zero bits (32) ① .exp(x) return e ^x ① .expm1(x) return e ^x -1 ① .hypot(x1, x2...) length of hypotenuse ① .imul(a, b) signed multiply ① .log(x) natural logarithm (base e) ① .log1p(x) natural logarithm (1+x) ① .log10(x) base 10 logarithm ① .log2(x) base 2 logarithm ① .max(x1, x2...) return max number ① .min(x1, x2...) return min number ① .pow(base, exp) return base ^{exp} ① .random() float random number [0,1) ① .sign(x) return sign of number ① .sqrt(x) square root of number ROUND METHODS ① .ceil(x) superior round (smallest) ① .floor(x) inferior round (largest) ① .round(x) nearest single precision ① .round(x) round (nearest integer) ① .trunc(x) remove fractional digits TRIGONOMETRIC METHODS ① .acos(x) arccosine ① .acosh(x) hyperbolic arccosine ① .asin(x) arcsine ① .asinh(x) hyperbolic arcsine ① .atan(x) arctangent ① .atan2(x, y) arctangent of quotient x/y ① .atanh(x) hyperbolic arctangent ① .cos(x) cosine ① .cosh(x) hyperbolic cosine ① .sin(x) sine ① .sinh(x) hyperbolic sine ① .tan(x) tangent ① .tanh(x) hyperbolic tangent	Object() PROPERTIES ① .constructor return ref. to object func. METHODS ① .assign(dst, src1, src2...) copy values ① .create(proto, prop) create obj w/prop ① .defineProperties(obj, prop) ① .defineProperty(obj, prop, desc) ① .freeze(obj) avoid properties changes ① .getOwnPropertyDescriptor(obj, prop) ① .getOwnPropertyNames(obj) ① .getOwnPropertySymbols(obj) ① .getPrototypeOf(obj) return prototype ① .is(val1, val2) check if are same value ① .isExtensible(obj) check if can add prop ① .isFrozen(obj) check if obj is frozen ① .isSealed(obj) check if obj is sealed ① .keys(obj) return only keys of object ① .preventExtensions(obj) avoid extend ① .seal(obj) prop are non-configurable ① .setPrototypeOf(obj, prot) change prot INSTANCE METHODS ① .hasOwnProperty(prop) check if exist ① .isPrototypeOf(obj) test in another obj ① .propertyIsEnumerable(prop) ① .toString() return equivalent string ① .toLocaleString() return locale version ① .valueOf() return primitive value Promise() METHODS ① .all(obj) return promise ① .catch(onRejected(s)) = .then(undef,s) ① .then(onFulfilled(v), onRejected(s)) ① .race(obj) return greedy promise (res/rej) ① .resolve(obj) return resolved promise ① .reject(reason) return rejected promise Proxy() METHODS ① .apply(obj, arg, arglist) trap function call ① .construct(obj, arglist) trap new oper ① .defineProperty(obj, prop, desc) ① .deleteProperty(obj, prop) trap delete ① .enumerate(obj) trap for...in ① .get(obj, prop, rec) trap get property ① .getOwnPropertyDescriptor(obj, prop) ① .getPrototypeOf(obj) ① .has(obj, prop) trap in operator ① .ownKeys(obj) ① .preventExtensions(obj) ① .set(obj, prop, value) trap set property ① .setPrototypeOf(obj, proto) globals METHODS ① eval(str) evaluate javascript code ① isFinite(obj) check if is a finite number ① isNaN(obj) check if is not a number ① parseInt(s, radix) string to integer ① parseFloat(s, radix) string to float ① encodeURIComponent(URI) = to %3D ① decodeURIComponent(URI) %3D to =	Set() PROPERTIES ① .size return number of items METHODS ① .add(item) add item to set WS ① .has(item) check if item exists WS ① .delete(item) del item & return if del WS ① .clear() remove all items from set ITERATION METHODS ① .entries() iterate items ① .values() iterate only value of items CALLBACK FOR EACH METHODS ① .forEach(cb(e,i,a), arg) exec for each Map() PROPERTIES ① .size return number of elements METHODS ① .set(key, value) add pair key=value WM ① .get(key) return value of key WM ① .has(key) check if key exist WM ① .delete(key) del elem. & return if ok WM ① .clear() remove all elements from map ITERATION METHODS ① .entries() iterate elements ① .keys() iterate only keys ① .values() iterate only values CALLBACK FOR EACH METHODS ① .forEach(cb(e,i,a), arg) exec for each Symbol() PROPERTIES ① .iterator specifies default iterator ① .match specifies match of regexp ① .species specifies constructor function METHODS ① .for(key) search existing symbols ① .keyFor(sym) return key from global reg Generator() METHODS ① .next(value) return obj w/{value,done} ① .return(value) return value & true done ① .throw(throw) throw an error Others var declare variable let declare block scope local variable const declare constant (read-only) func(a=1) default parameter value func(...a) rest argument (spread operator) (a) => { ... } function equivalent (fat arrow) 'string \${a}' template with variables 0b binary (2) number n to decimal 0o octal (8) number n to decimal 0x hexadecimal (16) number n to decimal for (i in array) { ... } iterate array, i = index for (e of array) { ... } iterate array, e = value class B extends A { } class sugar syntax
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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

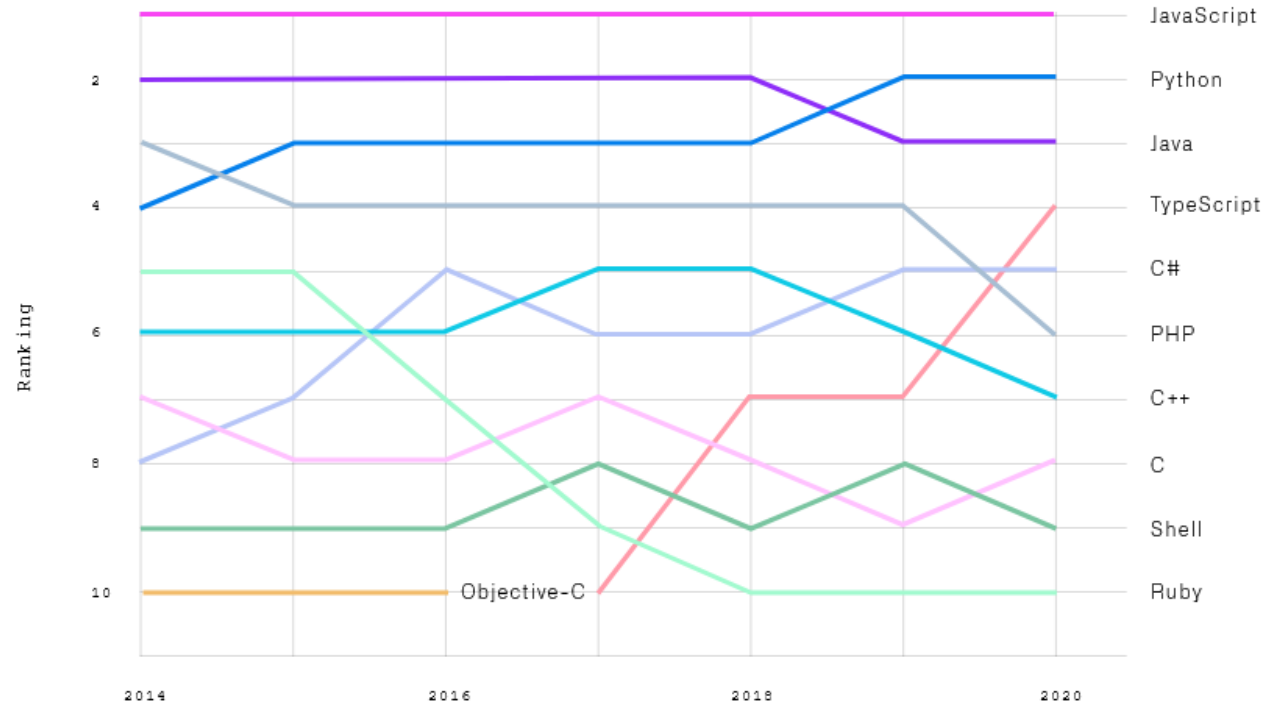
- What is JavaScript?
- History and versions
- Language structure
- Types, variables
- Expressions
- Control structures
- Arrays
- Strings

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

10
yrs

Main
target

ES9,
ES10,
...

Also: ES2015

Also: ES2016

Also: ES2017

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, 10th 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 contact information. The 'Introduction' section is partially visible at the bottom.

Search...

TABLE OF CONTENTS

- Introduction
- 1 Scope
- 2 Conformance
- 3 Normative References
- 4 Overview
- 5 Notational Conventions
- 6 ECMAScript Data Types and Values
- 7 Abstract Operations
- 8 Executable Code and Execution Contexts
- 9 Ordinary and Exotic Objects Behaviours
- 10 ECMAScript Language: Source Code
- 11 ECMAScript Language: Lexical Grammar
- 12 ECMAScript Language: Expressions
- 13 ECMAScript Language: Statements and Declarations
- 14 ECMAScript Language: Functions and Classes
- 15 ECMAScript Language: Scripts and Modules
- 16 Error Handling and Language Extensions
- 17 ECMAScript Standard Built-in Objects
- 18 The Global Object
- 19 Fundamental Objects
- 20 Numbers and Dates
- 21 Text Processing
- 22 Indexed Collections
- 23 Keyed Collections
- 24 Structured Data
- 25 Control Abstraction Objects
- 26 Reflection
- 27 Memory Model
- A Grammar Summary
- B Additional ECMAScript Features for Web Browsers
- C The Strict Mode of ECMAScript
- D Corrections and Clarifications in ECMAScript 2015 wit...
- E Additions and Changes That Introduce Incompatibiliti...
- F Colophon
- G Bibliography
- H Copyright & Software License

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ECMA-262, 10th 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	?

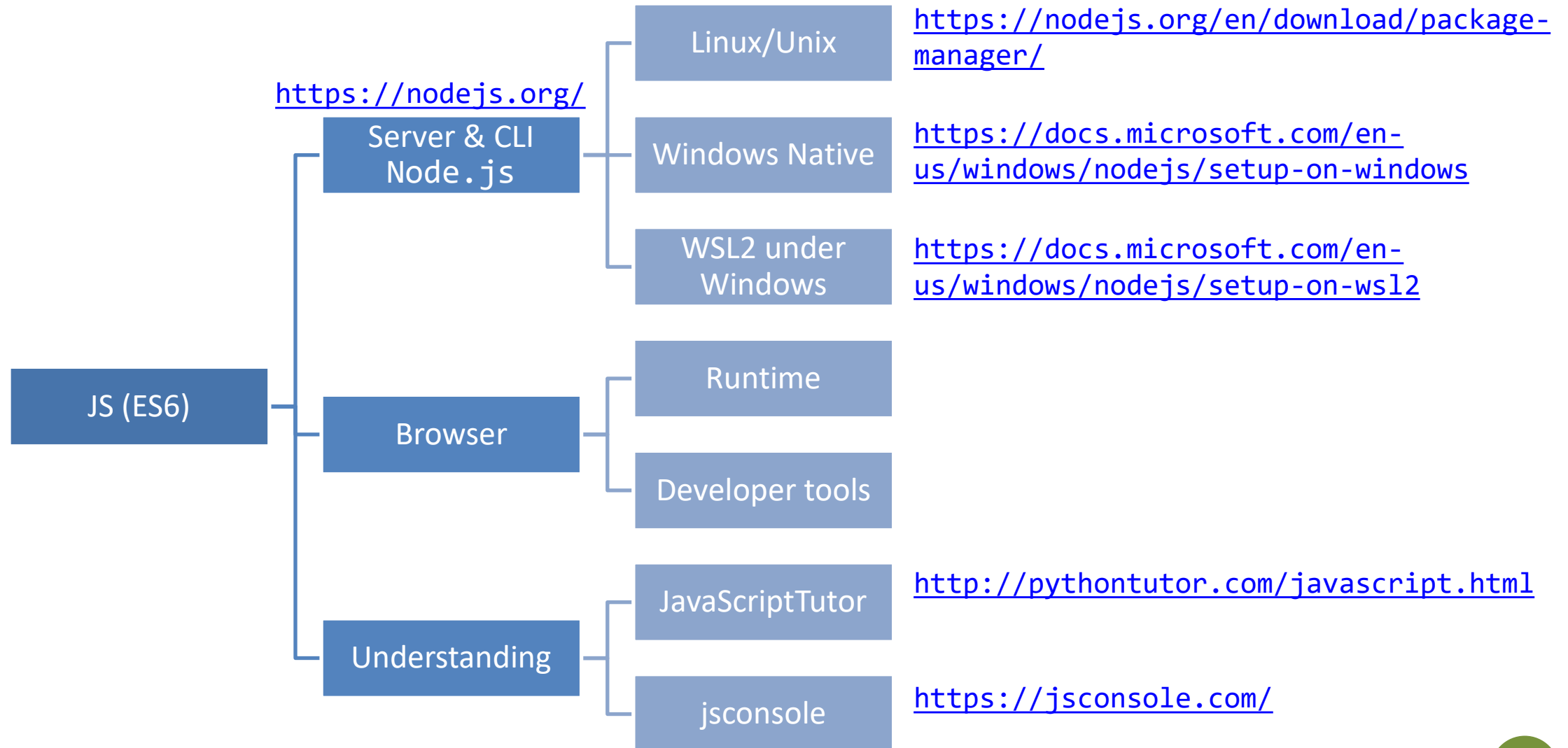
What are we missing?

- 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

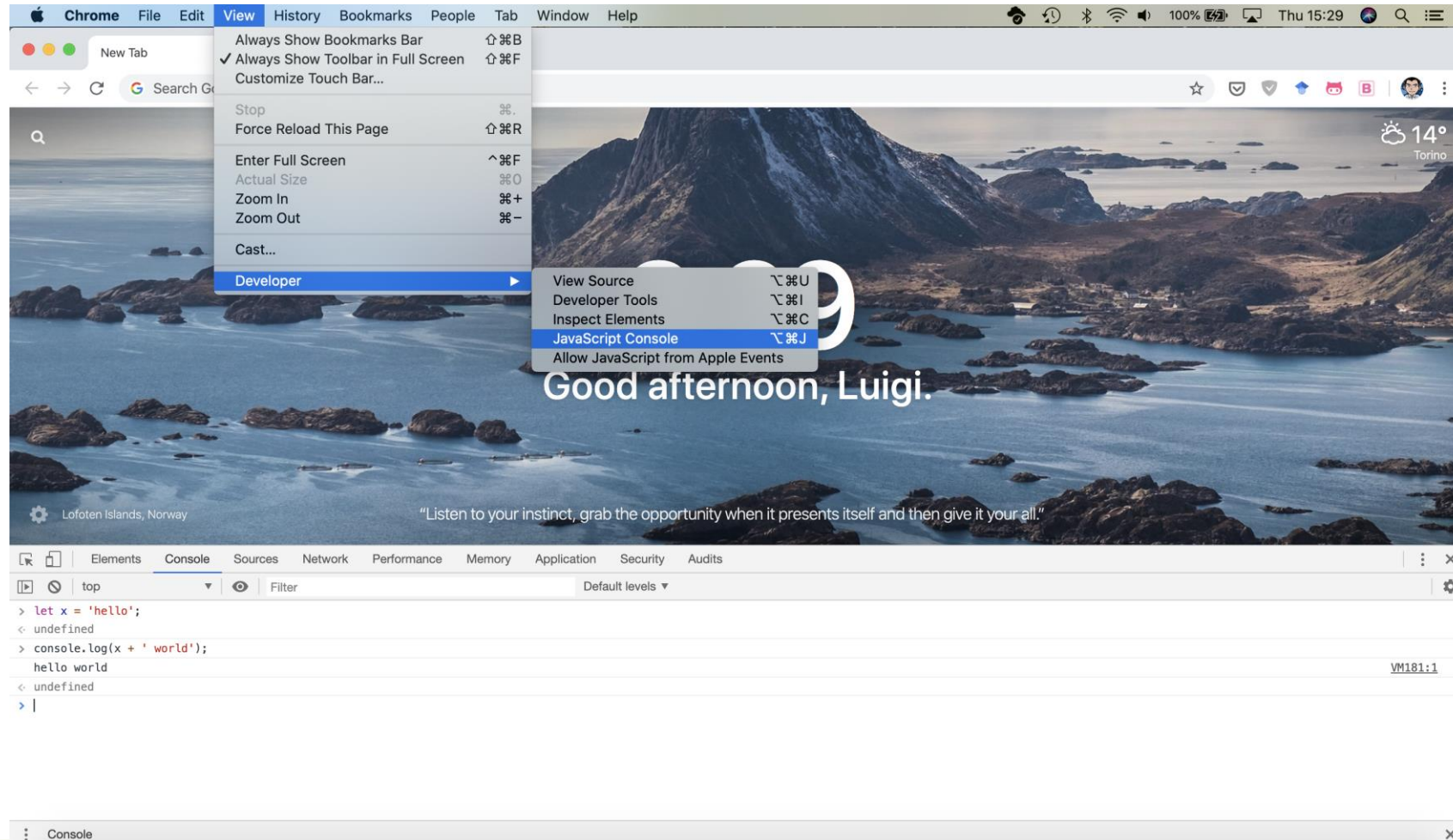
0	1	2	3	4	5
"F"	"u"	"l"	"v"	"i"	"o"

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)
 - ...

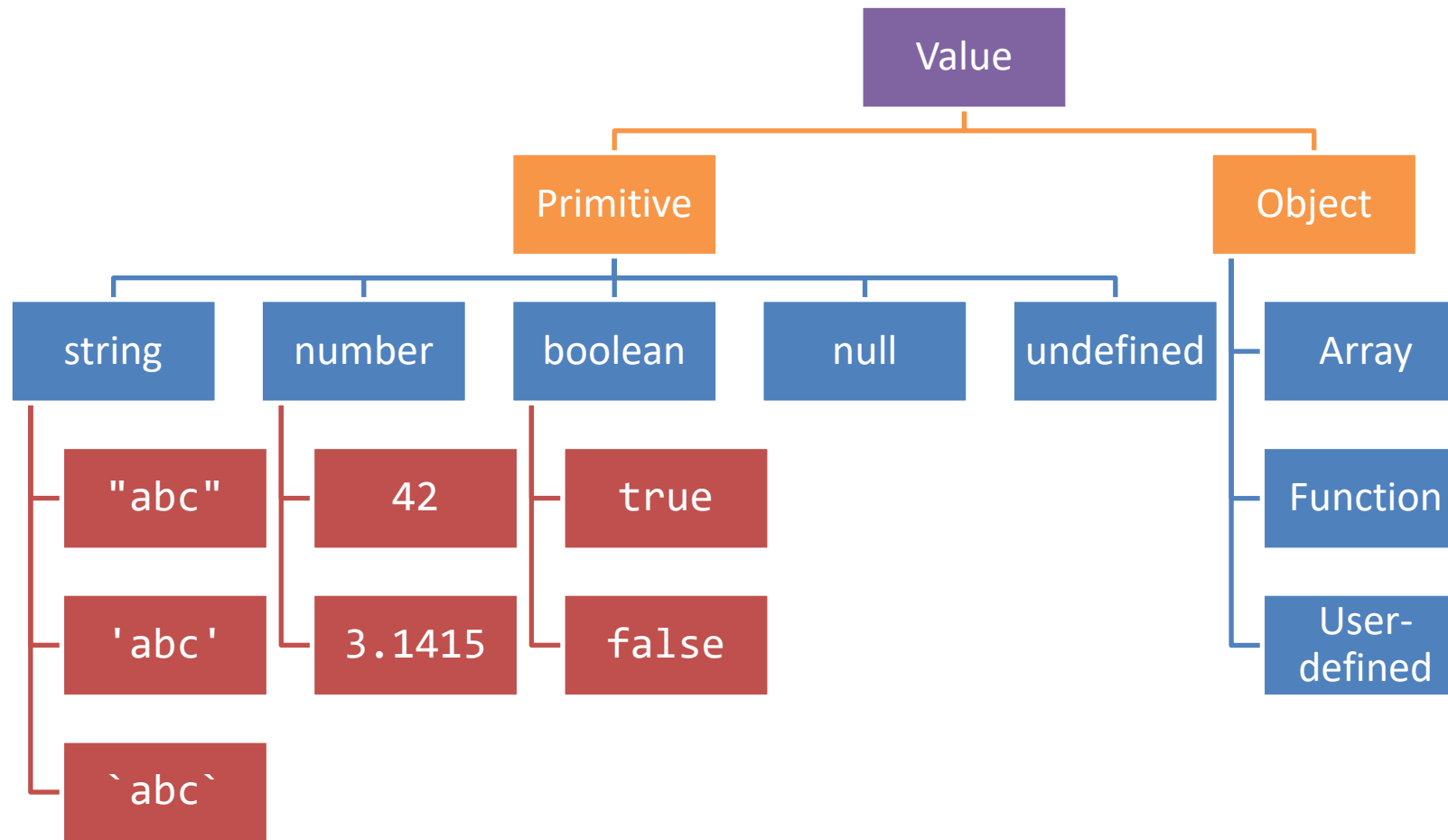


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TYPES AND VARIABLES

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
let	Yes	No	Enclosing block {...}	No	<i>Preferred</i>
const	No [§]	No	Enclosing block {...}	No	<i>Preferred</i>
var	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

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JavaScript Guide » Expressions and operators

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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:

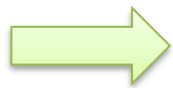
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Operator_Precedence#Table

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 <<= y</code>	<code>x = x << y</code>
Right shift assignment	<code>x >>= y</code>	<code>x = x >> y</code>
Unsigned right shift assignment	<code>x >>>= y</code>	<code>x = x >>> y</code>
Bitwise AND assignment	<code>x &= y</code>	<code>x = x & 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 Object.is and sameness in JS .	<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 > var1</code> <code>"12" > 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 >= var1</code> <code>var1 >= 3</code>
Less than (<)	Returns <code>true</code> if the left operand is less than the right operand.	<code>var1 < var2</code> <code>"2" < 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 <= var2</code> <code>var2 <= 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 }
```

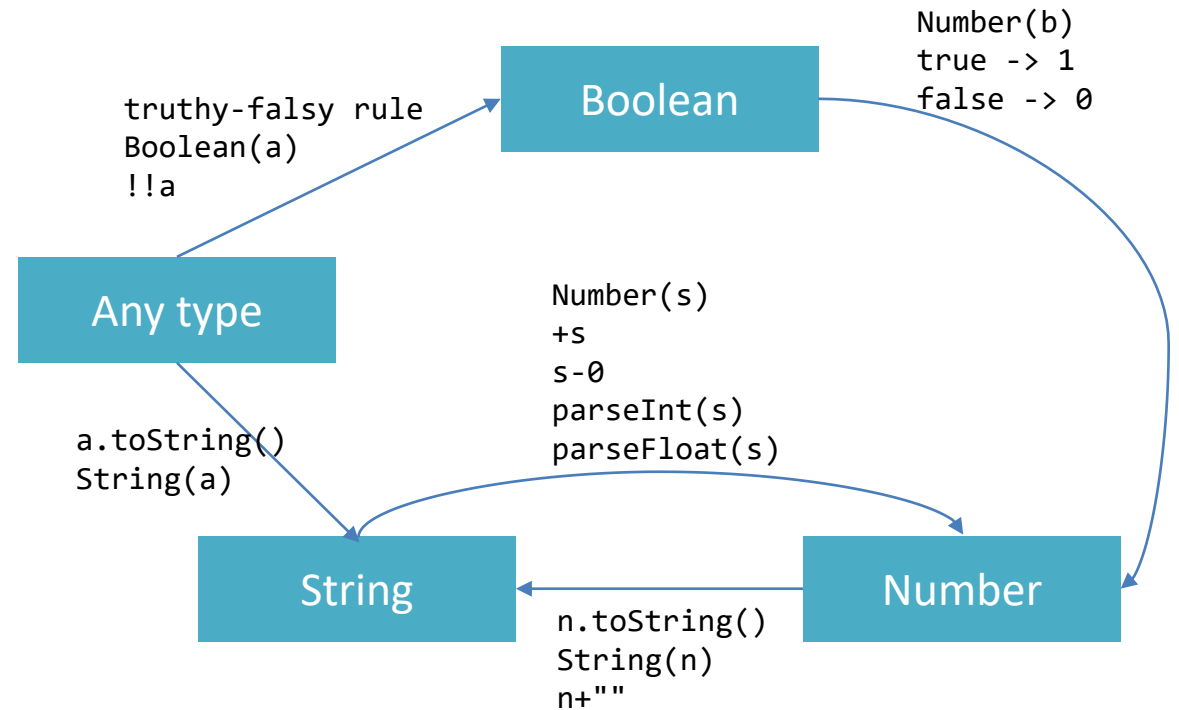
```
> b={x:1}  
{ x: 1 }
```

```
> 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>&&</code>)	<code>expr1 && 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>&&</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()`



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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;  
}
```

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

May also be a string

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



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Chapter 6. Arrays

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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

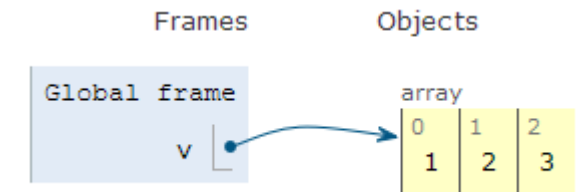
```
let v = [] ;
```

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

Do not access elements outside range

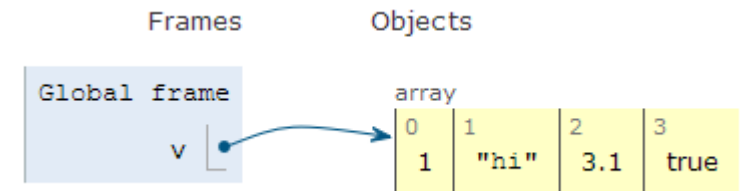
```
let v = [1, 2, 3] ;
```

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



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

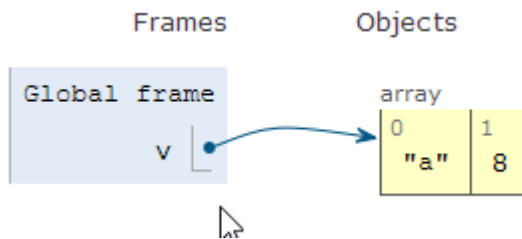
```
let v = Array.of(1, "hi", 3.1, true) ;
```



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 ;
```

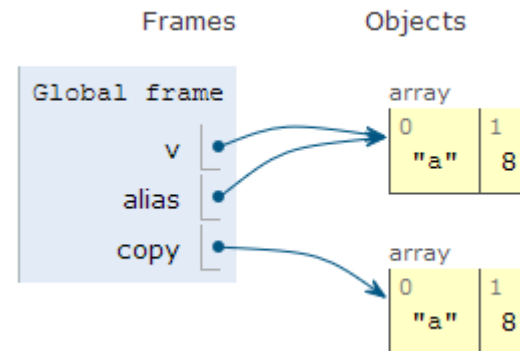
```
> console.log(v);  
[ 'a', 5 ]  
undefined  
> console.log(alias);  
[ 'a', 5 ]  
undefined
```

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 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);
```

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



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Chapter 2. Types, Values, and Variables

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STRINGS

Strings in JS

- A string is an **immutable** ordered sequence of Unicode 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.

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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