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THE COMPLETE JAVASCRIPT COURSE

FROM ZERO TO EXPERT!

SLIDES FOR THEORY LECTURES

(DON'T SKIP THEM, THEY ARE SUPER IMPORTANT 🤓)

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JS

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WELCOME, WELCOME, WELCOME!

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WELCOME, WELCOME, WELCOME!

LECTURE

WATCH BEFORE YOU START!

JS

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

✌️ **This course is for all of you!** So please don't write a bad review right away if the course is too easy, or too hard, or progressing too slow, or too fast for you. To make it perfect for **YOU**, you can rewatch lectures, jump to other sections, watch the course with slower or faster playback speed, or ask questions.

Please don't be that person.
Everyone is different...
(Unless the course *itself* is truly terrible)

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

👩‍💻 **You need to code along with me!** You will learn **ZERO** JavaScript skills by just sitting and watching me code. You have to code **YOURSELF**!

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

🤓 **Try all the coding challenges!** Try to do your best, but if you get stuck for too long, watch the solution. **Don't beat yourself up if you can't figure it out!** Just rewatch the lectures that were covered in the challenge, try to understand them better, and move on.

Watch for this sign!

PAUSE THE VIDEO
FOR CHALLENGE

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

📝 **If you want the course material to stick, take notes.** Notes on code syntax, notes on theory concepts, notes on everything!

Totally non-coding... Try to understand a single word 😂

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

😱 **If this is your first time ever programming, please don't get overwhelmed.** It's 100% normal that **you will not understand everything** at the beginning. ***Just don't think "I guess coding is not for me"!***

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

😅 **In the first sections of the course, don't bother understanding WHY things work the way they do in JavaScript. Also, don't stress about efficient code, or fast code, or clean code**. While learning, we just want to make things **WORK**. We will understand the **WHY** later in the course.

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

⏳ **Before moving on from a section, make sure that you understand exactly what was covered.** Take a break, review the code we wrote, review your notes, review the projects we built, and maybe even write some code yourself.

```
// We listen to the event on the buton element, because this is where the
click is supposed to happen
// Checking if number is correct
document.querySelector('.check').addEventListener('click', () => {
  const guess = Number(document.querySelector('.guess').value);

  if (!guess) {
    document.querySelector('.message').textContent = '⛔ No number!';
  } else if (guess === number) {
    document.querySelector('.number').textContent = number;
    document.querySelector('.message').textContent = '🎉 Correct number!';

    // If new highscore, then display it
    if (score > highscore) {
      highscore = score;
      document.querySelector('.highscore').textContent = highscore;
    }
  } else if (guess > number) {
    document.querySelector('.message').textContent = '📈 Too high!';
    // Decrease score
    score = --score;
    document.querySelector('.score').textContent = score;
  } else {
    document.querySelector('.message').textContent = '📉 Too low!';
    score = --score;
    document.querySelector('.scor
```

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

!? **If you have an error or a question, start by trying to solve it yourself! This is essential for your progress. If you can't solve it, check the Q&A section**. If that doesn't help, just **ask a new question**. Use a short description, and post relevant code.

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

🖥️ **I recorded this course on a Mac, but everything works the exact same way on Windows or Linux.** If something doesn't work on your computer, it's **NOT** because you're using a different OS.

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

😍 **Most importantly, have fun!** It's so rewarding to see something that **YOU** have built **YOURSELF**! So if you're feeling frustrated, stop whatever you're doing, and come back later!

And I mean REAL fun 😅

JAVASCRIPT FUNDAMENTALS – PART 1

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JAVASCRIPT FUNDAMENTALS – PART 1

LECTURE

A BRIEF INTRODUCTION TO JAVASCRIPT

JS

WHAT IS JAVASCRIPT?

JAVASCRIPT

We don't have to worry about complex stuff like memory management

JAVASCRIPT IS A HIGH-LEVEL, OBJECT-ORIENTED, MULTI-PARADIGM PROGRAMMING LANGUAGE. 🤯

Based on objects, for storing most kinds of data

We can use different styles of programming

Instruct computer to *do* things

JS

THE ROLE OF JAVASCRIPT IN WEB DEVELOPMENT

CONTENT

NOUNS

`<p></p>`

means "***paragraph***"

ADJECTIVES

`p {color: red}`

means "the paragraph text is ***red***"

VERBS

`p.hide();`

means "***hide*** the paragraph"

PRESENTATION

PROGRAMMING LANGUAGE:

BUILDING WEB APPLICATIONS

EXAMPLE OF DYNAMIC EFFECTS / WEB APPLICATION

Show spinner + loading data in the background

Show tweet box after clicking

Display tweets after loading data

Display user info on hover

Show spinner + loading data in the background

Show data after loading

THERE IS NOTHING YOU CAN'T DO WITH JAVASCRIPT (WELL, ALMOST...)

Front-end apps

Dynamic effects and web applications in the browser 😍

THIS COURSE

JS

100% based on JavaScript. They might go away, **but JavaScript won't!**

Back-end apps

Web applications on web servers

JS

Native mobile applications

JS

Native desktop applications

JS

JAVASCRIPT RELEASES... (MORE ABOUT THIS LATER)

🔥 Learn **modern JavaScript from the beginning**, but without forgetting the older parts!

🥳 **Let's finally get started!**

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JAVASCRIPT FUNDAMENTALS – PART 1

LECTURE

DATA TYPES

JS

OBJECTS AND PRIMITIVES

```
let me = {
  name: 'Jonas'
};
```

```
let firstName = 'Jonas';
let age = 30;
```

THE 7 PRIMITIVE DATA TYPES

1. **Number:** Floating point numbers 👉 Used for decimals and integers `let age = 23;`
2. **String:** Sequence of characters 👉 Used for text `let firstName = 'Jonas';`
3. **Boolean:** Logical type that can only be `true` or `false` 👉 Used for taking decisions `let fullAge = true;`
4. **Undefined:** Value taken by a variable that is not yet defined ('empty value') `let children;`
5. **Null:** Also means 'empty value'
6. **Symbol (ES2015):** Value that is unique and cannot be changed *[Not useful for now]*
7. **BigInt (ES2020):** Larger integers than the Number type can hold

☝️ **JavaScript has dynamic typing:** We do ***not*** have to manually define the data type of the value stored in a variable. Instead, data types are determined **automatically**.

Value has type, NOT variable!

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BOOLEAN LOGIC

JS

BASIC BOOLEAN LOGIC: THE AND, OR & NOT OPERATORS

A AND B

*"Sarah has a driver's license **AND** good vision"*

Possible values

B \ A	TRUE	FALSE
AND	TRUE	FALSE
TRUE	TRUE	FALSE
FALSE	FALSE	FALSE

Results of operation, depending on 2 variables

👇

`true` when **ALL** are `true`

No matter how many variables

A OR B

*"Sarah has a driver's license **OR** good vision"*

B \ A	TRUE	FALSE
OR	TRUE	FALSE
TRUE	TRUE	TRUE
FALSE	TRUE	FALSE

👇

`true` when **ONE** is `true`

NOT A, NOT B

👇

Inverts `true`/`false` value

👉 **EXAMPLE:**

A: Sarah has a driver's license

B: Sarah has good vision

Boolean variables that can be either TRUE or FALSE

AN EXAMPLE 🤦‍♀️

BOOLEAN VARIABLES

`age = 16`

- 👉 A: Age is greater or equal 20 — `false`
- 👉 B: Age is less than 30 — `true`

LET'S USE OPERATORS!

- 👉 `!A` (`false`) — `true`
- 👉 `A AND B` (`false` `true`) — `false`
- 👉 `A OR B` (`false` `true`) — `true`
- 👉 `!A AND B` (`true` `true`) — `true`
- 👉 `A OR !B` (`false` `false`) — `false`

A

B

AND	TRUE	FALSE
TRUE	TRUE	FALSE
FALSE	FALSE	FALSE

A

B

OR	TRUE	FALSE
TRUE	TRUE	TRUE
FALSE	TRUE	FALSE

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JAVASCRIPT FUNDAMENTALS – PART 1

LECTURE

JAVASCRIPT RELEASES: ES5, ES6+ AND ESNEXT

JS

A BRIEF HISTORY OF JAVASCRIPT

1995

- 👉 Brendan Eich creates the **very first version of JavaScript in just 10 days**. It was called Mocha, but already had many fundamental features of modern JavaScript!

1996

- 👉 Mocha changes to LiveScript and then to JavaScript, in order to attract Java developers. However, **JavaScript has almost nothing to do with Java** ☝️
- 👉 Microsoft launches IE, **copying JavaScript from Netscape** and calling it JScript;

1997

- 👉 With a need to standardize the language, ECMA releases ECMAScript 1 (ES1), the first **official standard for JavaScript** (ECMAScript is the standard, JavaScript the language in practice);

2009

- 👉 ES5 (ECMAScript 5) is released with lots of great new features;

2015

- 👉 ES6/ES2015 (ECMAScript 2015) was released: **the biggest update to the language ever!**
- 👉 ECMAScript changes to an **annual release cycle** in order to ship less features per update 🙏

2016 – ∞

- 👉 Release of ES2016 / ES2017 / ES2018 / ES2019 / ES2020 / ES2021 / … / ES2089 😅

BACKWARDS COMPATIBILITY: DON'T BREAK THE WEB!

```
// ES1 Code
function add(n) {
  var x = 5 + add.arguments[0];
  return x;
}
```

1997

Modern JavaScript Engine

2020

DON'T BREAK THE WEB!

- Old features are **never** removed;
- Not really new versions, just **incremental updates** (releases)
- Websites keep working **forever**!

Modern JavaScript Engine

2020

```
// ES2089 Code 😂
c int add n <=> int 5 + n
```

2089

HOW TO USE MODERN JAVASCRIPT TODAY

🧑‍💻 **During development:** Simply use the latest Google Chrome!

🚀 **During production:** Use Babel to transpile and polyfill your code (converting back to ES5 to ensure browser compatibility for all users).

http://kangax.github.io/compat-table

ES5

- 👉 Fully supported in all browsers (down to IE 9 from 2011);
- 👉 Ready to be used today 👍

BABEL

ES6/ES2015 ↓ ES2020

- 👉 **ES6+**: Well supported in all **modern** browsers;
- 👉 No support in **older** browsers;
- 👉 Can use **most** features in production with transpiling and polyfilling 😃

ES2021 – ∞

- 👉 **ESNext**: Future versions of the language (new feature proposals that reach Stage 4);
- 👉 Can already use **some** features in production with transpiling and polyfilling.

Will add new videos

(As of 2020)

MODERN JAVASCRIPT FROM THE BEGINNING

🔥 Learn **modern JavaScript from the beginning!**

☝️ But, also learn how some things used to be done **before** modern JavaScript (e.g. `const` & `let` vs `var` and function constructors vs ES6 `class`).

3 reasons why we should not forget the Good Ol' JavaScript:

- 👉 You will better understand how JavaScript actually works;
- 👉 Many tutorials and code you find online today are still in ES5;
- 👉 When working on old codebases, these will be written in ES5.

JAVASCRIPT FUNDAMENTALS – PART 2

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JAVASCRIPT FUNDAMENTALS – PART 2

LECTURE

FUNCTIONS CALLING OTHER FUNCTIONS

JS

CALLING A FUNCTION INSIDE A FUNCTION: DATA FLOW

```
const cutPieces = function (fruit) {
  return fruit * 4;
};

const fruitProcessor = function (apples, oranges) {

  const applePieces = cutPieces(apples);
  const orangePieces = cutPieces(oranges);

  const juice = `Juice with ${applePieces} pieces of
  apple and ${orangePieces} pieces of orange.`;
  return juice;
};

console.log(fruitProcessor(2, 3));
```

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JAVASCRIPT FUNDAMENTALS – PART 2

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REVIEWING FUNCTIONS

JS

FUNCTIONS REVIEW: 3 DIFFERENT FUNCTION TYPES

👉 **Function declaration**

Function that can be used before it's declared

👉 **Function expression**

Essentially a function *value* stored in a variable

👉 **Arrow function**

Great for a quick one-line functions. Has no `this` keyword (more later...)

```
function calcAge(birthYear) {
  return 2037 - birthYear;
}

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

const calcAge = birthYear => 2037 - birthYear;
```

☝️ Three different ways of writing functions, but they all work in a similar way: receive **input** data, **transform** data, and then **output** data.

FUNCTIONS REVIEW: ANATOMY OF A FUNCTION

Function name

Parameters: placeholders to receive **input** values. Like local variables of a function

Function body: block of code that we want to reuse. Processes the function's input data

```
function calcAge(birthYear, firstName) {
  const age = 2037 - birthYear;
  console.log(`${firstName} is ${age} years old`);
  return age;
}

const age = calcAge(1991, 'Jonas')
```

`return` statement to **output** a value from the function and terminate execution

Calling, running or invoking the function, using **`()`**

Variable to save returned value (function output)

Arguments: actual values of function parameters, to **input** data

DEVELOPER SKILLS & EDITOR SETUP

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DEVELOPER SKILLS & EDITOR SETUP

LECTURE

LEARNING HOW TO CODE

JS

HOW TO FAIL 🤦 AT LEARNING HOW TO CODE

John
(not actually...)

- He **didn't have a clear goal** at the beginning of his journey
- He started by watching courses and reading tutorials, but he would just **copy the code without caring how it works**. Sometimes he would just copy and paste code!
- He **didn't reinforce** what he was learning by doing small challenges or taking notes
- He **didn't practice coding**, and didn't come up with his own project ideas
- He **quickly became frustrated** when his code was not perfectly clean or efficient
- He **lost motivation** because he thought he could never know everything
- He was **learning in isolation**
- After finishing a couple of courses, **he thought he now was a web developer** and could start applying to jobs. But he couldn't even build an app on his own!

HOW TO SUCCEED 🎉 AT LEARNING HOW TO CODE

💥 He **didn't have a clear goal** at the beginning of his journey

↓ **FIX**

- 👍 Set a **specific**, **measurable**, **realistic** and **time-based** goal
- 👍 Know exactly **why** you are learning to code: Switching careers? Finding a better job?
- 👍 **Imagine a big project** you want to be able to build!
- 👍 Research technologies you need and then learn them

💥 He would just **copy the code without caring how it works**. Sometimes he would just copy and paste code!

↓ **FIX**

- 👍 Understand the code that you're studying and typing
- 👍 **Always type the code**, don't copy-paste!

💥 He **didn't reinforce** what he was learning by doing small challenges or taking notes

↓ **FIX**

- 👍 After you learn a new feature or concept, **use it immediately**
- 👍 Take notes
- 👍 **Challenge yourself** and practice with small coding exercises and challenges
- 👍 Don't be in a hurry to complete the course fast!

PAUSE THE VIDEO FOR CHALLENGE

codewars

HOW TO SUCCEED 🎉 AT LEARNING HOW TO CODE

💥 He **didn't practice coding**, and didn't come up with his own project ideas

↓ **FIX**

👍 Practicing on your own is the most important thing to do

👍 **This is NOT optional!** Without **practice outside of courses**, you won't go anywhere!

👍 Come up with your own project ideas or copy popular sites or applications, or just parts of them in the beginning

👍 Don't be stuck in "tutorial hell"

💥 He **quickly became frustrated** when his code was not perfectly clean or efficient

↓ **FIX**

👍 **Don't get stuck** trying to write the perfect code!

👍 Just write tons of code, **no matter the quality!**

👍 Clean and efficient code will come with time

👍 You can always refactor code later

💥 He **lost motivation** because he thought he could never know everything

↓ **FIX**

👍 Embrace the fact that **you will never you know everything**

👍 Just focus on what you need to achieve your goal!

HOW TO SUCCEED 🎉 AT LEARNING HOW TO CODE

💥 He was **learning in isolation**

↓ **FIX**

👍 Explain new concepts to other people. If you can explain it, you truly understand it!

👍 Share your goals to make **yourself accountable**

👍 Share your learning progress with the web dev community (#100DaysOfCode, #CodeNewbie, #webdev, etc.)

💥 After finishing a couple of courses, **he thought he now was a web developer** and could start applying to jobs

↓ **FIX**

👍 The **biggest misconception** that people have!

👍 Courses are an amazing starting point, but are only the **beginning of your journey**!

NEXT SLIDE →

LEARNING HOW TO CODE IS HARD, BUT YOU CAN DO IT!

Study courses: understand code, take challenges and notes

↓

Stay motivated! Keep writing lots of code on your own, no matter how bad

↓

Learn with other people, devs and beginners, and share progress

↓

Keep challenging yourself, run into lots of problems, and fix them

↓

Round up your skillset with best practices and tools (git, testing, …)

↓

JOB READY
(But the learning never stops 😅)

Source: https://www.thinkful.com/blog/why-learning-to-code-is-so-damn-hard/

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DEVELOPER SKILLS & EDITOR SETUP

LECTURE

HOW TO THINK LIKE A DEVELOPER:
BECOME A PROBLEM SOLVER!

JS

HOW TO FAIL 🤦 AT SOLVING PROBLEMS

John can code now 😄

WHENEVER JOHN ENCOUNTERS A PROBLEM:

💥 He jumps at the problem **without much thinking**

💥 He implements his solution in an **unstructured way**

💥 He **gets stressed out** when things don't work

💥 He is **too proud to research** solutions

↓ **FIX**

👍 **Stay calm and slow down**, don't just jump at a problem without a plan

👍 Take a very **logical and rational approach** (programming is just logic, in the end...)

👍 Use my **4-step framework** to solve any problem

→ **NEXT SLIDE**

👉 **Example:** *In an array of GPS coordinates, find the two closest points*

4 STEPS TO SOLVE ANY PROBLEM

1 Make sure you 100% understand the problem. **Ask the right questions** to get a clear picture of the problem

EXAMPLE

💬 Project Manager: *"We need a function that reverses whatever we pass into it"*

1

- 👉 What does "whatever" even mean in this context? What should be reversed? **Answer:** Only strings, numbers, and arrays make sense to reverse...
- 👉 What to do if something else is passed in?
- 👉 What should be returned? Should it always be a string, or should the type be the same as passed in?
- 👉 How to recognize whether the argument is a number, a string, or an array?
- 👉 How to reverse a number, a string, and an array?

4 STEPS TO SOLVE ANY PROBLEM

1. Make sure you 100% understand the problem. **Ask the right questions** to get a clear picture of the problem

2. **Divide and conquer:** Break a big problem into smaller sub-problems.

EXAMPLE

💬 Project Manager: *"We need a function that reverses whatever we pass into it"*

2 **SUB-PROBLEMS:**

- 👉 Check if argument is a number, a string, or an array
- 👉 Implement reversing a number
- 👉 Implement reversing a string
- 👉 Implement reversing an array
- 👉 Return reversed value

Looks like a task list that we need to implement

4 STEPS TO SOLVE ANY PROBLEM

1. Make sure you 100% understand the problem. **Ask the right questions** to get a clear picture of the problem

2. **Divide and conquer:** Break a big problem into smaller sub-problems.

3. Don't be afraid to do as much **research** as you have to

EXAMPLE

💬 Project Manager: *"We need a function that reverses whatever we pass into it"*

3

- 👉 How to check if a value is a number in JavaScript?
- 👉 How to check if a value is a string in JavaScript?
- 👉 How to check if a value is an array in JavaScript?
- 👉 How to reverse a number in JavaScript?
- 👉 How to reverse a string in JavaScript?
- 👉 How to reverse an array in JavaScript?

Google stackoverflow MDN web docs moz://a

4 STEPS TO SOLVE ANY PROBLEM

1. Make sure you 100% understand the problem. **Ask the right questions** to get a clear picture of the problem

2. **Divide and conquer:** Break a big problem into smaller sub-problems.

3. Don't be afraid to do as much **research** as you have to

4. For bigger problems, **write pseudo-code** before writing the actual code

EXAMPLE

💬 Project Manager: *"We need a function that reverses whatever we pass into it"*

4

```
function reverse(value)
 if value type !string && !number && !array
  return value

 if value type == string
  reverse string
 if value type == number
  reverse number
 if value type == array
  reverse array

 return reversed value
```

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DEVELOPER SKILLS & EDITOR SETUP

LECTURE

DEBUGGING (FIXING ERRORS)

JS

WHAT IS A SOFTWARE BUG?

- **Software bug:** Defect or problem in a computer program. Basically, any **unexpected or unintended behavior** of a computer program is a software bug.
- Bugs are **completely normal** in software development!

- **Previous example:** *"We need a function that reverses whatever we pass into it"*

```
reverse([1, 3, 5, 7])
        ↓
[5, 1, 7, 3]
```

Unexpected result: the array is scrambled, NOT reversed. So there is a **bug** in the `reverse` function 🐛

A *real bug* which was causing an error in Harvard's computer in the 1940s

- **Debugging:** Process of finding, fixing and preventing bugs.

THE DEBUGGING PROCESS

IDENTIFY → **FIND** → **FIX** → **PREVENT**

IDENTIFY — Becoming aware that there is a bug

- 👉 During development
- 👉 Testing software
- 👉 User reports during production
- 👉 Context: browsers, users, etc.

FIND — Isolating where exactly the bug is happening in code

- 👉 Developer console (*simple* code)
- 👉 Debugger (*complex* code)

FIX — Correct the bug

- 👉 Replace wrong solution with new correct solution

PREVENT — Preventing it from happening again

- 👉 Searching for the same bug in similar code
- 👉 Writing tests using testing software

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DEVELOPER SKILLS & EDITOR SETUP

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THE RISE OF AI TOOLS (CHATGPT, COPILOT, CURSOR AI, ETC.)

JS

THE WORKFLOW OF USING AI FOR CODING

Make sure you 100% understand the problem. **Ask questions** to get a clear picture

First step from lecture: "How to Think Like a Developer"

↓

Choose AI and give it a **very specific prompt** and enough context (language, style, etc.)

↓

✨ AI generates the solution as code

↓

Review and test the output solution. Make sure you introduce no bugs into your app

Correct or improve the solution

↓

Integrate the solution into your app

ChatGPT

GitHub Copilot

CURSOR

- 👉 Ask to write code snippets, functions, and even generate entire files
- 👉 Use code-aware autocomplete
- 👉 Chat with your codebase

GUIDELINES FOR SAFE USE OF AI

BEFORE YOU USE AI:

1. … you need to know **how to code on your own**. Fundamental skills are 100% essential!
2. … you need to be able to **solve problems on your own**
3. … you need to have very **critical thinking** (AI code contains a surprising amount of **bugs or bad code**)
4. … you need to have **curiosity and joy** while coding

INCORPORATE AI CODE:

1. … when you could have **written the code yourself**
2. … when you **truly understand** the generated code
3. … when you have ensured the code is **100% correct**
4. … when you're not using the code for **mission-critical parts** of your apps

☝️ Don't just use AI without knowing what you're doing. Otherwise, AI will turn you into a **terrible programmer**!

INSTEAD →

💪 Use AI as an **assistant, not a replacement**! Save time on repetitive and boring tasks. It's also great for **learning**!

🤖 WILL AI TAKE YOUR JOB?

- 👉 **There is a lot of hype around AI right now!** In the past, tools like Dreamweaver, Wordpress, or Wix were supposed to replace web developers...
- 👉 **Things *will* change:** a portion of apps will be written by AI. You might write less code in the future, but that's not a bad thing!
- 👉 **You will still be needed!** You're the one who maintains control and implements the app architecture. **You** are the one who asks AI to write the code in the first place, reviews it, corrects it, and integrates it into the app
- 👉 Software developers do a **lot more than just writing code**: maintain the bigger picture of huge projects / think about software / implement complex design principles / are creative / they collaborate with other developers and clients
- 👉 AI-generated code is **still buggy**, and AI is **not very good at debugging**
- 👉 The world **needs more software** than can be built by humans right now!
- 👉 **AI will help us, *not* replace us!**

JAVASCRIPT IN THE BROWSER: DOM AND EVENTS FUNDAMENTALS

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SECTION

JAVASCRIPT IN THE BROWSER: DOM AND EVENTS FUNDAMENTALS

LECTURE

WHAT'S THE DOM AND DOM MANIPULATION

JS

WHAT IS THE DOM?

DOM

DOCUMENT OBJECT MODEL: STRUCTURED REPRESENTATION OF HTML DOCUMENTS. ALLOWS JAVASCRIPT TO ACCESS HTML ELEMENTS AND STYLES TO MANIPULATE THEM.

Tree structure, generated by browser on HTML load

Change text, HTML attributes, and even CSS styles

THE DOM TREE STRUCTURE

```
<html>
  <head>
    <title>A Simple Page</title>
  </head>
  <body>
    <section>
      <p>A paragraph with a <a>link</a></p>
      <p>A second paragraph</p>
    </section>
    <section>
      <img src="dom.png" alt="The DOM" />
    </section>
  </body>
</html>
```

DOM !== JAVASCRIPT 🧐

DOM Methods and Properties for DOM Manipulation

JS

ecma INTERNATIONAL

For example
`document.querySelector()`

API: Application Programming Interface

WEB APIs

DOM Methods and Properties

Timers

Fetch

JS

HOW JAVASCRIPT WORKS BEHIND THE SCENES

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SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

AN HIGH-LEVEL OVERVIEW OF JAVASCRIPT

JS

WHAT IS JAVASCRIPT: REVISITED

JAVASCRIPT

JAVASCRIPT IS A HIGH-LEVEL, OBJECT-ORIENTED, MULTI-PARADIGM PROGRAMMING LANGUAGE.

JS

WHAT IS JAVASCRIPT: REVISITED

JAVASCRIPT

JAVASCRIPT IS A HIGH-LEVEL, PROTOTYPE-BASED OBJECT-ORIENTED MULTI-PARADIGM, INTERPRETED OR JUST-IN-TIME COMPILED DYNAMIC, SINGLE-THREADED, GARBAGE-COLLECTED PROGRAMMING LANGUAGE WITH FIRST-CLASS FUNCTIONS AND A NON-BLOCKING EVENT LOOP CONCURRENCY MODEL. 🤔 🤯 🤣

JS

DECONSTRUCTING THE MONSTER DEFINITION

- High-level
- Garbage-collected
- Interpreted or just-in-time compiled
- Multi-paradigm
- Prototype-based object-oriented
- First-class functions
- Dynamic
- Single-threaded
- Non-blocking event loop

DECONSTRUCTING THE MONSTER DEFINITION

- **High-level**
- Garbage-collected
- Interpreted or just-in-time compiled
- Multi-paradigm
- Prototype-based object-oriented
- First-class functions
- Dynamic
- Single-threaded
- Non-blocking event loop

👉 **Any computer program needs resources:**

+

LOW-LEVEL

Developer has to manage resources **manually**

HIGH-LEVEL

Developer does **NOT** have to worry, everything happens automatically

DECONSTRUCTING THE MONSTER DEFINITION

- High-level
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Cleaning the memory
so we don't have to

DECONSTRUCTING THE MONSTER DEFINITION

- High-level
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- Multi-paradigm
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- First-class functions
- Dynamic
- Single-threaded
- Non-blocking event loop

```
document.querySelector(".again").addEventListener("click", () => {
  document.querySelector(".message").textContent = "Start guessing...";
  document.querySelector(".number").textContent = "?";
  document.querySelector(".guess").value = "";
  score = 20;
  document.querySelector(".score").textContent = score;
  number = Math.floor(Math.random() * 20) + 1;
});
```

Abstraction over 0s and 1s

CONVERT TO MACHINE CODE = COMPILING

Happens inside the JavaScript engine

More about this **Later in this Section** 👇

DECONSTRUCTING THE MONSTER DEFINITION

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👉 **Paradigm**: An approach and mindset of structuring code, which will direct your coding style and technique.

The one we've been using so far

1. Procedural programming
2. Object-oriented programming (OOP)
3. Functional programming (FP)

☝️ **Imperative vs.**
👋 **Declarative**

More about this later in **Multiple Sections** 👉

DECONSTRUCTING THE MONSTER DEFINITION

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Prototype

Array

Array.prototype.push

Array.prototype.indexOf

(Oversimplification!)

Our array inherits methods from prototype

Built from prototype

```
const arr = [1, 2, 3];
arr.push(4);
const hasZero = arr.indexOf(0) > -1;
```

More about this in Section **Object Oriented Programming** 👉

DECONSTRUCTING THE MONSTER DEFINITION

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- Non-blocking event loop

👉 In a language with **first-class functions**, functions are simply **treated as variables**. We can pass them into other functions, and return them from functions.

```
const closeModal = () => {
  modal.classList.add("hidden");
  overlay.classList.add("hidden");
};

overlay.addEventListener("click", closeModal);
```

Passing a function into another function as an argument: First-class functions!

More about this in Section **A Closer Look at Functions** 👉

DECONSTRUCTING THE MONSTER DEFINITION

- High-level
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- Single-threaded
- Non-blocking event loop

👉 **Dynamically-typed language:**

No data type definitions. Types becomes known at runtime

Data type of variable is automatically changed

```
let x = 23;
let y = 19;
x = "Jonas";
```

TS

DECONSTRUCTING THE MONSTER DEFINITION

- High-level
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👉 **Concurrency model**: how the JavaScript engine handles multiple tasks happening at the same time.

↓ Why do we need that?

👉 JavaScript runs in one **single thread**, so it can only do one thing at a time.

↓ So what about a long-running task?

👉 Sounds like it would block the single thread. However, we want non-blocking behavior!

↓ How do we achieve that?

(Oversimplification!)

👉 By using an **event loop**: takes long running tasks, executes them in the "background", and puts them back in the main thread once they are finished.

More about this **Later in this Section** 👇

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SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

THE JAVASCRIPT ENGINE AND RUNTIME

JS

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.

JS

👉 **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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SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

EXECUTION CONTEXTS AND THE CALL STACK

JS

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!

EXECUTION

Compilation

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

👉 **One execution context <u>per function</u>:** 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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HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

SCOPE AND THE SCOPE CHAIN

JS

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';
}

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

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

- 👉 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

VARIABLE LOOKUP IN SCOPE CHAIN

(Considering only variable declarations)

Global variable

Global scope

myName = "Jonas"

SCOPE CHAIN

first() scope

age = 30
millennial = true

myName = "Jonas"

Scope has access to variables from all outer scopes

if block scope

decade = 3

age = 30
millennial = true

myName = "Jonas"

second() scope

job = "teacher"

age = 30
millennial = true

myName = "Jonas"

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)

third() EC

d = "Hey!"

second() EC

c = "Hi!"

first() EC

b = "Hello!"
second = <function>

Global EC

a = "Jonas"
first = <function>
third = <function>

CALL STACK

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

Global scope

a = "Jonas"
first = <function>
third = <function>

first() scope

b = "Hello!"
second = <function>

a = "Jonas"
first = <function>
third = <function>

second() scope

c = "Hi!"

b = "Hello!"
second = <function>

a = "Jonas"
first = <function>
third = <function>

third() scope

d = "Hey!"

a = "Jonas"
first = <function>
third = <function>

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!

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HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

VARIABLE ENVIRONMENT: HOISTING AND THE TDZ

JS

HOISTING IN JAVASCRIPT

👉 **Hoisting:** Makes some types of variables accessible/usable in the code before they are actually declared. “Variables lifted to the top of their scope”.

↓ ***BEHIND THE SCENES***

Before execution, code is scanned for variable declarations, and for each variable, a new property is created in the **variable environment object**.

EXECUTION CONTEXT

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

	HOISTED? 👇	INITIAL VALUE 👇	SCOPE 👇
`function` declarations	✅ YES	Actual function	Block
`var` variables	✅ YES	`undefined`	Function
`let` and `const` variables	🚫 NO	`<uninitialized>`, TDZ	Block
`function` expressions and arrows	🤷‍♂️ Depends if using `var` or `let/const`		

In strict mode. Otherwise: function!

Technically, yes. But not in practice

Temporal Dead Zone

TEMPORAL DEAD ZONE, LET AND CONST

```
const myName = 'Jonas';

if (myName === 'Jonas') {
  console.log(`Jonas is a ${job}`);
  const age = 2037 - 1989;
  console.log(age);
  const job = 'teacher';
  console.log(x);
}
```

TEMPORAL DEAD ZONE FOR `job` VARIABLE

- Different kinds of error messages:

`ReferenceError: Cannot access 'job' before initialization`

`ReferenceError: x is not defined`

WHY HOISTING?

- **Using functions before actual declaration;**
- `var` hoisting is just a byproduct.

WHY TDZ?

- **Makes it easier to avoid and catch errors:** accessing variables before declaration is bad practice and should be avoided;
- **Makes `const` variables actually work**

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HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

THE THIS KEYWORD

JS

HOW THE THIS KEYWORD WORKS

👉 **`this` keyword/variable:** Special variable that is created for every execution context (every function). Takes the value of (points to) the "owner" of the function in which the `this` keyword is used.

☝️ `this` is **NOT** static. It depends on **how** the function is called, and its value is only assigned when the function **is actually called**.

EXECUTION CONTEXT

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

Method 👉 `this` = <Object that is calling the method>

Simple function call 👉 `this = undefined`

In strict mode! Otherwise: `window` (in the browser)

Don't get own `this`

Arrow functions 👉 `this` = <`this` of surrounding function (lexical `this`)>

Event listener 👉 `this` = <DOM element that the handler is attached to>

`new`, `call`, `apply`, `bind` 👉 *<Later in the course... ⏳>*

☝️ `this` does **NOT** point to the function itself, and also **NOT** the its variable environment!

👉 Method example:

```
const jonas = {
  name: 'Jonas',
  year: 1989,
  calcAge: function() {
    return 2037 - this.year;
  }
};
jonas.calcAge(); // 48
```

`calcAge` is method

`jonas`

`1989`

Way better than using `jonas.year`!

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GOT QUESTIONS? FEEDBACK?

JUST POST IT IN THE Q&A OF THIS VIDEO, AND YOU WILL GET HELP THERE!

JS

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SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

MEMORY MANAGEMENT: PRIMITIVES VS. OBJECTS

JS

THE MEMORY LIFECYCLE IN JAVASCRIPT

🤔 **“How and where are variables created in JavaScript?”**

👉 Unlike other languages, **memory is automatically managed** by JavaScript behind the scenes

👉 Every value we create in JavaScript goes through a **memory lifecycle**

1️⃣ Allocate memory → **2️⃣ Use memory** → **3️⃣ Release memory**

```
let temp = 23.7
```

```
temp = temp + 5
round(temp)
```

```
temp is removed from memory
```

👉 Whenever we assign a value to a new variable, the engine automatically allocates (*reserves*) a **piece of memory to store the value**

👉 While code is running, **the value is written, read, and updated** in the allocated piece of memory

👉 When no longer needed, **the value is deleted from memory** to free up resources. The released memory is used for new values

WHERE IS MEMORY ALLOCATED?

1 Allocate memory

PRIMITIVES

- Number
- String
- Boolean
- Undefined
- Null
- Symbol
- BigInt

- **References to objects**

OBJECTS

- Object literals
- Arrays
- Functions
- Many more...

UNDERSTANDING OBJECT REFERENCES

1️⃣ Allocate memory

```
const name = 'Jonas';
const age = calcAge(1991);
let newAge = age;
newAge++;

const location = {
  city: 'Faro',
  country: 'Portugal',
};

const newLocation = location;
newLocation.city = 'Lisbon';

console.log(location);
// { city: 'Lisbon', country: 'Portugal' }

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

city in location has been destroyed 💥

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SECTION

HOW JAVASCRIPT WORKS BEHIND THE SCENES

LECTURE

MEMORY MANAGEMENT: GARBAGE COLLECTION

JS

REVIEW: THE MEMORY LIFECYCLE

1️⃣ **Allocate memory** → 2️⃣ **Use memory** → 3️⃣ **Release memory**

```
let temp = 23.7
```

```
temp = temp + 5
round(temp)
```

```
temp is removed from memory
```

GARBAGE COLLECTION

3️⃣ **Release memory**

🤔 **How is memory freed up after we no longer need a value?**

CALL STACK 💥 Variable environment is **simply deleted when EC pops off stack**

HEAP 🚚 **Garbage collection** (central memory management tool)

MARK-AND-SWEEP ALGORITHM:

1. **Mark:** Mark all objects that are ***reachable*** from a root as "alive"
2. **Sweep:** Delete un-marked (***unreachable***) objects and reclaim memory for future allocations

👉 **Memory leak:** When objects that are no longer needed are **incorrectly still reachable**, and therefore **not being garbage collected**

"HOW JAVASCRIPT WORKS BEHIND THE SCENES" TOPICS FOR LATER... ⏳

1. **Closures** 👉 A Closer Look at Functions
2. **Prototypal Inheritance** 👉 Object Oriented Programming (OOP) With JavaScript
3. **Event Loop** 👉 Asynchronous JavaScript: Promises, Async/Await and AJAX
4. **How the DOM Really Works** 👉 Advanced DOM and Events

DATA STRUCTURES, MODERN OPERATORS AND STRINGS

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SECTION

DATA STRUCTURES, MODERN OPERATORS AND STRINGS

LECTURE

SUMMARY: WHICH DATA STRUCTURE TO USE?

JS

DATA STRUCTURES OVERVIEW

SOURCES OF DATA

1. **From the program itself:** Data written directly in source code (e.g. status messages)
2. **From the UI:** Data input from the user or data written in DOM (e.g tasks in todo app)
3. **From external sources:** Data fetched for example from web API (e.g. recipe objects)

Application Programming Interface


```
{
  "count": 3,
  "recipes": [
    {
      "publisher": "101 Cookbooks",
      "title": "Best Pizza Dough Ever",
      "source_url": "http://www.101cookbooks.com/archiv
      "recipe_id": "47746",
      "image_url": "http://forkify-api.herokuapp.com/im
      "social_rank": 100,
      "publisher_url": "http://www.101cookbooks.com"
    },
    {
      "publisher": "The Pioneer Woman",
      "title": "Deep Dish Fruit Pizza",
      "source_url": "http://thepioneerwoman.com/cooking
      "recipe_id": "46956",
      "image_url": "http://forkify-api.herokuapp.com/im
      "social_rank": 100,
      "publisher_url": "http://thepioneerwoman.com"
    },
    {
      "publisher": "Closet Cooking",
      "title": "Pizza Dip",
      "source_url": "http://www.closetcooking.com/2011/
      "recipe_id": "35477",
      "image_url": "http://forkify-api.herokuapp.com/im
      "social_rank": 99.99999999999994,
      "publisher_url": "http://closetcooking.com"
    }
  ]
}
```


"Object" — Array — "Object"

JSON data format example

Collection of data

Data structure

SIMPLE LIST? → Arrays or Sets

KEY/VALUE PAIRS? → Objects or Maps

Keys allow us to *describe* values

OTHER BUILT-IN:

- WeakMap
- WeakSet

NON-BUILT IN:

- Stacks
- Queues
- Linked lists
- Trees
- Hash tables

ARRAYS VS. SETS AND OBJECTS VS. MAPS

ARRAYS VS. SETS

ARRAYS

```
tasks = ['Code', 'Eat', 'Code'];
// ["Code", "Eat", "Code"]
```

- Use when you need **ordered** list of values (might contain duplicates)
- Use when you need to **manipulate** data

SETS

```
tasks = new Set(['Code', 'Eat', 'Code']);
// {"Code", "Eat"}
```

- Use when you need to work with **unique** values
- Use when **high-performance** is *really* important
- Use to **remove duplicates** from arrays

OBJECTS VS. MAPS

OBJECTS

```
task = {
  task: 'Code',
  date: 'today',
  repeat: true
};
```

- More “traditional” key/value store (“abused” objects)
- Easier to write and access values with `.` and `[]`
- Use when you need to include **functions** (methods)
- Use when working with JSON (can convert to map)

MAPS

```
task = new Map([
  ['task', 'Code'],
  ['date', 'today'],
  [false, 'Start coding!']
]);
```

- Better performance
- Keys can have **any** data type
- Easy to iterate
- Easy to compute size
- Use when you simply need to map key to values
- Use when you need keys that are **not** strings

A CLOSER LOOK AT FUNCTIONS

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A CLOSER LOOK AT FUNCTIONS

LECTURE

FIRST-CLASS AND HIGHER-ORDER FUNCTIONS

JS

FIRST-CLASS VS. HIGHER-ORDER FUNCTIONS

FIRST-CLASS FUNCTIONS

- JavaScript treats functions as **first-class citizens**
- This means that functions are **simply values**
- Functions are just another **"type" of object**

- Store functions in variables or properties:

```
const add = (a, b) => a + b;
```

```
const counter = {
  value: 23,
  inc: function() { this.value++; }
```

- Pass functions as arguments to OTHER functions:

```
const greet = () => console.log('Hey Jonas');
btnClose.addEventListener('click', greet)
```

- Return functions FROM functions
- Call methods on functions:

```
counter.inc.bind(someOtherObject);
```

HIGHER-ORDER FUNCTIONS

- A function that **receives** another function as an argument, that **returns** a new function, or **both**
- This is only possible because of first-class functions

1. Function that receives another function

```
const greet = () => console.log('Hey Jonas');
btnClose.addEventListener('click', greet)
```

Higher-order function

Callback function

✅📞💬

2. Function that returns new function

```
function count() {
  let counter = 0;
  return function() {
    counter++;
  };
}
```

Higher-order function

Returned function

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A CLOSER LOOK AT FUNCTIONS

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CLOSURES

JS

"CREATING" A CLOSURE

```
const secureBooking = function () {
  let passengerCount = 0;

  return function () {
    passengerCount++;
    console.log(`${passengerCount} passengers`);
  };
};

const booker = secureBooking();
```

CALL STACK

Order in which functions were *called*

Order in which functions are *written in the code*

SCOPE CHAIN

UNDERSTANDING CLOSURES

secureBooking() EC

`passengerCount = 0`

- Variable environment (VE) that popped off stack after `secureBooking`
- Because of the closure, VE was **moved to heap and NOT garbage collected**
- **This execution context is where `booker` function was created!**

Global scope

`secureBooking = <f>`
`booker = <f>`

secureBooking() scope

`passengerCount = 0`

`secureBooking = <f>`
`booker = <f>`

booker() EC

`<empty>`

Global EC

`secureBooking = <f>`
`booker = <f>`

CALL STACK

```
const secureBooking = function () {
  let passengerCount = 0;

  return function () {
    passengerCount++;
    console.log(`${passengerCount}
    passengers`);
  };
};

const booker = secureBooking();

booker(); // 1 passengers
booker(); // 2 passengers
```

This is the function

booker() scope

`<empty>`

`secureBooking = <f>`
`booker = <f>`

How to access `passengerCount`?

SCOPE CHAIN

UNDERSTANDING CLOSURES

- A function has access to the variable environment (VE) of the execution context in which it was created
- **Closure:** VE attached to the function, exactly as it was at the time and place the function was created

CALL STACK

```
const secureBooking = function () {
  let passengerCount = 0;

  return function () {
    passengerCount++;
    console.log(`${passengerCount}
    passengers`);
  };
};

const booker = passengerCount = 2

booker(); // 1 passengers
booker(); // 2 passengers
```

This is the function

CLOSURE

How to access passengerCount?

SCOPE CHAIN

CLOSURES SUMMARY 🥳

- 👉 A closure is the closed-over **variable environment** of the execution context **in which a function was created**, even ***after*** that execution context is gone;

  ↓ Less formal

- 👉 A closure gives a function access to all the variables **of its parent function**, even ***after*** that parent function has returned. The function keeps a **reference** to its outer scope, which ***preserves*** the scope chain throughout time.

  ↓ Less formal

- 👉 A closure makes sure that a function doesn't loose connection to **variables that existed at the function's birth place**;

  ↓ Less formal

- 👉 A closure is like a **backpack** that a function carries around wherever it goes. This backpack has all the **variables that were present in the environment where the function was created**.

☝️ We do **NOT** have to manually create closures, this is a JavaScript feature that happens automatically. We can't even access closed-over variables explicitly. A closure is **NOT** a tangible JavaScript object.

WORKING WITH ARRAYS

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WORKING WITH ARRAYS

LECTURE

DATA TRANSFORMATIONS: MAP, FILTER, REDUCE

JS

DATA TRANSFORMATIONS WITH MAP, FILTER AND REDUCE

👉 `map` returns a **new array** containing the results of applying an operation on all original array elements

👉 `filter` returns a **new array** containing the array elements that passed a specified **test condition**

👉 `reduce` boils ("reduces") all array elements down to one single value (e.g. adding all elements together)

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WORKING WITH ARRAYS

LECTURE

SUMMARY: WHICH ARRAY METHOD TO USE?

JS

WHICH ARRAY METHOD TO USE? 🤔

"I WANT...:"

To *mutate* original

👉 Add to original:

- `.push` *(end)*
- `.unshift` *(start)*

👉 Remove from original:

- `.pop` *(end)*
- `.shift` *(start)*
- `.splice` *(any)*

👉 Others:

- `.reverse`
- `.sort`
- `.fill`

☝️ **These should usually be avoided!**

A *new* array based on original

👉 Same length as original:

- `.map` *(loop)*

👉 Filtered using condition:

- `.filter`

👉 Taking portion of original:

- `.slice`

👉 With one item replaced:

- `.with`

👉 Flattened:

- `.flat`
- `.flatMap`

👉 Reversed:

- `.toReversed`

👉 Sorted:

- `.toSorted`

👉 With deleted items:

- `.toSpliced`

👉 Joining two arrays:

- `.concat`

An array index

👉 Based on value:

- `.indexOf`

👉 Based on test condition:

- `.findIndex`
- `.findLastIndex`

An array element

👉 Based on test condition:

- `.find`
- `.findLast`

👉 Based on position:

- `.at`

Know if array includes

👉 Based on value:

- `.includes`

👉 Based on test condition:

- `.some`
- `.every`

A new string

👉 Based on separator:

- `.join`

To transform to value

👉 Based on accumulator:

- `.reduce`

(Boil down array to single value of any type: number, string, boolean, or even new array or object)

To just loop array

👉 Based on callback:

- `.forEach`

(Does not create a new array, just loops over it)

MORE ARRAY TOOLS AND TECHNIQUES

- **Grouping** an array by categories:

```
Object.groupBy
```

- Creating a new array **from scratch**:

```
Array.from
```

- Creating a new array **from scratch** with n empty positions (use together with `.fill` method):

```
new Array(n)
```

- **Joining** 2 or more arrays:

```
[...arr1, ...arr2]
```

- Creating a new array containing **unique** values from `arr`

```
[...new Set(arr)]
```

- Creating a new array containing unique elements that are present **in both** `arr1` and `arr2`

```
[...new Set(arr1).intersection(new Set(arr2))]
```

ADVANCED DOM AND EVENTS

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ADVANCED DOM AND EVENTS

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HOW THE DOM REALLY WORKS

JS

REVIEW: WHAT IS THE DOM?

DOM tree

- Allows us to make JavaScript interact with the browser;
- We can write JavaScript to create, modify and delete HTML elements; set styles, classes and attributes; and listen and respond to events;
- DOM tree is generated from an HTML document, which we can then interact with;
- DOM is a very complex API that contains lots of methods and properties to interact with the DOM tree

Application Programming Interface

```
.querySelector() / .addEventListener() / .createElement() /
.innerHTML / .textContent / .children / etc ...
```

"Types" of DOM objects (next slide)

HOW THE DOM API IS ORGANIZED BEHIND THE SCENES

MDN web docs
moz://a

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ADVANCED DOM AND EVENTS

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EVENT PROPAGATION: BUBBLING AND CAPTURING

JS

BUBBLING AND CAPTURING

```
<html>
  <head>
    <title>A Simple Page</title>
  </head>
  <body>
    <section>
      <p>A paragraph with a <a>link</a></p>
      <p>A second paragraph</p>
    </section>
    <section>
      <img src="dom.png" alt="The DOM" />
    </section>
  </body>
</html>
```

(THIS DOES NOT HAPPEN ON *ALL* EVENTS)

Click event

1 CAPTURING PHASE

2 TARGET PHASE

3 BUBBLING PHASE

```
document
  .querySelector('section')
  .addEventListener('click', () => {
  alert('You cliked me 😉');
});
```

127.0.0.1:8080 says

You cliked me 😉

```
document
  .querySelector('a')
  .addEventListener('click', () => {
  alert('You cliked me 😉');
});
```

127.0.0.1:8080 says

You cliked me 😉

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ADVANCED DOM AND EVENTS

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EFFICIENT SCRIPT LOADING: DEFER AND ASYNC

JS

DEFER AND ASYNC SCRIPT LOADING

HEAD

BODY END

REGULAR

```
<script src="script.js">
```

ASYNC

```
<script async src="script.js">
```

👉 Makes no sense 🤷

DEFER

```
<script defer src="script.js">
```

👉 Makes no sense 🤷

REGULAR VS. ASYNC VS. DEFER

END OF BODY

- Scripts are fetched and executed ***after the HTML is completely parsed***
- **Use if you need to support old browsers**

You can, of course, use **different strategies for different scripts**. Usually a complete web applications includes more than just one script

ASYNC IN HEAD

- Scripts are fetched ***asynchronously*** and executed ***immediately***
- Usually the `DOMContentLoaded` event waits for ***all*** scripts to execute, except for `async` scripts. So, `DOMContentLoaded` does ***not*** wait for an `async` script
- Scripts ***not*** guaranteed to execute in order
- **Use for 3rd-party scripts where order doesn't matter (e.g. Google Analytics)**

DEFER IN HEAD

- Scripts are fetched ***asynchronously*** and executed ***after the HTML is completely parsed***
- `DOMContentLoaded` event fires ***after*** `defer` script is executed
- Scripts are executed ***in order***
- **This is overall the best solution! Use for your own scripts, and when order matters (e.g. including a library)**

OBJECT ORIENTED PROGRAMMING (OOP) WITH JAVASCRIPT

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OBJECT ORIENTED PROGRAMMING (OOP) WITH JAVASCRIPT

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WHAT IS OBJECT-ORIENTED PROGRAMMING?

JS

WHAT IS OBJECT-ORIENTED PROGRAMMING? (OOP)

OOP

Data

```
const user = {
  user: 'jonas',
  password: 'dk23s',

  login(password) {
    // Login logic
  },
  sendMessage(str) {
    // Sending logic
  }
}
```

Behaviour

Style of code, “how” we write and organize code

- Object-oriented programming (OOP) is a programming paradigm based on the concept of objects;

E.g. user or todo list item

- We use objects to **model** (describe) real-world or abstract features;

E.g. HTML component or data structure

- Objects may contain data (properties) and code (methods). By using objects, we pack **data and the corresponding behavior** into one block;
- In OOP, objects are **self-contained** pieces/blocks of code;
- Objects are **building blocks** of applications, and **interact** with one another;
- Interactions happen through a **public interface** (API): methods that the code **outside** of the object can access and use to communicate with the object;
- OOP was developed with the goal of **organizing** code, to make it **more flexible and easier to maintain** (avoid “spaghetti code”).

CLASSES AND INSTANCES (TRADITIONAL OOP)

Like a blueprint from which we can create new objects

CLASS

```
User {
  user
  password
  email

  login(password) {
    // Login logic
  }
  sendMessage(str) {
    // Sending logic
  }
}
```

Just a representation, NOT actual JavaScript syntax!

JavaScript does NOT support *real* classes like represented here

```
new User('jonas')
```

```
new User('mary')
```

```
new User('steven')
```

Instance

```
{
  user = 'jonas'
  password = 'dk23s'
  email = 'hello@jonas.io'

  login(password) {
    // Login logic
  }
  sendMessage(str) {
    // Sending logic
  }
}
```

New object created from the class. Like a *real* house created from an *abstract* blueprint

Instance

```
{
  user = 'mary'
  password = 'qwerty23'
  email = 'mary@test.com'

  login(password) {
    // Login logic
  }
  sendMessage(str) {
    // Sending logic
  }
}
```

Instance

```
{
  user = 'steven'
  password = '5p8dz32dd'
  email = 'steven@tes.co'

  login(password) {
    // Login logic
  }
  sendMessage(str) {
    // Sending logic
  }
}
```

☝ Conceptual overview: it works a bit **differently** in JavaScript. Still important to understand!

THE 4 FUNDAMENTAL OOP PRINCIPLES

- Abstraction
- Encapsulation
- Inheritance
- Polymorphism

The 4 fundamental principles of Object-Oriented Programming

🤔 *"How do we actually design classes? How do we model real-world data into classes?"*

PRINCIPLE 1: ABSTRACTION

- **Abstraction**
- Encapsulation
- Inheritance
- Polymorphism

```
Phone {
  charge
  volume
  voltage
  temperature

  homeBtn() {}
  volumeBtn() {}
  screen() {}
  verifyVolt() {}
  verifyTemp() {}
  vibrate() {}
  soundSpeaker() {}
  soundEar() {}
  frontCamOn() {}
  frontCamOff() {}
  rearCamOn() {}
  rearCamOff() {}
}
```

Real phone

Abstracted phone

```
Phone {
  charge
  volume

  homeBtn() {}
  volumeBtn() {}
  screen() {}
}
```

Details have been abstracted away

Do we *really need* all these low-level details?

👉 **Abstraction:** Ignoring or hiding details that **don't matter**, allowing us to get an **overview** perspective of the *thing* we're implementing, instead of messing with details that don't really matter to our implementation.

PRINCIPLE 2: ENCAPSULATION

Abstraction

Encapsulation

Inheritance

Polymorphism

NOT accessible from **outside the class!**

STILL accessible from **within the class!**

STILL accessible from **within the class!**

NOT accessible from **outside the class!**

```
User {
  user
  private password
  private email

  login(word) {
    this.password === word
  }
  comment(text) {
    this.checkSPAM(text)
  }
  private checkSPAM(text) {
    // Verify logic
  }
}
```

Again, **NOT** actually JavaScript syntax (the `private` keyword doesn't exist)

WHY?

- 👉 Prevents external code from accidentally manipulating internal properties/state
- 👉 Allows to change internal implementation without the risk of breaking external code

👉 **Encapsulation:** Keeping properties and methods **private** inside the class, so they are **not accessible from outside the class**. Some methods can be **exposed** as a public interface (API).

PRINCIPLE 3: INHERITANCE

Abstraction

Encapsulation

Inheritance

Polymorphism

👉 **Inheritance:** Making all properties and methods of a certain class **available to a child class**, forming a hierarchical relationship between classes. This allows us to **reuse common logic** and to model real-world relationships.

PRINCIPLE 4: POLYMORPHISM

- Abstraction
- Encapsulation
- Inheritance
- Polymorphism

INHERITANCE

```
User {
  user
  password
  email

  login(password) {
    // Login logic
  }
  sendMessage(str) {
    // Sending logic
  }
}
```

PARENT CLASS

INHERITANCE

```
Admin {
  user
  password
  email
  permissions

  login(password, key) {
    // DIFFERENT LOGIN
  }
  deleteUser(user) {
    // Deleting logic
  }
}
```

CHILD CLASS

```
Author {
  user
  password
  email
  posts

  login(password) {
    // MORE DIFFERENT
  }
  writePost() {
    // Writing logic
  }
}
```

CHILD CLASS

Own `login` method, **overwriting** `login` method inherited from `User`

👉 **Polymorphism:** A child class can **overwrite** a method it inherited from a parent class [it's more complex that that, but enough for our purposes].

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LECTURE

OOP IN JAVASCRIPT

JS

OOP IN JAVASCRIPT: PROTOTYPES

"CLASSICAL OOP": CLASSES

Class

↓ INSTANTIATION

Instance

- Objects (instances) are **instantiated** from a class, which functions like a blueprint;
- Behavior (methods) is **copied** from class to all instances.

OOP IN JS: PROTOTYPES

Prototype ← Contains methods

↑ PROTOTYPAL INHERITANCE/ DELEGATION

Object ← Can access methods

- Objects are **linked** to a prototype object;
- **Prototypal inheritance:** The prototype contains methods (behavior) that are **accessible to all objects linked to that prototype;**
- Behavior is **delegated** to the linked prototype object.

Example: Array

```
const num = [1, 2, 3];
num.map(v => v * 2);
```

MDN web docs
moz://a

```
Array.prototype.keys()
Array.prototype.lastIndexOf()
Array.prototype.map()
```

`Array.prototype` is the **prototype** of all array objects we create in JavaScript

Therefore, **all** arrays have access to the `map` method!

```
▼ ƒ Array() ⓘ
    arguments: (...)
    caller: (...)
    length: 1
    name: "Array"
  ▼ prototype: Array(0)
    ▶ unique: ƒ ()
      length: 0
    ▶ constructor: ƒ Array()
    ▶ concat: ƒ concat()
    ▶ map: ƒ map()
```

3 WAYS OF IMPLEMENTING PROTOTYPAL INHERITANCE IN JAVASCRIPT

🤔 *"How do we actually create prototypes? And how do we link objects to prototypes? How can we create new objects, without having classes?"*

☝️ **The 4 pillars of OOP are still valid!**

- 👉 Abstraction
- 👉 Encapsulation
- 👉 Inheritance
- 👉 Polymorphism

1 Constructor functions

- 👉 Technique to create objects from a function;
- 👉 This is how built-in objects like Arrays, Maps or Sets are actually implemented.

2 ES6 Classes

- 👉 Modern alternative to constructor function syntax;
- 👉 "Syntactic sugar": behind the scenes, ES6 classes work **exactly** like constructor functions;
- 👉 ES6 classes do **NOT** behave like classes in "classical OOP" (last lecture).

3 `Object.create()`

- 👉 The easiest and most straightforward way of linking an object to a prototype object.

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PROTOTYPAL INHERITANCE AND THE PROTOTYPE CHAIN

JS

HOW PROTOTYPAL INHERITANCE / DELEGATION WORKS

Constructor function
[Person()]

```
const Person = function(name, birthYear) {
  this.name = name;
  this.birthYear = birthYear;
};
```

`.prototype` →

← `.constructor`

NOT of `Person`, but objects created by `Person`

Prototype
[Person.prototype]

`calcAge: function`

PROTOTYPE CHAIN

PROTOTYPAL INHERITANCE/ DELEGATION

`.__proto__`

```
const jonas = new Person('Jonas', 1990);

jonas.calcAge(); // 47
```

Can't find `calcAge` here!

Object
[jonas]

`name: 'Jonas'`

`birthYear: 1990`

`__proto__: Person.prototype`

Always points to an object's prototype

🆕 **The new operator:**

1. An empty object is created
2. `this` keyword in constructor function call is set to the new object
3. **The new object is linked (`__proto__` property) to the constructor function's prototype property**
4. The new object is returned from the constructor function call

☝️ This is how it works with **function constructors** and **ES6 classes**

THE PROTOTYPE CHAIN

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OBJECT.CREATE

JS

HOW OBJECT.CREATE WORKS

Prototype
[PersonProto]

calcAge: *function*

```
const PersonProto = {
  calcAge() {
    console.log(2037 - this.birthYear);
  },
};
```

.__proto__

```
const steven = Object.create(PersonProto);
```

Object
[steven]

name: 'Steven'

birthYear: 2002

proto : PersonProto

OBJECT.CREATE

CONSTRUCTOR FUNCTIONS

~~Constructor function~~
~~[Person()]~~

~~.prototype~~

Prototype
[Person.prototype]

calcAge: *function*

AUTOMATIC
.__proto__

```
const jonas = new Person('Jonas', 1990);
```

Object
[jonas]

name: 'Jonas'

birthYear: 1990

__proto__: Person.prototype

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INHERITANCE BETWEEN "CLASSES": CONSTRUCTOR FUNCTIONS

JS

INHERITANCE BETWEEN "CLASSES"

1. Constructor functions
2. ES6 Classes
3. `Object.create()`

☝ Using class terminology here to make it easier to understand.

INHERITANCE BETWEEN "CLASSES"

INHERITANCE BETWEEN "CLASSES"

```
Student.prototype = Object.create(Person.prototype);
```

👍 GOOD

```
Student.prototype = Person.prototype;
```

👎 BAD

INHERITANCE BETWEEN "CLASSES"

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OBJECT ORIENTED PROGRAMMING (OOP) WITH JAVASCRIPT

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INHERITANCE BETWEEN "CLASSES": OBJECT.CREATE

JS

INHERITANCE BETWEEN "CLASSES": OBJECT.CREATE

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ES6 CLASSES SUMMARY

JS

Public field (similar to property, available on created object)

Private fields (not accessible **outside** of class)

Static public field (available **only** on **class**)

Call to parent (super) class (necessary with `extend`). Needs to happen before accessing `this`

Instance property (available on created object)

Redefining private field

Public method

Referencing private field and method

Private method (⚠️ Might not yet work in your browser. "Fake" alternative: _ instead of #)

Getter method

Setter method (use _ to set property with same name as method, and also add getter)

Static method (available **only** on **class**. Can **not** access instance properties nor methods, only static ones)

Creating new object with new operator

```
class Student extends Person {
  university = 'University of Lisbon';
  #studyHours = 0;
  #course;
  static numSubjects = 10;

  constructor(fullName, birthYear, startYear, course) {
    super(fullName, birthYear);

    this.startYear = startYear;

    this.#course = course;
  }

  introduce() {
    console.log(`I study ${this.#course} at ${this.university}`);
  }

  study(h) {
    this.#makeCoffe();
    this.#studyHours += h;
  }

  #makeCoffe() {
    return 'Here is a coffe for you 🧑';
  }

  get testScore() {
    return this._testScore;
  }

  set testScore(score) {
    this._testScore = score ≤ 20 ? score : 0;
  }

  static printCurriculum() {
    console.log(`There are ${this.numSubjects} subjects`);
  }
}

const student = new Student('Jonas', 2020, 2037, 'Medicine');
```

Parent class

Inheritance between classes, automatically sets prototype

Child class

Constructor method, called by new operator. Mandatory in regular class, might be omitted in a **child** class

- 👉 Classes are just "**syntactic sugar**" over constructor functions
- 👉 Classes are **not** hoisted
- 👉 Classes are **first-class** citizens
- 👉 Class body is always executed in **strict mode**

MAPTY APP: OOP, GEOLOCATION, EXTERNAL LIBRARIES, AND MORE!

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HOW TO PLAN A WEB PROJECT

JS

PROJECT PLANNING

Description of the application's functionality from the **user's perspective**. All user stories put together describe the entire application.

WHAT we will build

HOW we will build it

1. USER STORIES → 2. FEATURES → 3. FLOWCHART → 4. ARCHITECTURE → DEVELOPMENT STEP

PLANNING STEP

Implementation of our plan using code

1. USER STORIES

mapty

- **User story:** Description of the application's functionality from the user's perspective.
- **Common format:** As a *[type of user]*, I want *[an action]* so that *[a benefit]*

Who? Example: user, admin, etc. **What?** **Why?**

1. As a user, I want to **log my running workouts with location, distance, time, pace and steps/minute**, so I can keep a log of all my running
2. As a user, I want to **log my cycling workouts with location, distance, time, speed and elevation gain**, so I can keep a log of all my cycling
3. As a user, I want to **see all my workouts at a glance**, so I can easily track my progress over time
4. As a user, I want to **also see my workouts on a map**, so I can easily check where I work out the most
5. As a user, I want to **see all my workouts when I leave the app and come back later**, so that I can keep using there app over time

2. FEATURES

mapty

USER STORIES	FEATURES
1 Log my **running** workouts with location, distance, time, pace and steps/minute	👉 Map where user clicks to add new workout (best way to get location coordinates) 👉 Geolocation to display map at current location (more user friendly) 👉 Form to input distance, time, pace, steps/minute
2 Log my **cycling** workouts with location, distance, time, speed and elevation gain	👉 Form to input distance, time, speed, elevation gain
3 See all my workouts at a glance	👉 Display all workouts in a list
4 See my workouts on a map	👉 Display all workouts on the map
5 See all my workouts when I leave the app and come back later	👉 Store workout data in the browser using local storage API 👉 On page load, read the saved data from local storage and display

3. FLOWCHART

mapty

FEATURES

1. Geolocation to display map at current location
2. Map where user clicks to add new workout
3. Form to input distance, time, pace, steps/minute
4. Form to input distance, time, speed, elevation gain
5. Display workouts in a list
6. Display workouts on the map
7. Store workout data in the browser
8. On page load, read the saved data and display
9. Move map to workout location on click

Added later

☝ In the real-world, you don't have to come with the final flowchart right in the planning phase. It's normal that it changes throughout implementation!

FOR NOW, LET'S JUST START CODING 😍

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FINAL CONSIDERATIONS

JS

10 ADDITIONAL FEATURE IDEAS: CHALLENGES 🤓

mapty

- 👉 Ability to **edit** a workout;
- 👉 Ability to **delete** a workout;
- 👉 Ability to **delete all** workouts;
- 👉 Ability to **sort** workouts by a certain field (e.g. distance);
- 👉 **Re-build** `Running` and `Cycling` objects coming from Local Storage;
- 👉 More realistic error and confirmation **messages**;
- 👉 Ability to position the map to **show all workouts** [very hard];
- 👉 Ability to **draw lines and shapes** instead of just points [very hard];
- 👉 **Geocode location** from coordinates (“Run in Faro, Portugal”) [only after asynchronous JavaScript section];
- 👉 **Display weather** data for workout time and place [only after asynchronous JavaScript section].

ASYNCHRONOUS JAVASCRIPT: PROMISES, ASYNC/AWAIT AND AJAX

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ASYNCHRONOUS JAVASCRIPT, AJAX AND APIS

JS

SYNCHRONOUS CODE

BLOCKING

```
const p = document.querySelector('.p');
p.textContent = 'My name is Jonas!';
alert('Text set!');
p.style.color = 'red';
```

Part of execution context that actually executes the code in computer's CPU

SYNCHRONOUS

- 👉 Most code is **synchronous**;
- 👉 Synchronous code is **executed line by line**;
- 👉 Each line of code **waits** for previous line to finish;
- 👎 Long-running operations **block** code execution.

ASYNCHRONOUS CODE

Asynchronous

CALLBACK WILL RUN AFTER TIMER

```
const p = document.querySelector('.p');
setTimeout(function () {
  p.textContent = 'My name is Jonas!';
}, 5000);
p.style.color = 'red';
```

👉 **Example:** Timer with callback

```
[1, 2, 3].map(v => v * 2);
```

Callback does NOT automatically make code asynchronous!

Executed after all other code

ASYNCHRONOUS

Coordinating behavior of a program over a period of time

- 👉 Asynchronous code is executed **after a task that runs in the "background" finishes**;
- 👍 Asynchronous code is **non-blocking**;
- 👉 Execution doesn't wait for an asynchronous task to finish its work;
- 👉 Callback functions alone do **NOT** make code asynchronous!

ASYNCHRONOUS CODE

Asynchronous

CALLBACK WILL RUN AFTER IMAGE LOADS

```
const img = document.querySelector('.dog');
img.src = 'dog.jpg';
img.addEventListener('load', function () {
  img.classList.add('fadeIn');
});
p.style.width = '300px';
```

`addEventListener` does NOT automatically make code asynchronous!

👉 **Example:** Asynchronous image loading with event and callback

👉 **Other examples:** Geolocation API or **AJAX calls**

ASYNCHRONOUS

Coordinating behavior of a program over a period of time

👉 Asynchronous code is executed **after a task that runs in the "background" finishes**;

👍 Asynchronous code is **non-blocking**;

👉 Execution doesn't wait for an asynchronous task to finish its work;

👉 Callback functions alone do **NOT** make code asynchronous!

WHAT ARE AJAX CALLS?

AJAX

Asynchronous **J**avaScript **A**nd **X**ML: Allows us to communicate with remote web servers in an **asynchronous way**. With AJAX calls, we can **request data** from web servers dynamically.

WHAT IS AN API?

API

- **A**pplication **P**rogramming **I**nterface: Piece of software that can be used by another piece of software, in order to allow **applications to talk to each other**;
- There are be many types of APIs in web development:

  DOM API | Geolocation API | Own Class API | **"Online" API**

  Just "API"
- **"Online" API:** Application running on a server, that receives requests for data, and sends data back as response;
- We can build **our own** web APIs (requires back-end development, e.g. with node.js) or use **3rd-party** APIs.

There is an API for everything

- Weather data
- Data about countries
- Flights data
- Currency conversion data
- APIs for sending email or SMS
- Google Maps
- *Millions of possibilities...*

AJAX

~~XML data format~~

JSON data format


```
{
  "publisher": "101 Cookbooks",
  "title": "Best Pizza Dough Ever",
  "source_url": "http://www.101cookbo
  "recipe_id": "47746",
  "image_url": "http://forkify-api.he
  "social_rank": 100,
  "publisher_url": "http://www.101coo
},
```


Most popular API data format

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ASYNCHRONOUS JAVASCRIPT: PROMISES, ASYNC/AWAIT AND AJAX

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HOW THE WEB WORKS: REQUESTS AND RESPONSES

JS

WHAT HAPPENS WHEN WE ACCESS A WEB SERVER

👉 **Request-response model** or **Client-server architecture**

WHAT HAPPENS WHEN WE ACCESS A WEB SERVER

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PROMISES AND THE FETCH API

JS

WHAT ARE PROMISES?

PROMISE

- **Promise:** An object that is used as a placeholder for the future result of an asynchronous operation.

  ↓ Less formal

- **Promise:** A container for an asynchronously delivered value.

  ↓ Less formal

- **Promise:** A container for a future value.

  Example: Response from AJAX call

- We no longer need to rely on events and callbacks passed into asynchronous functions to handle asynchronous results;
- Instead of nesting callbacks, we can **chain promises** for a sequence of asynchronous operations: **escaping callback hell** 🎉

Promise that I will receive money if I guess correct outcome

🤞 I buy lottery ticket (promise) right now

↓

🔮 Lottery draw happens asynchronously

↓

💰 If correct outcome, I receive money, because it was promised

THE PROMISE LIFECYCLE

👉 We are able **handle** these different states in our code!

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ASYNCHRONOUS JAVASCRIPT: PROMISES, ASYNC/AWAIT AND AJAX

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ASYNCHRONOUS BEHIND THE SCENES: THE EVENT LOOP

JS

REVIEW: JAVASCRIPT RUNTIME

👉 **Concurrency model**: How JavaScript handles multiple tasks happening at the same time.

"Container" which includes all the pieces necessary to execute JavaScript code

"Heart" of the runtime

APIs provided to the engine

Sends callbacks from queue to call stack

Ready-to-be-executed callback functions (coming from events)

Where object are stored in memory

Where code is actually executed → Only ONE thread of execution. No multitasking!

HOW ASYNCHRONOUS JAVASCRIPT WORKS BEHIND THE SCENES

Where asynchronous tasks run

CALL STACK

EVENT LOOP

Decides when each callback is executed: orchestration

WEB APIs

Loading image

```
() => {
  el.classList.add('fadeIn');
}
```

Fetching data

```
res => console.log(res)
```

fetch()

setTimeout()

DOM()

...

```
el = document.querySelector('img');
el.src = 'dog.jpg';
el.addEventListener('load', () => {
  el.classList.add('fadeIn');
});

fetch('https://someurl.com/api')
  .then(res => console.log(res));

// More code ...
```

MICROTASKS QUEUE

Like callback queue, but for callbacks related to **promises**. Has **priority** over callback queue!

Some callback

Another callback

CALLBACK QUEUE

🤔 How can **asynchronous** code be executed in a **non-blocking way**, if there is **only one thread** of execution in the engine?

MODERN JAVASCRIPT DEVELOPMENT: MODULES AND TOOLING

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MODERN JAVASCRIPT DEVELOPMENT: MODULES AND TOOLING

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AN OVERVIEW OF MODERN JAVASCRIPT DEVELOPMENT

JS

MODERN JAVASCRIPT DEVELOPMENT

- Contains open-source packages to **include 3rd-party code in our own code** (e.g React, jQuery, Leaflet, etc.)
- Contains **development tools** that help build our applications (e.g. live-server, Parcel, Babel, etc.)

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AN OVERVIEW OF MODULES IN JAVASCRIPT

JS

AN OVERVIEW OF MODULES

MODULE

- Reusable piece of code that **encapsulates** implementation details;
- Usually a **standalone file**, but it doesn't have to be.

WHY MODULES?

- **Compose software:** Modules are small building blocks that we put together to build complex applications;
- **Isolate components:** Modules can be developed in isolation without thinking about the entire codebase;
- **Abstract code:** Implement low-level code in modules and import these abstractions into other modules;
- **Organized code:** Modules naturally lead to a more organized codebase;
- **Reuse code:** Modules allow us to easily reuse the same code, even across multiple projects.

IMPORT (DEPENDENCY)

MODULE

```
import { rand } from './math.js';
const diceP1 = rand(1, 6, 2);
const diceP2 = rand(1, 6, 2);
const scores = { diceP1, diceP2 };
export { scores };
```

Module code

EXPORT (PUBLIC API)

NATIVE JAVASCRIPT (ES6) MODULES

ES6 MODULES

Modules stored in files, **exactly one module per file.**

```
import { rand } from './math.js';
const diceP1 = rand(1, 6, 2);
const diceP2 = rand(1, 6, 2);
const scores = { diceP1, diceP2 };
export { scores };
```

`import` and `export` syntax

	ES6 MODULE	SCRIPT
👉 **Top-level variables**	Scoped to module	Global
👉 **Default mode**	Strict mode	“Sloppy” mode
👉 **Top-level `this`**	`undefined`	`window`
👉 **Imports and exports**	✅ YES	🚫 NO
👉 **HTML linking**	`<script type="module">`	`<script>`
👉 **File downloading**	Asynchronous	Synchronous

☝️ Need to happen at top-level

Imports are hoisted!

HOW ES6 MODULES ARE IMPORTED

```
import { rand } from './math.js';
import { showDice } from './dom.js';
const dice = rand(1, 6, 2);
showDice(dice);
```

👉 index.js

```
const rand = () => {
  // Random numbers
};
export { rand };
```

👉 math.js

```
const showDice = () => {
  // Display dice
};
export { showDice };
```

👉 dom.js

Live connection, NOT copies

Live connection, NOT copies

Parsing `index.js`

Asynchronous downloading `math.js`

Asynchronous downloading `dom.js`

Linking imports to `math.js` exports

Linking imports to `dom.js` exports

Execution `math.js`

Execution `dom.js`

Execution `index.js`

IMPORTING MODULES BEFORE EXECUTION

- 👉 Modules are **imported synchronously**
- 👉 Possible thanks to top-level (“static”) imports, which make **imports known before execution**
- 👉 This makes **bundling** and **dead code elimination** possible

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MODERN JAVASCRIPT DEVELOPMENT: MODULES AND TOOLING

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REVIEW: WRITING CLEAN AND MODERN JAVASCRIPT

JS

REVIEW: MODERN AND CLEAN CODE

READABLE CODE

- 👉 Write code so that **others** can understand it
- 👉 Write code so that **you** can understand it in 1 year
- 👉 Avoid too “clever” and overcomplicated solutions
- 👉 Use descriptive variable names: **what they contain**
- 👉 Use descriptive function names: **what they do**

GENERAL

- 👉 Use DRY principle (refactor your code)
- 👉 Don’t pollute global namespace, encapsulate instead
- 👉 Don’t use `var`
- 👉 Use strong type checks (=== and `!`==)

FUNCTIONS

- 👉 Generally, functions should do **only one thing**
- 👉 Don’t use more than 3 function parameters
- 👉 Use default parameters whenever possible
- 👉 Generally, return same data type as received
- 👉 Use arrow functions when they make code more readable

OOP

- 👉 Use ES6 classes
- 👉 Encapsulate data and **don’t mutate** it from outside the class
- 👉 Implement method chaining
- 👉 Do **not** use arrow functions as methods (in regular objects)

REVIEW: MODERN AND CLEAN CODE

AVOID NESTED CODE

- 👉 Use early `return` (guard clauses)
- 👉 Use ternary (conditional) or logical operators instead of `if`
- 👉 Use multiple `if` instead of `if/else-if`
- 👉 Avoid `for` loops, use array methods instead
- 👉 Avoid callback-based asynchronous APIs

ASYNCHRONOUS CODE

- 👉 Consume promises with async/await for best readability
- 👉 Whenever possible, run promises in **parallel** (`Promise.all`)
- 👉 Handle errors and promise rejections

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DECLARATIVE AND FUNCTIONAL JAVASCRIPT PRINCIPLES

JS

IMPERATIVE VS. DECLARATIVE CODE

Two fundamentally different ways of writing code (paradigms)

IMPERATIVE

- Programmer explains **"HOW to do things"**
- We explain the computer *every single step* it has to follow to achieve a result
- **Example:** Step-by-step recipe of a cake

```
const arr = [2, 4, 6, 8];
const doubled = [];
for (let i = 0; i < arr.length; i++)
  doubled[i] = arr[i] * 2;
```

DECLARATIVE

- Programmer tells **"WHAT do do"**
- We simply *describe* the way the computer should achieve the result
- The **HOW** (step-by-step instructions) gets abstracted away
- **Example:** Description of a cake

```
const arr = [2, 4, 6, 8];
const doubled = arr.map(n => n * 2);
```

FUNCTIONAL PROGRAMMING PRINCIPLES

FUNCTIONAL PROGRAMMING

- **Declarative** programming paradigm
- Based on the idea of writing software by combining many **pure functions**, avoiding **side effects** and **mutating** data
- **Side effect:** Modification (mutation) of any data **outside** of the function (mutating external variables, logging to console, writing to DOM, etc.)
- **Pure function:** Function without side effects. Does not depend on external variables. **Given the same inputs, always returns the same outputs**.
- **Immutability:** State (data) is **never** modified! Instead, state is **copied** and the copy is mutated and returned.
- **Examples:** React Redux

FUNCTIONAL PROGRAMMING TECHNIQUES

- Try to avoid data mutations
- Use built-in methods that don't produce side effects
- Do data transformations with methods such as `.map()`, `.filter()` and `.reduce()`
- Try to avoid side effects in functions: this is of course not always possible!

DECLARATIVE SYNTAX

- Use array and object destructuring
- Use the spread operator (`...`)
- Use the ternary (conditional) operator
- Use template literals

FORKIFY APP: BUILDING A MODERN APPLICATION

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FORKIFY APP: BUILDING A MODERN APPLICATION

LECTURE

PROJECT OVERVIEW AND PLANNING

JS

PROJECT PLANNING

1. USER STORIES

forkify

- **User story:** Description of the application's functionality from the user's perspective.
- **Common format:** As a *[type of user]*, I want *[an action]* so that *[a benefit]*

1. As a user, I want to **search for recipes**, so that I can find new ideas for meals
2. As a user, I want to be able to **update the number of servings**, so that I can cook a meal for different number of people
3. As a user, I want to **bookmark recipes**, so that I can review them later
4. As a user, I want to be able to **create my own recipes**, so that I have them all organized in the same app
5. As a user, I want to be able to **see my bookmarks and own recipes when I leave the app and come back later**, so that I can close the app safely after cooking

2. FEATURES

forkify

USER STORIES	FEATURES
1 Search for recipes	👉 Search functionality: input field to send request to API with searched keywords 👉 Display results with pagination 👉 Display recipe with cooking time, servings and ingredients
2 Update the number of servings	👉 Change servings functionality: update all ingredients according to current number of servings
3 Bookmark recipes	👉 Bookmarking functionality: display list of all bookmarked recipes
4 Create my own recipes	👉 User can upload own recipes 👉 User recipes will automatically be bookmarked 👉 User can only see their own recipes, not recipes from other users
5 See my bookmarks and own recipes when I leave the app and come back later	👉 Store bookmark data in the browser using local storage 👉 On page load, read saved bookmarks from local storage and display

3. FLOWCHART (PART 1)

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FEATURES

1. Search functionality: API search request
2. Results with pagination
3. Display recipe

Other features later

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FORKIFY APP: BUILDING A MODERN APPLICATION

LECTURE

THE MVC ARCHITECTURE

JS

WHY WORRY ABOUT ARCHITECTURE?

👉 Like a house, software needs a structure: the way we **organize our code**

The perfect architecture

- 👉 We can create our own architecture (Mapty project)
- 👉 We can use a well-established architecture pattern like MVC, MVP, Flux, etc. (**this project**)
- 👉 We can use a framework like React, Angular, Vue, Svelte, etc.

👉 A project is never done! We need to be able to easily **change it in the future**

👉 We also need to be able to easily **add new features**

COMPONENTS OF ANY ARCHITECTURE

BUSINESS LOGIC

- Code that **solves the actual business problem**;
- Directly related to what business does and what it needs;
- **Example:** sending messages, storing transactions, calculating taxes, …

STATE

- Essentially **stores all the data** about the application
- Should be the "single source of truth"
- UI should be kept in sync with the state
- State libraries exist

HTTP LIBRARY

- Responsible for making and receiving AJAX requests
- Optional but almost always necessary in real-world apps

APPLICATION LOGIC (ROUTER)

- Code that is only concerned about the **implementation of application itself**;
- Handles navigation and UI events

PRESENTATION LOGIC (UI LAYER)

- Code that is concerned about the **visible part** of the application
- Essentially displays application state

Keeping in sync

THE MODEL-VIEW-CONTROLLER (MVC) ARCHITECTURE

BUSINESS LOGIC

STATE

HTTP LIBRARY

APPLICATION LOGIC

- 👉 Bridge between model and views (which don't know about one another)
- 👉 Handles UI events and **dispatches tasks to model and view**

PRESENTATION LOGIC

→ Connected by function call and import

⇢ Data flow

MODEL, VIEW AND CONTROLLER IN FORKIFY (RECIPE DISPLAY ONLY)

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MVC IMPLEMENTATION (RECIPE DISPLAY ONLY)

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FORKIFY APP: BUILDING A MODERN APPLICATION

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EVENT HANDLERS IN MVC: PUBLISHER-SUBSCRIBER PATTERN

JS

EVENT HANDLING IN MVC: PUBLISHER-SUBSCRIBER PATTERN

forkify

- 👉 `controlRecipes` will be passed into `addHandlerRender` when program starts
- 👉 `addHandlerRender` listens for events (`addEventListener`), and uses `controlRecipes` as callback

- 👉 Events should be **handled** in the **controller** (otherwise we would have application logic in the view)
- 👉 Events should be **listened for** in the **view** (otherwise we would need DOM elements in the controller)

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FORKIFY APP: BUILDING A MODERN APPLICATION

LECTURE

WRAPPING UP: FINAL CONSIDERATIONS

JS

IMPROVEMENT AND FEATURE IDEAS: CHALLENGES 🤓

forkify

- 👉 Display **number of pages** between the pagination buttons;
- 👉 Ability to **sort** search results by duration or number of ingredients;
- 👉 Perform **ingredient validation** in view, before submitting the form;
- 👉 **Improve recipe ingredient input**: separate in multiple fields and allow more than 6 ingredients;
- 👉 **Shopping list feature**: button on recipe to add ingredients to a list;
- 👉 **Weekly meal planning feature**: assign recipes to the next 7 days and show on a weekly calendar;
- 👉 **Get nutrition data** on each ingredient from spoonacular API (https://spoonacular.com/food-api) and calculate total calories of recipe.

END