Complete Full Stack JavaScript Revision Guide

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1. Introduction to JavaScript (Full Stack Perspective)

Theory: JavaScript (JS) is a high-level, interpreted programming language. In the context of Full Stack Web Development, JavaScript is unique because it is the *only* language that runs natively in the web browser (Frontend) and can also run on the server (Backend) using environments like Node.js.

- **Frontend (The Client):** JS adds interactivity to websites. If HTML is the skeleton and CSS is the skin/clothing, JavaScript is the muscles and nervous system (handling clicks, fetching data, updating the screen dynamically).
- **Backend (The Server):** Using Node.js, JS handles database connections, user authentication, and API creation.

Key Characteristics:

- **Dynamically Typed:** You don't have to declare a variable's type (e.g., integer, string) explicitly.
- **Single-Threaded & Non-Blocking:** It does one thing at a time but can offload heavy tasks (like database queries) to the background, keeping the application responsive.

How to Run JavaScript

Depending on where you are working in the stack, JS is executed differently.

1. In the Browser (Frontend)

You connect a JavaScript file to your HTML document using the `<script>` tag. Place it just before the closing `</body>` tag so the HTML loads first.

Syntax:

```
<!DOCTYPE html>
<html>
<head>
    <title>My Full Stack App</title>
</head>
<body>
    <h1>Hello World</h1>

    <script src="app.js"></script>
</body>
</html>
```

1.1 The Frontend: JavaScript in the Browser

When you visit a website, the server sends three main files to your browser: HTML, CSS, and JavaScript.

- **HTML:** The structure (text, images, buttons).
- **CSS:** The design (colors, layouts, fonts).
- **JavaScript:** The behavior (what happens when you click a button, fetching new data without reloading the page, animations).

How it works: Every modern browser (Chrome, Firefox, Safari) has a built-in "JavaScript Engine." For example, Google Chrome uses the **V8 Engine**. This engine takes the human-readable JS code you write and compiles it into machine code that your computer can understand on the fly.

> **Key Concept: The DOM** In the browser, JS has access to the **DOM (Document Object Model)**. The DOM is essentially an object-oriented representation of your HTML. JS uses the DOM to change the page dynamically.

1.2 The Backend: Why We Need Node.js

For a long time, JavaScript was "trapped" inside the web browser. If you wanted to build a server or talk to a database, you had to learn a completely different language like PHP, Python, Java, or Ruby.

The Node.js Revolution: In 2009, a developer named Ryan Dahl took the **V8 Engine** out of Google Chrome and embedded it inside a C++ program called **Node.js**.

What is Node.js? Node.js is **not** a programming language, and it is **not** a framework. It is a **Runtime Environment**. It allows you to run JavaScript directly on your computer's operating system or a server, completely independent of a web browser.

Why Node.js is powerful for Full Stack:

1. **JavaScript Everywhere:** You can write both your frontend user interface (e.g., React, Vue) and your backend API (e.g., Express.js) using the exact same language. This drastically speeds up development.
2. **Non-Blocking I/O:** Traditional server languages often handle requests linearly (waiting for one database query to finish before moving to the next). Node.js is asynchronous. It can handle thousands of simultaneous requests (like reading files or querying databases) in the background without freezing, making it incredibly fast for web applications.

1.3 ECMAScript vs. JavaScript

As you read documentation, you will constantly see the terms "ES6" or "ECMAScript."

- **ECMAScript:** This is the official *rulebook* or standard for the language.
- **JavaScript:** This is the actual language that *implements* those rules.
- **ES6 (ECMAScript 2015):** This was a massive update to the language that introduced modern features you will use daily (arrow functions, classes, `let`/`const`, promises).

1.4 Syntax and Environments: A Side-by-Side Comparison

Because JS runs in two places, certain features only exist in their specific environment.

Frontend Example (Browser Environment)

You link this file to your HTML. It has access to the `window` and `document` objects.

```
// frontend.js

// 1. Core JS (Works everywhere)
const greeting = "Hello User";

// 2. Browser API (Only works in the browser!)
// This alerts the user and changes the HTML text
window.alert("Welcome to the app!");
document.getElementById('title').innerText = greeting;

// NOTE: If you run this file in Node.js, it will crash because
// Node has no concept of a 'window' or a 'document'.
```

2. Variables, Scope, and Hoisting

Before ES6 (2015), JavaScript only had one way to declare variables: `var`. This led to a lot of unpredictable bugs. Modern JavaScript introduced `let` and `const` to fix these issues. To understand *why* `var` is bad and `let/const` are good, we must understand Scope and Hoisting.

2.1 Variables (`var`, `let`, `const`)

Theory: Variables are containers for storing data values. In modern Full Stack development, you will almost exclusively use `const` and `let`.

- `const` **(Constant):** The variable cannot be reassigned to a new value.
- `let`**:** The variable can be reassigned later.
- `var`**:** The legacy way of declaring variables. Avoid using it in modern code.

Syntax:

```
const myName = "Alice";
let age = 25;
var legacyVariable = "Don't use me";
```

Example:

```
// Using const
const API_URL = "[https://api.mywebsite.com/data]
(https://api.mywebsite.com/data)";
// API_URL = "[https://newapi.com](https://newapi.com)"; // ERROR! You cannot
reassign a const.

// Using let
```

```
let userScore = 0;
userScore = 10; // This is perfectly fine. userScore is now 10.
```

> **Watch Out:** > Always default to using `const`. Only switch to `let` if you know exactly why that variable's value needs to change in the future (like a counter in a loop). This makes your code much more predictable.

2.2 Scope

Theory: Scope determines the accessibility (visibility) of variables. If you declare a variable in one part of your code, can another part of your code see it?

JavaScript has three main types of scope:

1. **Global Scope:** Declared outside any function or block. Accessible from *anywhere* in the file.
2. **Function Scope:** Declared inside a function. Only accessible *inside* that function.
3. **Block Scope (ES6):** Declared inside a `{}` block (like an `if` statement or `for` loop). Only accessible *inside* that block. **Only `let` and `const` respect block scope. `var` ignores it.**

Example:

```
// 1. Global Scope
const globalVar = "I am everywhere";

function testScope() {
    // 2. Function Scope
    const functionVar = "I am trapped in the function";
    console.log(globalVar); // Works!
}
// console.log(functionVar); // ERROR! functionVar is not defined outside the
function.

// 3. Block Scope
if (true) {
    let blockVar = "I am trapped in the if-statement";
    var sneakyVar = "I escape the block!";
}

// console.log(blockVar); // ERROR! blockVar is block-scoped.
console.log(sneakyVar); // Works! 'var' ignores the {} block. This causes terrible
bugs.
```

> **Watch Out:** > In Full Stack development, avoid Global variables whenever possible. On a Node.js server, polluting the global scope can cause data from one user's request to leak into another user's request, creating severe security vulnerabilities.

2.3 Hoisting

Theory: Hoisting is JavaScript's default behavior of moving declarations to the top of the current scope *before* code execution.

When the JS engine reads your file, it does a quick first pass. It finds all your variable and function *declarations* and "hoists" them to the top of memory. However, it handles `var`, `let`/`const`, and functions very differently.

- **Functions:** Fully hoisted. You can call a function before you write it.
- **`var`:** Hoisted, but initialized with a value of `undefined`.
- **`let` & `const`:** Hoisted, but placed in a "Temporal Dead Zone" (TDZ). You cannot access them before the line they are actually written on.

Example:

```
// 1. Function Hoisting (Works)
sayHello(); // Output: "Hello!"
function sayHello() {
    console.log("Hello!");
}

// 2. 'var' Hoisting (Returns undefined instead of an error)
console.log(oldScore); // Output: undefined
var oldScore = 100;

// 3. 'let' / 'const' Hoisting (Throws an error - Temporal Dead Zone)
console.log(newScore); // ERROR! Cannot access 'newScore' before initialization
let newScore = 100;
```

> **Watch Out:** Interviewers love asking about hoisting. Remember: `let` and `const` are hoisted (the engine knows they exist), but they remain uninitialized in the *Temporal Dead Zone* until the execution reaches their line of code.

```

```

3. Data Types, Operators, and Type Conversion

JavaScript is a **dynamically typed** language. This means you do not have to explicitly tell JS what kind of data a variable holds (unlike Java or C++). The JS engine figures it out automatically when the code runs.

3.1 Data Types (Primitives vs. References)

Theory: In JavaScript, data is split into two major categories based on how it is stored in the computer's memory: **Primitives** and **Reference Types**.

1. Primitive Types (Stored by Value)

Primitives are basic data types. They are stored directly in the "Stack" memory, meaning they are fast to access and immutable (the actual value cannot be altered, only replaced).

- `String`**:** Text data, wrapped in quotes (`""`, `''`, or backticks ``` ``).
- `Number`**:** Integers and decimals (e.g., `42`, `3.14`).
- `Boolean`**:** Logical entities (`true` or `false`).
- `Undefined`**:** A variable that has been declared but not assigned a value yet.
- `Null`**:** Intentional absence of any object value (you explicitly set this).
- `Symbol` **(ES6):** Unique identifiers (rarely used in basic web dev).
- `BigInt` **(ES2020):** For massively large numbers beyond the safe integer limit.

Example:

```
let username = "JohnDoe"; // String
let age = 30;             // Number
let isAuthenticated = true; // Boolean
let userToken;            // Undefined (JS sets this automatically)
let userProfile = null;   // Null (You set this to clear data)
```

2. Reference Types (Stored by Reference)

Objects, Arrays, and Functions are Reference Types. Because they can be massive, they are stored in the "Heap" memory. The variable merely holds a *pointer* (or reference) to that location in memory.

Example:

```
let user = { name: "Alice", role: "Admin" }; // Object
let scores = [95, 80, 100];                  // Array
```

> **Watch Out:** > Because Reference types point to a memory location, copying them can be tricky. `let arr1 = [1, 2, 3]; let arr2 = arr1; arr2.push(4);` If you log `arr1`, it will *also* have the `4`! You didn't create a new array; you just created two variables pointing to the exact same memory address.

3.2 Operators

Theory: Operators allow you to manipulate values, perform math, and compare data.

1. Arithmetic & Assignment Operators

Standard math operations (`+`, `-`, `*`, `/`, `%` for remainder/modulo, `**` for exponentiation). Assignment operators assign values (`=`, `+=`, `-=`).

```
let count = 10;
count += 5; // Same as count = count + 5; (count is now 15)
let isEven = 10 % 2 === 0; // Modulo is heavily used to find even/odd numbers
```

2. Comparison Operators (== vs ===)

This is arguably the most important operator rule in JS.

- `==` **(Loose Equality):** Checks if the *values* are the same, but it will try to convert the types to match first.
- `===` **(Strict Equality):** Checks if the *values* AND the *data types* are exactly the same.

```
console.log(5 == "5");  // true (JS converts the string "5" to a number first)
console.log(5 === "5"); // false (Number does not equal String)
```

3. Logical Operators (&&, ||, !)

Used to combine multiple conditions. Heavy usage in React for conditional rendering!

- `&&` **(AND):** Both sides must be true.
- `||` **(OR):** At least one side must be true.
- `!` **(NOT):** Reverses the boolean value.

```
let isLoggedIn = true;
let hasPaid = false;

console.log(isLoggedIn && hasPaid); // false
console.log(isLoggedIn || hasPaid); // true
console.log(!isLoggedIn);           // false
```

> **Watch Out:** > In modern Full Stack dev, **ALWAYS use `===` and `!==`**. Using loose equality (`==`) is considered bad practice because it leads to unpredictable bugs where strings and numbers accidentally match.

3.3 Type Conversion & Coercion

Theory: Often, you need to change data from one type to another (e.g., taking a user's age from an HTML input, which is always a String, and converting it to a Number to do math).

1. Explicit Conversion (Type Casting)

This is when *you* manually force a type change using built-in JS functions.

```
let stringAge = "25";
let realAge = Number(stringAge); // Explicitly converts to 25 (Number)
let str = String(100);           // Explicitly converts to "100" (String)
```

2. Implicit Conversion (Type Coercion)

This is when the JavaScript engine changes the type automatically behind the scenes. The `+` operator triggers string concatenation if any string is involved, but `-`, `*`, and `/` trigger math operations.

```
console.log("5" + 2); // "52" (Number 2 is coerced into a String)
console.log("5" - 2); // 3 (String "5" is coerced into a Number)
console.log("5" * "2"); // 10 (Both coerced to Numbers)
```

3. Truthy and Falsy Values

In JavaScript, every single value inherently translates to a boolean (`true` or `false`) when evaluated in a logical context (like an `if` statement).

Falsy Values (Memorize these! Everything else is Truthy):

1. `false`
2. `0`
3. `""` (Empty string)
4. `null`
5. `undefined`
6. `NaN` (Not a Number)

Example:

```
let userCart = []; // An empty array is TRUTHY!
let username = ""; // An empty string is FALSY!

if (username) {
    console.log("Welcome " + username);
} else {
    console.log("Please enter a name."); // This will run because "" is falsy.
}
```

> **Watch Out:** > A common Full Stack bug occurs when fetching data from an API. If the API fails and returns `undefined`, and you try to render it on the frontend without checking if it's truthy/falsy first, your application will crash.

4. Control Flow: Conditionals and Switch Statements

Theory: By default, JavaScript reads your code top-to-bottom, executing every single line. "Control Flow" allows you to break this linear path. You use conditional statements to tell the JavaScript engine to make decisions: "If *this* condition is true, run this block of code. Otherwise, run *that* block of code."

4.1 The `if`, `else if`, and `else` Statements

Theory: This is the most common way to handle logic. You evaluate a condition (which JS will implicitly convert to a boolean: `true` or `false`), and execute code based on the result.

Syntax:

```
if (condition1) {
    // Runs if condition1 is true
} else if (condition2) {
    // Runs if condition1 is false AND condition2 is true
} else {
    // Runs if ALL previous conditions are false
}
```

Example (Full Stack Context - Authentication):

```
const userRole = "editor";
const isLoggedIn = true;

if (!isLoggedIn) {
    console.log("Redirecting to login page...");
} else if (userRole === "admin") {
    console.log("Access granted to Admin Dashboard. You can delete users.");
} else if (userRole === "editor") {
    console.log("Access granted. You can write and edit posts.");
} else {
    console.log("Access denied. Insufficient permissions.");
}
```

> **Watch Out:** > Do not over-nest your `if` statements (often called the "Pyramid of Doom"). If you find yourself writing `if` statements inside `if` statements inside `if` statements, it makes your code incredibly hard to read. Look into "Guard Clauses" (returning early from a function) to keep your code flat and clean.

4.2 The Ternary Operator (The One-Line `if/else`)

Theory: The ternary operator is a shortcut for an `if/else` statement. If you are going into Full Stack development (especially using React), you **must** memorize this. React heavily relies on the ternary operator to conditionally render HTML based on state.

Syntax:

```
condition ? expressionIfTrue : expressionIfFalse;
```

Example:

```
let age = 20;

// The old way (if/else)
let drinkChoice;
if (age >= 21) {
    drinkChoice = "Beer";
} else {
    drinkChoice = "Juice";
}

// The modern, concise way (Ternary)
let modernDrinkChoice = age >= 21 ? "Beer" : "Juice";

console.log(`You get a ${modernDrinkChoice}`);
```

4.3 The `switch` Statement

Theory: When you have a single variable that you want to check against many specific, discrete values, a `switch` statement is cleaner and often slightly faster than a long chain of `else if` statements.

Syntax:

```
switch (expression) {
    case value1:
        // Code to run
        break;
    case value2:
        // Code to run
        break;
    default:
        // Runs if no cases match (like an 'else')
}
```

Example (Full Stack Context - Handling API Responses):

```
const httpStatusCode = 404;

switch (httpStatusCode) {
    case 200:
        console.log("Success! Data fetched from database.");
        break; // Stops the switch from continuing to the next case
    case 201:
        console.log("Created! New user added to the database.");
        break;
    case 400:
        console.log("Bad Request! The data you sent is invalid.");
        break;
    case 401:
    case 403: // You can stack cases to share the same outcome!
        console.log("Unauthorized! Please log in.");
        break;
    case 404:
        console.log("Not Found! That page doesn't exist.");
        break;
    case 500:
        console.log("Server Error! Our backend crashed.");
        break;
    default:
        console.log("Unknown status code received.");
}
```

> **Watch Out: Never forget the `break` keyword!** If you forget it, JavaScript will execute the matching case, and then *fall through* and execute every single case below it, regardless of whether they match or not. This is a notorious source of bugs. *Note: You don't need a `break` on the `default` case because it's at the very end.*

5. Logical Operators & Short-Circuiting

Theory: Logical operators are used to combine multiple conditions or to flip the boolean value of a condition. However, in JavaScript, they do more than just return `true` or `false`—they can actually return the underlying values themselves, a feature known as "short-circuiting."

5.1 The Core Logical Operators

1. Logical AND (&&)

- **Rule:** Returns `true` ONLY if **both** sides are true. If the first side is false, it immediately stops and returns false.
- **Full Stack Use Case:** Checking if a user exists AND has the correct password.

```
let isUserLoggedIn = true;
let hasAdminRights = false;

if (isUserLoggedIn && hasAdminRights) {
    console.log("Welcome to the Admin Dashboard.");
} else {
    console.log("Access Denied."); // This will run.
}
```

2. Logical OR (`||`)

- **Rule:** Returns `true` if **at least one** side is true. If the first side is true, it immediately stops and returns true without even checking the second side.
- **Full Stack Use Case:** Giving a user a default avatar if they haven't uploaded one.

```
let userPlan = "Free";
let isTrialActive = true;

if (userPlan === "Pro" || isTrialActive) {
    console.log("You can use premium features."); // This will run.
}
```

3. Logical NOT (`!`)

- **Rule:** Reverses the boolean state. `true` becomes `false`, and `false` becomes `true`.
- **Pro-Tip (`!!`):** Using a double bang `!!` is a quick way to forcefully convert any value into a pure boolean.

```
let isLoading = false;

if (!isLoading) {
    console.log("Data finished loading! Show the UI."); // This will run.
}

// Double NOT trick
console.log(!!"hello"); // true (converts truthy string to boolean true)
console.log(!!0);       // false (converts falsy 0 to boolean false)
```

5.2 Short-Circuit Evaluation (Crucial for React!)

Theory: JavaScript logical operators evaluate from left to right. When using `&&` and `||`, JS doesn't always return `true` or `false`. It actually returns the **value** that stopped the evaluation.

- `&&` **(AND) Short-Circuit:** Returns the *first falsy* value it finds. If everything is truthy, it returns the *last* value.
- `||` **(OR) Short-Circuit:** Returns the *first truthy* value it finds. If everything is falsy, it returns the *last* value.

Example (React & Frontend focus):

```
// Using && to conditionally render UI
let unreadMessages = 5;

// If unreadMessages > 0 is true, it returns the right side ("You have mail!")
// In React, this is how you hide/show components dynamically.
let notification = (unreadMessages > 0) && "You have mail!";
console.log(notification); // "You have mail!"

// Using || to set default values
let userProvidedName = ""; // User left the input blank (falsy)
let defaultName = "Guest";

// JS sees "" is falsy, so it moves to "Guest", which is truthy, and returns it.
let displayName = userProvidedName || defaultName;
console.log(displayName); // "Guest"
```

5.3 Nullish Coalescing Operator (`??`) - ES2020

Theory: The `||` operator has a flaw: it treats *all* falsy values (like `0` or `""`) as failures. But what if a user's score is actually `0`? You don't want to accidentally overwrite their score with a default value just because `0` is falsy.

The `??` operator fixes this. It only short-circuits if the first value is **strictly `null` or `undefined`**. It ignores other falsy values like `0` or `""`.

Syntax:

```
let result = leftSide ?? rightSide;
```

Example:

```
let playerHPSettings = 0; // The player has 0 Health Points
```

```
// Using OR (||) - Creates a bug!
let hp1 = playerHPSettings || 100;
console.log(hp1); // 100. (Bug: JS saw 0 as falsy and gave them 100 HP)

// Using Nullish Coalescing (??) - Works perfectly!
let hp2 = playerHPSettings ?? 100;
console.log(hp2); // 0. (JS says: "It's 0, but it's not null/undefined, so keep
the 0")
```

> **Watch Out:** > When configuring Node.js servers or handling API data, favor `??` over `||` if `0` or an empty string `""` are valid pieces of data you want to keep. Only use `||` if you genuinely want to reject *all* falsy values.

6. Loops and Iteration

Theory: Loops are used to execute the same block of code repeatedly as long as a specific condition is true. They are the backbone of the **DRY (Don't Repeat Yourself)** principle. Instead of writing `console.log()` 100 times, you write it once inside a loop.

6.1 The Standard `for` Loop

Theory: The `for` loop is the most common loop. You use it when you know *exactly* how many times you want the code to run.

Syntax:

```
for (initialization; condition; increment/decrement) {
    // Code to run on each iteration
}
```

Example (Full Stack Context - Paginating Results):

```
const totalPages = 5;

// Starts at 1; runs as long as i is <= 5; adds 1 to i after each loop
for (let i = 1; i <= totalPages; i++) {
    console.log(`Fetching data for Page ${i}...`);
}
// Output: Fetches pages 1, 2, 3, 4, 5.
```

6.2 The `while` and `do...while` Loops

1. The `while` Loop

Theory: Use a `while` loop when you **do not know** how many times the loop needs to run in advance. It continues to run as long as the condition evaluates to `true`.

Example (Full Stack Context - Backend processing):

```
let isDatabaseConnected = false;
let connectionAttempts = 0;

while (!isDatabaseConnected && connectionAttempts < 3) {
    console.log("Attempting to connect to database...");
    connectionAttempts++;
    // Imagine some code here that tries to connect and might set
isDatabaseConnected = true
}
```

2. The `do...while` Loop

Theory: Almost identical to the `while` loop, but with one critical difference: **it will always run at least once**, even if the condition is false from the very beginning. This is because it executes the code block *before* checking the condition.

```
let userInput = "";

do {
    // In a real app, this might be a prompt asking for a valid password
    console.log("Please enter your password.");
    userInput = "password123";
} while (userInput === "");
```

6.3 Modern ES6 Loops (`for...of` and `for...in`)

As a modern Full Stack developer, you will actually use these more often than the standard `for` loop when dealing with data structures.

1. `for...of` (Used for Arrays and Strings)

Iterates over the **values** of an iterable object (like an Array or a String).

```
const shoppingCart = ["Laptop", "Mouse", "Keyboard"];

// Much cleaner than a standard for loop!
for (const item of shoppingCart) {
    console.log(`Processing item: ${item}`);
}
```

2. `for...in` (Used for Objects)

Iterates over the **keys** (property names) of an Object.

```
const userProfile = {
    username: "dev_guru",
    role: "Admin",
    status: "Active"
};

for (const key in userProfile) {
    // Accessing the key and the dynamically evaluated value
    console.log(`${key}: ${userProfile[key]}`);
}
// Output:
// username: dev_guru
// role: Admin
// status: Active
```

6.4 Loop Control: `break` and `continue`

Sometimes you need to prematurely alter the flow of a loop.

- **`break`:** Completely destroys the loop and stops it from running entirely.
- **`continue`:** Skips the *current* iteration and instantly moves to the next one.

Example:

```
const userIDs = [101, 102, "ERROR", 104, 105];

for (let i = 0; i < userIDs.length; i++) {
    if (userIDs[i] === "ERROR") {
        console.log("Corrupted data found. Skipping...");
        continue; // Skips "ERROR" but continues to 104
    }

    if (userIDs[i] === 104) {
        console.log("Target user 104 found. Stopping search.");
```

```
            break; // Destroys the loop completely. 105 is never checked.
        }

        console.log(`Processing User ID: ${userIDs[i]}`);
    }
```

> **Watch Out: Infinite Loops!** If you create a `while` loop or a `for` loop where the condition *never* becomes false (e.g., you forget to increment your `i` variable), your program will run forever, ultimately freezing the user's browser or crashing your Node.js server. Always double-check your exit conditions!

7. Functions (The Basics)

Theory: A function is a reusable block of code designed to perform a particular task. You can think of a function like a mini-machine: you put raw materials in (Inputs), the machine does some work (Code Execution), and it spits out a finished product (Output).

7.1 Function Declarations (The Traditional Way)

Theory: This is the standard, oldest way to write a function in JavaScript. Because of "hoisting" (which we covered in section 2), function declarations are hoisted to the top of the file, meaning you can actually call them *before* you write them in your code.

Syntax:

```
function functionName(parameters) {
    // Code to execute
    return result;
}
```

Example:

```
// Calling the function
const myGreeting = sayHello("Alice");
console.log(myGreeting); // Output: "Hello, Alice!"

// Declaring the function
function sayHello(name) {
    return `Hello, ${name}!`;
}
```

7.2 Parameters vs. Arguments

Theory: These two terms are constantly used interchangeably by mistake.

- **Parameters:** The variable *placeholders* you write when you **create** the function.
- **Arguments:** The actual *data values* you pass in when you **call** the function.

```
// 'num1' and 'num2' are PARAMETERS
function addNumbers(num1, num2) {
    return num1 + num2;
}

// '5' and '10' are ARGUMENTS
addNumbers(5, 10);
```

7.3 The `return` Keyword

Theory: By default, if a function finishes running and doesn't have a `return` statement, it will output `undefined`. The `return` keyword is how a function hands data back to the rest of your program so you can use it.

Crucial Rule: The moment JavaScript hits a `return` keyword, the function **stops executing immediately**. Any code written below the `return` statement inside that function is completely ignored.

```
function checkAge(age) {
    if (age >= 18) {
        return "You are an adult.";
    }

    return "You are a minor.";

    console.log("This will NEVER run because a return happened above it.");
}
```

> **Watch Out:** > Beginners often confuse `console.log()` with `return`.
>
> - `console.log()` just prints text to your screen for debugging. It does not give data back to the program.
> - `return` actually spits the data out so another variable or function can use it.

7.4 Function Expressions

Theory: Because JavaScript treats functions like any other piece of data (like a string or a number), you can actually store a function inside a variable. This is called a Function Expression. Unlike Declarations, these are **not** hoisted, meaning you must write them before you call them.

Syntax:

```
const functionName = function(parameters) {
    // Code to execute
};
```

Example:

```
// calculateTotal(100, 0.2); // ERROR! Cannot access before initialization

const calculateTotal = function(price, taxRate) {
    const tax = price * taxRate;
    return price + tax;
};

console.log(calculateTotal(100, 0.2)); // Output: 120
```

```

```

8. Arrow Functions (Deep Dive)

Theory: Introduced in ES6 (2015), Arrow Functions are not just a shorter way to write functions—they actually behave differently under the hood compared to traditional `function` declarations. They are the absolute standard for writing callbacks, array methods (`map`, `filter`), and React components.

8.1 Syntax Variations

Arrow functions are highly flexible. Depending on how many parameters you have and what you are returning, you can shrink the syntax down significantly.

1. Standard Arrow Function

If you have multiple parameters and multiple lines of code, you need parentheses `()` around the parameters, curly braces `{}` for the body, and a `return` keyword.

```
const calculateArea = (width, height) => {
    const area = width * height;
    return area;
```

```
};
```

2. Implicit Return (The Super Shortcut)

If your function only has **one line of code** that returns a value, you can delete the curly braces `{}` and the `return` keyword. The arrow `=>` implicitly returns whatever is on the right side.

```
// This does the exact same thing as the function above!
const calculateAreaShort = (width, height) => width * height;
```

3. Single Parameter Shortcut

If you have exactly **one parameter**, you can even omit the parentheses `()` around it. *(Note: Code formatters like Prettier often add them back automatically, but it's important to know this syntax exists).*

```
const squareNumber = num => num * num;
console.log(squareNumber(5)); // Output: 25
```

4. Returning an Object Implicitly

If you want to implicitly return a JavaScript Object, you **must** wrap the object's curly braces inside parentheses `()`. Otherwise, JS thinks the object's `{}` are the function's body block!

```
// WRONG: JS thinks this is an empty function block with a syntax error
// const getUser = (name) => { username: name, role: "Admin" };

// CORRECT: Wrap the object in ()
const getUser = (name) => ({ username: name, role: "Admin" });
```

8.2 Arrow Functions vs. Regular Functions (The `this` Keyword)

Theory: This is the #1 interview question regarding arrow functions.

- A **regular function** creates its own `this` context based on *how* the function is called.
- An **arrow function** does NOT create its own `this`. Instead, it inherits `this` from the parent scope surrounding it (this is called "Lexical Scoping").

Example (Why Arrow Functions are great for Callbacks): Imagine an object representing a user, and a method that prints their name after a 1-second delay.

```
const userProfile = {
    name: "Alice",

    // Using a Regular Function inside a callback (Creates a bug!)
    printNameBad: function() {
        setTimeout(function() {
            // In a regular function, 'this' loses its connection to 'userProfile'
            // when it gets executed by setTimeout (it points to the global
window/timeout object instead).
            console.log("Bad: " + this.name);
        }, 1000);
    },

    // Using an Arrow Function (Fixes the bug!)
    printNameGood: function() {
        setTimeout(() => {
            // The arrow function doesn't have its own 'this'.
            // It looks up and borrows 'this' from printNameGood, which points to
userProfile!
            console.log("Good: " + this.name);
        }, 1000);
    }
};

userProfile.printNameBad();  // Output after 1 sec: "Bad: undefined"
userProfile.printNameGood(); // Output after 1 sec: "Good: Alice"
```

> **Watch Out:** > Because Arrow Functions don't have their own `this`, **never use them as Object Methods** if that method needs to access properties on the object itself.
>
> ```
> const car = {
>     brand: "Toyota",
>     // DON'T DO THIS! 'this.brand' will be undefined.
>     getBrand: () => console.log(this.brand)
> };
> ```
>
> Use regular functions for object methods, and arrow functions for callbacks inside them!

8.3 No `arguments` Object

Traditional functions have access to a hidden array-like object called `arguments` that holds all passed arguments. Arrow functions **do not** have this. If you need to accept an unlimited number of arguments in an arrow function, you must use the Rest operator (`...`).

```
// Modern Full Stack approach for unlimited arguments
const sumAll = (...numbers) => {
    return numbers.reduce((total, num) => total + num, 0);
};
console.log(sumAll(1, 2, 3, 4, 5)); // Output: 15
```

9. Callbacks and Higher-Order Functions

Theory: In JavaScript, functions are **"First-Class Citizens"**. This means the JS engine treats functions exactly like any other piece of data (like a String or a Number). You can assign a function to a variable, store it in an array, pass it as an argument into another function, or even return a function from another function.

This single feature is what makes Callbacks and Higher-Order Functions possible.

9.1 Callback Functions

Theory: A Callback Function is simply a function that you pass into *another* function as an argument, with the intention that it will be executed (called back) at a later time.

You don't execute the callback immediately yourself (no parentheses `()` when passing it). You hand the instructions over to the parent function to execute when it's ready.

Example 1: A Custom Synchronous Callback

```
// 1. We create two simple callback functions
const add = (a, b) => a + b;
const multiply = (a, b) => a * b;

// 2. We create a parent function that ACCEPTS a callback
const calculate = (num1, num2, operationCallback) => {
    console.log("Calculating...");
    // We execute the callback inside the parent function
    return operationCallback(num1, num2);
};

// 3. We pass the callback in WITHOUT parentheses ()
console.log(calculate(5, 10, add));      // Output: 15
console.log(calculate(5, 10, multiply)); // Output: 50
```

Example 2: Built-in Asynchronous Callbacks (Full Stack Context) You will use callbacks constantly when dealing with delays, event listeners, or reading databases in Node.js.

```
// setTimeout takes a callback function and a delay in milliseconds
setTimeout(() => {
    console.log("This callback runs after 2 seconds!");
}, 2000);

// Event Listeners take a callback that runs only when the user clicks
// document.querySelector('button').addEventListener('click', () => {
//     console.log("Button was clicked!");
// });
```

9.2 Higher-Order Functions (HOFs)

Theory: A Higher-Order Function is simply the "parent" function. By definition, a function is a Higher-Order Function if it does at least one of two things:

1. It **accepts** a function as an argument (like `calculate` or `setTimeout` above).
2. It **returns** a new function.

Example: A Function that Returns a Function (Advanced but crucial for React) In React, you will often see this pattern used in custom Hooks or currying.

```
// This is a Higher-Order Function because it returns a brand new function
const createGreeting = (greetingWord) => {
    // It returns this inner arrow function
    return (userName) => {
        console.log(`${greetingWord}, ${userName}!`);
    };
};

// 1. We create specific functions using the HOF
const sayHello = createGreeting("Hello");
const sayWelcome = createGreeting("Welcome to the app");

// 2. Now we use our freshly minted functions!
sayHello("Alice");       // Output: Hello, Alice!
sayWelcome("Bob");       // Output: Welcome to the app, Bob!
```

9.3 Callback Hell (The Problem)

Theory: Before Promises and `async/await` were invented, developers had to rely strictly on callbacks to handle asynchronous tasks (like fetching data from an API, then getting the user's profile, then getting their posts).

If you nest too many callbacks inside each other, your code becomes shaped like a triangle. This is famously known as **Callback Hell** or the **Pyramid of Doom**, making code incredibly hard to read and debug.

Example (What to Avoid):

```
// This is Callback Hell. It is deeply nested and hard to read.
getUserData(userId, (user) => {
    getProfile(user.profileId, (profile) => {
        getPosts(profile.id, (posts) => {
            getComments(posts[0].id, (comments) => {
                console.log("Finally got the comments!", comments);
            });
        });
    });
});
```

> **Watch Out:** When passing a callback to a function like an event listener, a very common beginner mistake is accidentally executing it immediately by adding parentheses.
>
> - **WRONG:** `button.addEventListener('click', submitForm());` (This runs `submitForm` instantly on page load!)
> - **RIGHT:** `button.addEventListener('click', submitForm);` (This hands the blueprint to the button to run *later*).

10. Arrays (Data Structures)

Theory: An Array is a special type of variable that can hold more than one value at a time. They are used to store lists of data (like a list of user objects, a string of comments, or a series of temperature readings).

In JavaScript, arrays are **zero-indexed** (the first item is at position 0, not 1) and they are **Reference Types** (meaning they are stored in the Heap memory, and the variable just points to them).

10.1 Creating and Accessing Arrays

While you can create an array using the `new Array()` constructor, the standard Full Stack practice is to use the **Array Literal** syntax `[]`.

Syntax & Access:

```
// 1. Creating an array (Can hold mixed data types, but usually kept uniform)
const fruits = ["Apple", "Banana", "Cherry"];
const mixedData = [42, "Hello", true, null];
```

```
// 2. Accessing elements via their Index
console.log(fruits[0]); // "Apple"
console.log(fruits[1]); // "Banana"

// 3. Finding how many items are in the array
console.log(fruits.length); // 3

// 4. Pro-Tip: Accessing the LAST element dynamically
console.log(fruits[fruits.length - 1]); // "Cherry"
```

10.2 Modifying Arrays (Basic Methods)

It is crucial to understand that these methods **mutate** (permanently change) the original array.

1. Adding/Removing from the END (Fastest)

- `push(item)`**:** Adds one or more elements to the end. Returns the new length.
- `pop()`**:** Removes the *last* element. Returns the removed element.

```
const cart = ["Shirt", "Shoes"];

cart.push("Hat"); // cart is now ["Shirt", "Shoes", "Hat"]
const droppedItem = cart.pop(); // cart is back to ["Shirt", "Shoes"]
console.log(droppedItem); // "Hat"
```

2. Adding/Removing from the BEGINNING (Slower)

- `unshift(item)`**:** Adds elements to the front. (Slower because it has to re-index every other item).
- `shift()`**:** Removes the *first* element.

```
const queue = ["Bob", "Charlie"];

queue.unshift("Alice"); // queue is now ["Alice", "Bob", "Charlie"]
queue.shift();          // queue is back to ["Bob", "Charlie"]
```

10.3 Searching and Checking Arrays

These methods are incredibly useful for simple conditional logic.

- `indexOf(item)`**:** Returns the first index at which a given element can be found, or `-1` if it is not present.
- `includes(item)` **(ES7):** Returns `true` if the array contains the item, `false` otherwise. (Much cleaner than checking if `indexOf !== -1`).

```
const userRoles = ["Admin", "Editor", "Subscriber"];

console.log(userRoles.indexOf("Editor")); // 1
console.log(userRoles.indexOf("Guest"));  // -1

if (userRoles.includes("Admin")) {
    console.log("Show admin dashboard."); // This will run
}
```

10.4 The Big Interview Trap: `slice()` vs. `splice()`

1. `slice(startIndex, endIndex)` -> Does NOT Mutate

Theory: Extracts a section of an array and returns a **brand new array**. The original array remains completely untouched. The `endIndex` is *exclusive* (it stops right before it).

```
const colors = ["Red", "Green", "Blue", "Yellow"];
const primaryColors = colors.slice(0, 3);

console.log(primaryColors); // ["Red", "Green", "Blue"]
console.log(colors);        // ["Red", "Green", "Blue", "Yellow"] (Unchanged!)
```

2. `splice(startIndex, deleteCount, itemToAdd)` -> MUTATES

Theory: Changes the contents of an array by removing or replacing existing elements and/or adding new elements *in place*.

```
const months = ["Jan", "March", "April", "June"];

// Insert "Feb" at index 1, delete 0 items
months.splice(1, 0, "Feb");
console.log(months); // ["Jan", "Feb", "March", "April", "June"]

// Start at index 4, delete 1 item, replace with "May"
months.splice(4, 1, "May");
console.log(months); // ["Jan", "Feb", "March", "April", "May"]
```

```
```

11. Array Higher-Order Functions

Theory: In modern Full Stack development (especially with React, Node.js, and functional programming patterns), you will rarely use standard `for` or `while` loops to manipulate arrays. Instead, you will use built-in Higher-Order Array Methods.

These methods take a **callback function** as an argument. The most important feature of methods like `map` and `filter` is that they are **non-mutating**—they do not change the original array, but instead return a brand new array. This is a core rule of state management in frontend frameworks.

11.1 Iteration: `forEach()`

Theory: `forEach` simply executes a provided function once for each array element. It is the functional equivalent of a `for` loop. **Crucial Rule:** `forEach` ALWAYS returns `undefined`. You cannot chain it, and you cannot use it to create a new array. It is strictly used for "side effects" (like logging to the console or saving items to a database one by one).

Syntax: `array.forEach((element, index, originalArray) => { ... })`

Example:

```
const users = ["Alice", "Bob", "Charlie"];

// Just doing something WITH the data, not changing or returning it.
users.forEach((user, index) => {
    console.log(`User ${index + 1}: ${user}`);
});
```

11.2 Transformation: `map()`

Theory: `map` is arguably the most used array method in all of web development. It creates a **brand new array** populated with the results of calling a provided function on every element in the calling array. The new array will *always* be the exact same length as the original.

Example (Full Stack Context - Extracting Data):

```
const products = [
    { id: 1, name: "Laptop", price: 1000 },
    { id: 2, name: "Mouse", price: 25 },
    { id: 3, name: "Keyboard", price: 75 }
];

// We just want an array of the names for a dropdown menu
const productNames = products.map((product) => {
    return product.name;
});

// Implicit return shortcut (Super common in React!)
```

```
// const productNames = products.map(product => product.name);

console.log(productNames); // ["Laptop", "Mouse", "Keyboard"]
console.log(products);     // Original array is completely untouched
```

11.3 Selection: `filter()`

Theory: `filter` creates a **brand new array** with all elements that pass the test implemented by the provided callback function. The callback must return a boolean (`true` or `false`). If `true`, the item is kept. If `false`, it is skipped. The resulting array can be shorter than the original.

Example (Full Stack Context - Searching/Sorting):

```
const allUsers = [
    { name: "Alice", active: true },
    { name: "Bob", active: false },
    { name: "Charlie", active: true }
];

// Return ONLY the users where 'active' is true
const activeUsers = allUsers.filter(user => user.active === true);

console.log(activeUsers);
// [{ name: "Alice", active: true }, { name: "Charlie", active: true }]
```

11.4 Accumulation: `reduce()`

Theory: `reduce` is the most powerful (and most confusing) array method. It executes a "reducer" callback function on each element, passing in the return value from the calculation on the preceding element. The final result is a **single value** (which could be a number, a string, or even a brand new object/array).

Syntax: `array.reduce((accumulator, currentValue) => { ... }, initialValue)`

- **Accumulator:** The running total / aggregated value.
- **CurrentValue:** The current item being processed in the array.
- **InitialValue:** What the accumulator should start as (ALWAYS provide this to avoid bugs).

Example (Full Stack Context - Shopping Cart Total):

```
const cartPrices = [29.99, 9.99, 4.00, 50.00];

const cartTotal = cartPrices.reduce((total, currentPrice) => {
    return total + currentPrice;
}, 0); // 0 is the initialValue for 'total'
```

```
console.log(cartTotal); // 93.98
```

11.5 Utilities: `find()`, `some()`, and `every()`

These are highly optimized HOFs that "short-circuit" (stop running) as soon as they find what they are looking for, saving processing power.

1. `find()`

Returns the **first element** that satisfies the testing function. If no values satisfy the testing function, `undefined` is returned. (Great for finding a specific user by ID in a database array).

```
const ids = [10, 22, 99, 104];
const firstOver50 = ids.find(id => id > 50);
console.log(firstOver50); // 99 (It stops checking after 99)
```

2. `some()`

Returns `true` if **at least one** element passes the test. Returns `false` otherwise.

```
const grades = [80, 90, 65, 95];
const hasFailingGrade = grades.some(grade => grade < 70);
console.log(hasFailingGrade); // true
```

3. `every()`

Returns `true` ONLY if **every single element** passes the test.

```
const ages = [21, 25, 30, 19];
const allAdults = ages.every(age => age >= 18);
console.log(allAdults); // true
```

```

```

12. Introduction to the DOM (Document Object Model)

Theory: The DOM is exactly what it sounds like: a **Model** of your HTML **Document** represented as a JavaScript **Object**.

When a web browser loads an HTML file, it reads the code and creates a hierarchical tree of "nodes" (objects) in its memory. JavaScript uses this tree to read, change, add, or delete HTML elements and CSS styles dynamically without needing to refresh the page.

> **Crucial Full Stack Context:** The DOM is **NOT** a part of the core JavaScript language. It is a "Web API" provided by the browser. This means the DOM only exists on the Frontend. If you try to access the DOM (`document.querySelector`) in a backend Node.js file, your server will immediately crash because servers don't have web pages!

12.1 The `document` Object

Theory: The entry point to the DOM is the global `document` object. Every single HTML tag on your page is a property or method nested somewhere deep inside this massive object.

```
// This logs the entire visible HTML document to your console
console.log(document.body);

// This gives you the title of the webpage (from the <title> tag)
console.log(document.title);
```

12.3 Manipulating Text and HTML

Once you have selected an element and stored it in a variable, you can change what it displays.

- **`innerText`:** Changes the visible text inside the element.
- **`innerHTML`:** Changes the text AND renders any HTML tags you pass into it.

Example:

```
<div id="welcome-message">Hello User</div>
```

```
// JavaScript
const welcomeDiv = document.querySelector('#welcome-message');

// 1. Changing Text
welcomeDiv.innerText = "Welcome back, Alice!";
// Result: <div id="welcome-message">Welcome back, Alice!</div>

// 2. Changing HTML (Be careful with this due to security risks!)
welcomeDiv.innerHTML = "Welcome back, <strong>Alice</strong>!";
```

```
// Result: <div id="welcome-message">Welcome back, <strong>Alice</strong>!</div>
```

12.4 Manipulating CSS Styles and Classes

You can also use JS to dynamically change how elements look (e.g., turning an input border red if the user types an invalid email).

1. Inline Styles (`element.style`)

You can apply CSS directly to an element. Notice that CSS properties with hyphens (like `background-color`) must be written in **camelCase** in JavaScript (`backgroundColor`).

```
const box = document.querySelector('.box');

box.style.backgroundColor = 'blue';
box.style.fontSize = '24px';
box.style.display = 'none'; // Hides the element
```

2. The `classList` API (The Recommended Way)

Instead of adding inline styles (which is messy), it is better practice to pre-write your CSS classes in your stylesheet, and use JS to simply toggle those classes on and off.

- **`classList.add('className')`:** Adds a class.
- **`classList.remove('className')`:** Removes a class.
- **`classList.toggle('className')`:** Adds it if it's missing, removes it if it's there.

Example:

```
/* CSS */
.dark-mode {
    background-color: black;
    color: white;
}
```

```
// JavaScript
const body = document.querySelector('body');

// Turns dark mode on
body.classList.add('dark-mode');

// If they click a button, this toggles it on and off
```

```
body.classList.toggle('dark-mode');
```

> **Watch Out:** When using `classList`, **do not** put a dot `.` in front of the class name!
>
> - **WRONG:** `box.classList.add('.active');`
> - **RIGHT:** `box.classList.add('active');` The dot is only used for querying (`querySelector`), not for naming classes.

```

```

13. Deep Dive: `querySelector` and `querySelectorAll`

Theory: In the early days of JavaScript, developers had to memorize multiple different methods to find elements (`getElementById`, `getElementsByTagName`, etc.). Modern JavaScript simplified this entirely with the `querySelector` API.

It allows you to use **exact CSS selector syntax** to hunt down elements in the DOM tree. If you know how to style it in CSS, you know how to select it in JavaScript.

13.1 `querySelector()` (Selecting a Single Element)

Theory: This method searches the DOM from top to bottom and returns the **very first** HTML element that matches your CSS query. Once it finds a match, it stops looking. If it finds nothing, it returns `null`.

Syntax:

```
const element = document.querySelector('any-valid-css-selector');
```

Examples (Full Stack Context - Form Selection):

```
// 1. Tag Selector (Finds the first <button> on the page)
const firstButton = document.querySelector('button');

// 2. Class Selector (Finds the first element with class "error-text")
const errorMsg = document.querySelector('.error-text');

// 3. ID Selector (Finds the exact element with ID "login-form")
const loginForm = document.querySelector('#login-form');

// 4. Advanced CSS Combinators (Highly useful!)
```

```
// Finds the first <input> that is nested directly inside a form with class "auth"
const emailInput = document.querySelector('form.auth > input');

// 5. Attribute Selectors
// Finds the first input where the type attribute is specifically "password"
const passwordInput = document.querySelector('input[type="password"]');
```

13.2 `querySelectorAll()` (Selecting Multiple Elements)

Theory: What if you want to find *every* matching element, not just the first one? `querySelectorAll` returns a collection of all elements that match the given CSS selector.

Crucial Rule: It does NOT return a standard JavaScript Array. It returns a **NodeList**.

```
// Grabs EVERY single <li> item inside the navigation menu
const navLinks = document.querySelectorAll('nav ul li');

// Grabs all buttons on the page with the class "btn-danger"
const deleteButtons = document.querySelectorAll('button.btn-danger');

console.log(deleteButtons.length); // You can check how many it found
```

13.3 NodeList vs. Array

Because `querySelectorAll` returns a NodeList, it behaves *almost* like an array, but lacks the powerful Higher-Order Functions we covered in Section 11.

- **What you CAN do with a NodeList:** You can check its `.length` and you can use `.forEach()` to loop over it.
- **What you CANNOT do with a NodeList:** You cannot use `.map()`, `.filter()`, or `.reduce()`.

Example (Converting NodeList to Array): If you need to use advanced array methods on your DOM elements, you must convert the NodeList into a true Array first using the Spread Operator (`...`) or `Array.from()`.

```
const allImagesNodeList = document.querySelectorAll('img');

// allImagesNodeList.map(...) // ERROR! .map is not a function

// Modern Solution: Spread it into a real array!
const allImagesArray = [...allImagesNodeList];

// Now you can use array methods to extract data
const imageSources = allImagesArray.map(img => img.src);
```

```
console.log(imageSources);
```

```

```

14. Traditional DOM Querying (ID and Class Name)

Theory: Before `querySelector` was introduced to JavaScript, developers had to use specific methods depending on exactly *what* HTML attribute they were looking for.

While `querySelector` uses CSS syntax (requiring `.` for classes and `#` for IDs), these traditional methods **do not**. They only take the raw string name.

14.1 `document.getElementById()`

Theory: Because HTML IDs are supposed to be strictly unique (you should only ever have one specific ID per page), this method searches the DOM and returns the **single HTML element** that matches. If it doesn't exist, it returns `null`.

Syntax:

```
const element = document.getElementById('id-name-here');
```

Example:

```
// HTML: <div id="dashboard-container">...</div>

// CORRECT: Just the raw string name
const dashboard = document.getElementById('dashboard-container');

// WRONG: Do not use the CSS '#' selector here! It will return null.
const dashboardWrong = document.getElementById('#dashboard-container');
```

14.2 `document.getElementsByClassName()`

Theory: Because multiple HTML elements can share the exact same class, this method returns a collection of **all** elements that have the specified class name.

Crucial Rule: Notice that the method name is plural (`getElements...`). It does NOT return a single element, and it does NOT return a standard Array. It returns an **HTMLCollection**.

Syntax:

```
const elements = document.getElementsByClassName('class-name-here');
```

Example:

```
// HTML:
// <button class="btn-primary">Submit</button>
// <button class="btn-primary">Cancel</button>

// CORRECT: Just the raw string name
const primaryButtons = document.getElementsByClassName('btn-primary');

// WRONG: Do not use the CSS '.' selector here!
const primaryButtonsWrong = document.getElementsByClassName('.btn-primary');

// Accessing elements inside the HTMLCollection
console.log(primaryButtons[0]); // Logs the "Submit" button
console.log(primaryButtons.length); // 2
```

```
```

15. Event Listeners and the Event Object

Theory: JavaScript in the browser is heavily **event-driven**. This means your code sits quietly and waits for specific things to happen—like a user clicking a button, typing in a text field, scrolling, or submitting a form.

To "listen" for these actions, we attach an **Event Listener** to a specific DOM element.

15.1 The `addEventListener()` Method

Theory: This is the modern, standard way to handle events. It takes two main arguments: the name of the event you are listening for (as a string), and a **callback function** that will run *only* when that event happens.

Syntax:

```
element.addEventListener('eventType', callbackFunction);
```

Example (A Simple Click):

```
```

```
const submitBtn = document.querySelector('#submit-btn');

// The arrow function is the callback. It waits until the click happens.
submitBtn.addEventListener('click', () => {
    console.log("Button was clicked! Sending data to server...");
    // You could also change the DOM here, like:
    // document.body.style.backgroundColor = 'green';
});
```

15.2 The Event Object (`e` or `event`)

Theory: Whenever an event happens, the browser automatically creates an **Event Object** packed with details about what just occurred (e.g., what exact pixel was clicked, what key was pressed on the keyboard).

The browser passes this object as the **first argument** into your callback function. Developers usually name this parameter `e`, `evt`, or `event`.

Crucial Properties:

- `e.target`**:** The exact HTML element that triggered the event.
- `e.type`**:** The type of event that was triggered (e.g., "click", "keydown").
- `e.key`**:** (For keyboard events) The specific key that was pressed.

Example (Reading Text Input):

```
const usernameInput = document.querySelector('#username');

// 'input' fires every single time a keystroke happens in the field
usernameInput.addEventListener('input', (e) => {
    // e.target is the <input> element itself.
    // e.target.value is whatever text the user has typed so far.
    console.log(`User is typing: ${e.target.value}`);
});
```

15.3 Handling Forms and `e.preventDefault()`

Theory: In Full Stack development, forms are everything. By default, when a user clicks the "Submit" button inside an HTML `<form>`, the browser tries to refresh the entire page and send the data to a new URL.

In modern web apps (like React or standard Single Page Applications), **we do not want the page to refresh**. We want JavaScript to intercept the data so we can send it to our Node.js backend using an API call.

We stop the default refresh behavior using `e.preventDefault()`.

Example (The Full Stack Standard Form Submission):

```
<form id="login-form">
    <input type="email" id="email" />
    <button type="submit">Log In</button>
</form>
```

```
// JavaScript
const loginForm = document.querySelector('#login-form');
const emailField = document.querySelector('#email');

// Always listen for 'submit' on the FORM, not 'click' on the BUTTON!
loginForm.addEventListener('submit', (e) => {
    // 1. STOP the page from refreshing!
    e.preventDefault();

    // 2. Grab the data from the inputs
    const userEmail = emailField.value;

    // 3. (Usually) Send this data to your backend...
    console.log(`Sending ${userEmail} to the database for validation.`);
});
```

```
```

16. Creating and Removing Elements Dynamically

Theory: When you want to add new content to the screen without refreshing the page (like adding a new comment to a post or rendering a shopping cart), you must construct new HTML elements using JavaScript.

Creating an element in JS is a strict **3-Step Process**. If you miss a step, your element will not show up on the screen.

16.1 The 3-Step Process

Step 1: Create the Element (The "Ghost" Node)

You use `document.createElement('tagName')`. This creates the HTML tag, but it only exists in the computer's memory. It is not visible on the page yet.

```
const newListItem = document.createElement('li');
// In memory: <li></li>
```

Step 2: Modify the Element

Now that the element exists in memory, you add text, CSS classes, or attributes (like `src` or `id`) to it.

```
newListItem.innerText = "Buy groceries";
newListItem.classList.add('todo-item');
// In memory: <li class="todo-item">Buy groceries</li>
```

Step 3: Attach (Append) the Element to the DOM

Finally, you must select an existing element on the page (the parent) and physically attach your new element inside it.

- `parentElement.append(newChild)`**:** (Modern) Adds the new element to the *bottom* (end) of the parent.
- `parentElement.prepend(newChild)`**:** Adds the new element to the *top* (beginning) of the parent.

```
// Assume we have <ul id="todo-list"></ul> in our HTML
const todoList = document.querySelector('#todo-list');

// Attach the new <li> to the existing <ul>
todoList.append(newListItem);
```

16.3 Removing Elements

Theory: Removing an element is much simpler than creating one. You simply select the element you want to destroy and call the `.remove()` method on it.

```
const banner = document.querySelector('.promo-banner');

// User clicks a close button
document.querySelector('#close-promo').addEventListener('click', () => {
    banner.remove(); // Completely deletes the element from the DOM
});
```

```

```

17. Asynchronous JavaScript: Promises

Theory: A Promise in JavaScript is exactly like a promise in real life. It is an object representing the eventual completion (or failure) of an asynchronous operation.

The Restaurant Analogy: You order food at a busy restaurant. The cashier doesn't make you stand at the register until the food is ready (which would block the line). Instead, they give you a buzzer. That buzzer is a **Promise**. You can go sit down, text your friends, and drink water (execute other code). The buzzer promises to let you know when your food is ready, or if they ran out of ingredients.

17.1 The Three States of a Promise

A Promise will always be in one of these three distinct states:

1. **Pending:** The initial state. The operation has started, but hasn't finished yet (The buzzer is in your hand, quiet).
2. **Fulfilled (Resolved):** The operation completed successfully. The promise returns the requested data (The buzzer flashes, you get your food).
3. **Rejected:** The operation failed. The promise returns an error message (The cashier comes over and says they are out of food).

17.2 Creating a Promise (The Blueprint)

Theory: While Full Stack developers *consume* promises daily (like fetching data), you will occasionally need to *create* your own. You do this using the `new Promise` constructor, which takes a callback function with two arguments provided by JavaScript: `resolve` and `reject`.

Example:

```
const orderFood = new Promise((resolve, reject) => {
    console.log("Kitchen is cooking...");

    // Simulating a 2-second delay for cooking
    setTimeout(() => {
        const ingredientsAvailable = true; // Change to false to see the rejection

        if (ingredientsAvailable) {
            resolve({ meal: "Burger", drink: "Cola" }); // Success! We pass the
data out.
        } else {
            reject("Error: We ran out of beef."); // Failure! We pass the error
out.
        }
    }, 2000);
});
```

17.3 Consuming a Promise (`.then`, `.catch`, `.finally`)

Theory: Once a promise is created (or returned to you by a library/API), you have to handle what happens when it resolves or rejects. You do this by chaining specific methods onto the promise object.

- `.then(data)`: Runs ONLY if the promise is **Fulfilled**. It catches the data passed into `resolve()`.
- `.catch(error)`: Runs ONLY if the promise is **Rejected**. It catches the error passed into `reject()`.
- `.finally()`: Runs ALWAYS, regardless of success or failure. (Great for hiding loading spinners).

Example:

```
// We call the promise we made above
orderFood
    .then((foodData) => {
        console.log(`Success! I am eating a ${foodData.meal}.`);
    })
    .catch((errorMessage) => {
        console.error(`Oh no. ${errorMessage}`);
    })
    .finally(() => {
        console.log("Leaving the restaurant now."); // This runs no matter what
    });
```

```
```

18. API Calling and `async` / `await`

Theory: In modern Full Stack development, you will spend a massive amount of time making HTTP requests to APIs (e.g., fetching a list of YouTube videos, sending a new user registration to your database).

While `.then()` and `.catch()` work perfectly fine for Promises, ES8 (2017) introduced `async / await`. This is "syntactic sugar" that allows you to write asynchronous, non-blocking code that *looks* and *reads* like traditional, synchronous, top-to-bottom code.

18.1 The `async` and `await` Keywords

- `async`: You place this keyword in front of a function declaration. It tells JavaScript: *"Hey, this function is going to take some time, and it will automatically return a Promise."*
- `await`: You can ONLY use this keyword inside an `async` function. It tells JavaScript: *"Pause the execution of this specific function right here, and wait until the Promise resolves before moving to the next line."*

18.2 Making a GET Request (Fetching Data)

Theory: A GET request is the default method for APIs. You use it when you only want to *read* data from a server, not change it.

To safely use `async/await`, you must wrap your code in a `try...catch` block. This is how you handle errors (like a broken URL or a server crash) since you are no longer using `.catch()`.

Example (Fetching a User Profile):

```
// 1. Declare the function as 'async'
const fetchUserProfile = async (userId) => {
    try {
        console.log("Fetching user...");

        // 2. 'await' the fetch request. The code stops here until the server
responds.
        const response = await
fetch(`https://jsonplaceholder.typicode.com/users/${userId}`);

        // 3. Manually check if the network response was OK (Status 200-299)
        if (!response.ok) {
            throw new Error(`HTTP Error! Status: ${response.status}`);
        }

        // 4. 'await' the parsing of the JSON data. (response.json() returns a
Promise!)
        const userData = await response.json();

        // 5. Do something with the data!
        console.log("User Data Received:", userData.name);
        return userData;

    } catch (error) {
        // 6. This block catches network errors AND our manual HTTP Error throw
        console.error("Failed to fetch user:", error.message);
    }
};

// Calling the function
fetchUserProfile(1);
```

18.3 Making a POST Request (Sending Data)

Theory: When you want to send *new* data to your backend (like submitting a signup form or creating a new blog post), you must make a POST request.

To do this with `fetch()`, you have to pass a **configuration object** as the second argument. This object tells the API *how* you are sending the data.

Example (Creating a New Post):

```
const createNewPost = async (postTitle, postBody) => {
    // 1. Prepare the data you want to send
    const newPostData = {
        title: postTitle,
        body: postBody,
        userId: 1
    };

    try {
        const response = await fetch('[https://jsonplaceholder.typicode.com/posts]
(https://jsonplaceholder.typicode.com/posts)', {
            method: 'POST', // Change method from default GET to POST
            headers: {
                // Tell the server we are sending JSON data
                'Content-Type': 'application/json'
            },
            // Convert our JS Object into a raw JSON String
            body: JSON.stringify(newPostData)
        });

        if (!response.ok) {
            throw new Error(`HTTP Error! Status: ${response.status}`);
        }

        const savedPost = await response.json();
        console.log("Successfully created post!", savedPost);

    } catch (error) {
        console.error("Error creating post:", error);
    }
};

// Calling the function
createNewPost("My First API Post", "This is so cool!");
```

19. Web Storage (`localStorage` and `sessionStorage`)

Theory: The Web Storage API provides mechanisms by which browsers can store key/value pairs locally within the user's browser. It is much more intuitive than using old-school cookies, and it can store much more data (usually around 5MB per domain).

There are two main mechanisms within Web Storage, and they behave almost identically except for their lifespan.

19.1 `localStorage` vs. `sessionStorage`

- **`localStorage`:** Data stored here has **no expiration date**. It persists even if the user closes the browser, restarts their computer, and comes back a week later. (Great for: Dark mode preferences, persistent shopping carts).
- **`sessionStorage`:** Data stored here gets **cleared immediately** when the user closes that specific browser tab or window. (Great for: Multi-page form data that shouldn't be saved if the user bails out).

19.2 The Core Methods (CRUD Operations)

Both `localStorage` and `sessionStorage` use the exact same four built-in methods. Data is always stored as a `key` (the name of the data) and a `value` (the actual data).

Crucial Rule: Web Storage can ONLY store **Strings**. It cannot natively store Numbers, Booleans, Objects, or Arrays.

1. Saving Data: `setItem(key, value)`

```
// Saving simple strings
localStorage.setItem('theme', 'dark');
localStorage.setItem('username', 'Alice_Dev');

// Trying to save a number (JS will silently convert the 25 to "25")
localStorage.setItem('age', 25);
```

2. Reading Data: `getItem(key)`

Returns the value as a string. If the key doesn't exist, it returns `null`.

```
const currentTheme = localStorage.getItem('theme');
console.log(currentTheme); // "dark"

// Remember, it returns a string!
const userAge = localStorage.getItem('age');
console.log(typeof userAge); // "string"
```

3. Deleting Data: `removeItem(key)` and `clear()`

```
// Removes a single specific item
localStorage.removeItem('username');

// Wipes out EVERYTHING stored for your entire website (Use with caution!)
localStorage.clear();
```

19.3 The Golden Rule: Storing Objects and Arrays

Theory: Because `localStorage` only accepts strings, what happens if you try to save a JavaScript Object or an Array?

```
// The Mistake:
const userProfile = { name: "Bob", role: "Admin" };
localStorage.setItem('user', userProfile);

// If you try to get it back, you will just get the literal string "[object
Object]"
console.log(localStorage.getItem('user')); // "[object Object]" (Your data is
destroyed!)
```

The Solution: You must convert your Objects/Arrays into a **JSON String** before saving, and parse them back into JavaScript Objects when reading.

- `JSON.stringify(data)`**:** Converts JS data into a pure string.
- `JSON.parse(string)`**:** Converts a JSON string back into usable JS data.

Example (The Full Stack Standard):

```
const cartItems = [
    { id: 1, item: "Laptop", price: 1000 },
    { id: 2, item: "Mouse", price: 25 }
];

// 1. Saving Complex Data
// Stringify the array before saving it to localStorage
localStorage.setItem('shoppingCart', JSON.stringify(cartItems));

// 2. Retrieving Complex Data
// Grab the string, and immediately parse it back into a real Array
const savedCartString = localStorage.getItem('shoppingCart');
const parsedCart = JSON.parse(savedCartString);

console.log(parsedCart[0].item); // "Laptop" (It works!)
```

20. Advanced Functions & Functional Patterns

Theory: As you move deeper into Full Stack development, you stop writing basic functions that just calculate numbers, and start writing functions that manipulate, return, and compose *other* functions. These patterns are essential for writing clean, modular, and bug-free code.

20.1 Closures

Theory: A Closure is arguably the most important advanced concept in JavaScript. A closure is created when an **inner function** has access to the variables of its **outer function**, *even after the outer function has finished running*.

Normally, when a function finishes executing, its variables are destroyed (Garbage Collected). But if you return an inner function that relies on those variables, JavaScript keeps that specific memory "alive" inside a invisible backpack called a closure.

Example (Data Privacy / State Memory):

```
function createCounter() {
    // This variable is "private". It cannot be accessed directly from the
outside.
    let count = 0;

    // We return an inner function. This forms a closure!
    return function() {
        count++; // It remembers 'count' even after createCounter is done.
        return count;
    };
}

const myCounter = createCounter(); // createCounter runs and finishes.

console.log(myCounter()); // 1
console.log(myCounter()); // 2
console.log(myCounter()); // 3
// console.log(count);    // ERROR! count is not defined globally.
```

20.2 IIFE (Immediately Invoked Function Expression)

Theory: An IIFE (pronounced "iffy") is a function that runs the exact millisecond it is defined. Before ES6 modules and `let`/`const` block scoping existed, IIFEs were the primary way to keep variables from leaking into the Global Scope and causing naming collisions.

Syntax: You wrap the entire anonymous function in parentheses `()`, and then immediately call it by adding `()` at the end.

```
(function() {
    // Code runs immediately
```

```
})();
```

Example (Full Stack Context - Initialization):

```
// This data is completely hidden from the rest of the application
(function initializeApp() {
    const defaultTheme = "dark";
    const secretKey = "12345";

    console.log(`App initialized with theme: ${defaultTheme}`);
})();

// console.log(secretKey); // ERROR! secretKey is safely trapped inside the IIFE.
```

20.3 Currying

Theory: Currying is a functional programming technique where you transform a function that takes multiple arguments into a sequence of nested functions that each take a **single argument**.

Instead of calling `f(a, b, c)`, you call `f(a)(b)(c)`. It relies heavily on closures to remember the previous arguments.

Example:

```
// 1. Traditional Function
const addTraditional = (a, b, c) => a + b + c;
console.log(addTraditional(1, 2, 3)); // 6

// 2. Curried Function
const addCurried = (a) => {
    return (b) => {
        return (c) => {
            return a + b + c; // Closure remembers 'a' and 'b'
        };
    };
};

// Calling it all at once
console.log(addCurried(1)(2)(3)); // 6

// 3. Why is this useful? "Partial Application"
// You can lock in certain arguments to create specialized functions!
const addFive = addCurried(5);
const addFiveAndTen = addFive(10);
```

```
console.log(addFiveAndTen(4)); // 19 (5 + 10 + 4)
```

20.4 Function Composition

Theory: Composition is the process of combining two or more simple functions to build a more complex one. Instead of writing one massive function that does 10 things, you write 10 tiny functions and chain them together. The output of one function becomes the input of the next.

Example:

```
const double = (x) => x * 2;
const square = (x) => x * x;

// Traditional nested calling (Reads right-to-left, which is confusing)
const result1 = square(double(5)); // double(5) is 10. square(10) is 100.

// A simple Compose function (Reads right-to-left)
const compose = (func1, func2) => (value) => func1(func2(value));

const doubleThenSquare = compose(square, double);
console.log(doubleThenSquare(5)); // 100
```

> **Watch Out:** > In modern React and Redux, you will see utility functions like `compose()` or `pipe()` used constantly to wrap components in multiple layers of logic (like authentication, styling, and data fetching) without creating a messy "Pyramid of Doom."

20.5 Generator Functions

Theory: A normal function runs from top to bottom without stopping. A Generator Function is special: it can be **paused** right in the middle of executing, yield a value to the outside world, and then be **resumed** later right where it left off.

Syntax: You define it using an asterisk `function*` and pause it using the `yield` keyword.

Example (Generating unique IDs):

```
// 1. Define the generator
function* idMaker() {
    let id = 1;
    while (true) { // Normally an infinite loop crashes JS. Generators make it
safe!
        yield id;  // Pauses here and returns the 'id'
        id++;      // This runs when the function is resumed
    }
```

```
}

// 2. Initialize it
const generateId = idMaker();

// 3. Use the .next() method to pull values one by one
console.log(generateId.next().value); // 1
console.log(generateId.next().value); // 2
console.log(generateId.next().value); // 3

// You can pause for 10 minutes, run other code, and then call it again.
// It will remember that the next number is 4!
```