THE COMPLETE JAVASCRIPT COURSE

FROM ZERO TO EXPERT!

SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

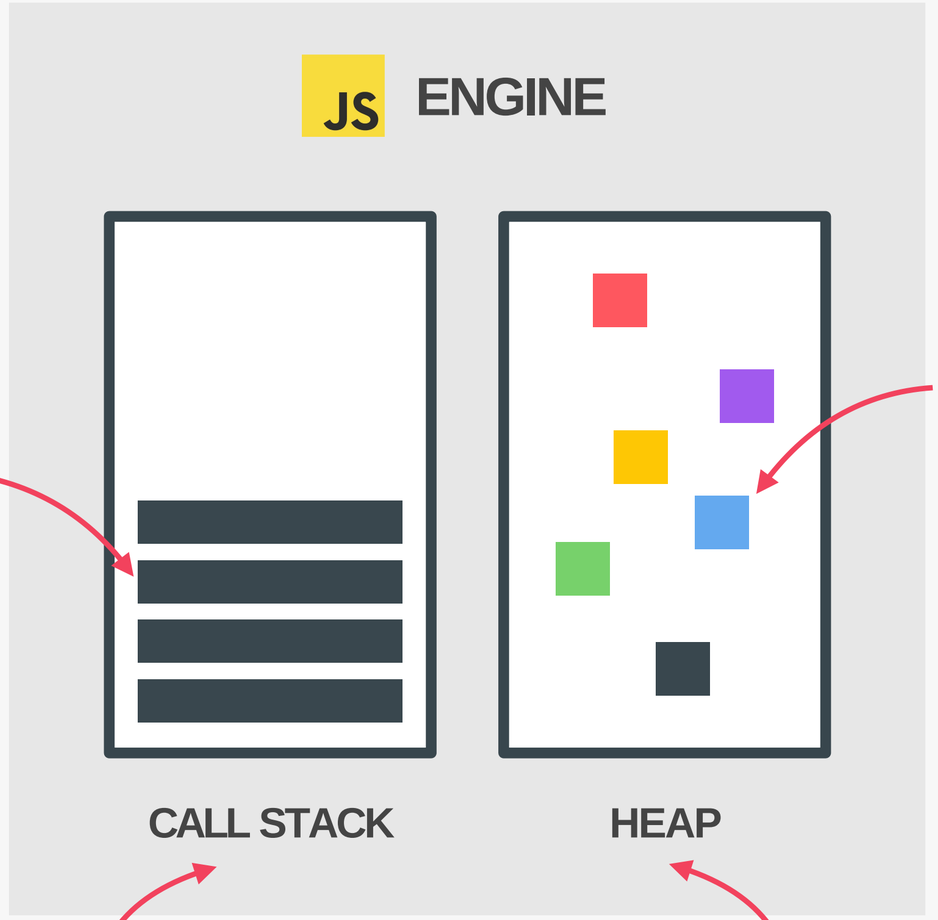
THE JAVASCRIPT ENGINE AND RUNTIME

WHAT IS A JAVASCRIPT ENGINE?

JS ENGINE

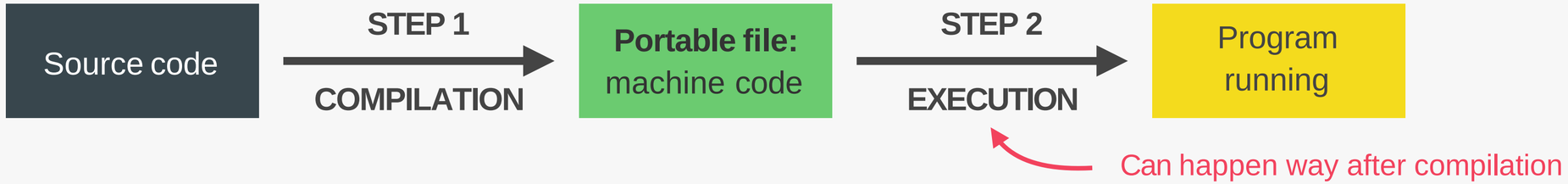
PROGRAM THAT EXECUTES JAVASCRIPT CODE.

👉 **Example: V8 Engine**

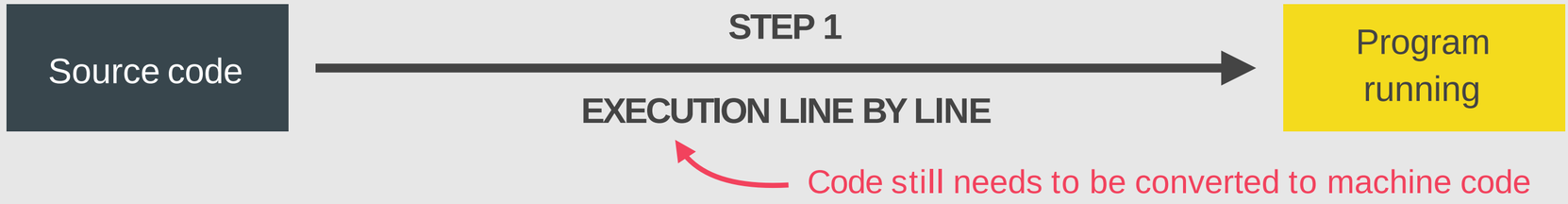


COMPUTER SCIENCE SIDENOTE: COMPILATION VS. INTERPRETATION

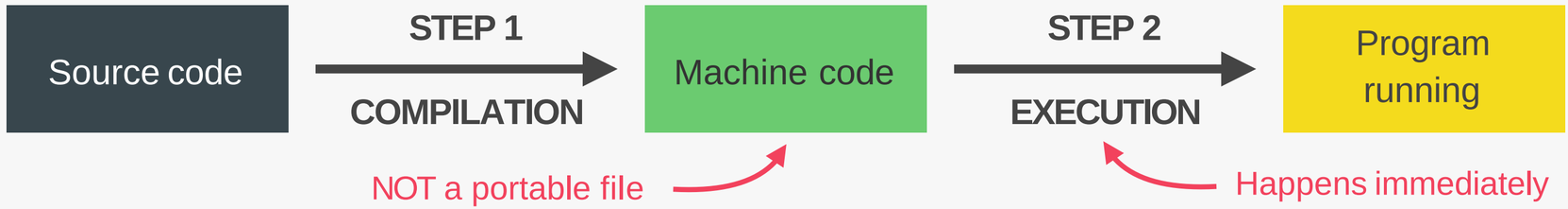
👉 Compilation: Entire code is converted into machine code at once, and written to a binary file that can be executed by a computer.



👉 Interpretation: Interpreter runs through the source code and executes it line by line.



👉 Just-in-time (JIT) compilation: Entire code is converted into machine code at once, then executed immediately.



MODERN JUST-IN-TIME COMPILATION OF JAVASCRIPT

```
document.querySelector(".again").addEventListener("click", () => {
  document.querySelector(".message").textContent = "Start guessing...";
  document.querySelector(".number").textContent = "?";
  document.querySelector(".guess").value = "";
});
```

~~"JavaScript is an interpreted language"~~

JS ENGINE

Happens in special threads that we can't access from code

Parsing

AST

Example

Compilation

Just-in-time compilation

Optimization

Execution

Happens in Call Stack

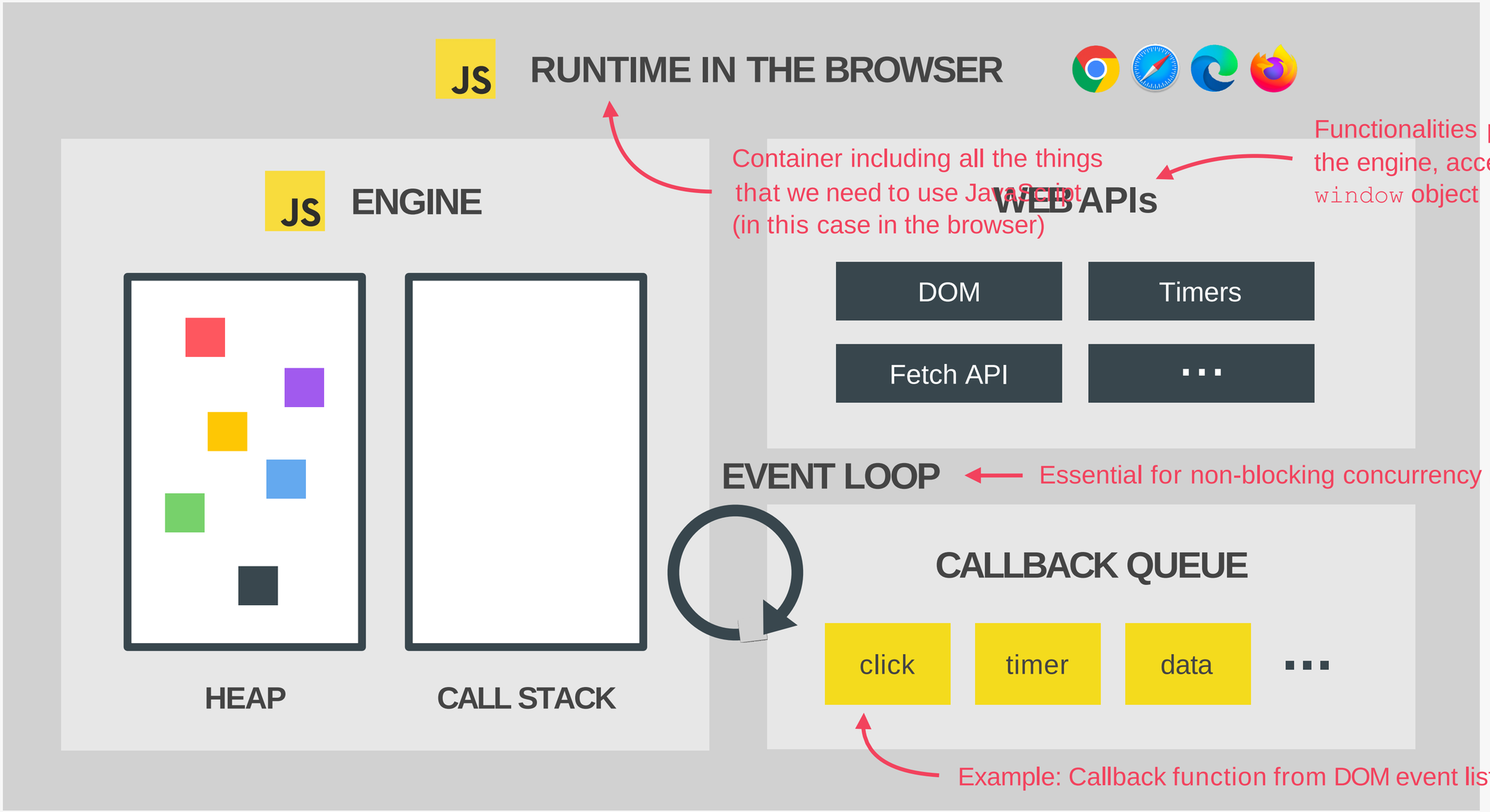
During execution!

👉 AST Example

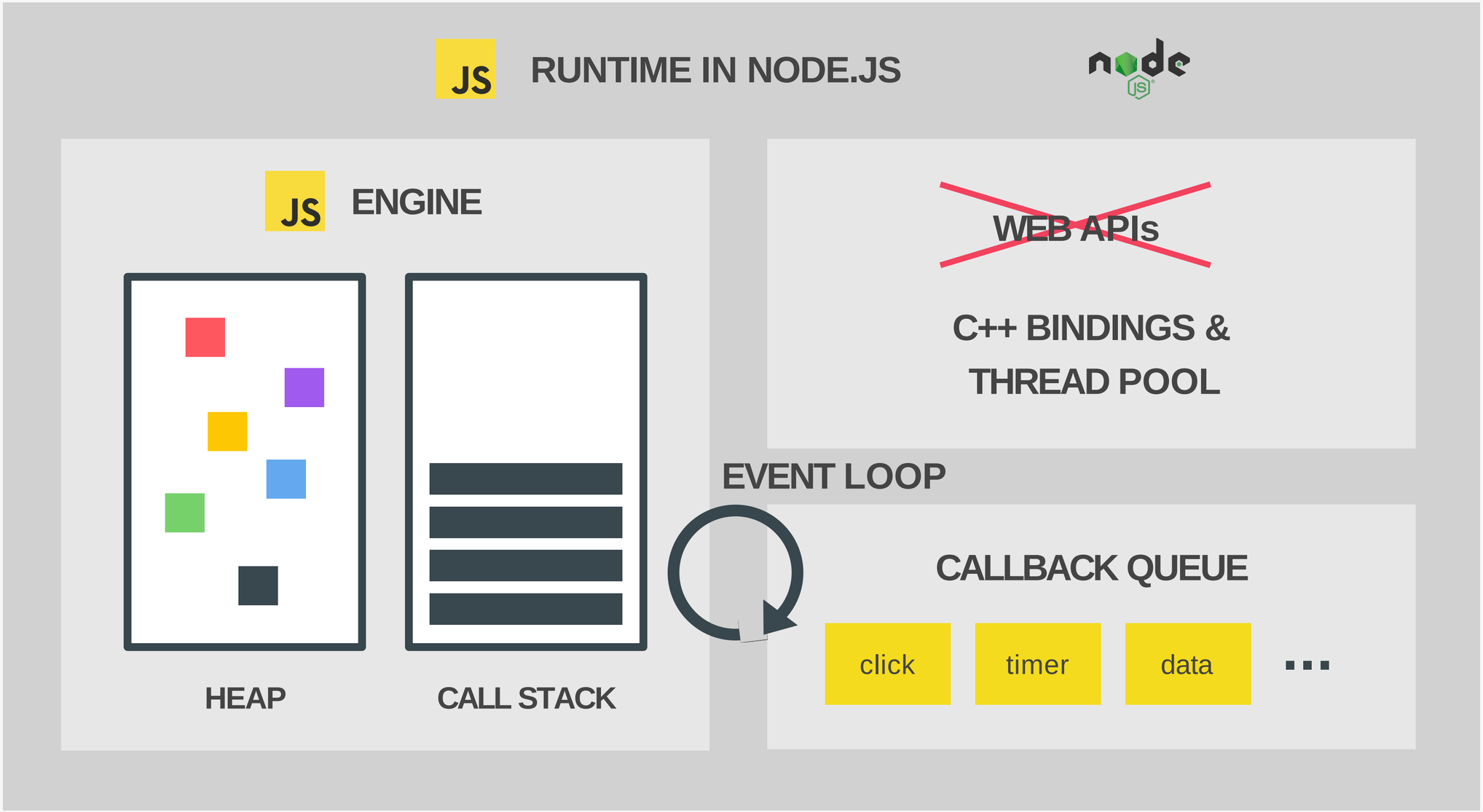
```
const x = 23;
```

```
- VariableDeclaration {
    start: 0
    end: 13
  - declarations: [
    - VariableDeclarator {
        start: 6
        end: 12
      - id: Identifier {
          start: 6
          end: 7
          name: "x"
        }
      - init: Literal = $node {
          start: 10
          end: 12
          value: 23
          raw: "23"
        }
    }
  ]
  kind: "const"
```

THE BIGGER PICTURE: JAVASCRIPT RUNTIME



THE BIGGER PICTURE: JAVASCRIPT RUNTIME



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EXECUTION CONTEXTS AND THE CALL STACK

WHAT IS AN EXECUTION CONTEXT?

👉 Human-readable code:

```
const name = 'Jonas';

const first = () => {
  let a = 1;
  const b = second();
  a = a + b;
  return a;
};

function second() {
  var c = 2;
  return c;
}
```

Function body only executed when called!

Compilation

EXECUTION

Creation of **global execution context** (for top-level code)

NOT inside a function

Execution of **top-level code** (inside global EC)

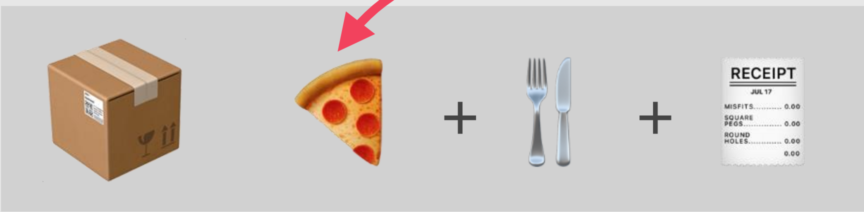
Execution of **functions** and waiting for **callbacks**

Example: click event callback

EXECUTION CONTEXT

Environment in which a piece of JavaScript is executed. Stores all the necessary information for some code to be executed.

“JavaScript code"



Pizza “execution context”

👉 Exactly **one** global execution context (EC): Default context, created for code that is not inside any function (top-level).

👉 One execution context **per function**: For each function call, a new execution context is created.

All together make the call stack

EXECUTION CONTEXT IN DETAIL

WHAT'S INSIDE EXECUTION CONTEXT?

1. Variable Environment
   - 👉 `let`, `const` and `var` declarations
   - 👉 Functions
   - 👉 ~~`arguments`~~ object
2. Scope chain
3. ~~`this`~~ keyword

NOT in arrow functions!

Generated during "creation phase", right before execution

```
const name = 'Jonas';

const first = () => {
  let a = 1;
  const b = second(7, 9);
  a = a + b;
  return a;
};

function second(x, y) {
  var c = 2;
  return c;
}

const x = first();
```

Global

```
name = 'Jonas'
first = <function>
second = <function>
x = <unknown>
```

Literally the function code

Need to run **`first()`** first

first()

```
a = 1
b = <unknown>
```

Need to run **`second()`** first

second()

```
c = 2
arguments = [7, 9]
```

Array of passed arguments. Available in all "regular" functions (not arrow)

(Technically, values only become known during execution)

THE CALL STACK

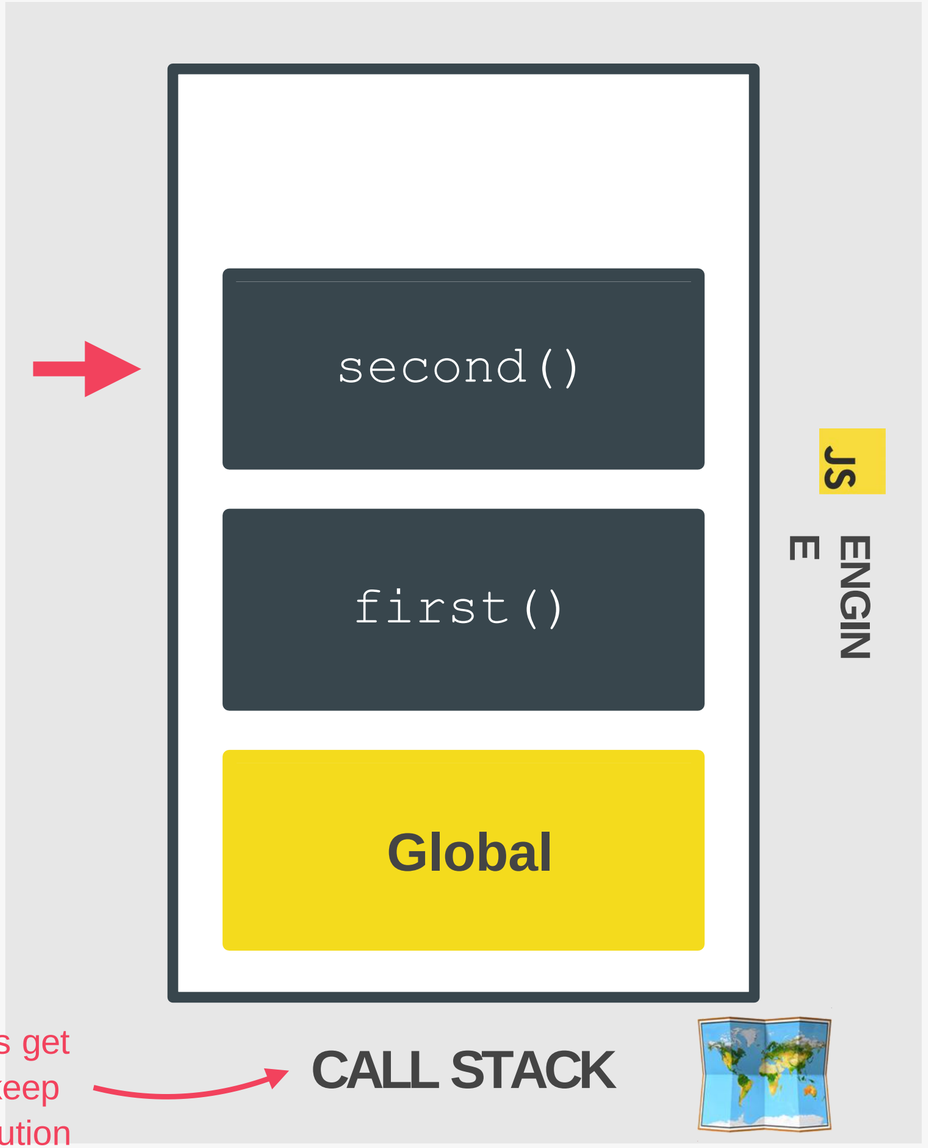
👉 Compiled code starts execution

```
const name = 'Jonas';

const first = () => {
  let a = 1;
  const b = second(7, 9);
  a = a + b;
  return a;
};

function second(x, y) {
  var c = 2;
  return c;
}

const x = first();
```



"Place" where execution contexts get stacked on top of each other, to keep track of where we are in the execution

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SCOPE AND THE SCOPE CHAIN

SCOPING AND SCOPE IN JAVASCRIPT: CONCEPTS

EXECUTION CONTEXT

- 👉 Variable environment
- 👉 Scope chain
- 👉 `this` keyword

SCOPE CONCEPTS

- 👉 **Scoping:** How our program's variables are organized and accessed. *"Where do variables live?"* or *"Where can we access a certain variable, and where not?"*;
- 👉 **Lexical scoping:** Scoping is controlled by placement of functions and blocks in the code;
- 👉 **Scope:** Space or environment in which a certain variable is declared (*variable environment in case of functions*). There is global scope, function scope, and block scope;
- 👉 **Scope of a variable:** Region of our code where a certain variable can be accessed.

THE 3 TYPES OF SCOPE

GLOBAL SCOPE

```
const me = 'Jonas';
const job = 'teacher';
const year = 1989;
```

- 👉 Outside of any function or block
- 👉 Variables declared in global scope are accessible everywhere

FUNCTION SCOPE

```
function calcAge(birthYear) {
  const now = 2037;
  const age = now - birthYear;
  return age;
}

console.log(now); // ReferenceError
```

- 👉 Variables are accessible only inside function, NOT outside
- 👉 Also called local scope

BLOCK SCOPE (ES6)

```
if (year >= 1981 && year <= 1996) {
  const millenial = true;
  const food = 'Avocado toast';
}
```

Example: `if` block, `for` loop block, etc.

```
console.log(millenial); // ReferenceError
```

- 👉 Variables are accessible only inside block (block scoped)
- ⚠️ HOWEVER, this only applies to **`let`** and **`const`** variables!
- 👉 Functions are also block scoped (only in strict mode)

THE SCOPE CHAIN

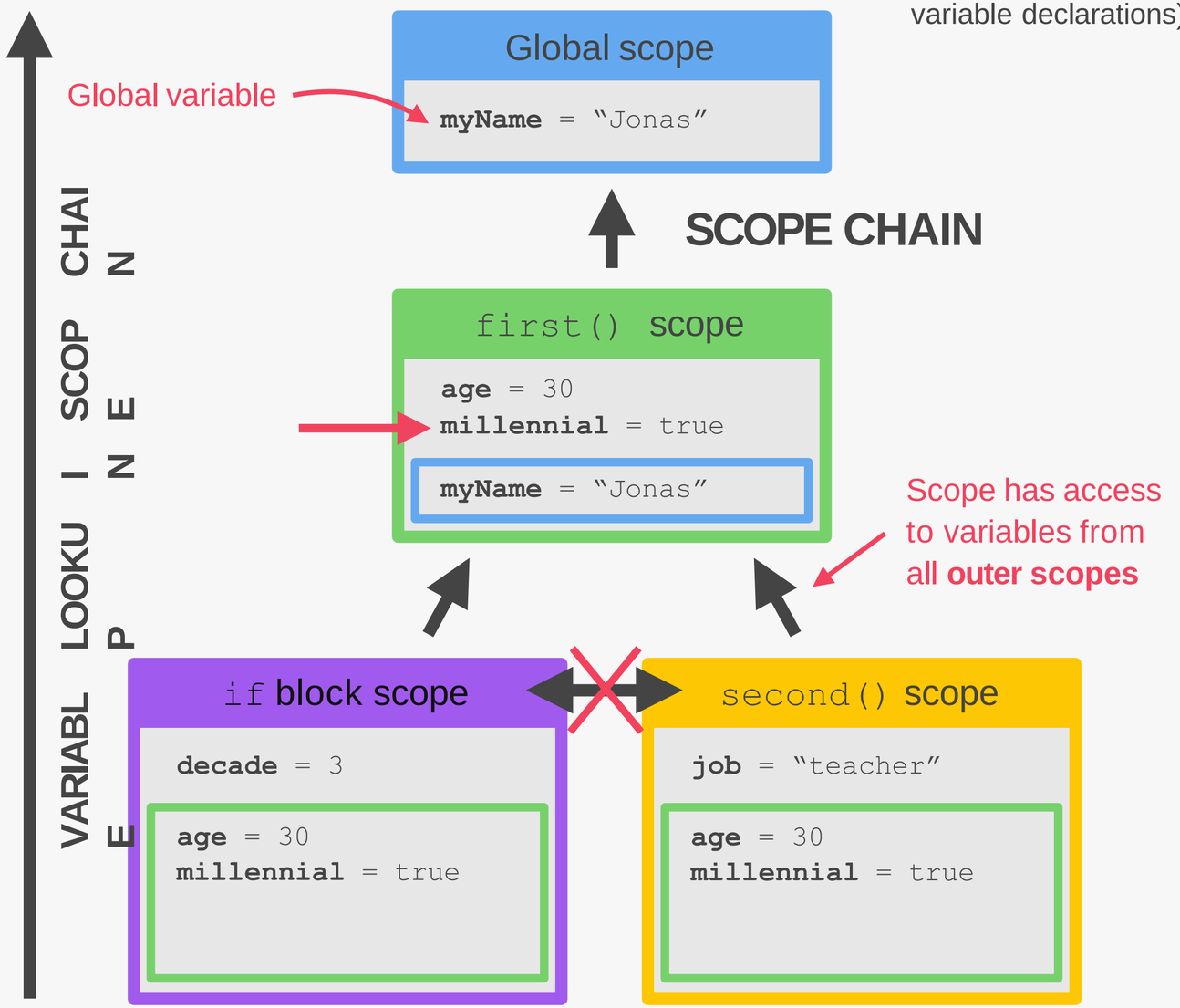
```
const myName = 'Jonas';

function first() {
  const age = 30;

  if (age >= 30) {  // true
    const decade = 3;
    var millenial = true;
  }

  function second() {
    const job = 'teacher';

    console.log(`${myName} is a ${age}-old ${job}`);
    // Jonas is a 30-old teacher
  }

  second();
}

first();
```

let and const are **block-scoped**

var is **function-scoped**

Variables not in current scope

(Considering only variable declarations)

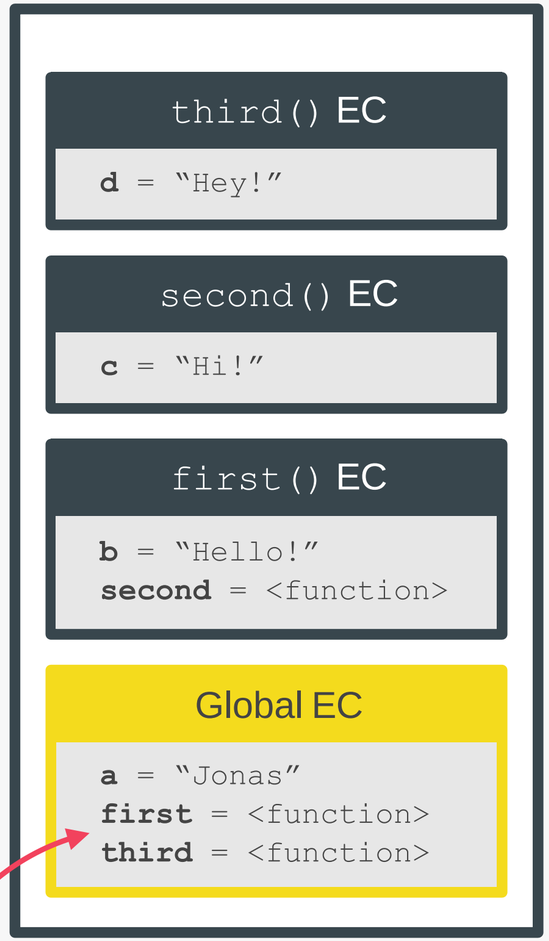


SCOPE CHAIN VS. CALL STACK

```
const a = 'Jonas';
first();

function first() {
  const b = 'Hello!';
  second();

  function second() {
    const c = 'Hi!';
    third();
  }
}

function third() {
  const d = 'Hey!';
  console.log(d + c + b + a);
  // ReferenceError
}
```

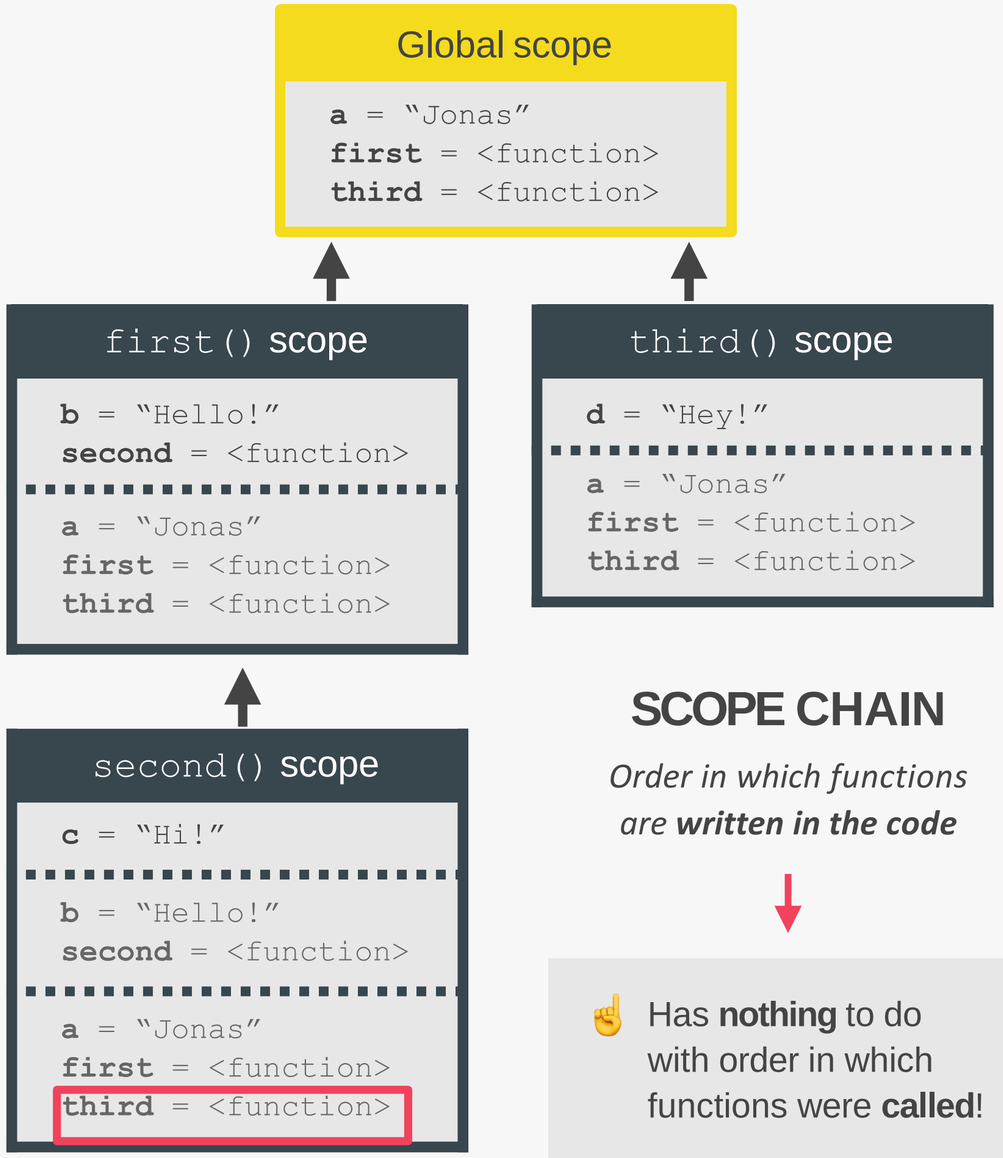
`c` and `b` can NOT be found in `third()` scope!

Variable environment (VE)



CALL STACK

*Order in which functions were **called***



SCOPE CHAIN

*Order in which functions are **written in the code***

☝ Has **nothing** to do with order in which functions were **called**!

SUMMARY 🥳

- 👉 Scoping asks the question *“Where do variables live?”* or *“Where can we access a certain variable, and where not?”*;
- 👉 There are 3 types of scope in JavaScript: the global scope, scopes defined by functions, and scopes defined by blocks;
- 👉 Only `let` and `const` variables are block-scoped. Variables declared with `var` end up in the closest function scope;
- 👉 In JavaScript, we have lexical scoping, so the rules of where we can access variables are based on exactly where in the code functions and blocks are written;
- 👉 Every scope always has access to all the variables from all its outer scopes. This is the scope chain!
- 👉 When a variable is not in the current scope, the engine looks up in the scope chain until it finds the variable it’s looking for. This is called variable lookup;
- 👉 The scope chain is a one-way street: a scope will never, ever have access to the variables of an inner scope;
- 👉 The scope chain in a certain scope is equal to adding together all the variable environments of the all parent scopes;
- 👉 The scope chain has nothing to do with the order in which functions were called. It does not affect the scope chain at all!