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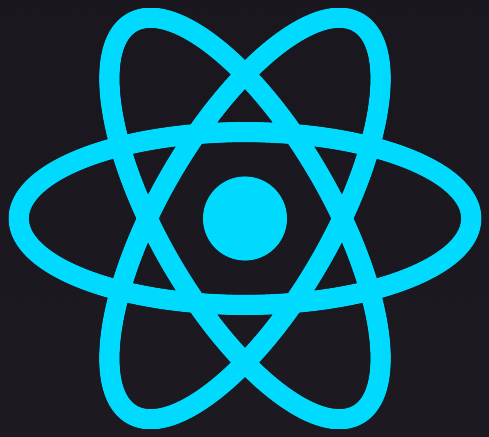

What is React?

And why exactly would you use it?

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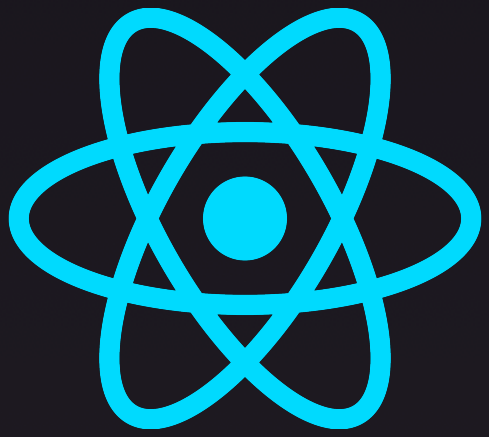

React is a library for building user interfaces

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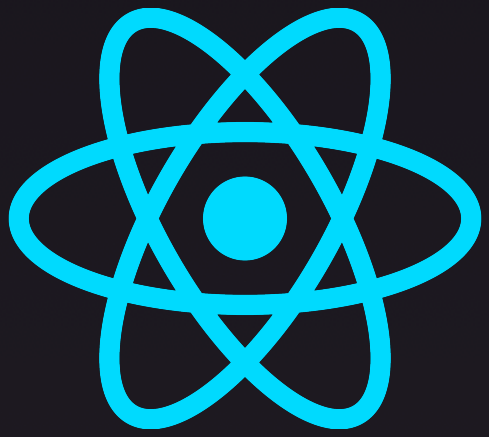

A JavaScript library for building user interfaces

But why would you use it?

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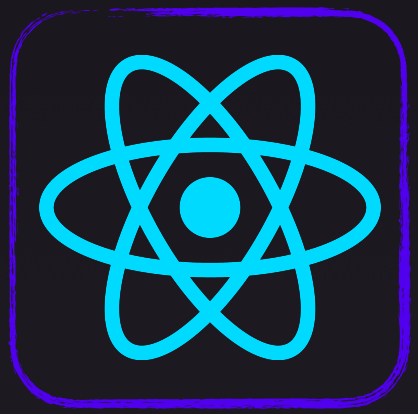
Displays & manages website content & UI



React builds up on JavaScript (it's a library!)

As a React developer, you'll write React-specific JavaScript code

In the end, it's JavaScript doing "the magic"

React just uses JavaScript features

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Why not just JavaScript?

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Using "Just JavaScript" Typically Isn't A Great Option

- Writing complex JavaScript code quickly becomes **cumbersome**
- Complex JavaScript code quickly becomes **error-prone**
- Complex JavaScript code often is **hard to maintain or edit**
- React offers a **simpler mental model**

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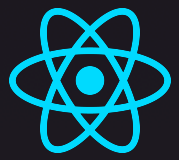
Basic Web Dev & JavaScript Knowledge is Assumed!

React = Declarative UI Programming

With React, you define the target UI state(s) — not the steps to get there!

Instead, React will figure out & perform the necessary steps



Declarative

Define the goal, not the steps

```
let content;

if (user.isLoggedIn) {
  content = <button>Continue</button>
} else {
  content = <button>Log In</button>
}

return content;
```

Imperative

Define the steps, not the goal

```
let btn = document.querySelector('button');

if (user.isLoggedIn) {
  button.textContent = 'Continue';
} else {
  button.textContent = 'Log In';
}

document.body.append(btn);
```

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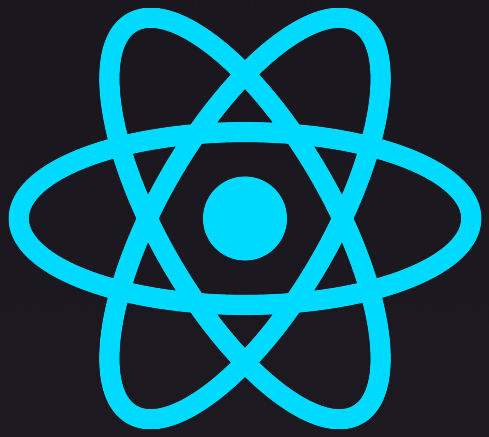

Our First React App

Time to get your hands dirty!

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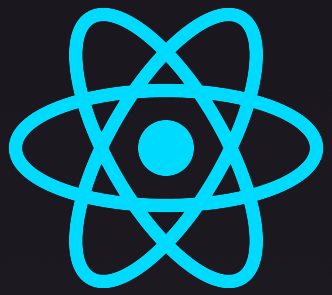
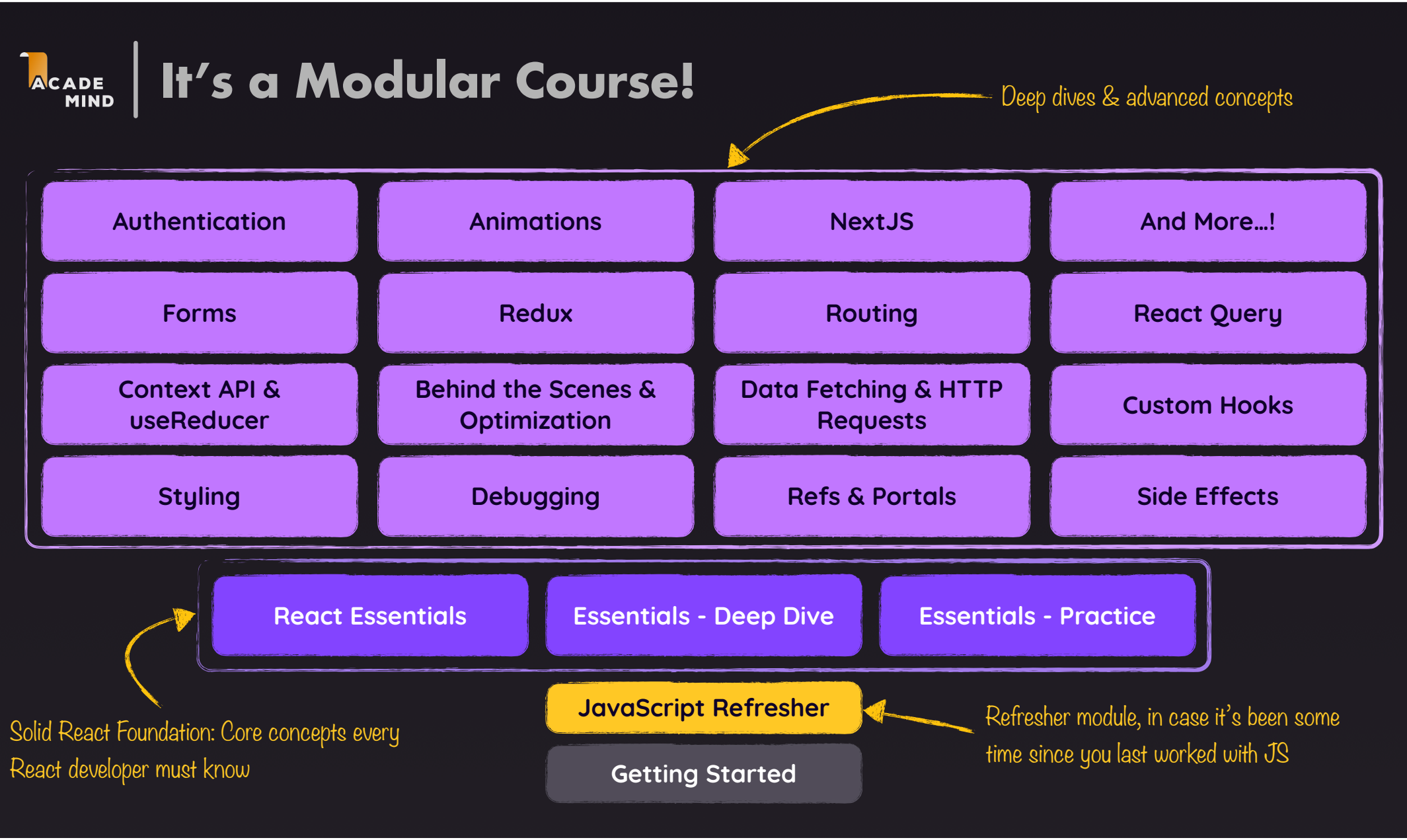


Our First React App

Time to get your hands dirty!

- Use the attached (updated!) demo app
- Add a fourth button
- Load the content for this button from the “content” array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It's a Modular Course!
Deep dives & advanced concepts
Authentication
Animations
NextJS
And More...!
Forms
Redux
Routing
React Query
Context API & useReducer
Behind the Scenes & Optimization
Data Fetching & HTTP Requests
Custom Hooks
Styling
Debugging
Refs & Portals
Side Effects
React Essentials
Essentials - Deep Dive
Essentials - Practice
Solid React Foundation: Core concepts every React developer must know
JavaScript Refresher
Getting Started
Refresher module, in case it's been some time since you last worked with JS

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One Course, Two Paths

Standard Path

Recommended

Start with lecture 1 in section 1

Complete the course lecture by lecture & section by section

You'll learn React step-by-step, from the ground up & in great detail!

Summary Path

If you got limited time

Complete the "Summary" section

You'll get a good overview of basic & advanced React concepts

It's also a great refresher after finishing the course

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How To Get The Most Out Of This Course

Meet the Prerequisites

Basic web dev & JavaScript knowledge is required

Use the JavaScript refresher if needed

Watch the Videos

Watch them at your pace

Slow me down or speed me up

Pause & rewind

Repeat sections

Practice!

Complete coding exercises

Pause & practice on your own

Build dummy demo projects

Help each other

Use code attachments if stuck

Ask & answer in the Q&A section

Find fellow developers on our Discord

React Code Must Be Transformed!

React Code

JavaScript code that typically uses JSX ("HTML in JavaScript")

Code is **transformed** & **optimized** (e.g., unnecessary whitespace is removed)

Code that runs in the browser

JavaScript code without JSX

Handled by build tool (e.g., Vite)

→ That's why a "more complex" project setup (which includes such a build tool) is needed

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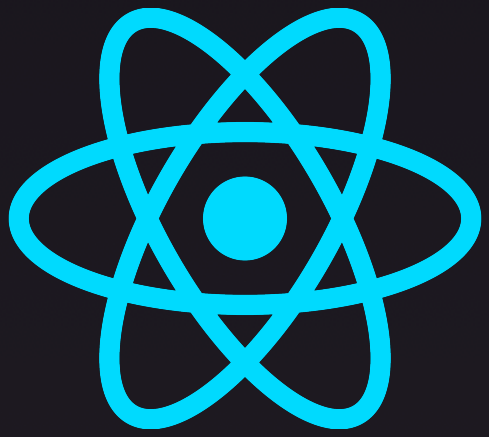


You Need A React Project

If you want to write React code

JavaScript Refresher

In case it's been some time...

Maximilian Schwarzmüller

This course section is optional!

It's recommended if you haven't used JavaScript in a while or if you don't have a lot of JavaScript experience

This section does not replace a JavaScript course!

But it will revisit crucial JavaScript concepts needed for building React apps

JavaScript Refresher

In case it's been some time since you last worked with JavaScript

- Core Syntax & Rules
- Essential, Modern JavaScript Features
- Key JavaScript Features Used In React Apps

Maximilian Schwarzmüller

JavaScript Can Be Executed In Many Environments

In the Browser
(i.e., as part of websites)

JavaScript code can be included in any website

The code then executes inside the browser (i.e., on the machine of the website visitor)

On any Computer
(e.g, server-side code)

Thanks to Node.js or Deno, JavaScript code can be executed outside of the browser, too

The code then executes directly on the machine

On mobile Devices
(e.g., via embedded websites)

With extra technologies like Capacitor or React Native, you can build mobile apps based on JavaScript

The code then executes on the mobile device

Adding JavaScript Code To A Website

Between <script> Tags

```
<script>
alert('Hello')
</script>
```

Can quickly lead to unmaintainable & complex HTML files

Typically only used for very short scripts

Via <script> Import

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

Separates HTML & JavaScript code

Maintaining complex JS-powered apps becomes easier

JavaScript code is just plain text!

How Code Is Executed

Code is read top to bottom,
left to right

JavaScript Code Consists Of “Statements”

Statement

The “thing” that gets executed

Keywords

Built into JavaScript

Required to “tell” JavaScript that a certain feature is used

`let`, `if`, `for`, …

Identifiers

Defined by developers

Used to identify commands (functions), variables (values) etc.

`alert()`, `age`, …

Values / Expressions

Defined by developers

Hardcoded values or expressions that produce new values

‘Hello world’, `5 - 3`, …

Keywords

Keywords enable language features

```
let, const, if, for, function, …
```

Identifiers

Identifiers identify “things”

Variables

Functions
(“Commands”)

Parameters

Property

JavaScript code is case-sensitive!

Identifiers Must Follow Certain Rules & Recommendations

#1

Must not contain whitespace or special characters (except $ and _)

Valid: $userName, age, user_name, data$, ...

Invalid: %userName, age/, user name, ...

#2

May contain numbers but must not start with a number

Valid: user3, us3r, ...

Invalid: 3user, 11players, ...

#3

Must not clash with reserved keywords

Valid: user, age, data, ...

Invalid: let, const, if, ...

#4

Should use camelCasing

Recommended: userName, isCorrect, ...

Uncommon: user_name, iscorrect, ...

#5

Should describe what the "thing" it identifies contains or does

Recommended: userName, isCorrect, loadData, ...

Uncommon: userDataPoint, correctness, dataLoader, ...

Semicolons are optional
(in most cases)!

Whitespace is ignored in many cases!

Use it to format your code & improve readability

But avoid adding too much whitespace

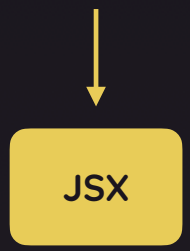
React projects use a build process

The code **you write** is **not** the code that gets **executed** (like this) in the browser

Your code is **transformed** before it's handed off to the browser

React Projects Use A Build Process

1. Raw, unprocessed React code **won't execute** in the browser



JSX is not a default JavaScript feature

2. In addition, the code would **not be optimized for production** (e.g., not minified)

React projects require a build process that transforms your code

create-react-app, vite etc. give you such a build process (no custom setup or tweaking needed)

There Are Different Types Of Values

String

Text values

Wrapped with single or double quotes

Can also be created with backticks (`)

```
"Hello World"

'Max'

`Hi there`
```

Number

Positive or negative

With decimal point (float) or without it (integer)

```
5
-23

3.14
-8.12
```

Boolean

True or false

A simple “Yes” or “No” value type

Typically used in conditions

```
true

false
```

Null & undefined

“There is no value”

undefined: Default if no value was assigned yet

null: Explicitly assigned by developer (reset value)

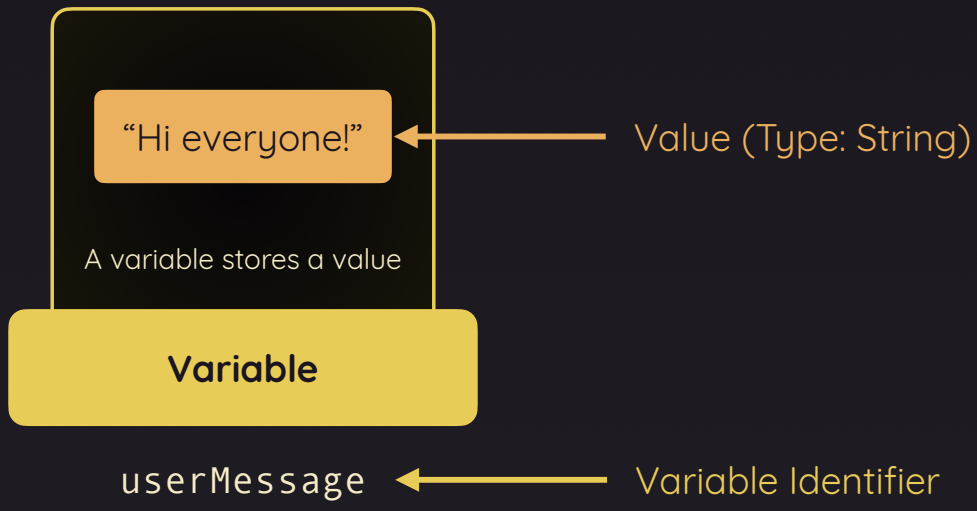
```
undefined

null
```

Additionally → **Objects**

Variables store Values

Variables Are Data Containers



Why Use Variables?

1

Reusability

Store a value in a variable once and use it as often and in as many places as needed

2

Readability

Organize your code over several lines rather than cramming everything into a single line

Variables vs Constants

Variables

Defined via `let`

Can be **re-assigned**
(i.e., the stored value can be overwritten)

```
let age = 34;
```

Allowed → `age = 29;` ✓

Constants

Defined via `const`

Cannot be **re-assigned**
(i.e., the stored value can't be overwritten)

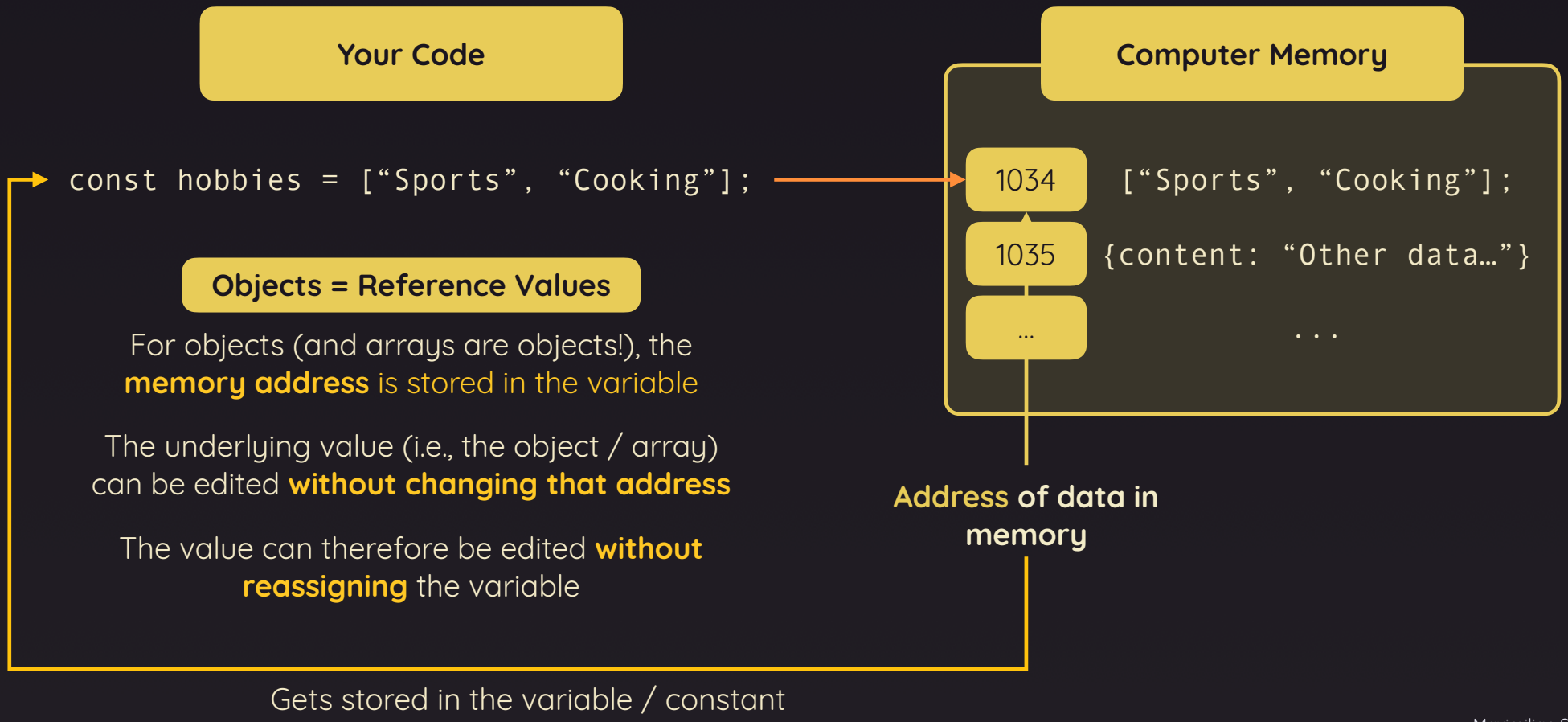
```
const age = 34;
```

✗ `age = 29;` ← Error

Values can be hardcoded

But they can also be derived via Expressions & Operators

Reference Values



Objects = Reference Values

For objects (and arrays are objects!), the **memory address** is stored in the variable

The underlying value (i.e., the object / array) can be edited **without changing that address**

The value can therefore be edited **without reassigning** the variable

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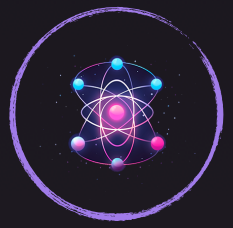

React Essentials

Components, JSX & State

- Building User Interfaces with **Components**
- Using, Sharing & Outputting **Data**
- Handling User **Events**
- Building Interactive UIs with **State**

About This Section

What you'll learn in this section

- How to build web user interfaces with React Components
- How to make those user interfaces interactive with State
- How to output static, dynamic & conditional data

What you'll be able to do after finishing this section

- Build basic, interactive React web applications
- Use React Components to build user interfaces with ease
- Handle user events & output data

What you should know before starting this section

- You must have basic JavaScript knowledge (variables, objects, arrays, functions, control structures, DOM)
- NO prior React knowledge is required!


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E2E Testing
Props
JSX
Refs
Custom Hooks
Classes
Reducers
Components
Routing
Effects
Fragments
Redux
DevTools
Suspense
Hooks
Portals
State
Animations
Strict Mode
Styling
RSC
Context
NextJS
Unit Testing

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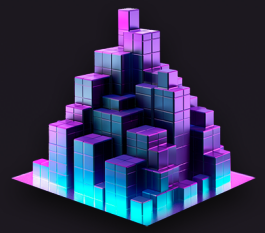

Components

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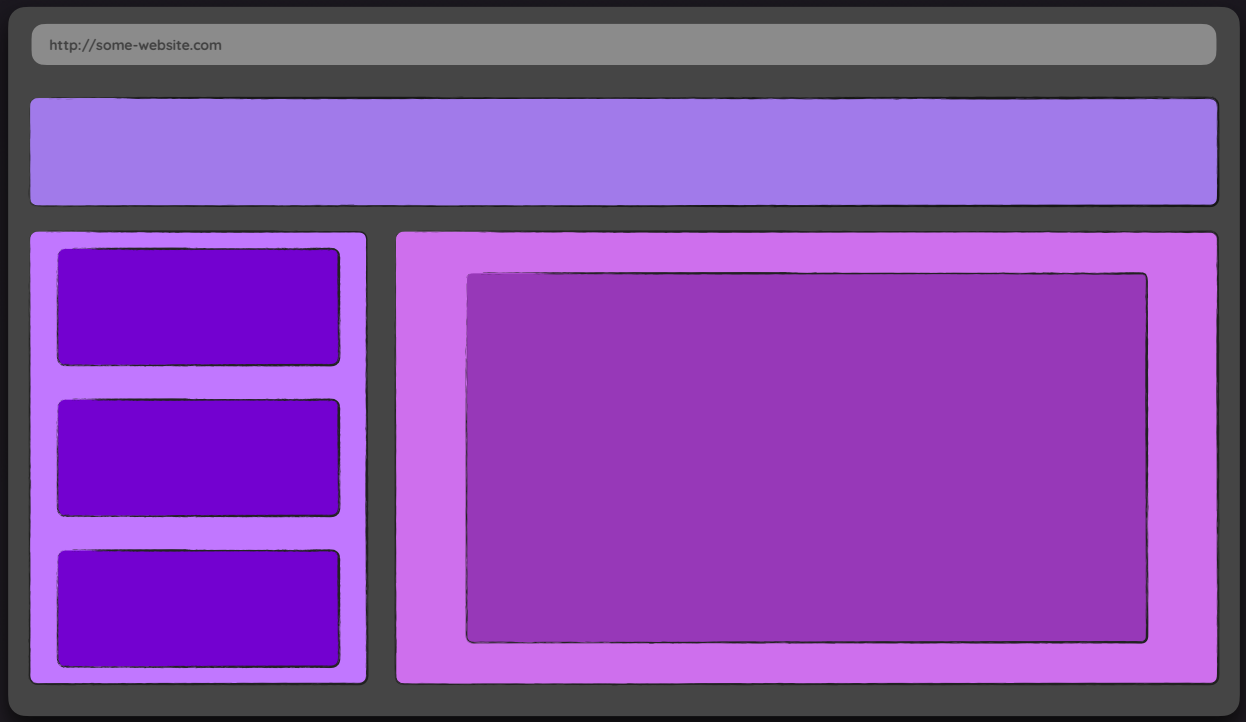
Components Are UI Building Blocks



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React Apps Are Built By Combining Components

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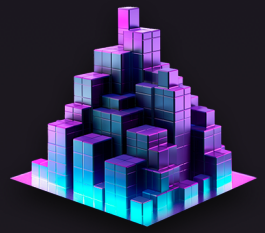
Components Are The Foundation



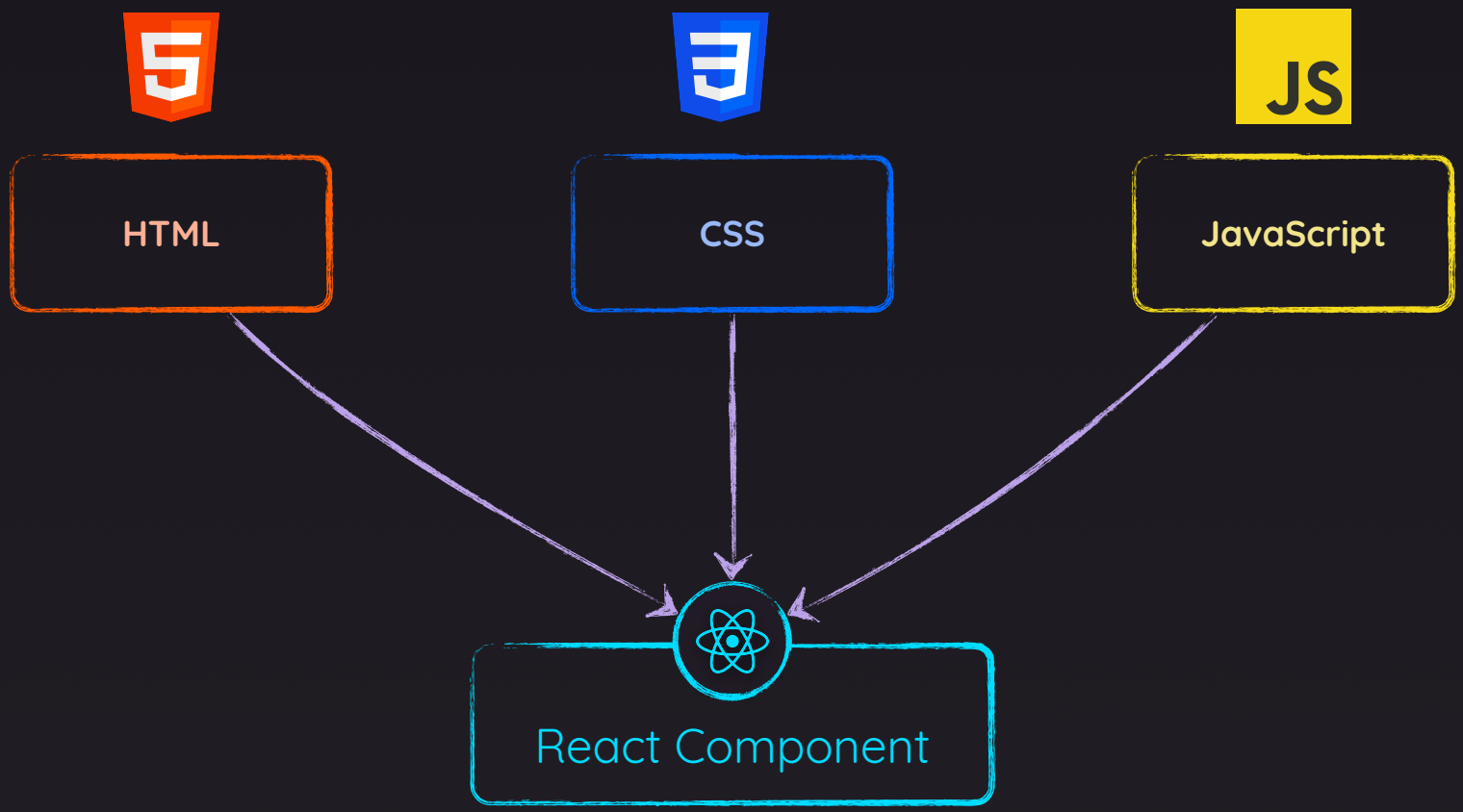
Components

JSX

State

Props

Creating Components



Build User Interfaces With Components

Any website or app can be broken down into
smaller building blocks: **Components**

It can therefore also be built by creating & combining such components

Header

Core Concept Items

Interactive Tabs

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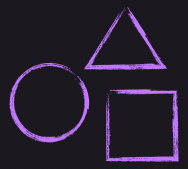
Why Components?

Reusable Building Blocks

Create **small building blocks** & **compose** the UI from them

If needed: **Reuse** a building block in different parts of the UI (e.g., a reusable button)



Related Code Lives Together

Related HTML & JS (and possibly CSS) code is **stored together**

Since JS influences the output, storing JS + HTML together makes sense

Separation of Concerns

Different components handle different data & logic

Vastly **simplifies** the process of working on complex apps

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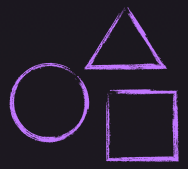

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Components Can Potentially Be Reused

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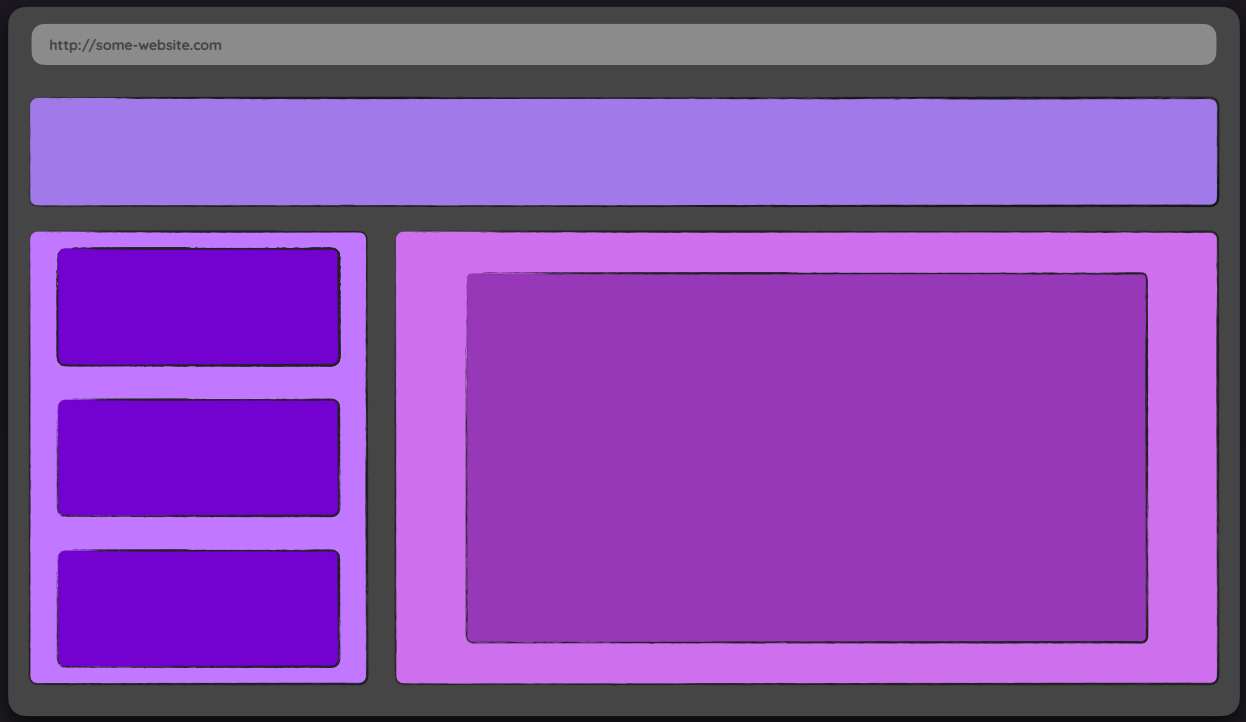
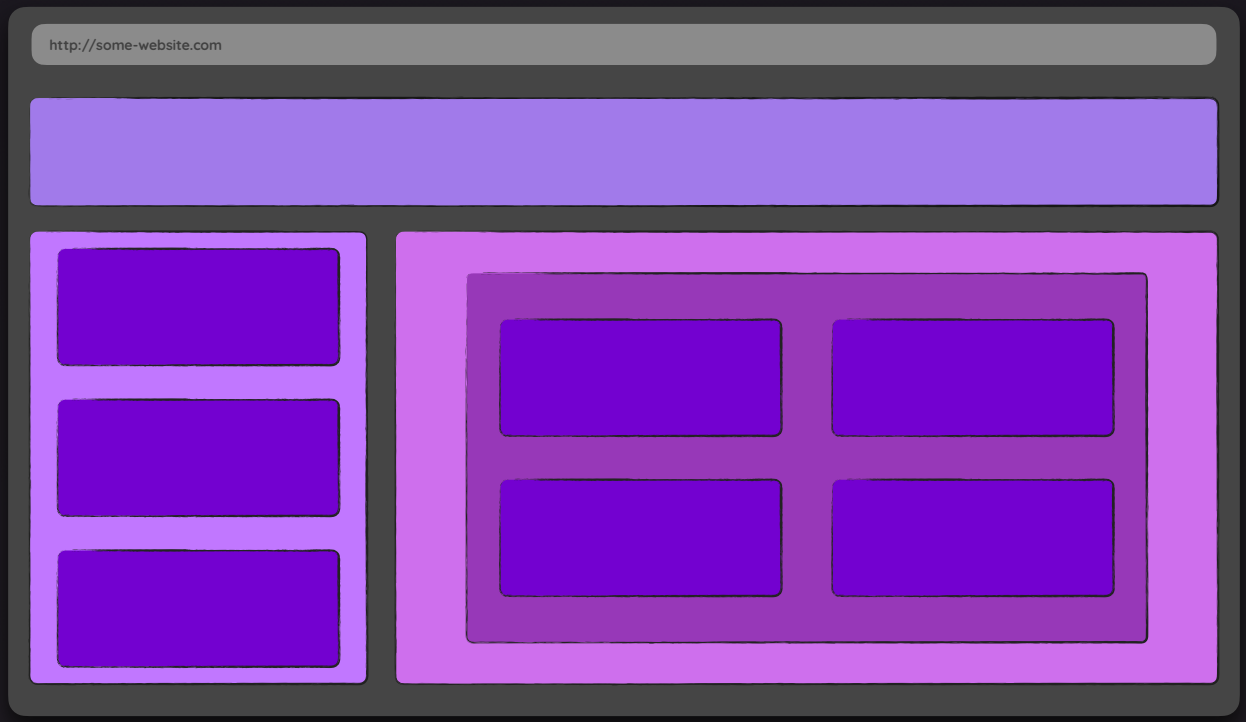
Components Can Potentially Be Reused



Components Can Potentially Be Reused



Components Can Potentially Be Reused

Header

Core Concept Items

The same component is used multiple times with different input data

Interactive Tabs

Different Components, Different Responsibilities

Header

Displaying main title, subtitle & image

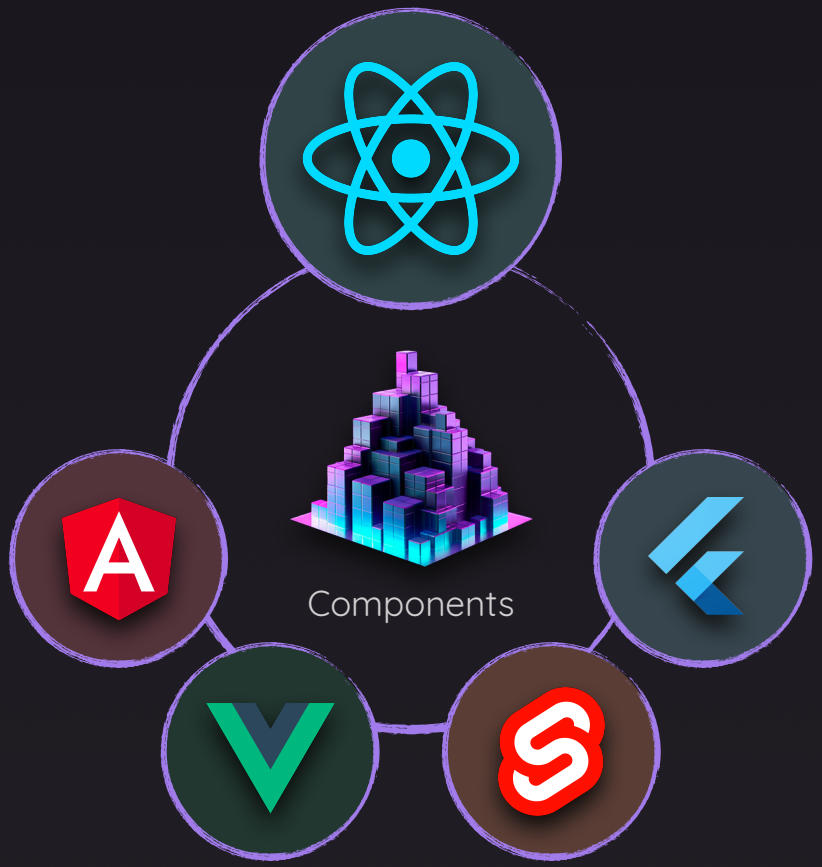
Core Concept Items

Outputting core concept information

Interactive Tabs

Handling user input & switching between tabs

Components Are A Fundamental Concept



Describe The Target UI With JSX

JavaScript Syntax eXtension

JSX

```
<div>
  <h1>Hello World!</h1>
  <p>JSX code is awesome!</p>
</div>
```

Used to describe & create HTML elements in JavaScript in a **declarative** way

BUT → **Browsers do not support JSX!**

React projects come with a **build process** that **transforms** JSX code (behind the scenes) to code that **does work** in browsers

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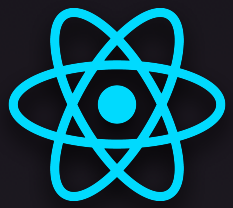


With React, You Write Declarative Code

You define the target HTML structure & UI — not the steps to get there!

Component Functions Must Follow Two Rules

Name Starts With Uppercase Character

The function name **must start** with an **uppercase** character

Multi-word names should be written in **PascalCase** (e.g., “MyHeader”)

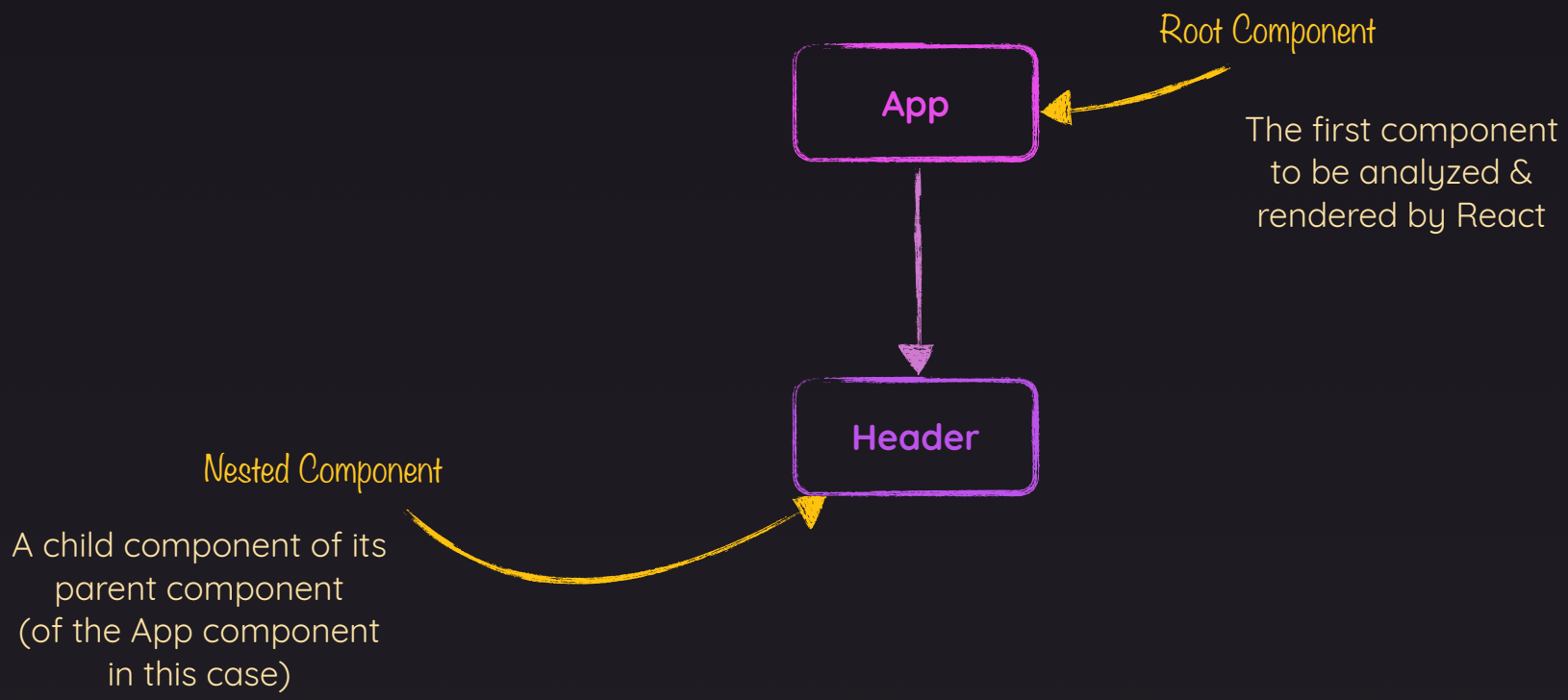
It’s **recommended** to pick a name that **describes** the UI building block (e.g., “Header” or “MyHeader”)

Returns “Renderable” Content

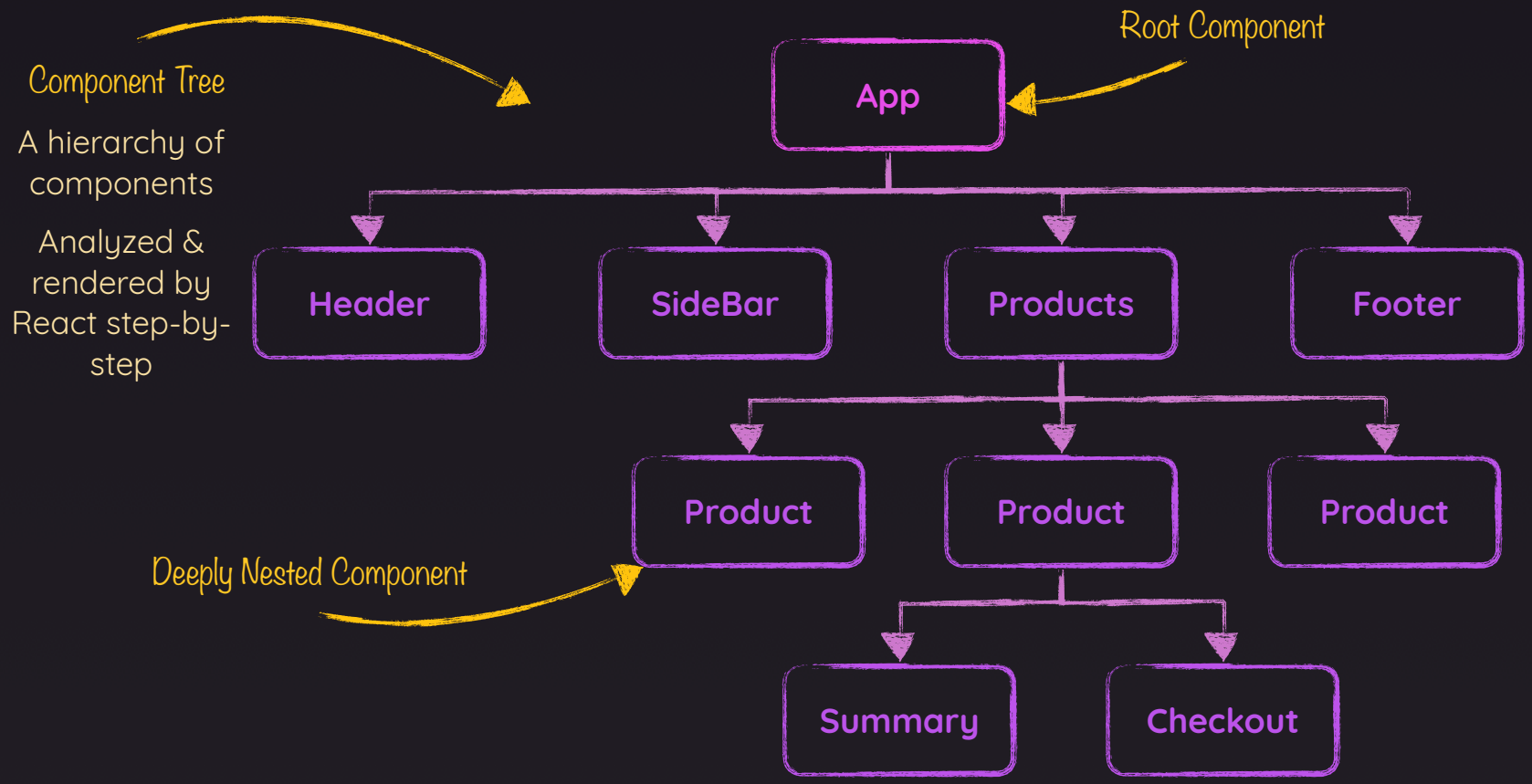
The function must **return** a value that can be **rendered** (“displayed on screen”) by React

In **most** cases: Return **JSX**
Also allowed: string, number, boolean, null, array of allowed values

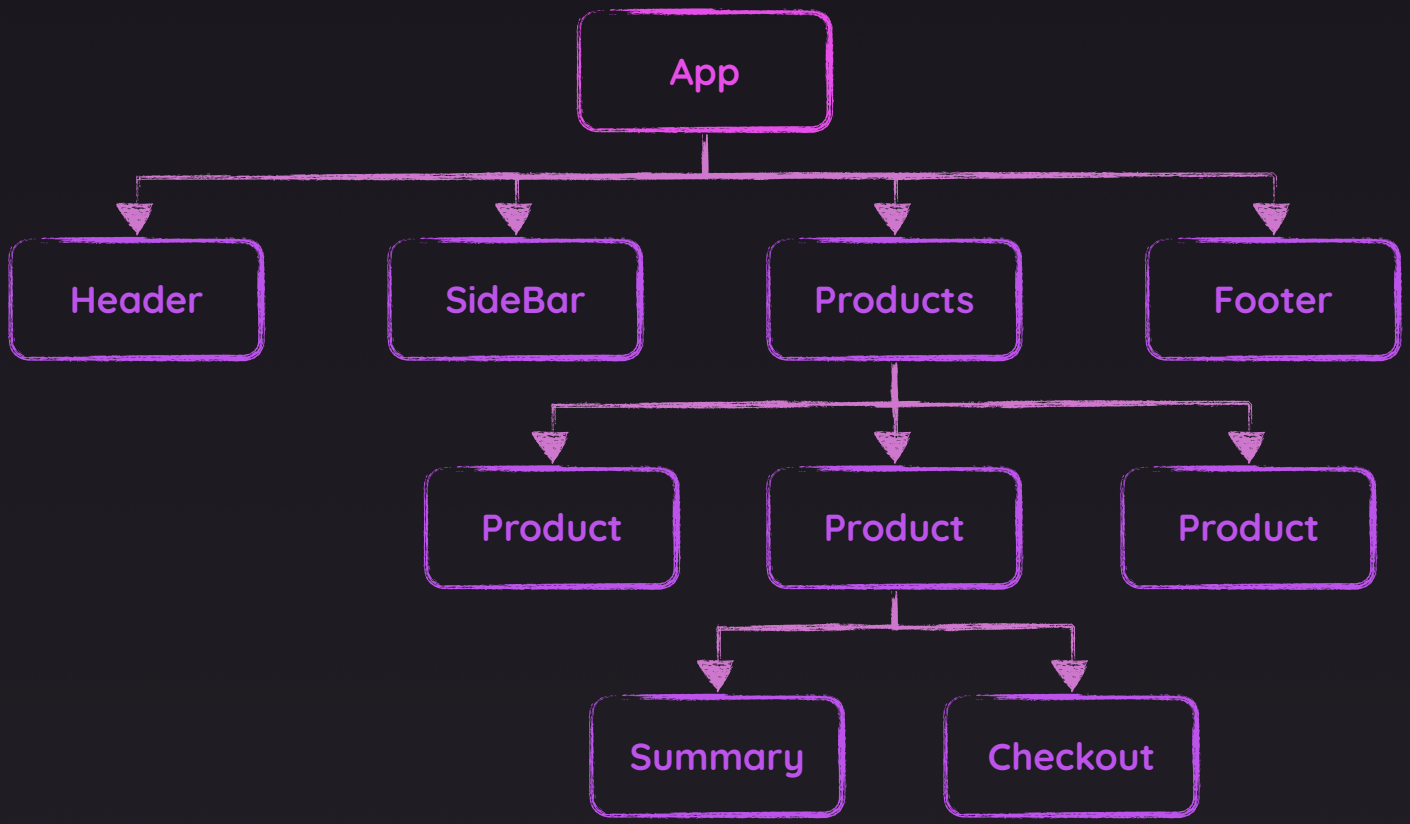
How Components Get Rendered



Building a Component Hierarchy



Building a Component Hierarchy



From Component Tree To DOM Node Tree

```
<div>
  <header>
    <img src="…" alt="…">
    <h1>React Essentials</h1>
    <p>Learn about all the core React concepts!</p>
  </header>
  <main>
    <p>Time to get started!</p>
  </main>
</div>
```

Built-in Components vs Custom Components

Built-in Components

Name starts with a **lowercase** character

Only **valid, officially defined** HTML elements are allowed

Are **rendered as DOM nodes** by React (i.e., displayed on the screen)

Custom Components

Name starts with **uppercase** character

Defined by you, "**wraps**" built-in or other custom components

React "**traverses**" the component tree until it has only built-in components left

Outputting Dynamic Content in JSX

Static Content

Content that's **hardcoded** into the JSX code

Can't change at runtime

Example

```
<h1>Hello World!</h1>
```

Dynamic Content

Logic that **produces the actual value** is added to JSX

Content / value is **derived** at runtime

Example

```
<h1>{userName}</h1>
```

React Projects & "The Build Process"

React projects must be "built" (via a build process) before deployment

The React code you write & test

Changes & optimizes your code

Transforms it such that it runs in the browser

Also (potentially) optimizes other assets like CSS & image files

A collection of generated files that include your optimized code and any other extra assets (e.g., CSS code files, optimized images etc)

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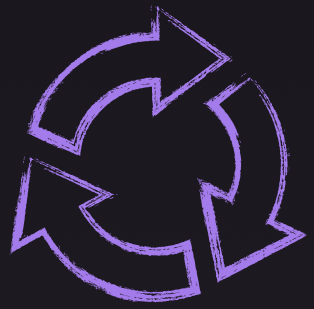
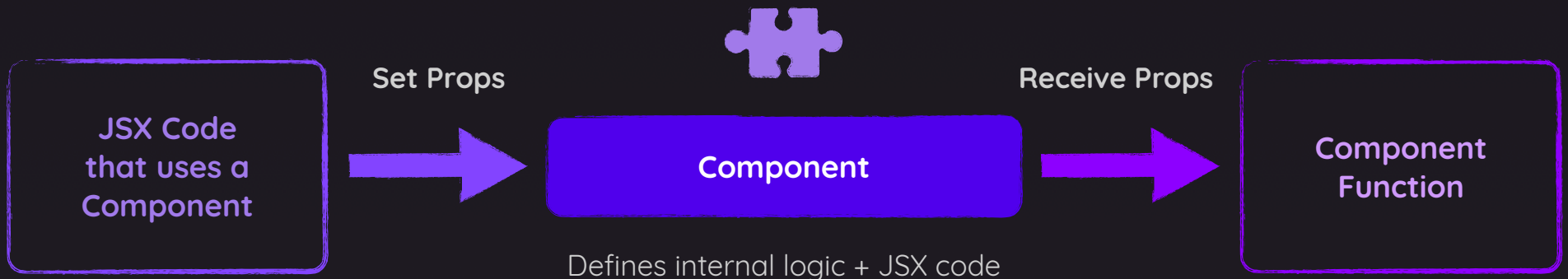


You Can Reuse React Components

But You Don't Have To!

Configuring Components With "Props"

React allows you to **pass data to components** via a concept called **"Props"**



Set component input data via "custom HTML attributes" (props)

Defines internal logic + JSX code that should be rendered

Receives props parameter with configuration data

Props Accept All Value Types

You're not limited to text values!

String value

Number value

Curly braces are required to pass the value as a number.

If quotes were used, it would be considered a string.

```
<UserInfo
  name="Max"
  age={34}
  details={{userName: 'Max'}}
  hobbies={['Cooking', 'Reading']}
/>
```

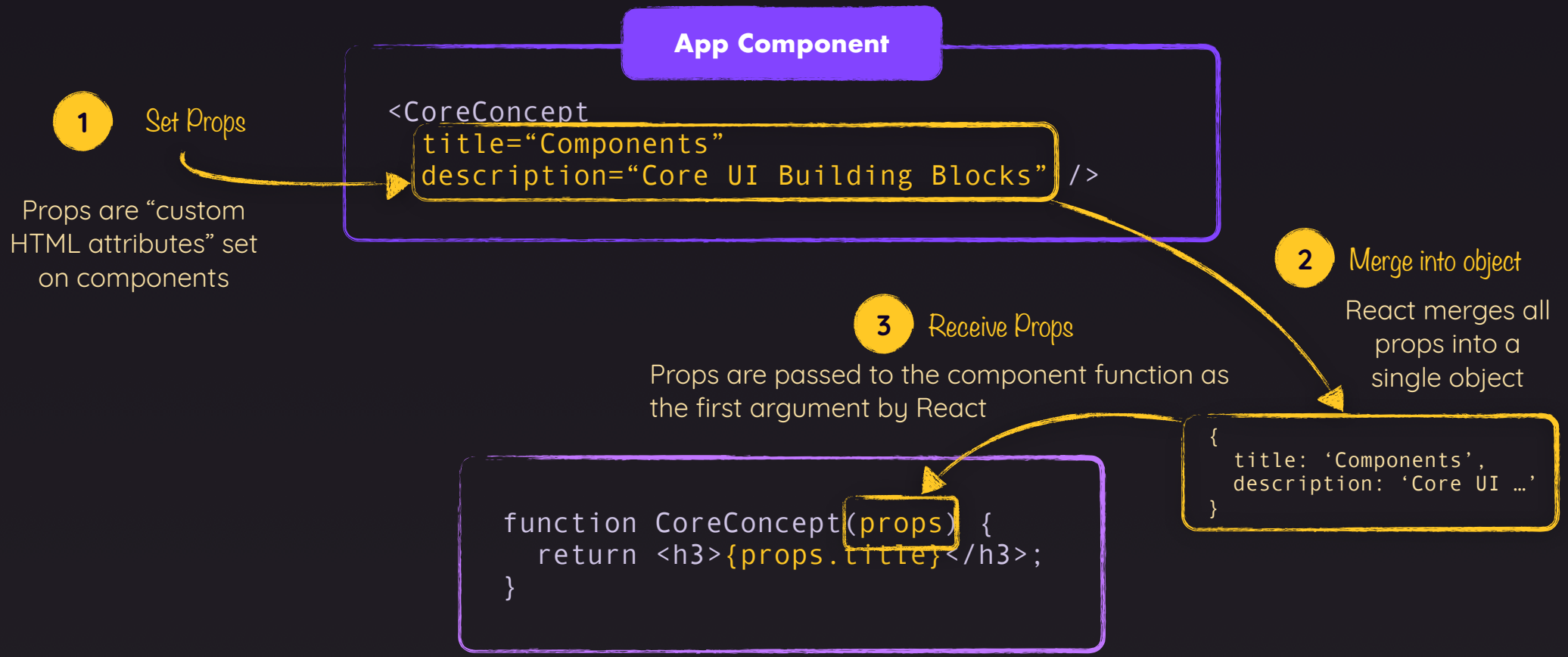
Object value

This is **no special "double curly braces" syntax!**

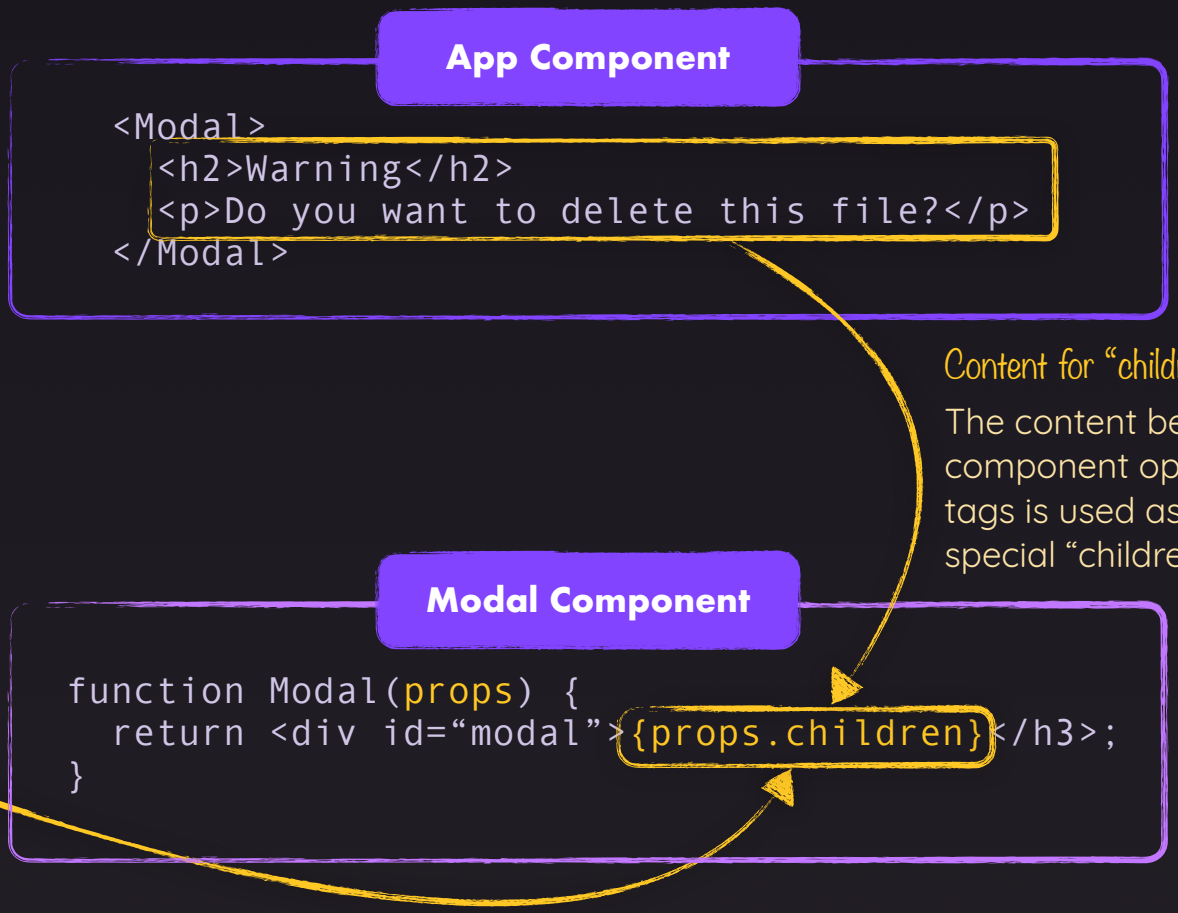
It's simply a JS object passed as a value.

Array value

Understanding Props



The Special “children” Prop



“children” Prop vs “Attribute Props”

Using “children”

```
<TabButton>Components</TabButton>
```

```
function TabButton({ children }) {
  return <button>{children}</button>;
}
```

For components that take a **single piece of renderable content**, this approach is closer to “normal HTML usage”

This approach is **especially convenient** when passing **JSX code as a value** to another component

Using Attributes

```
<TabButton label=“Components”></TabButton>
```

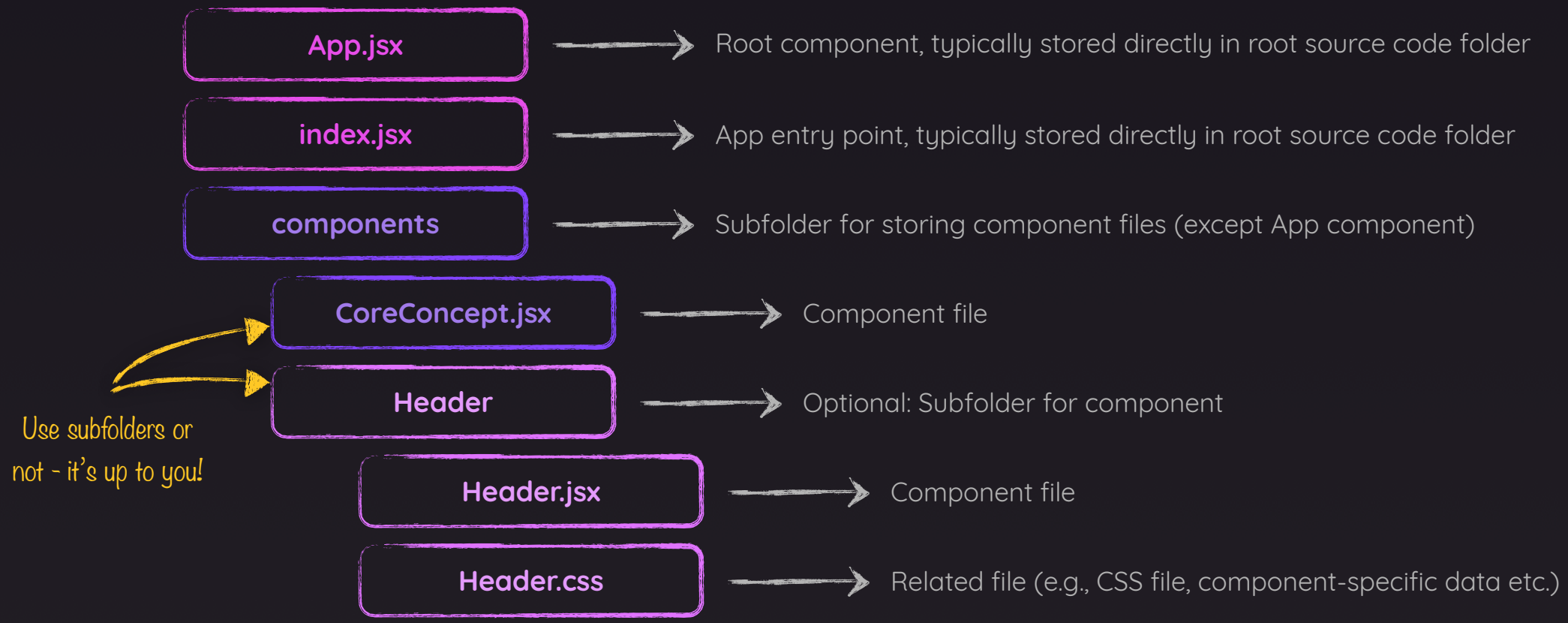
```
function TabButton({ label }) {
  return <button>{label}</button>;
}
```

This approach makes sense if you got **multiple smaller pieces of information** that must be passed to a component

Adding **extra props** instead of just wrapping the content with the component tags mean **extra work**

Ultimately, it comes down to your use-case and personal preferences.

Structuring React Projects - The "src" Folder



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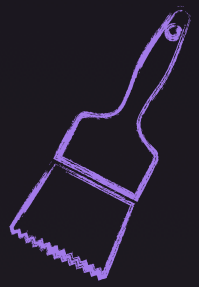
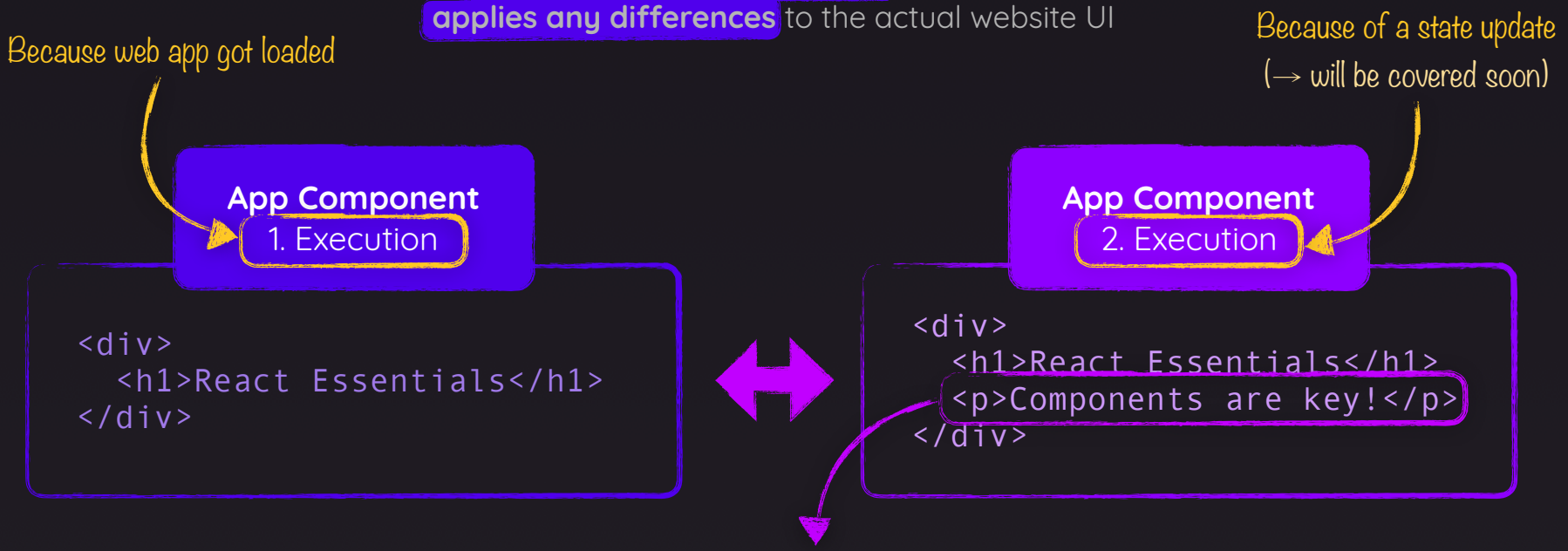


By Default, React Components Execute **Only Once**

You have to **"tell"** React If A Component Should be Executed Again

How React Checks If UI Updates Are Needed

React **compares** the **old output** ("old JSX code") of your component function to the **new output** ("new JSX code") and **applies any differences** to the actual website UI



Necessary updates will be applied to the real DOM, ensuring that the visible UI matches the expected output.

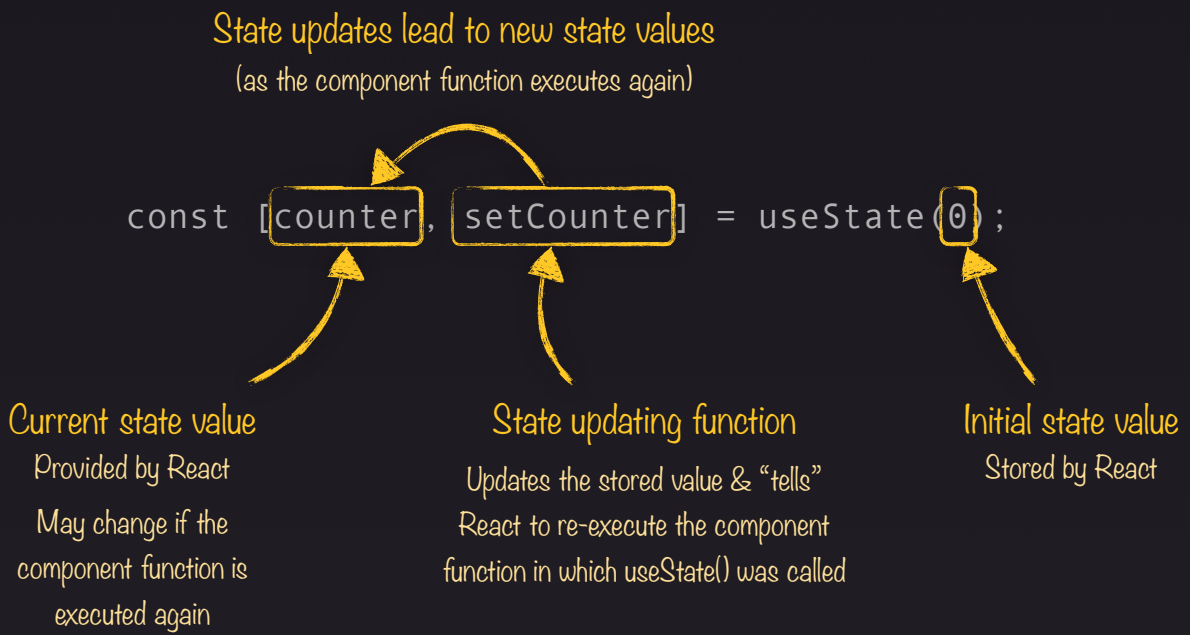
useState() Yields An Array With Two Elements

And it will always be exactly two elements

```
const stateArray = useState('Please click a button');
```

Manage State

Manage data & **"tell"** React to **re-execute** a component function via React's **useState()** Hook



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Rules of Hooks

1 Only call Hooks inside of Component Functions

React Hooks must not be called outside of React component functions

```
function App() {
  const [val, setVal] = useState(0);
}
```

```
const [val, setVal] = useState(0);

function App() { … }
```

2 Only call Hooks on the top level

React Hooks must not be called in nested code statements (e.g., inside of if-statements)

```
function App() {
  const [val, setVal] = useState(0);
}
```

```
function App() {
  if (someCondition)
    const [val, setVal] = useState(0);
}
```

Transforming Data To JSX

```
[
  { userName: 'Max', age: 34 },
  { userName: 'Manuel', age: 35 },
  { userName: 'Marie', age: 38 },
]
```

Transform

```
[
  <User {...user[0]} />,
  <User {...user[1]} />,
  <User {...user[2]} />,
]
```

Output in JSX

```
<ul>
  <User {...user[0]} />
  <User {...user[1]} />
  <User {...user[2]} />
</ul>
```

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Essential React Concepts

Components

Reusable building blocks which are used to build the overall app UI

Props

Component “attributes” (input data) used to configure components

JSX

JS syntax extension to describe HTML in JavaScript

State

React-managed data which, when changed, causes React to re-execute the related component function

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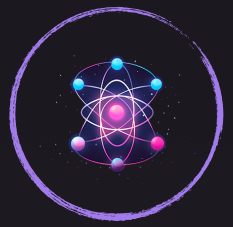


React Essentials - Deep Dive

Beyond The Basics

- Behind The Scenes of **JSX**
- Structuring **Components** and **State**
- **Advanced State** Usage
- **Patterns & Best Practices**

You Don't Need JSX (But It's Convenient)

```jsx
<div id="content">
  <p>Hello World!</p>
</div>
```

Requires build process & code transformation

Easy to read & understand

```jsx
React.createElement(
  'div',
  { id: 'content' },
  React.createElement(
    'p',
    null,
    'Hello World'
  )
);
```

Works without special build process & transformation

Pretty verbose & not necessarily intuitive

Component Type

Identifies the to-be-rendered component

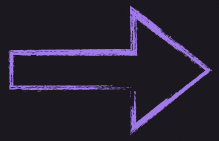
Props Object

Sets component props

Child Content

The content passed between the component tags

Additional Key Component & Props Concepts



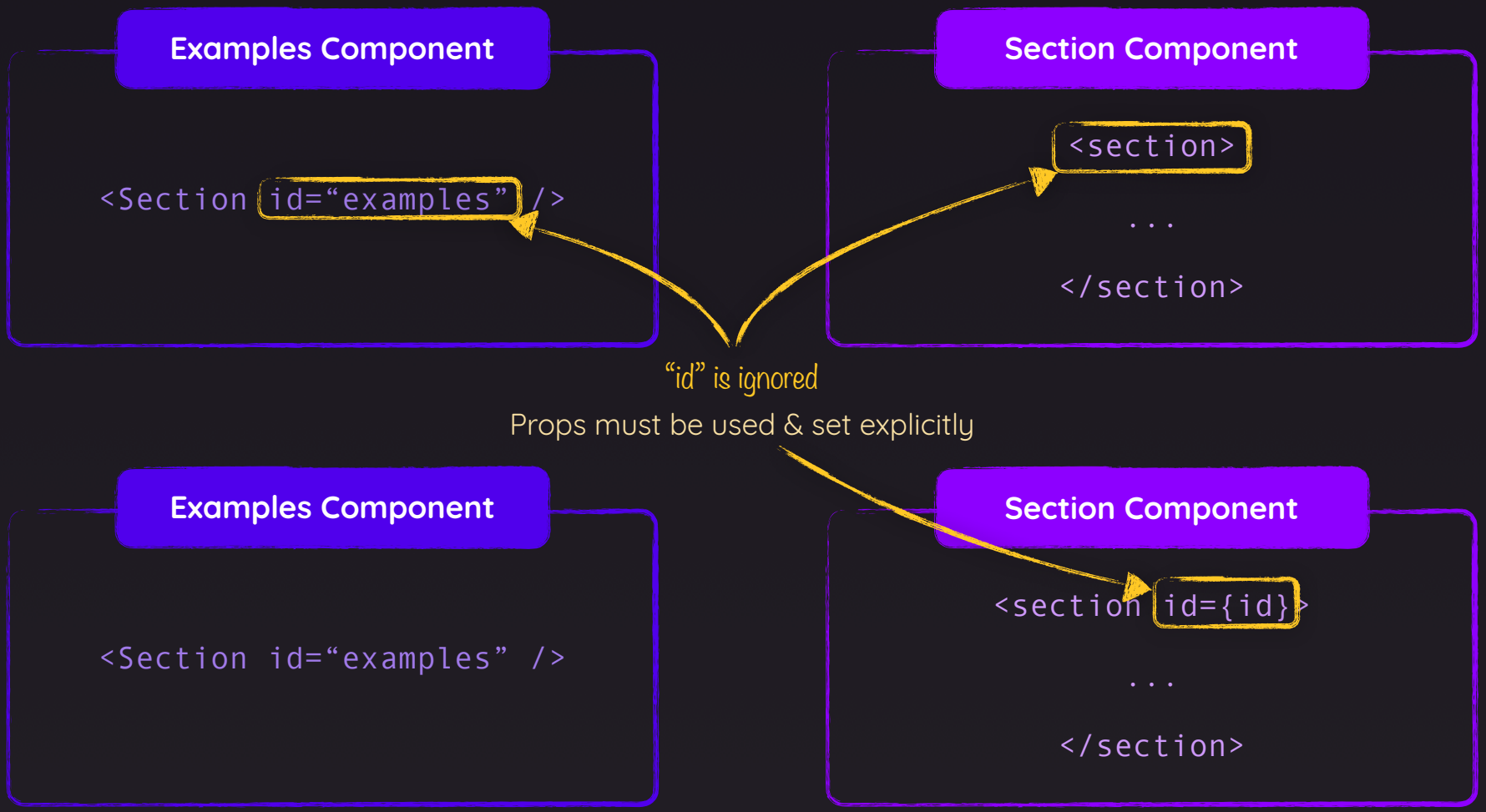
Forwarded Props

Multiple Component Slots

Element Identifiers as Props

Default Prop Values

Props Are Not Forwarded Automatically



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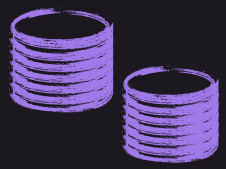
New Project, New Concepts



Multiple State Values

Nested Lists

Lifting State Up

Array & Object States

Derived State

Component Functions vs "Normal Functions"

Updating State Based On Old State

```
setIsEditing(!isEditing);
```

If your **new state depends on your previous state** value, you should **not** update the state like this

```
setIsEditing(wasEditing => !wasEditing);
```

Instead, **pass a function** to your state updating function

This function will **automatically be called** by React and will receive the **guaranteed latest state value**

React Is Scheduling State Updates

Somewhere in your code

Code snippets in different places in your app's code

```
setIsEditing(true);
...
setIsEditing(false);
...
setIsEditing(true);
...
setIsEditing(false);
```

React's State Updating Schedule

Managed behind the scenes by React

1 → Update state to `true`

2 → Update state to `false`

3 → Update state to `true`

4 → Update state to `false`

State updates are **not performed instantly** but at some point in the future
(when React has time for it)

In most cases, those state updates of course still are executed **almost instantly**

Update Object-State Immutably

Objects & arrays (which technically are objects) are **reference values** in JavaScript

You should therefore **not mutate** them directly — instead create a **(deep) copy** first!

NOT creating a copy (because user is an object = a reference value)

```
const updatedUser = user;
user.name = 'Max'
```

Editing the user object in memory

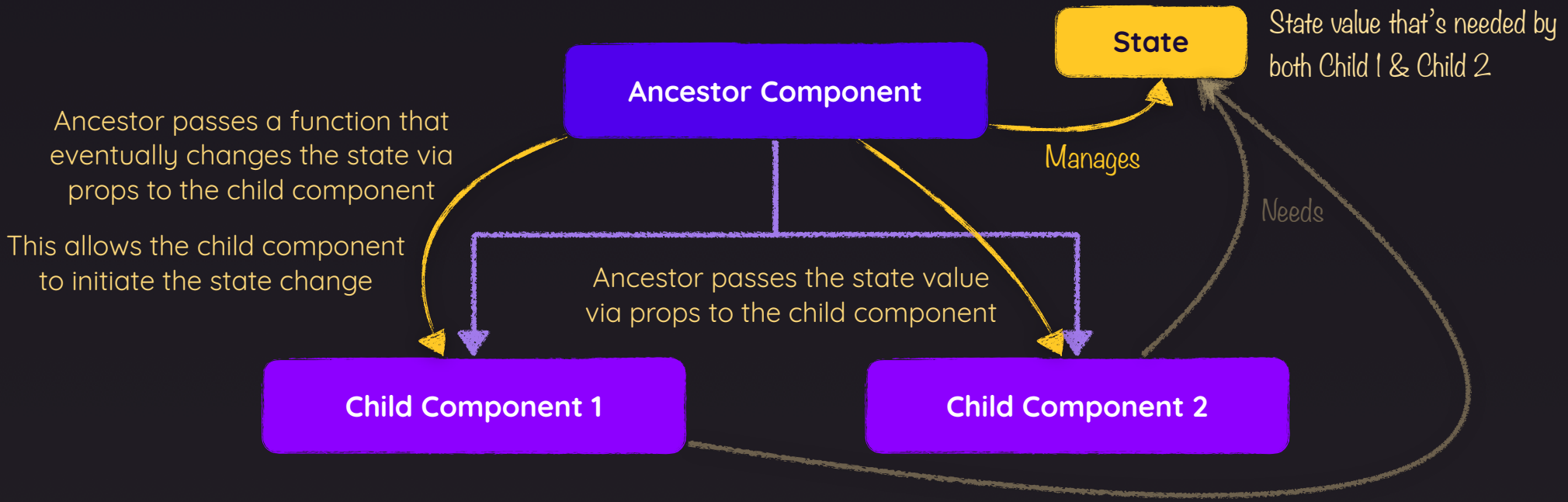
Creating a copy via JavaScript's "Spread" operator

```
const updatedUser = { ...user }
updatedUser.name = 'Max'
```

Editing the copy, not the original

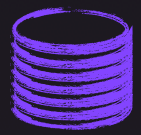
Lifting State Up

Lift the state up to the **closest ancestor component** that has access to all components that need to work with that state



You Don't Always Have Just One State Value

Player data and **game state** must be managed



Combined State Object

Data from different app features is managed in a **single, shared state object**

You must ensure that you don't **accidentally lose data** related to feature B when feature A's data changes

Separate State Slices

Data from different app features is managed in **different state values**

Suboptimal if states from different features depend on each other

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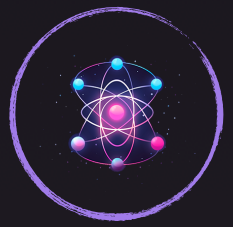

React Essentials - Practice Project

Apply Your Knowledge & Practice What You Learned

- Build an “Investment Calculator” Web App
- Build, Configure & Combine **Components**
- Manage Application **State**
- Output **List** & **Conditional** Content

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Time To Practice!

Your Task

Build an “Investment Calculator” web app

Use the **starting project** attached to this lecture

Add **components** for displaying a **header**, fetching **user input** & outputting the **results table**

Fetch & store user input (i.e., the entered investment parameters)

Derive investment results with help of the provided utility function (in the starting project)

Display investment results in a HTML **table** (use `<table>`, `<thead>`, `<tbody>` `<tr>`, `<th>`, `<td>`)

Conditionally display an info message if an **invalid duration** (< 1) was entered

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There's More Than One Way Of Building This!

My solution (shown in the next lectures) is **not the only correct solution!**

And even if you can't build the entire app — simply **try to get as close as possible!**

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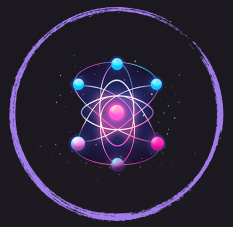


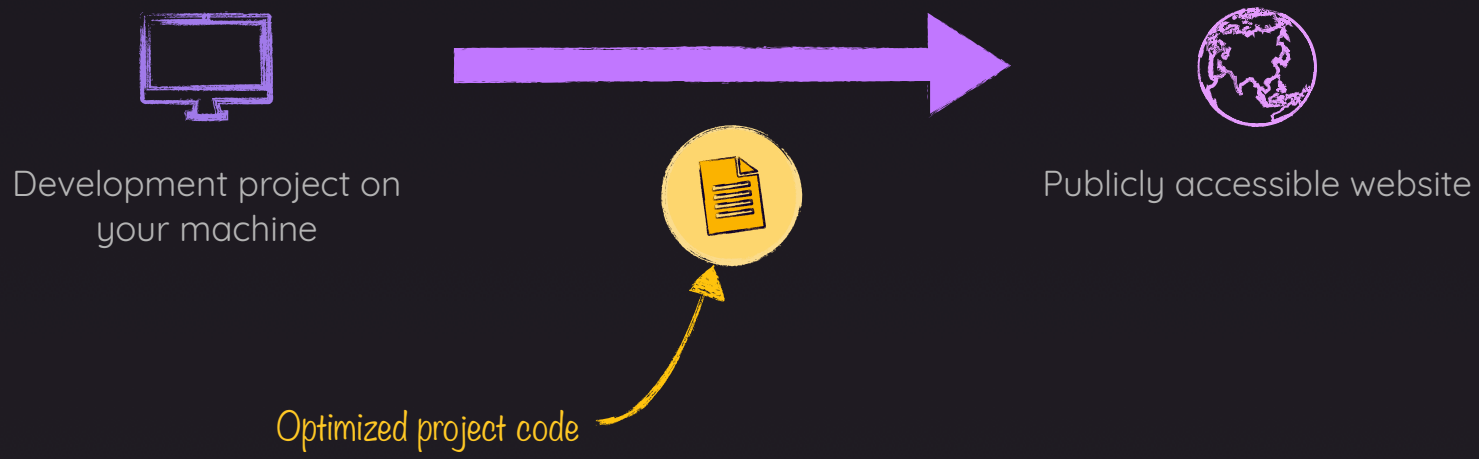
Deploying React Projects

From Development To Production

- What Does “**Deployment**” Mean?
- React Project **Hosting Requirements**
- **Example** Deployment

What Does "Deployment" Mean?

Deployment: The process of **publishing** your project



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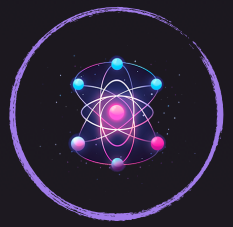

Debugging React Apps

Finding & Fixing Errors

- Making Sense of **React Error Messages**
- Finding **Logical Errors** via the Browser **DevTools & Debugger**
- Enabling React's **Strict Mode**
- Using the **React DevTools** for Application Analysis & Manipulation

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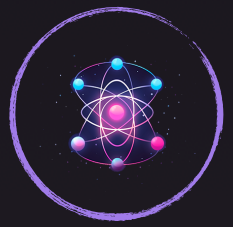

Styling React Apps

Static & Dynamic Styling for Pretty Apps

- Styling with **Vanilla CSS**
- **Scoping** Styles with **CSS Modules**
- **CSS-in-JS** Styling with **“Styled Components”**
- Styling with **Tailwind CSS**
- Static & **Dynamic (Conditional)** Styling

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This is not a CSS course

But you should know how to apply
CSS to your React components

Inline Styles: Advantages & Disadvantages

Advantages

Quick & easy to add to JSX

Styles only affect the element to which you add them

Dynamic (conditional) styling is simple

Disadvantages

You need to know CSS

You need to style every element individually

No separation between CSS & JSX code

Vanilla CSS: Advantages & Disadvantages

Advantages

CSS code is decoupled from JSX code

You write CSS code as you (maybe) know and (maybe) love it

CSS code can be written by another developer who needs only a minimal amount of access to your JSX code

Disadvantages

You need to know CSS

CSS code is not scoped to components → CSS rules may clash across components (e.g., same CSS class name used in different components for different purposes)

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CSS Modules

Vanilla CSS with file-specific scoping

CSS Modules: Advantages & Disadvantages

Advantages

CSS code is decoupled from JSX code

You write CSS code as you (maybe) know and (maybe) love it

CSS code can be written by another developer who needs only a minimal amount of access to your JSX code

CSS classes are scoped to the component (files) which import them → No CSS class name clashes

Disadvantages

You need to know CSS

You may end up with many relatively small CSS files in your project

Styled Components: Advantages & Disadvantages

Advantages

Quick & easy to add

You continue “thinking in React” (→ configurable style functions)

Styles are scoped to components → No CSS rule clashes

Disadvantages

You need to know CSS

No clear separation of React & CSS code

You end up with many relatively small “wrapper” components

Tailwind CSS: Advantages & Disadvantages

Advantages

You don't need to know (a lot about) CSS

Rapid development

No style clashes between components since you don't define any CSS rules

Highly configurable & extensible

Disadvantages

Relatively long className values

Any style changes require editing JSX

You end up with many relatively small "wrapper" components OR lots of copy & pasting

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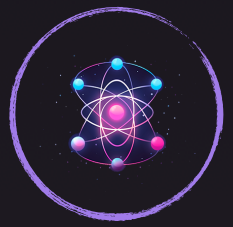

Refs & Portals

Advanced DOM Access & Value Management

- Accessing **DOM Elements** with **Refs**
- **Managing Values** with Refs
- **Exposing API Functions** from Components
- **Detaching DOM Rendering** from JSX Structure with **Portals**

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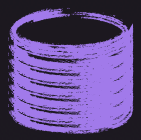
State vs Refs



State

Causes component re-evaluation (re-execution) when changed

Should be used for values that are directly reflected in the UI

Should not be used for “behind the scenes” values that have no direct UI impact

Refs

Do not cause component re-evaluation when changed

Can be used to gain direct DOM element access (→ great for reading values or accessing certain browser APIs)

Can be used to expose API functions from your components

Should not be used for managing values that have a direct UI impact

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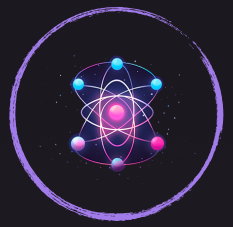

Practice Project: Advanced Concepts

Working with Components, State, Styling, Refs & Portals

- Build a “Project Management” Web App
- Build, Style, Configure & Re-use **Components**
- Manage **State**
- Access DOM Elements & Browser APIs with **Refs**
- Manage JSX Rendering Positions with **Portals**

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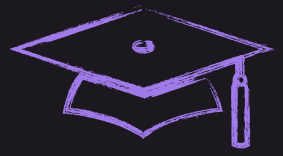

Challenge Time!

Try building this project on your own — or at least try to get as far as possible

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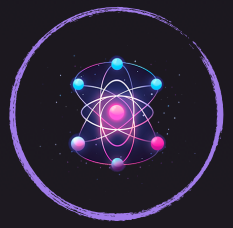
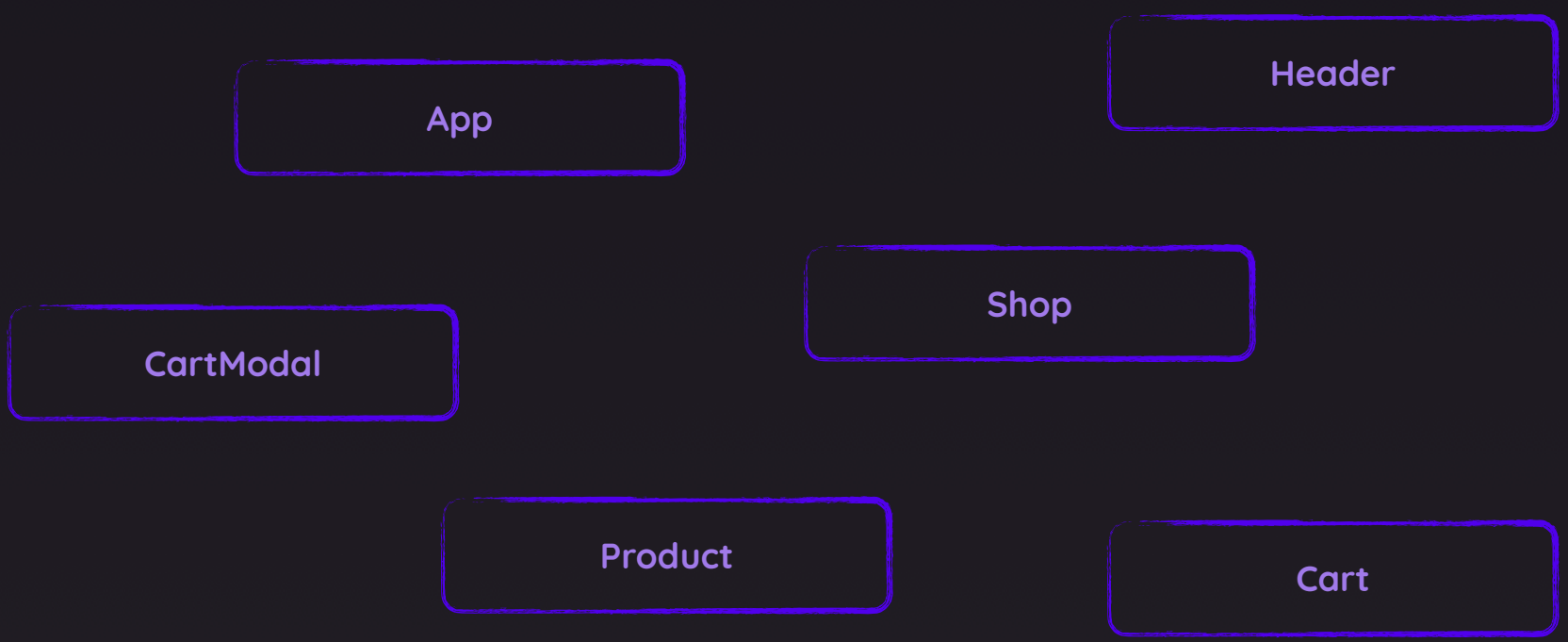


Advanced State Management

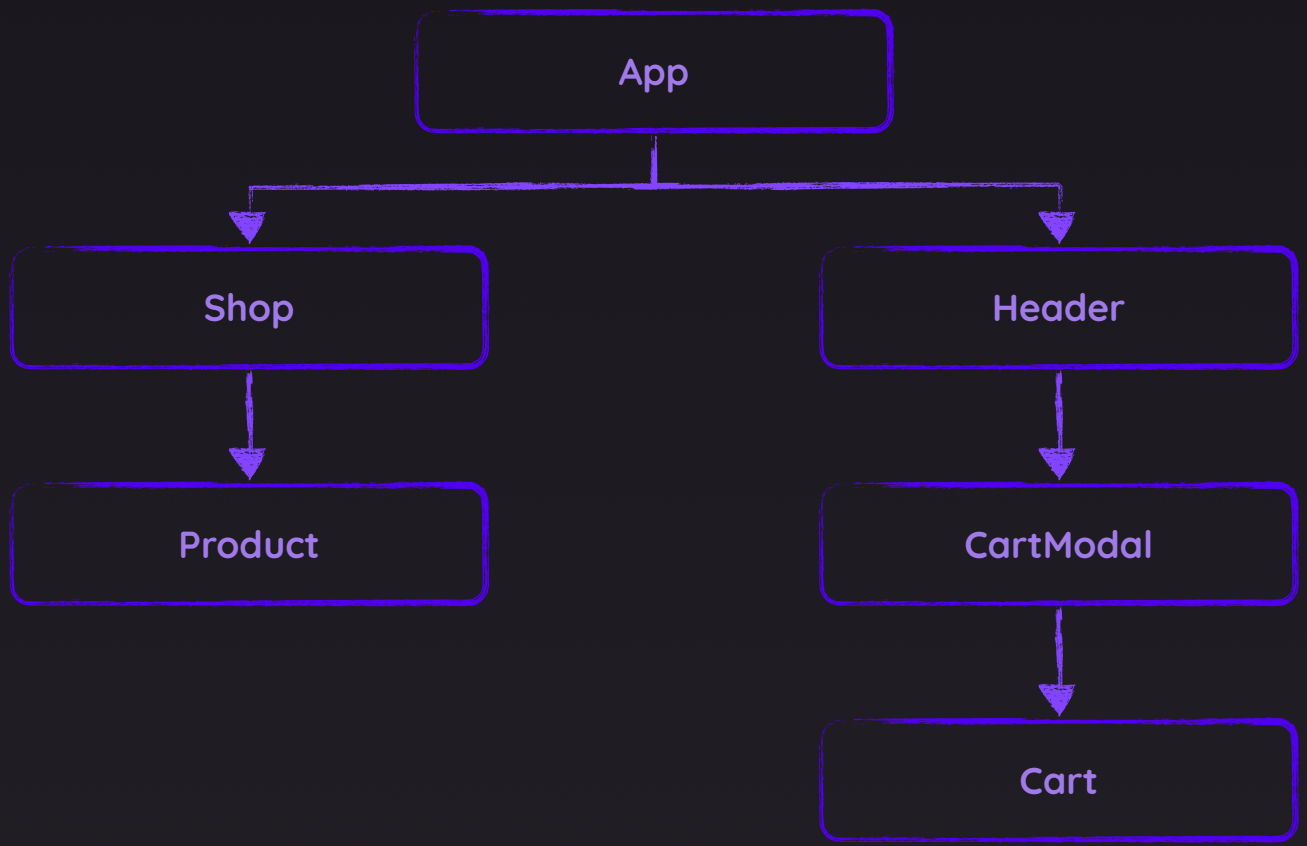
Beyond Basic Apps & "Lifting Up State"

- The Problem Of Shared State: Prop Drilling
- Embracing **Component Composition**
- Sharing State with **Context**
- Managing Complex State with **Reducers**

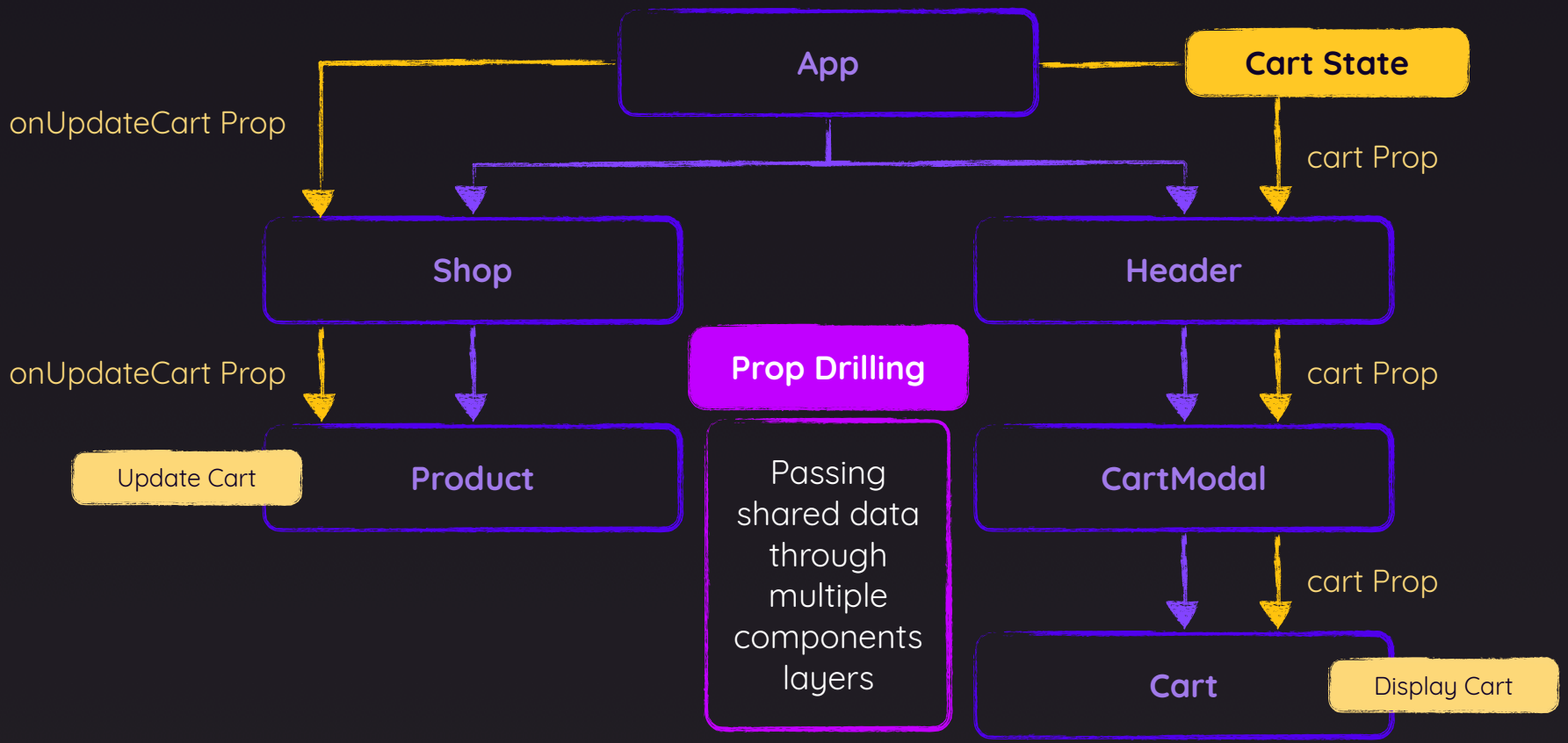
Most React Apps Consist Of Multiple Components



Most React Apps Consist Of Multiple Components



Most React Apps Consist Of Multiple Components



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Component Composition

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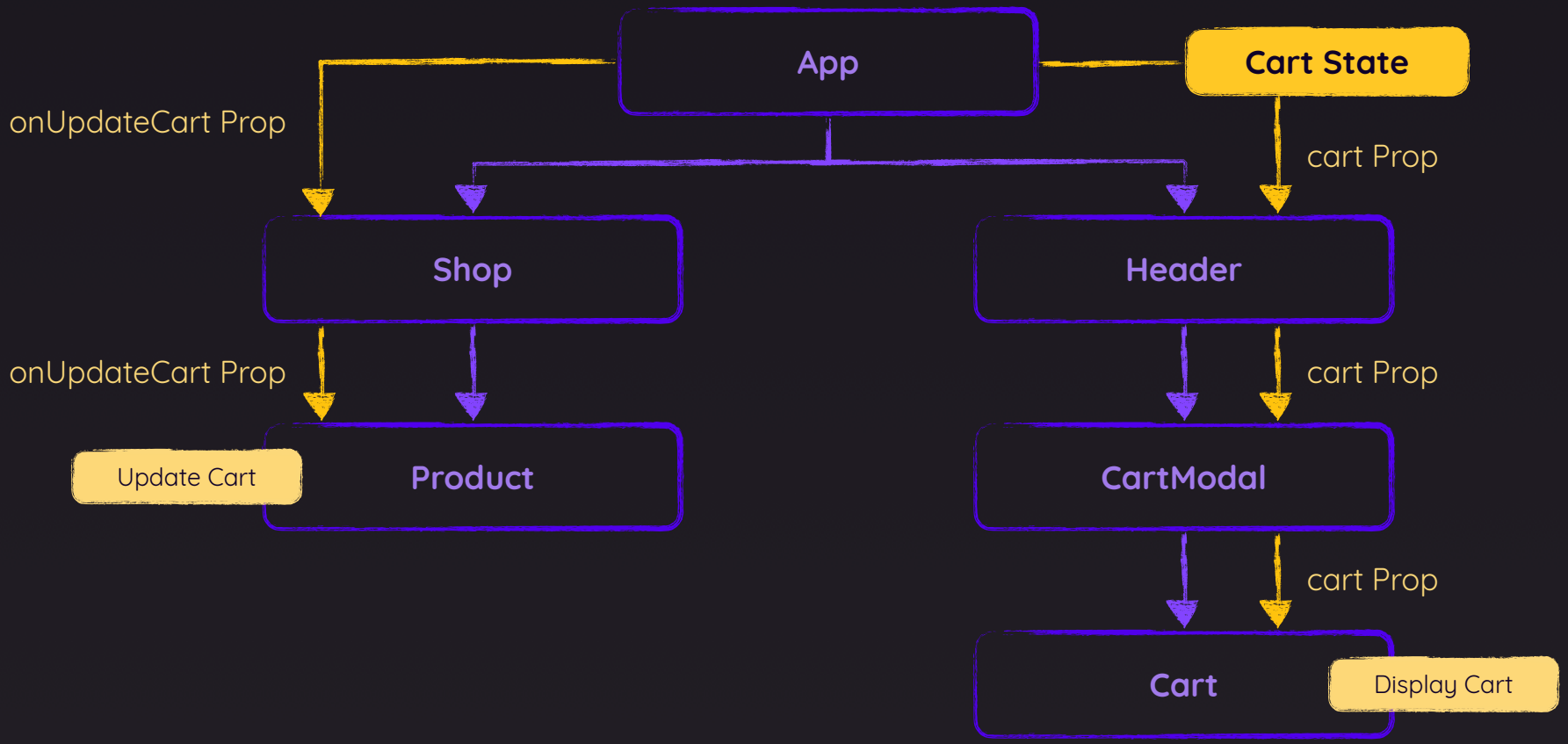
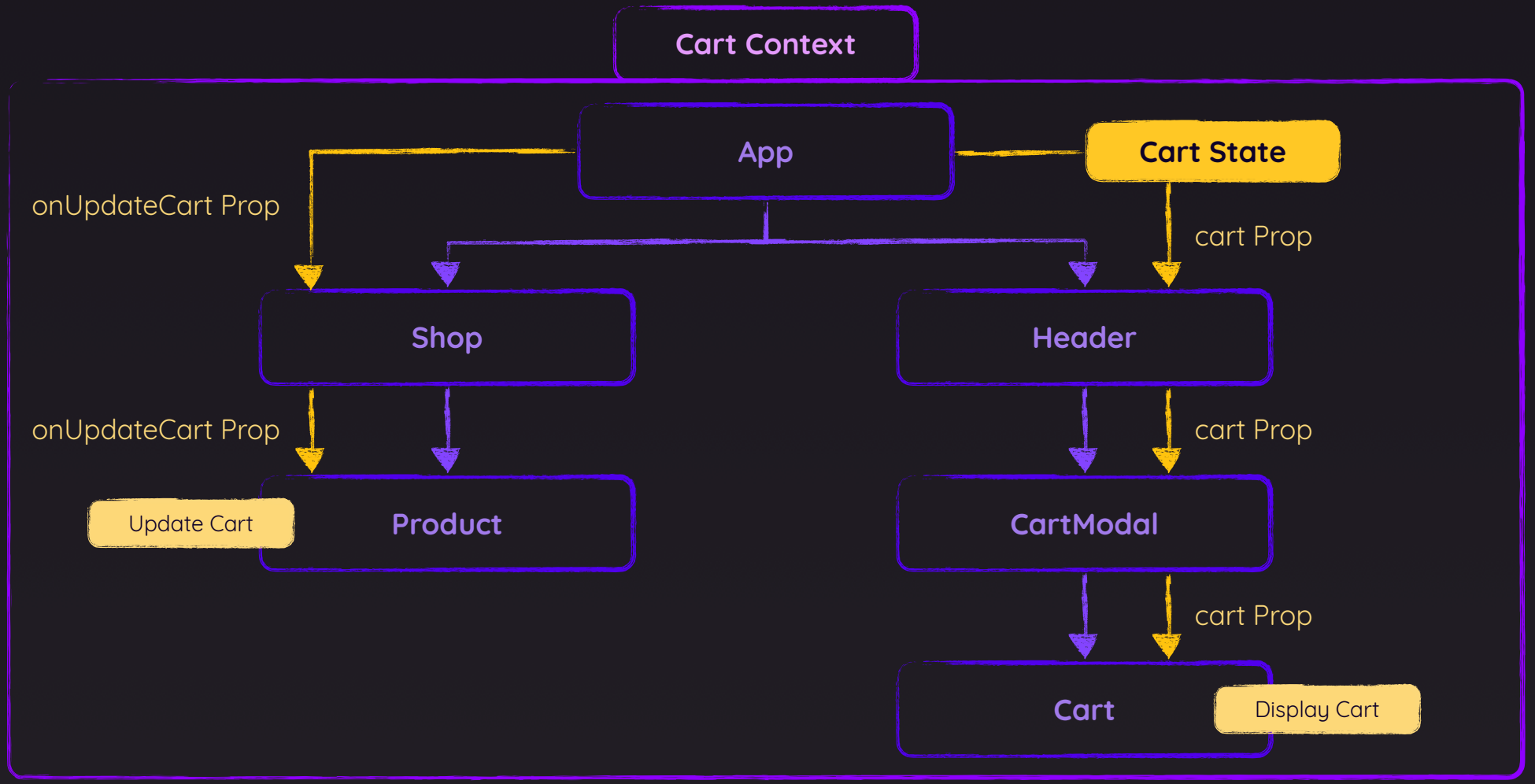
React's Context API

Most React Apps Consist Of Multiple Components



Most React Apps Consist Of Multiple Components



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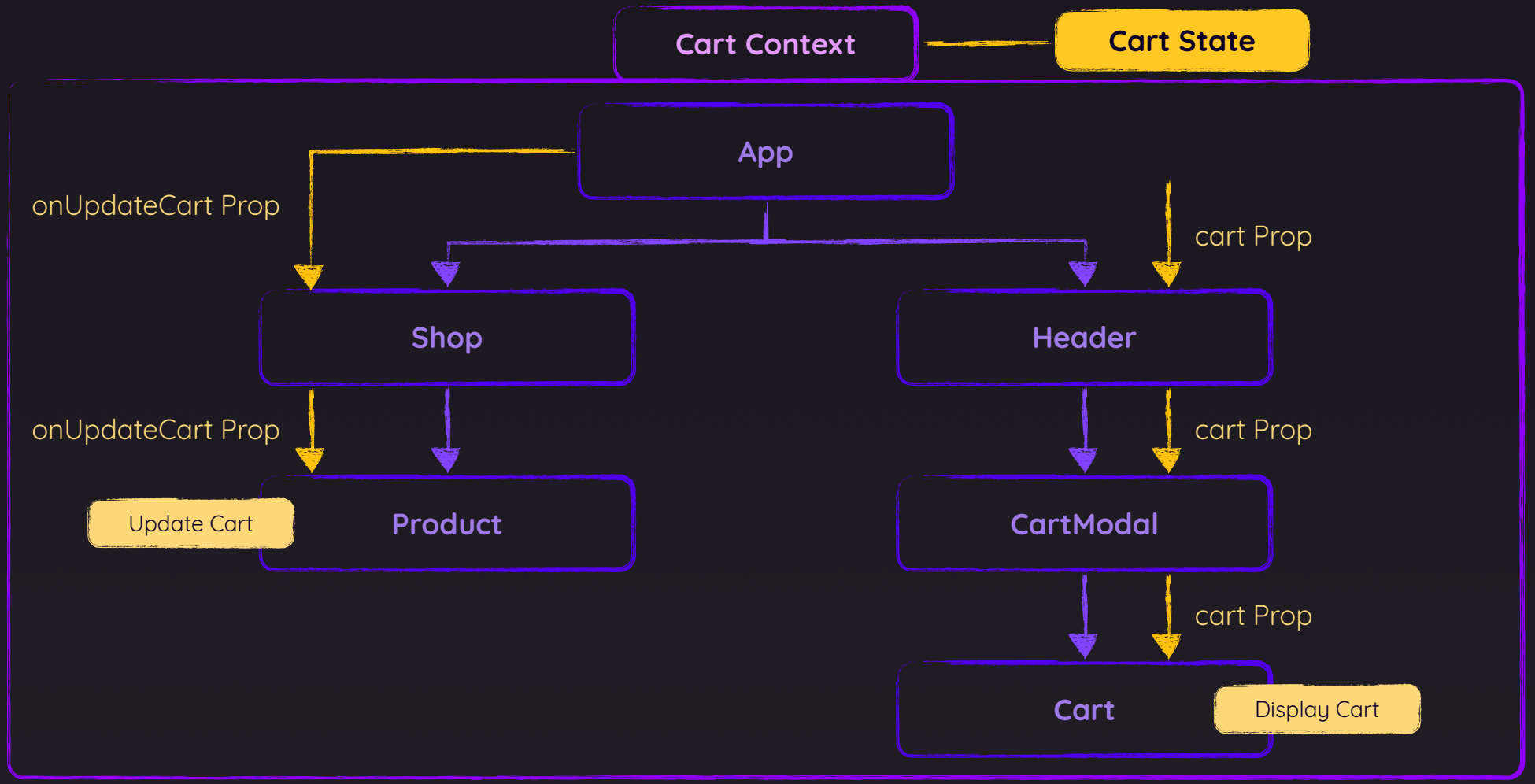
Most React Apps Consist Of Multiple Components



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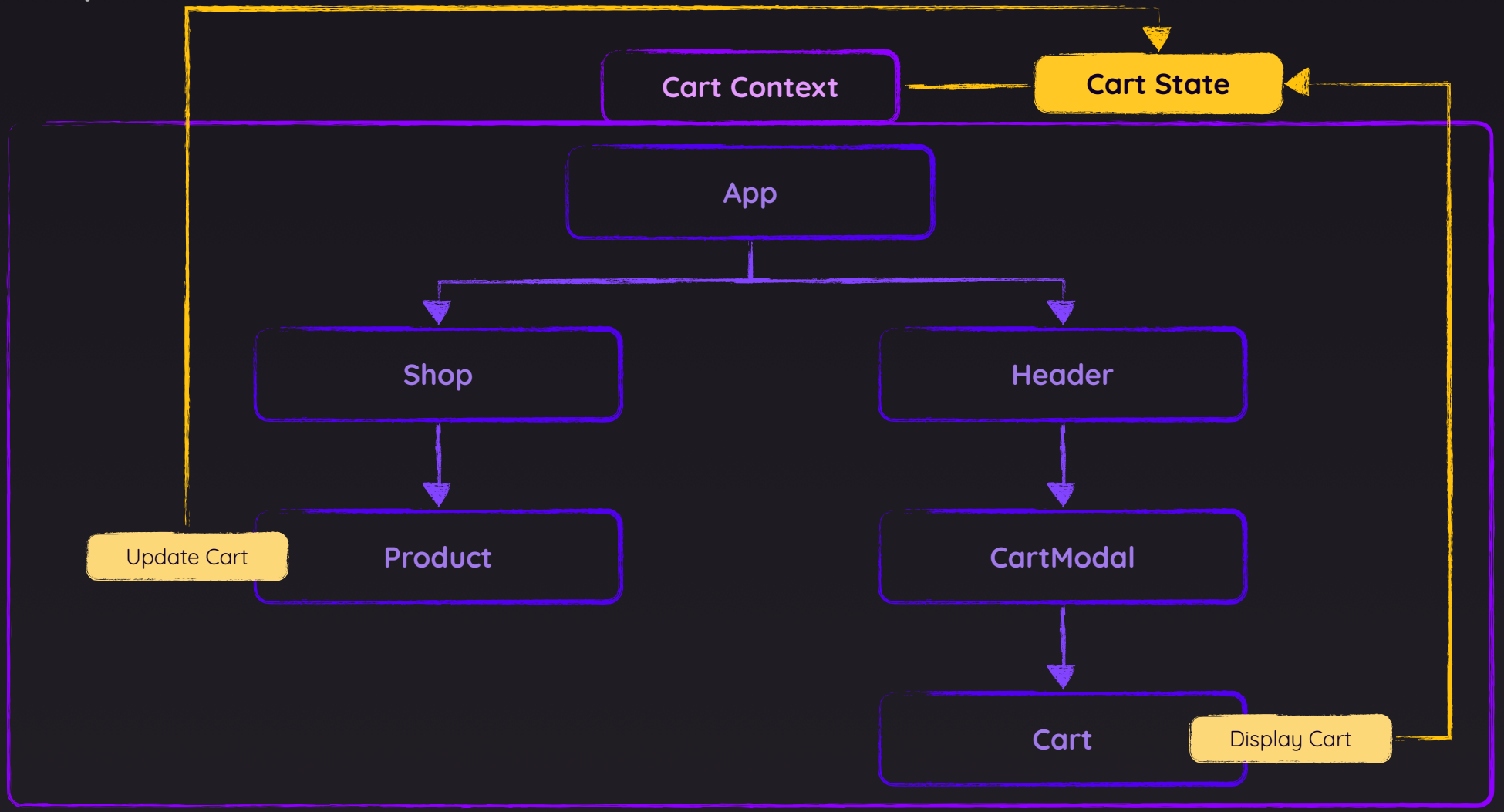
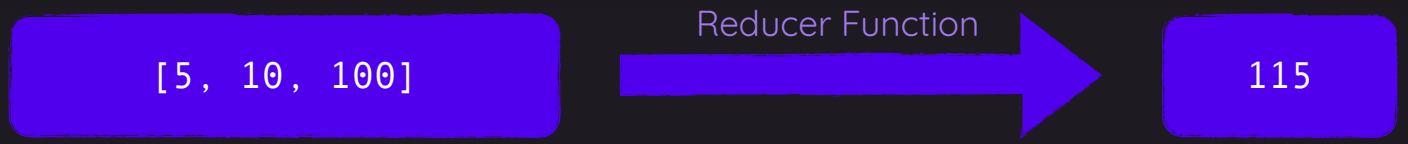


What's a "Reducer"?

A function that reduce one or more **complex values** to a **simpler one**



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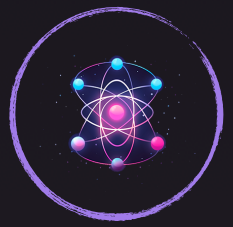

Dealing with Side Effects

Keeping the UI Synchronized

- Understanding **Side Effects & useEffect()**
- Effects & **Dependencies**
- **When NOT** to use useEffect()

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What are “Side Effects”?

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Side effects are “tasks” that don’t impact the current component render cycle

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You Might Not Need useEffect()!

Use it as a last resort

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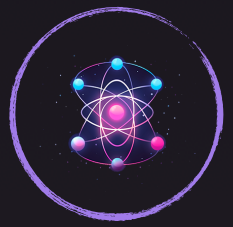

Working with Effects

Practice & Dive Deeper

- Apply Your Knowledge
- Dealing with Effect **Dependencies & Cleanup**
- Combining Effects with Other React Concepts

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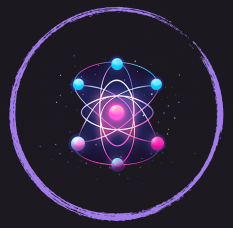

Behind The Scenes

Understanding & Optimizing React

- How React **Updates The DOM**
- **Avoiding** Unnecessary Updates
- A Closer Look At **Keys**
- State **Scheduling** & State **Batching**

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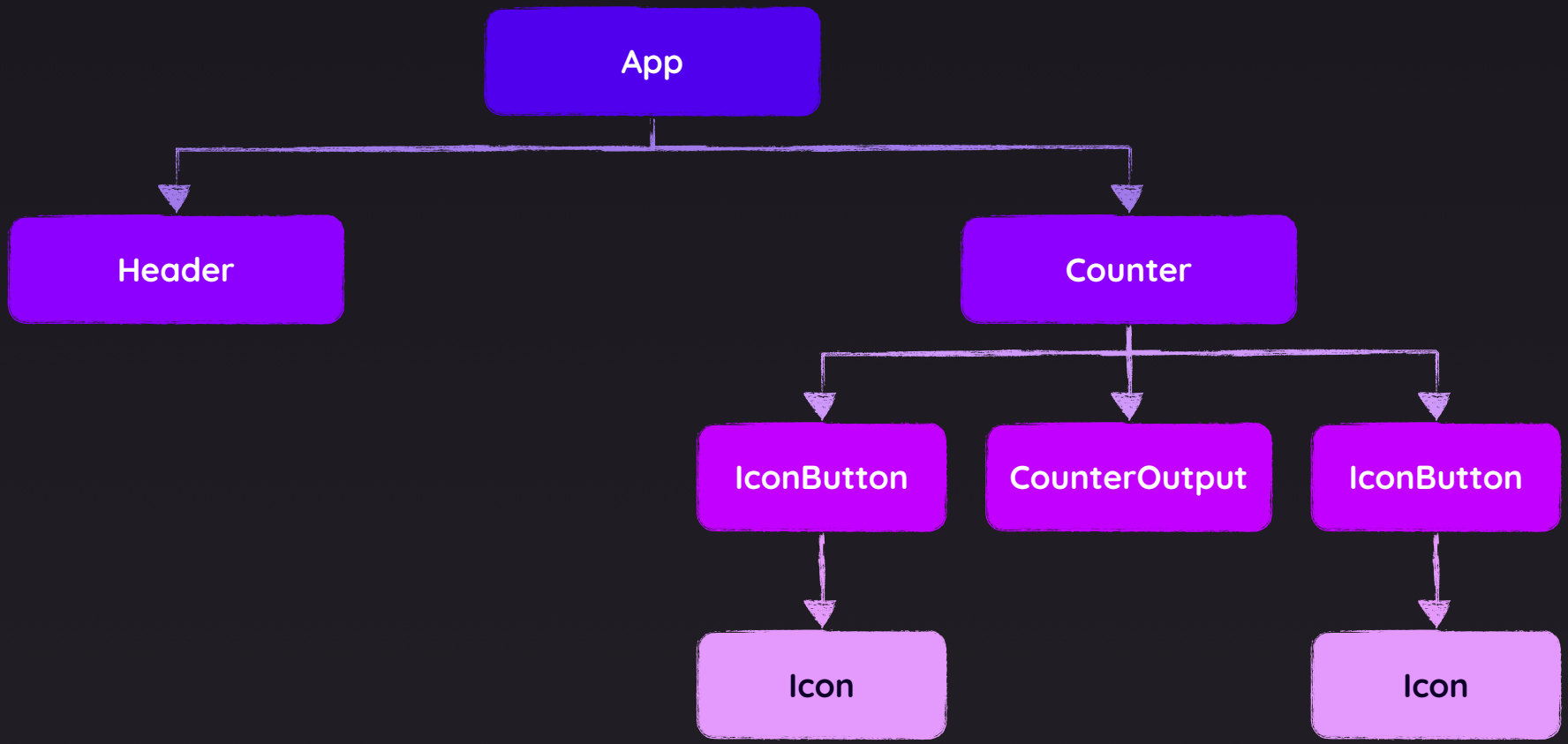
How Does React Update The DOM?

And how are component functions executed?

React Builds A Component Tree

The **relation between components** is internally modelled as a tree structure



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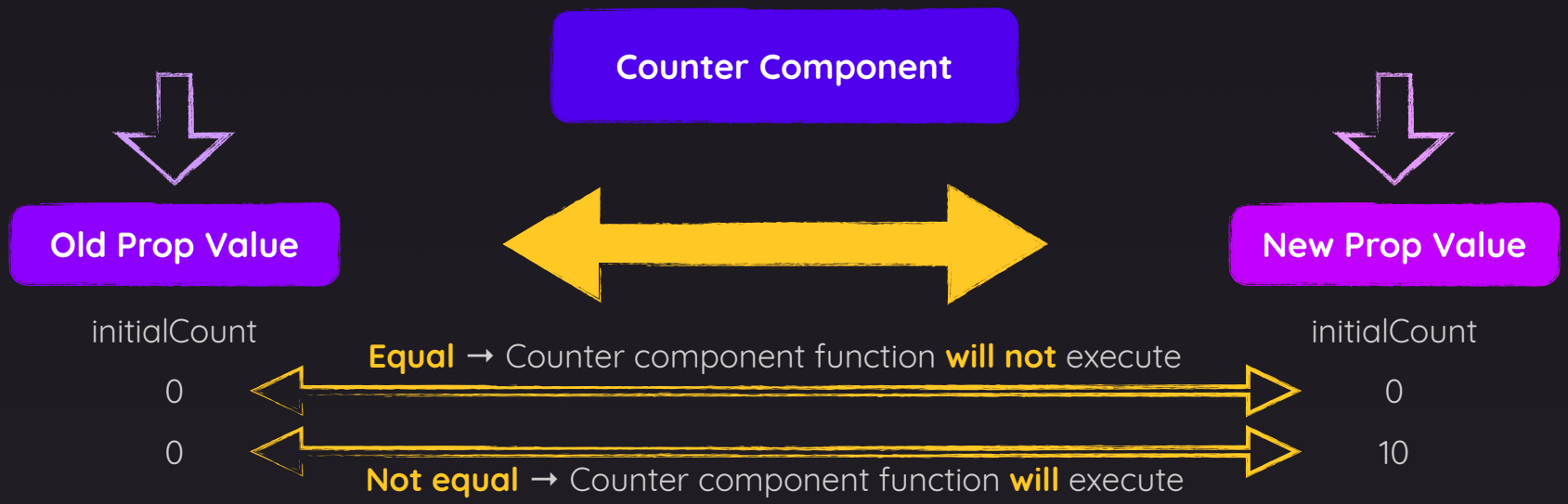
memo() compares prop values



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Don't overuse memo()!

Use it **as high up in the component tree as possible**

→ blocking a component execution there will also block all child component executions

Checking props with memo() **costs performance**!

→ don't wrap it around all your components – it will just add a lot of unnecessary checks

Don't use it on components where **props will change frequently**

→ memo() would just perform a meaningless check in such cases (which costs performance)

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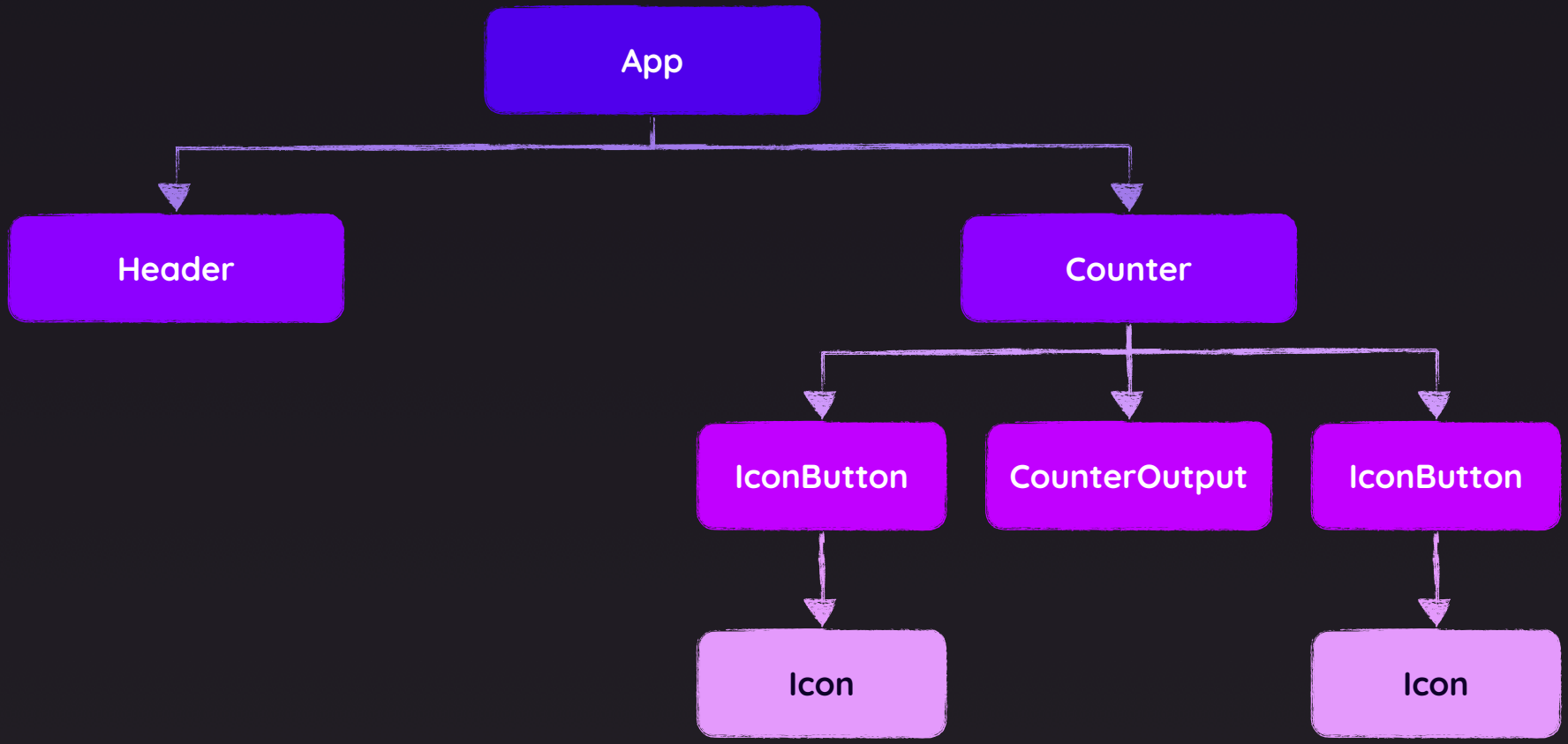
React checks for necessary DOM updates via a "Virtual DOM"

It creates & compares virtual DOM snapshots to find out which parts of the rendered UI need to be updated

How React Updates The Website UI

Step 1: Creating a Component Tree



How React Updates The Website UI

Step 2: Creating a Virtual Snapshot of the Target HTML Code

```
<header id="main-header">
  <img src="/src/assets/logo.png" alt="Magnifying glass analyzing a document">
  <h1>React - Behind The Scenes</h1>
</header>
<main>
  <section id="configure-counter">
    <h2>Set Counter</h2>
    <input type="number" value="0">
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    <p>
      <button class="button">...</button>
      <span class="counter-output">1</span>
      <button class="button">...</button>
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```
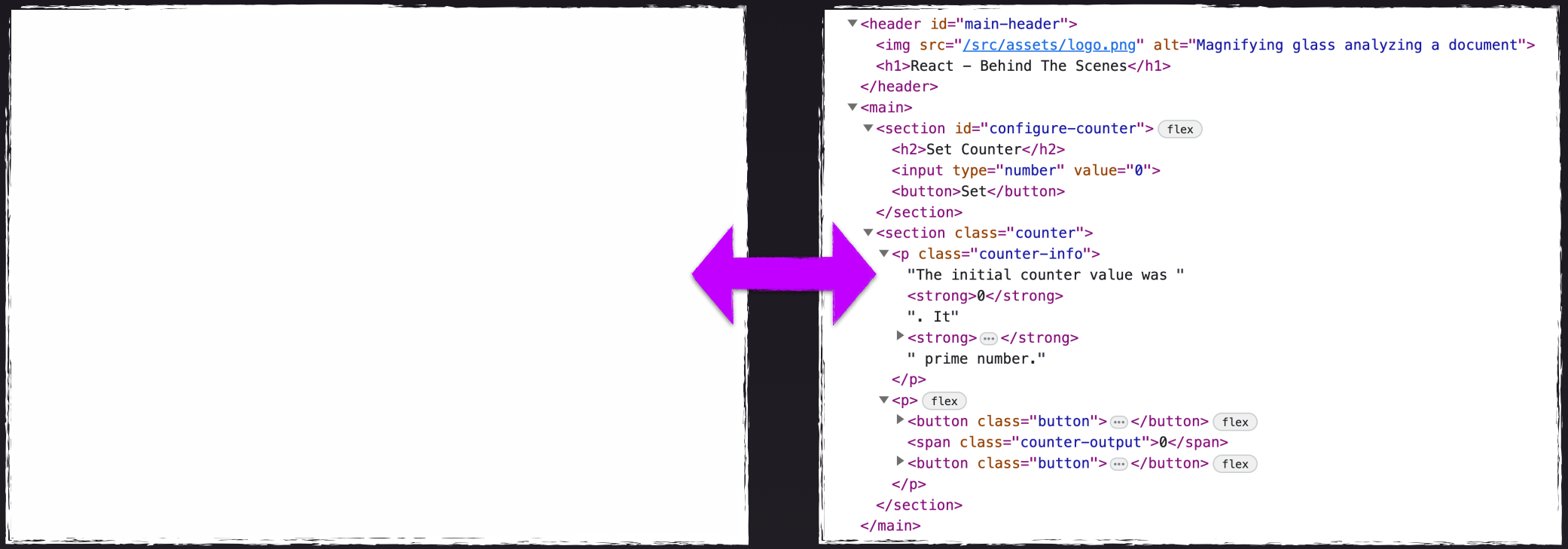

How React Updates The Website UI

Step 3: Compare New Virtual DOM Snapshot to Previous (Old) Virtual DOM Snapshot

Old Snapshot

New Snapshot



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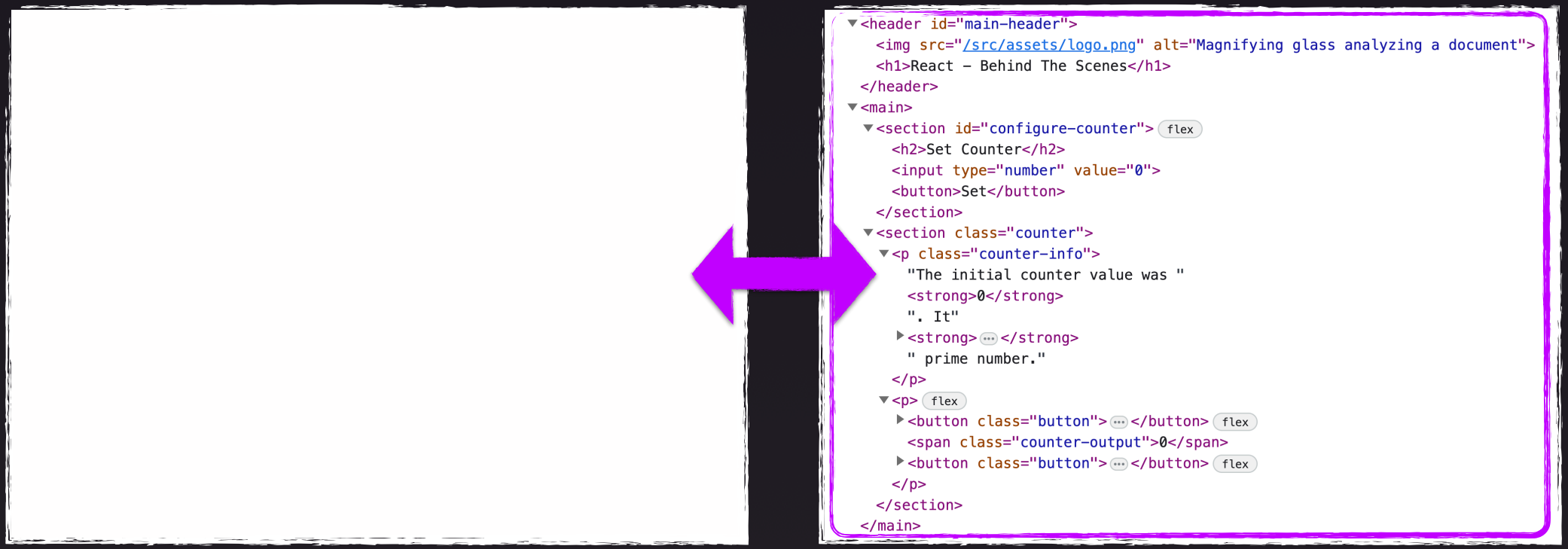
How React Updates The Website UI

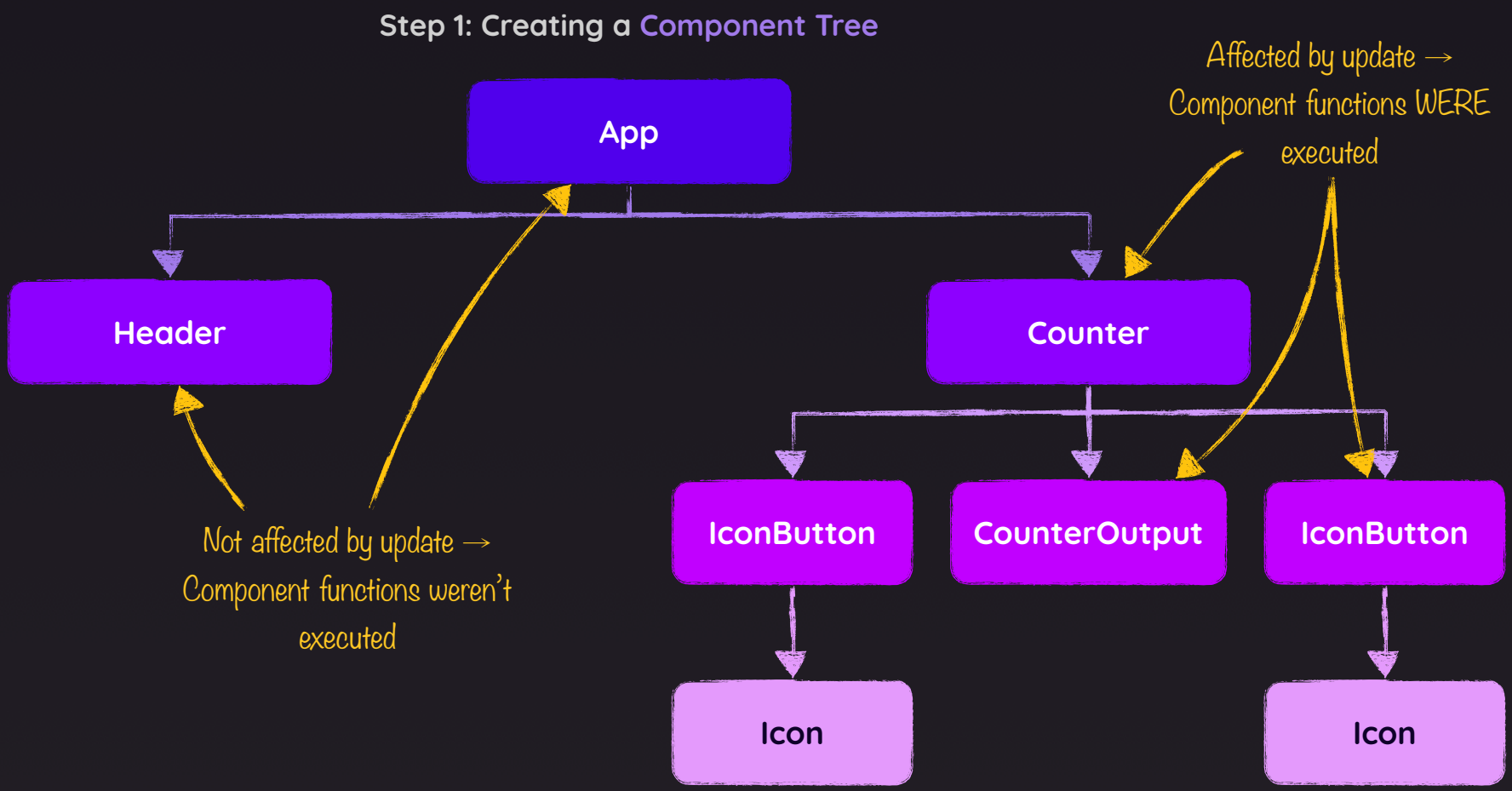
Step 4: Identify & Apply Changes to the "Real DOM"

Old Snapshot

New Snapshot



Updating The Website UI After A Button Click



How React Updates The Website UI

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How React Updates The Website UI

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How React Updates The Website UI

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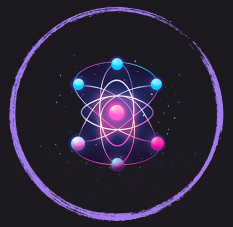

Class-Based Components

An Alternative Way Of Building Components

- What & Why?
- Working with Class-based Components
- Error Boundaries

Class Components vs Functional Components

Functional Components

```
function Product(props) {
  return <h2>A Product!</h2>
}
```

Components are regular JavaScript functions which return renderable results (typically JSX)

The default & most modern approach!

Class-based Components

```
class Product extends Component {
  render() {
    return <h2>A Product!</h2>
  }
}
```

Components can also be defined as JS classes where a render() method defines the to-be-rendered output

Was required in the past

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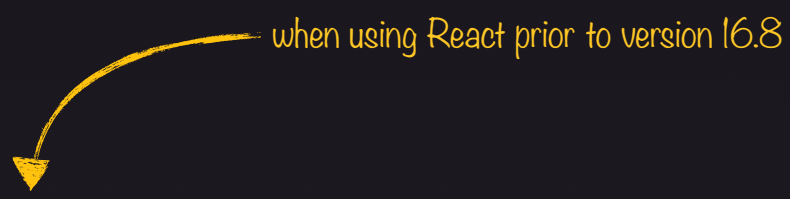

Traditionally, you had to use class-based components to manage "State"

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React 16.8 introduced "React Hooks" for functional components

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Class-based components can't use React Hooks

Class Components Lifecycle

Side Effects in **Functional** Components: **useEffect()**

Class-based components can't use Hooks!

`componentDidMount()`	Called once a component **mounted** → evaluated & rendered by React	`useEffect(…, [])`
`componentDidUpdate()`	Called once a component **updated** → re-evaluated & re-rendered by React	`useEffect(…, [someValue])`

`componentWillUnmount()`	Called right before component is **unmounted**
	→ right before removed from DOM
		`useEffect(() => {`
		`  return () => { … }`
		`}, [])`

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You Don't Have To Use Functional Components!

You can use class-based components if you prefer them (though it's really not necessarily recommended...)

Which Component Type Should You Use?

Strong Recommendation: You should prefer **functional components!**

Use class-based if ...

- ...you **prefer** them
- ...you're working on an existing project or in a team where they're getting used
- ...you're building an Error Boundary

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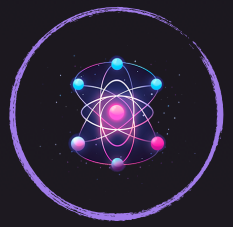

Understanding Redux

Managing App-Wide State with Redux

- **What** Is Redux? And **Why** Would You Use It?
- Redux **Basics** & **Using Redux** with React
- Working with **Redux Toolkit**

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A state management system for cross-component or app-wide state

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State

Data which, when changed, should **affect the UI**

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State?

useState()!

or useReducer

What Is Cross-Component & App-Wide State?

Local State

State belongs to a single component

E.g., listening to user input on an input field or toggling a "show more details" field

Should be **managed inside the component** via `useState()` / `useReducer()`

Cross-component State

State affecting multiple components

E.g., open / closed state of a modal overlay

Requires "**prop drilling**"

App-wide State

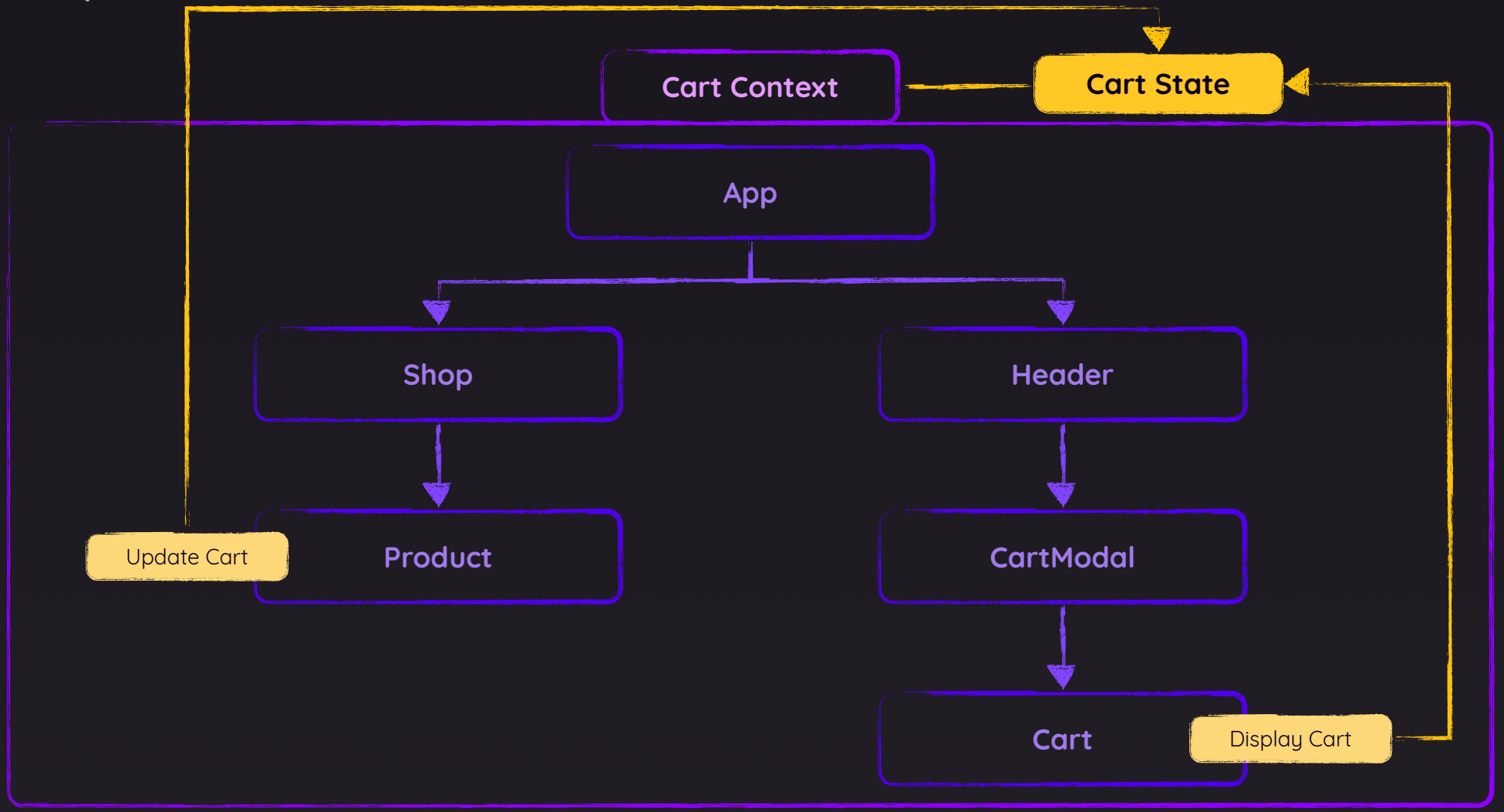
State affecting the entire app

E.g., user authentication status or chosen theme

Requires "**prop drilling**"

Or: **React Context** or **Redux**

React Context Manages Multi-Component State



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A state management system for cross-component or app-wide state

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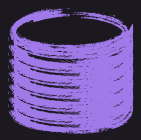
A state management system for cross-component or app-wide state

Don’t we have React Context already?

React Context Has Some Potential Disadvantages



Complex Setup & Management

In more complex apps, using React Context can lead to deeply nested or “fat” “Context Provider” components

Performance

React Context is not optimized for high-frequency state changes

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Potential Problem: Deeply Nested Providers

```
return (
  <AuthContextProvider>
    <ThemeContextProvider>
      <UIInteractionContextProvider>
        <MultiStepFormContextProvider>
          <UserRegistration />
        </MultiStepFormContextProvider>
      </UIInteractionContextProvider>
    </ThemeContextProvider>
  </AuthContextProvider>
);
```

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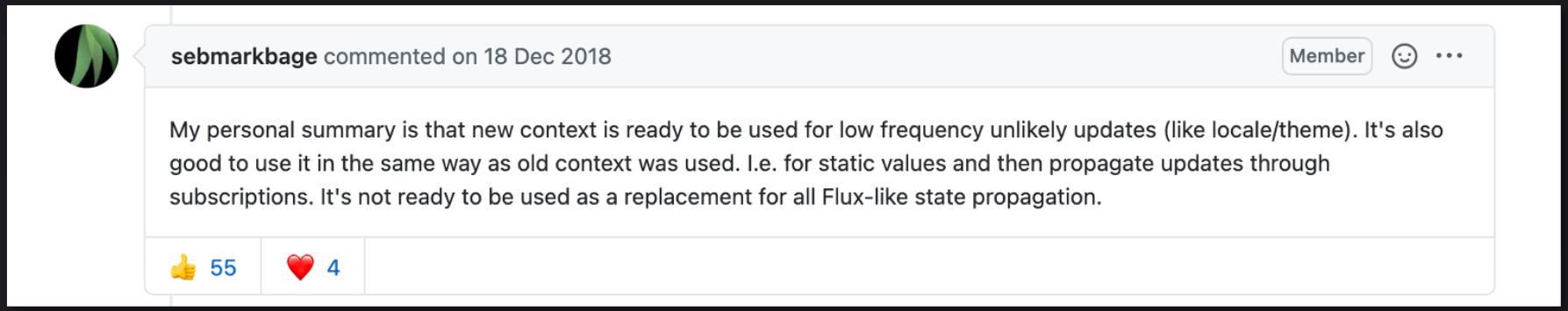
Potential Problem: Complex Providers

```
function AllContextProvider() {
  const [isAuth, setIsAuth] = useState(false);
  const [isEvaluatingAuth, setIsEvaluatingAuth] = useState(false);
  const [activeTheme, setActiveTheme] = useState('default');
  const [ ... ] = useState(...);

  function loginHandler(email, password) { ... };

  function signupHandler(email, password) { ... };

  function changeThemeHandler(newTheme) { ... };

  ...

  return (
    <AllContext.Provider>

    </AllContext.Provider>
  )
}
```

Potential Problem: High-Frequency Changes



sebmarkbage commented on 18 Dec 2018 — Member

My personal summary is that new context is ready to be used for low frequency unlikely updates (like locale/theme). It's also good to use it in the same way as old context was used. I.e. for static values and then propagate updates through subscriptions. It's not ready to be used as a replacement for all Flux-like state propagation.

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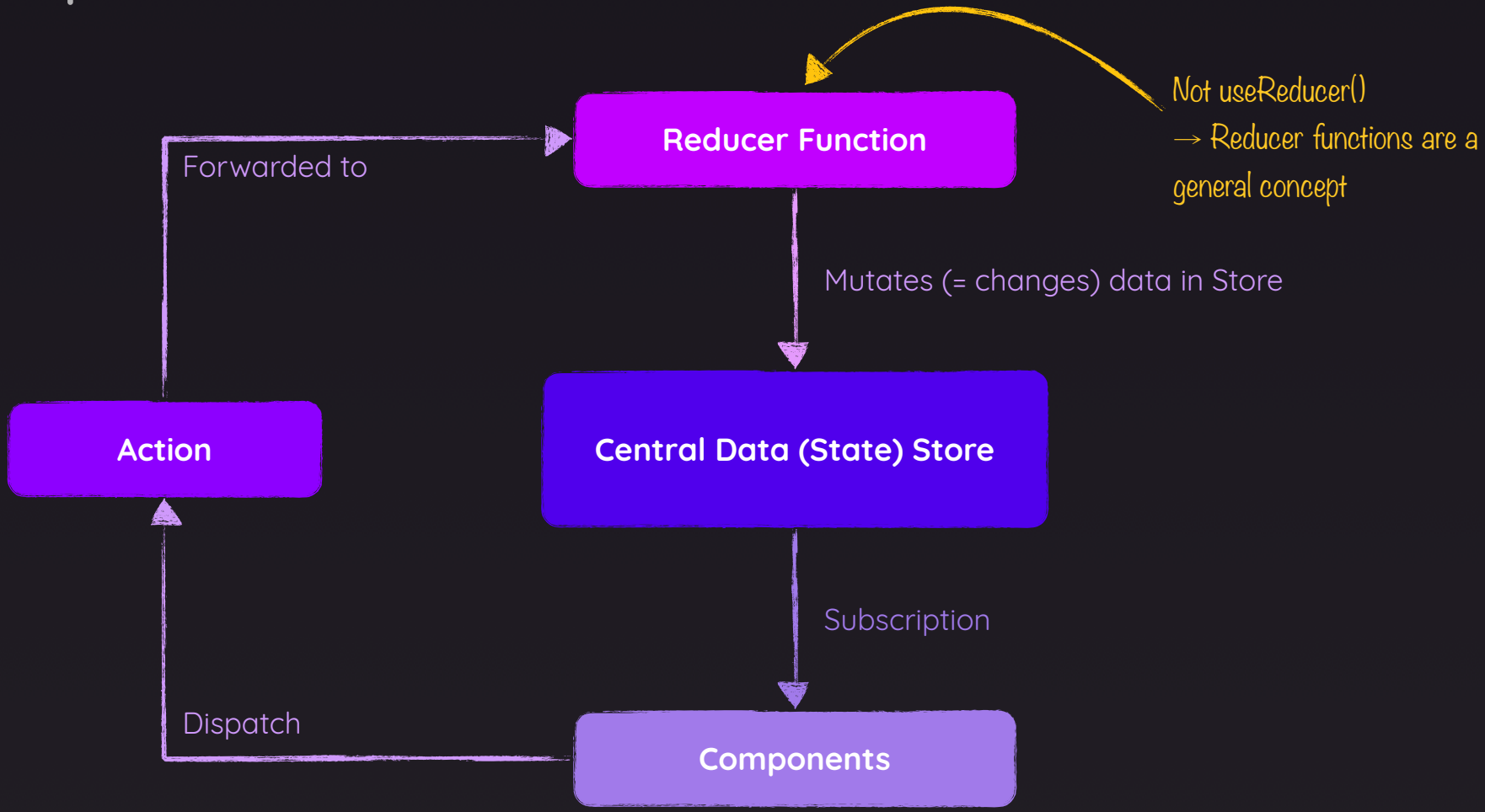
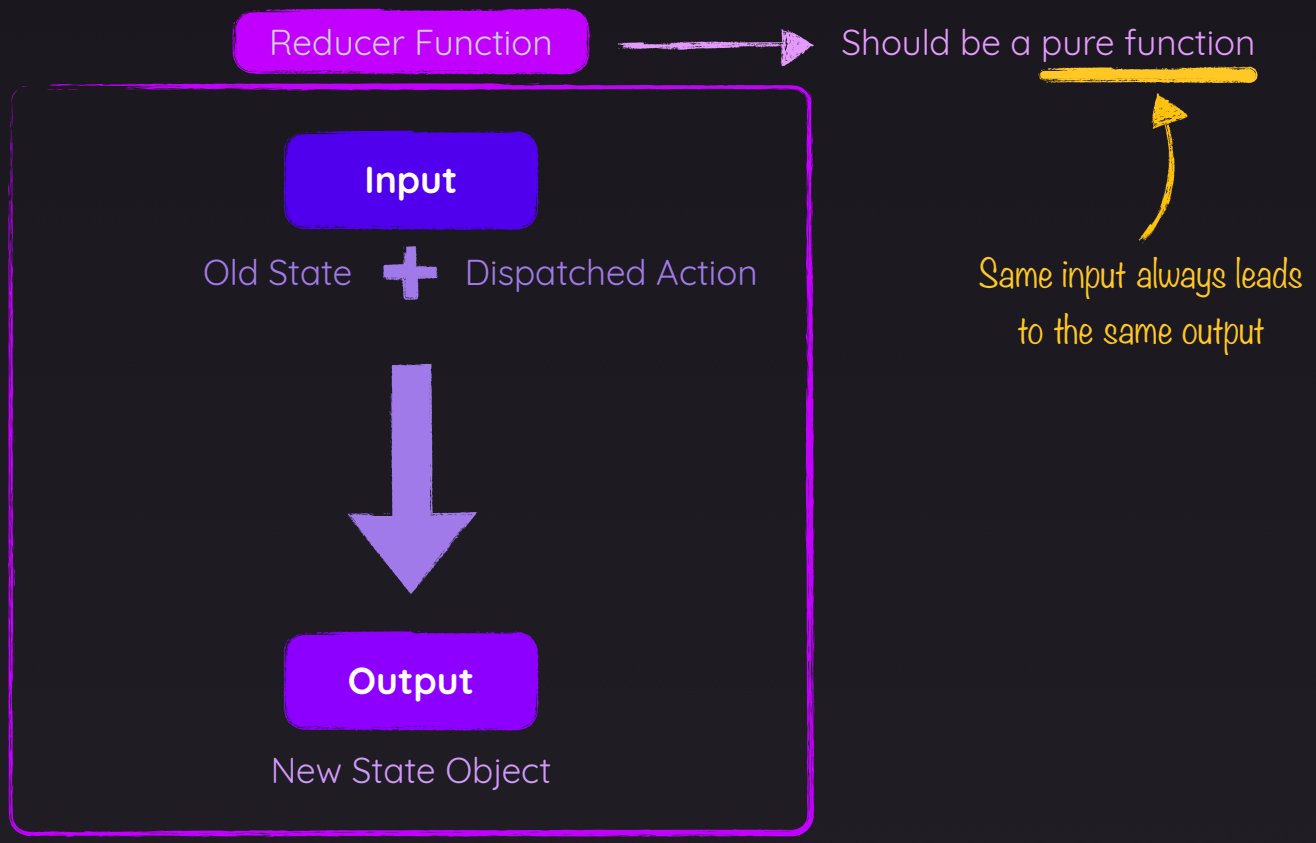
Core Redux Concepts



The Reducer Function



The Role Of Immutability

State updates must be done in an immutable way!

Can be tricky because **objects and arrays** are **reference values** in JavaScript

→ Changes to an object property **affect all places** where the object gets used

New object / array copies (also of nested objects / arrays) must be created when producing new state

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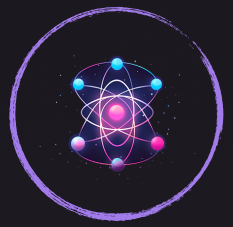


Redux Deep Dive

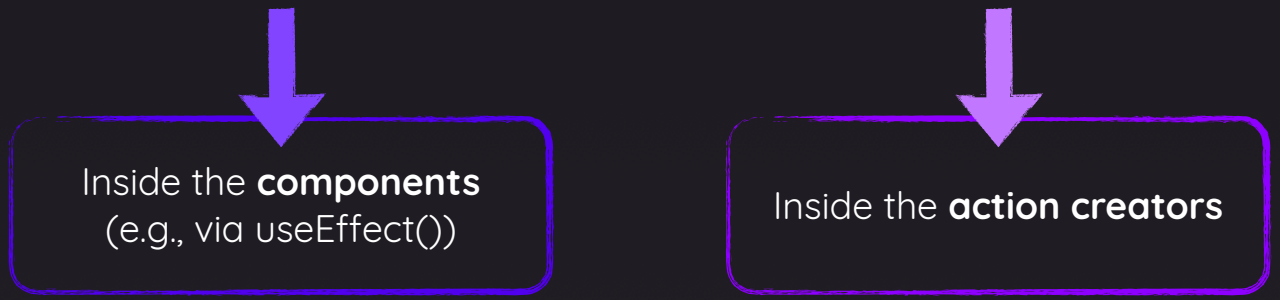
Taking A Closer Look

- Handling **Async Tasks** With Redux
- Where To **Put Your Code**
- The Redux **DevTools**

Side Effects, Async Tasks & Redux

Reducers must be **pure**, **side-effect free**, **synchronous** functions!

Where should side-effects & async tasks be executed?



Fat Reducers vs Fat Components vs Fat Actions

Where should your **logic** (= code) go?

Synchronous, side-effect free code
(i.e., data transformations)

Prefer reducers

Avoid action creators or components

Async code or code with side-effects

Prefer action creators or components

Never use reducers!

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What is a “Thunk”?

A function that **delays an action** until later

An action creator function that does **NOT return the action itself** but instead **another function** which **eventually** returns the action

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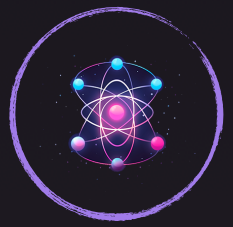
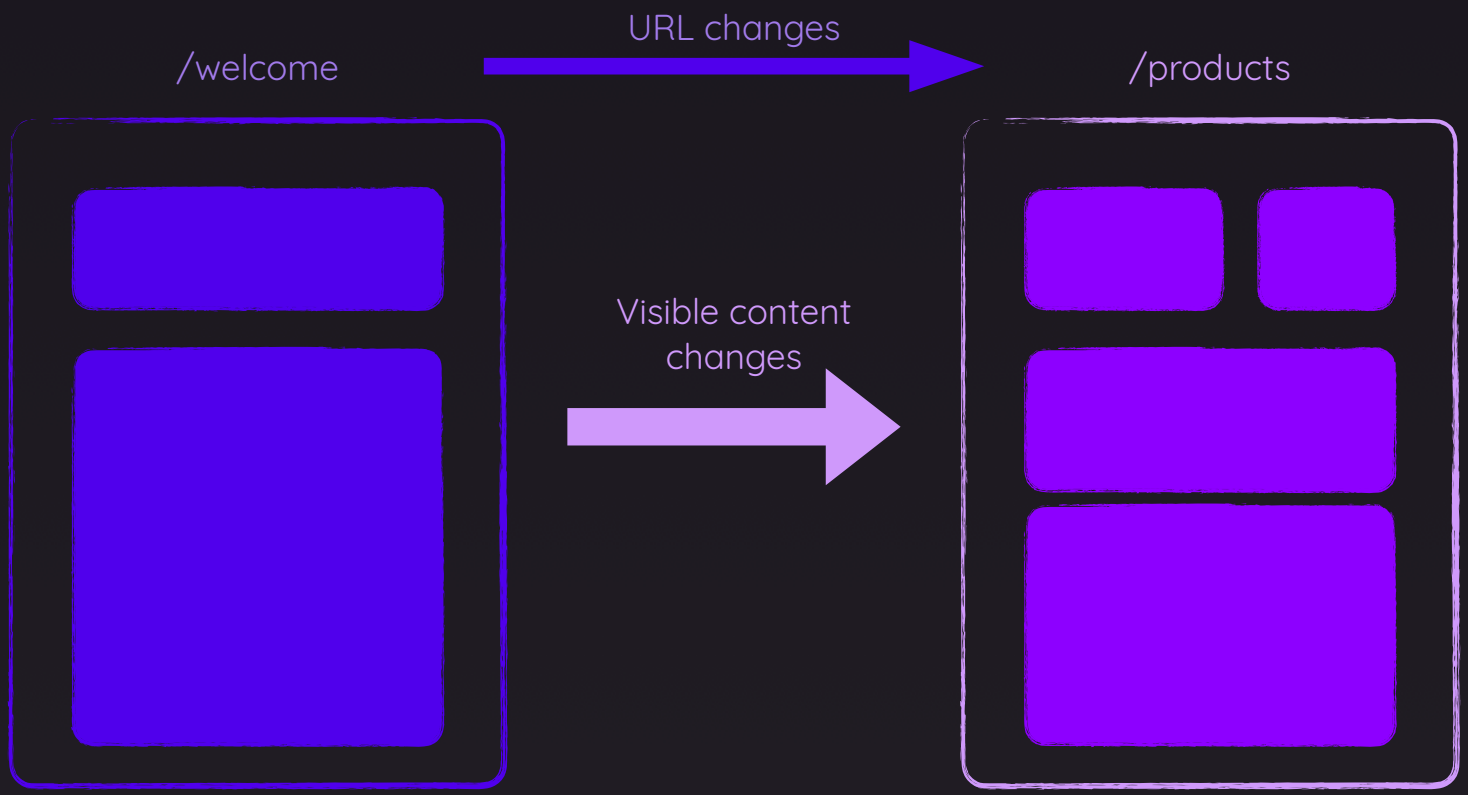


Single-Page Application Routing

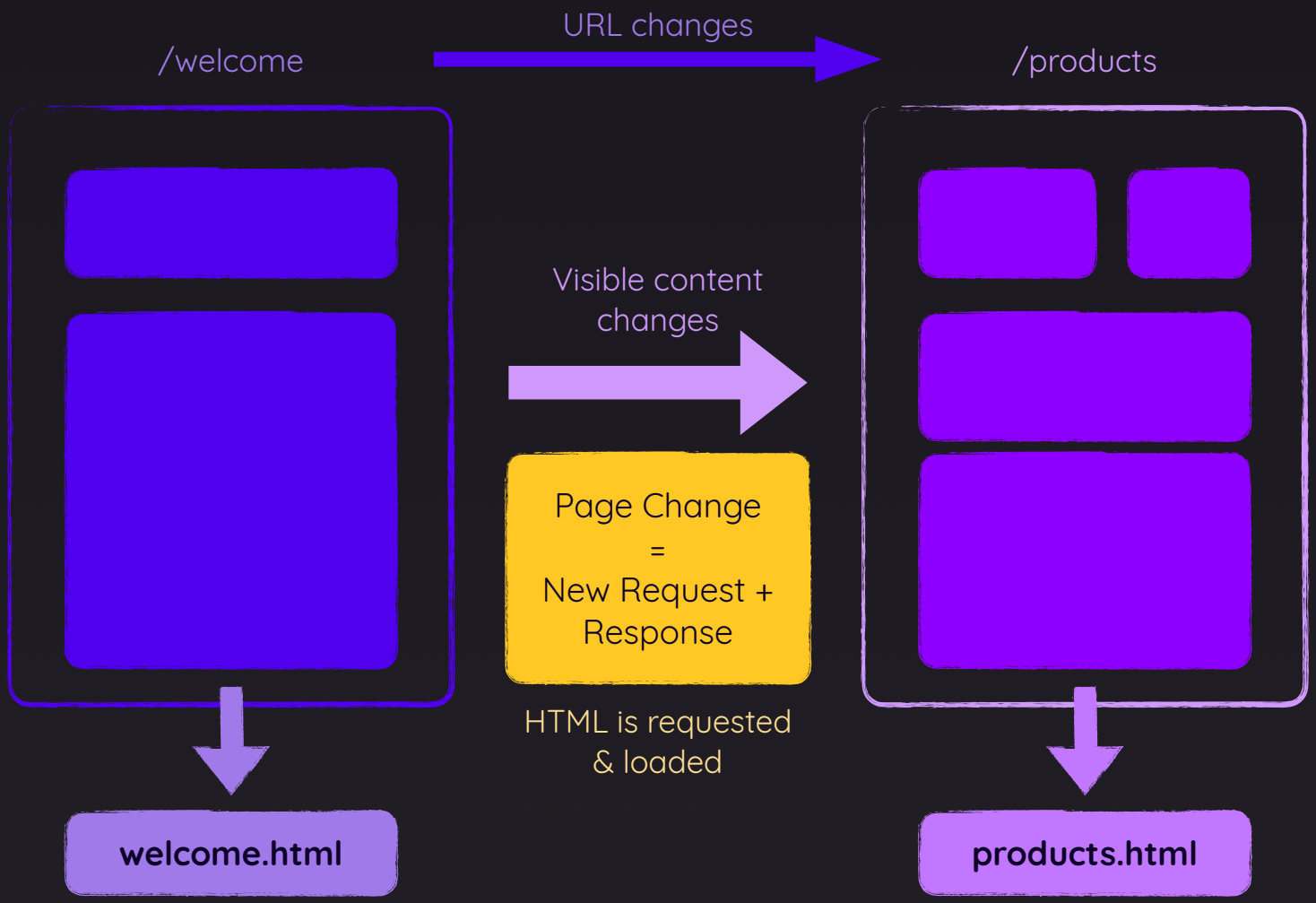
Multiple Pages In Single-Page Apps

- What & Why?
- Using **React Router**
- Data Fetching & Submission

What is a Routing?



Multi-Page Routing



Building SPAs

When building complex user interfaces, we typically build **Single Page Applications** (SPAs)

Only one initial HTML request & response

Page (URL) changes are then handled by client-side React code

Visible content is changed without fetching a new HTML file

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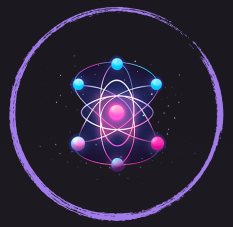

Authentication

User Signup & Login

- **How Authentication Works** In React Apps
- **Implementing** User Authentication
- Adding Authentication **Persistence & Auto-Logout**

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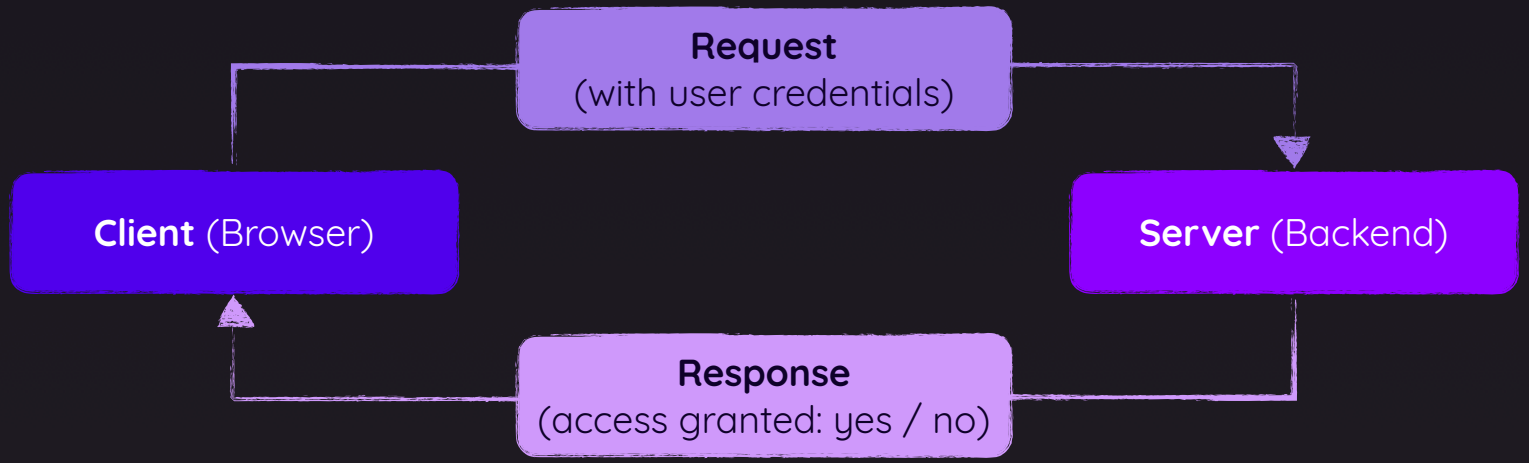
Authentication is needed if content should be protected

i.e., if content should not be accessible by everyone

Getting Permission



Is that enough?

A “yes” alone is **not enough** to access protected resources /API endpoints)

Any client could simply send a request to our backend that “tells” the backend that we previously were granted access

How Does Authentication Work?

Client and server can't just exchange a "Yes"

Any client could simply send a request to our backend that "tells" the backend that we previously were granted access

Server-side Sessions

Store unique identifier on server, send same identifier to client

Client sends identifier along with requests to protected resources

Server can then check if the identifier is valid (= previously issued by server to client)

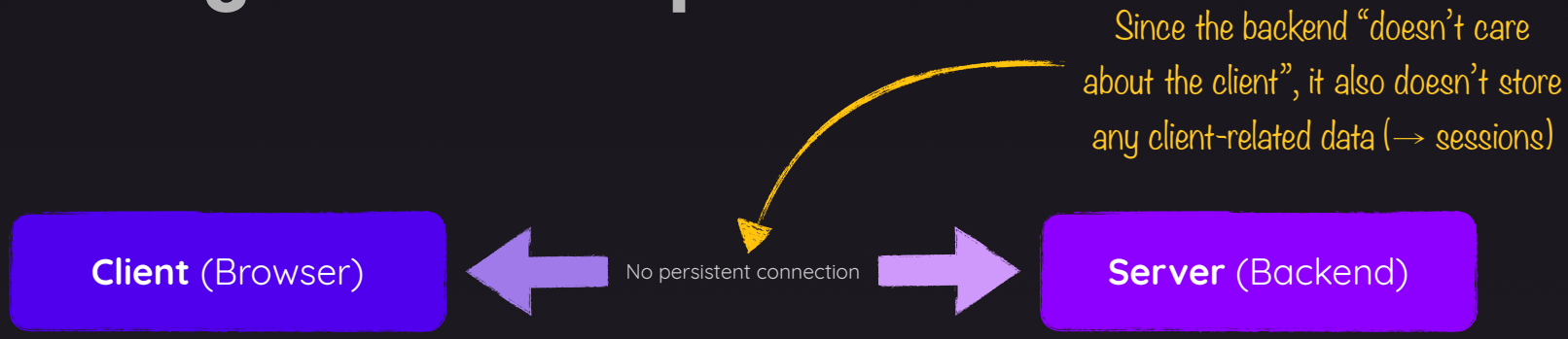
Authentication Tokens

Create (but not store) "permission" token on server & send it to the client

Client attaches token to future requests for protected resources

Server can then verify the attached token

Working with Decoupled Backends



Most React apps are **SPAs** that are served by a server that's **decoupled from the backend**

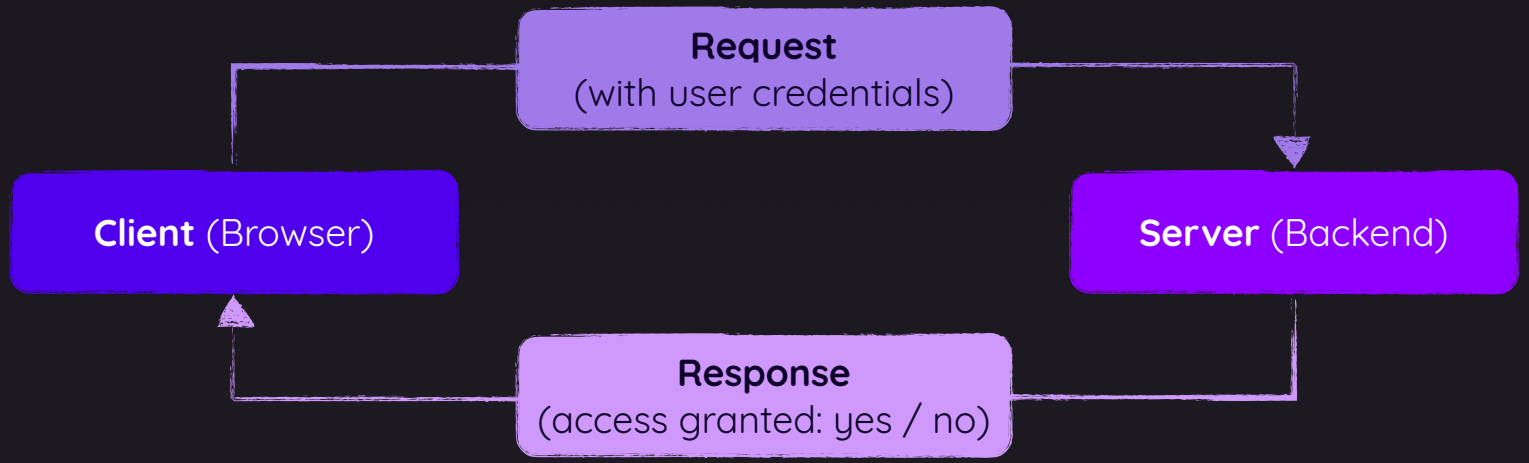
The SPA **handles routing** (on the client side) and only "talks" to the backend if it **needs data** (or needs to change data)

A **decoupled backend** is served by **different server** than the React frontend app

The backend **provides various resources routes** with which the client-side app my communicate

The backend does not register client-side routing actions or user interactions → it **may theoretically server multiple, different client-side apps** (React apps, mobile apps, etc)

Getting Permission



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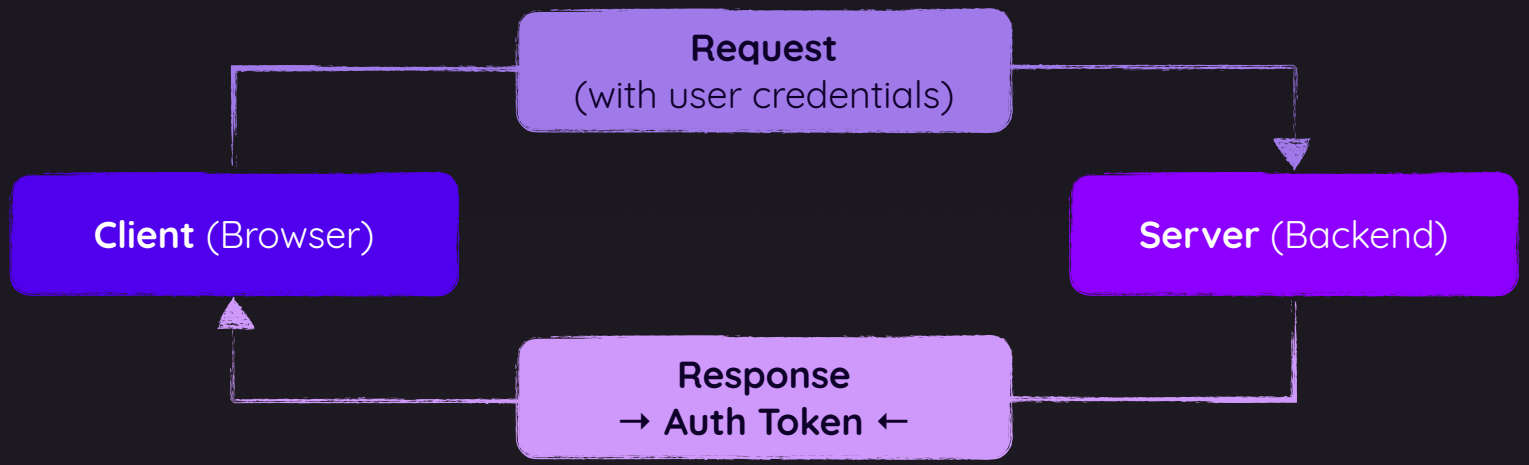
Getting Permission



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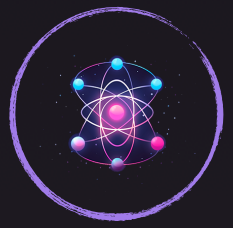

Deploying React Apps

From Development To Production

- Deployment **Steps & Pitfalls**
- **Server-side** Routing vs **Client-side** Routing

Deployment Steps

Test Code: Manually & with automated tests

Optimize Code: Optimize user experience & performance

Build App: Run build process to parse, transform & optimize code

Upload App: Upload production code to hosting server

Configure Server: Ensure app is served securely & as intended

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Lazy Loading

Load code only when it's needed

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A React SPA is a "Static Website"

Only HTML, CSS & JavaScript

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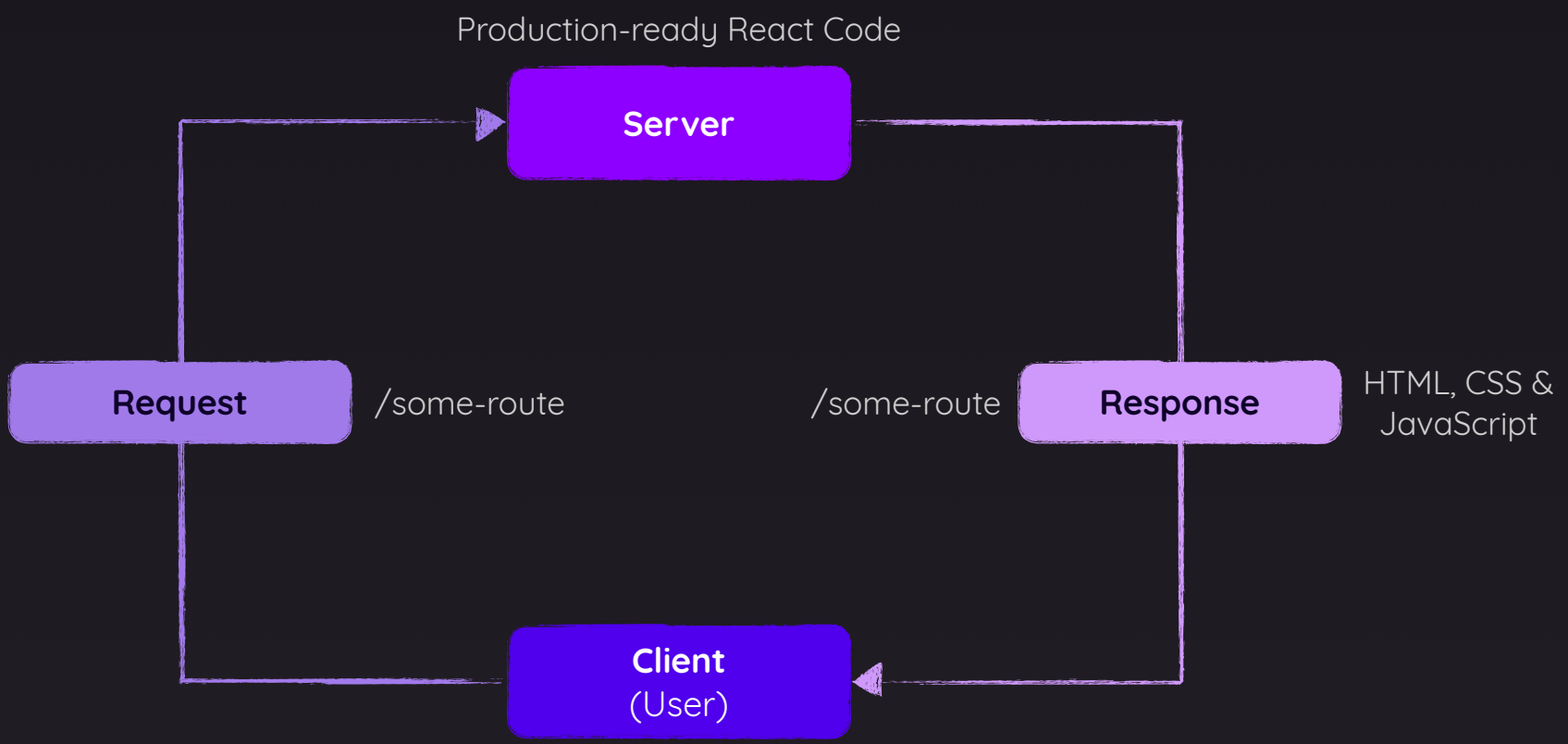
A React SPA is a "Static Website"

Only HTML, CSS & JavaScript

A static site host is needed

Server-side Routing vs Client-side Routing



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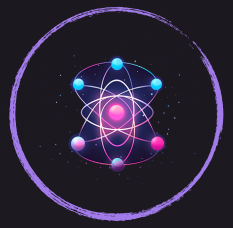
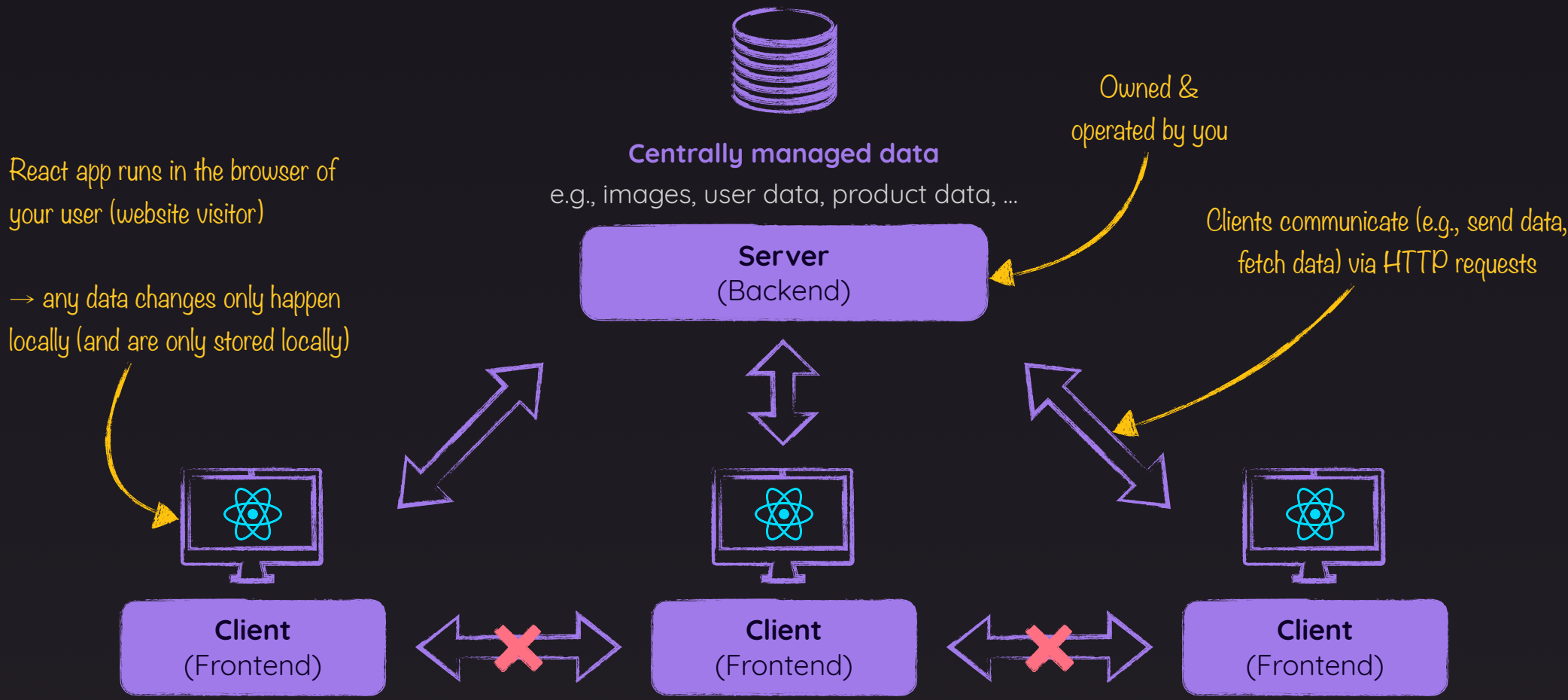


Data Fetching & HTTP Requests

Sending & Receiving Data via HTTP

- How To **Connect a Backend** / Database
- **Fetching** Data
- **Sending** Data

Some Data Must Be Managed Centrally



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How Do You Connect Your React App To A Database?

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You Don't!

At least not directly

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Always keep in mind

Your React code runs in the browsers of your users

They can view that code (via the browser developer tools) if they want to!

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There also are technical restrictions & constraints

Not all operations can be performed in the browser

E.g, you can't access a (centrally managed) file system

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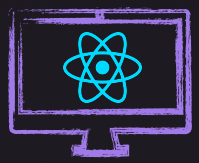
Communicate with a Backend Server Instead



Frontend

Runs in the user's browser

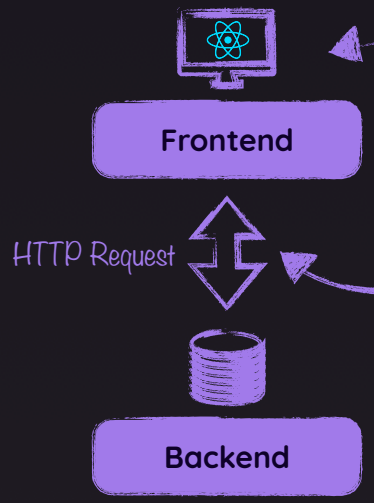
Users can theoretically view the entire code

Backend

Runs on a separate (inaccessible) server

Backend code can interact with databases etc

How To Connect A Backend / Database



(REST) API

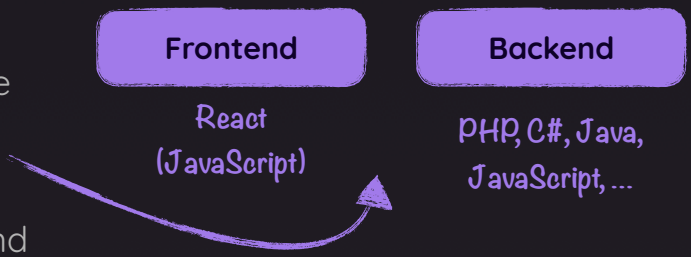
A web server that exposes certain "endpoints" (URLs) to which you can send requests & data (to receive data back)

With React, you build a **client-side** web application (= it runs in the browser)

You communicate with a backend (API) via **HTTP requests**

You should **not** try to **connect to a database** directly (→ credentials would be exposed)

Frontend (React app) & backend (API) are **often separated** (= separate projects)



You can build a **fullstack** React app (= blend frontend & backend) via **NextJS** or **Remix**

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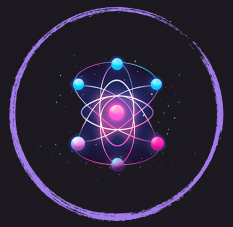

Custom Hooks

Creating & Using Custom React Hooks

- Repetition: **Rules of Hooks**
- **Why** Custom Hooks?
- **Creating** Custom Hooks
- **Using** Custom Hooks

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Rules of Hooks

1 Only call Hooks inside of Component Functions

React Hooks must not be called outside of React component functions

```
function App() {
  const [val, setVal] = useState(0);
}
```

```
const [val, setVal] = useState(0);

function App() { … }
```

2 Only call Hooks on the top level

React Hooks must not be called in nested code statements (e.g., inside of if-statements)

```
function App() {
  const [val, setVal] = useState(0);
}
```

```
function App() {
  if (someCondition)
    const [val, setVal] = useState(0);
}
```

Rules of Hooks — Updated

1 Only call Hooks in Component or Other Hook Functions

React Hooks must not be called outside of React component functions or other Hook functions

✓

```
function App() {
  const [val, setVal] = useState(0);
}
```

✗

```
const [val, setVal] = useState(0);

function App() { … }
```

2 Only call Hooks on the top level

React Hooks must not be called in nested code statements (e.g., inside of if-statements)

✓

```
function App() {
  const [val, setVal] = useState(0);
}
```

✗

```
function App() {
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    const [val, setVal] = useState(0);
}
```

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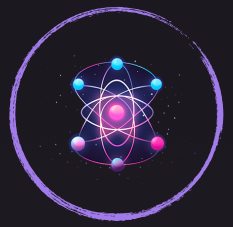


Working with Forms & User Input

It's Trickier Than It Might Seem

- What's **Difficult** About Forms?
- Handling **Form Submission** & **Validating** User Input
- Using **Built-in** Form Features
- Building **Custom** Solutions

What's So Difficult?

Form Submission

Handling submission is relatively **easy**

Entered values can be managed via **state**

Alternatively, they can be extracted via **refs**

Or via **FormData** and native browser features

Input Validation

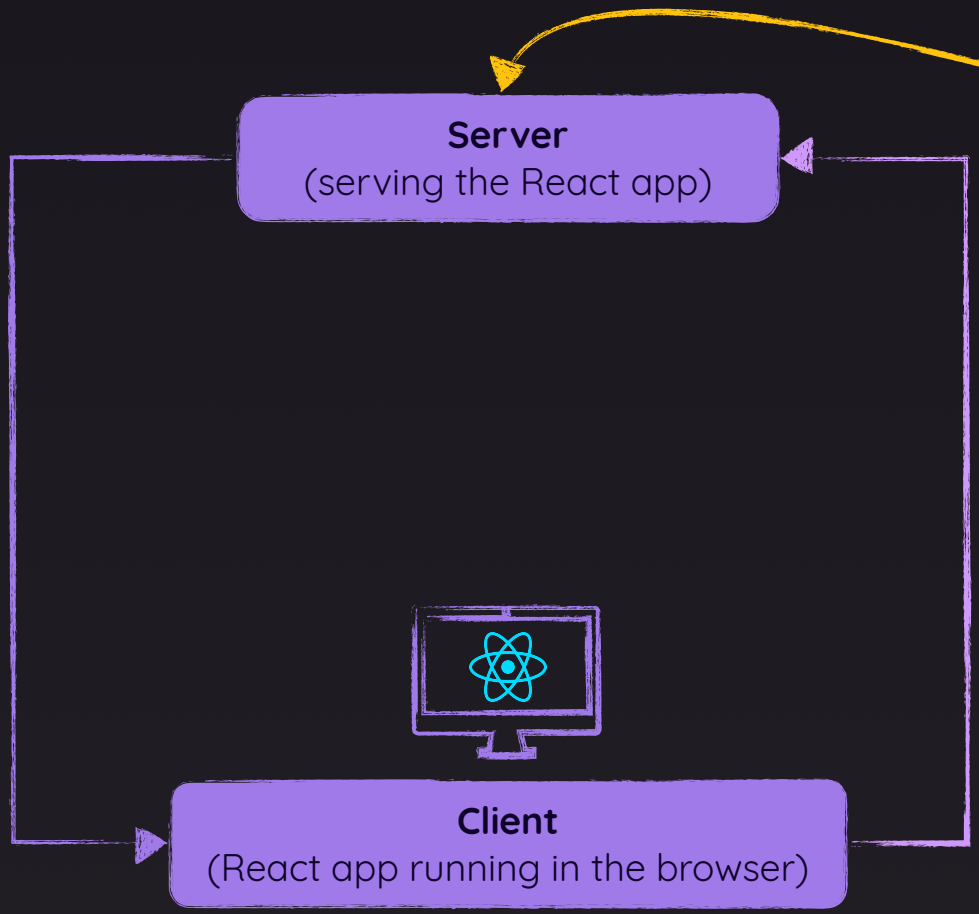
Providing a good user experience is **tricky**

You can **validate** on every **keystroke** → errors may be shown **too early**

You can **validate** on **lost focus** → errors may be shown **too long**

You can **validate** on **form submission** → errors may be shown **too late**

By Default The Browser Sends a HTTP Request



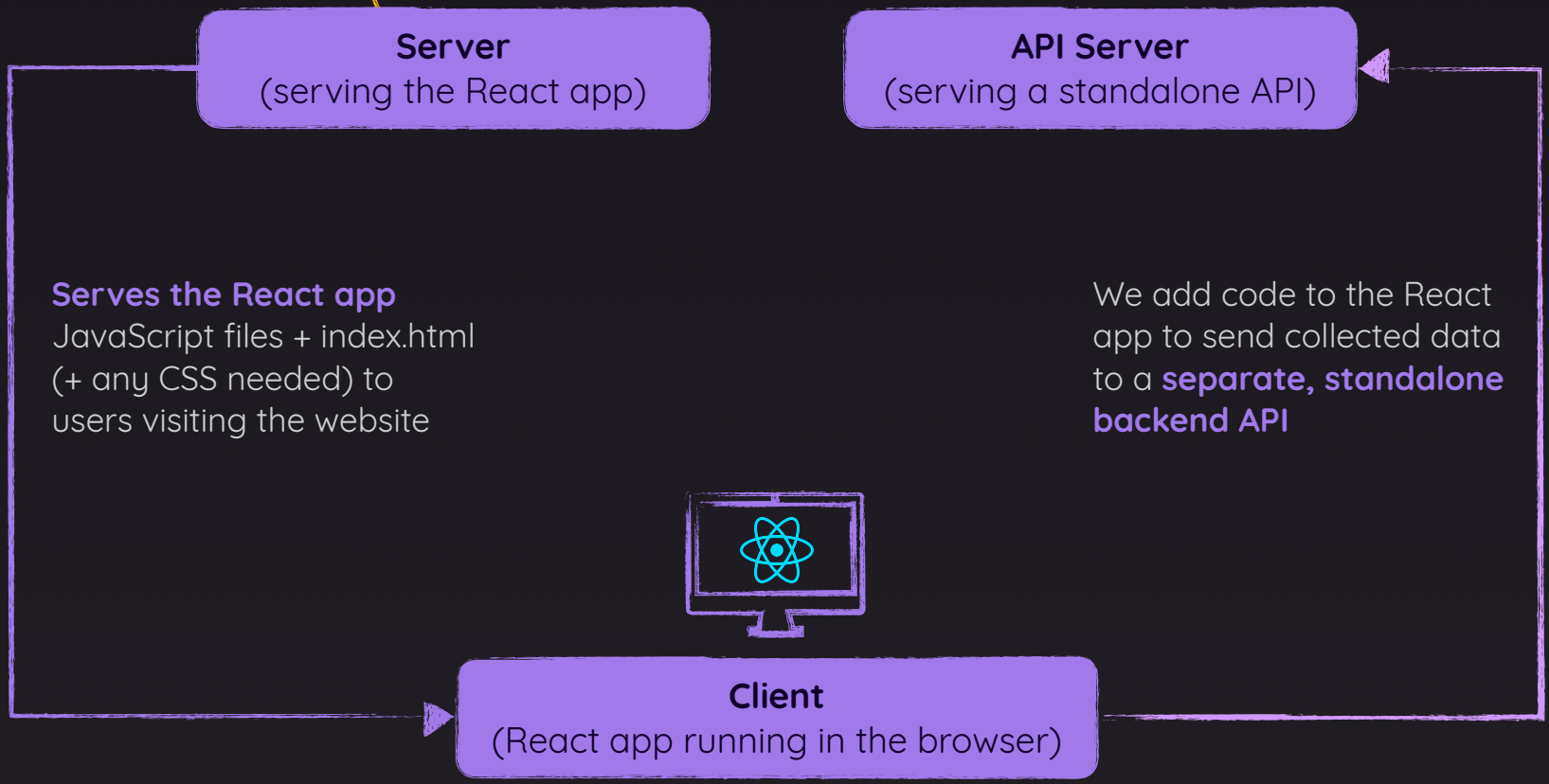
During development, that's the development server started via "npm run dev"

Serves the React app
JavaScript files + index.html (+ any CSS needed) to users visiting the website

Browser **automatically creates & sends a HTTP request** with entered **form data**

Often, Data Should Be Sent To A Backend

During development, that's the development server started via "npm run dev"



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Consider Using The Native, Built-in Form Handling Features!

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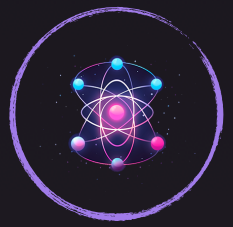

Time To Practice: Food Order App

Components, State, Context, Effects, HTTP Requests & More!

- Building a **Complete Project** From The Ground Up
- **Building & Configuring Components**
- Using **State & Context**
- Managing **HTTP Requests & Side Effects**

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Time To Practice!

A Challenge For You

Build a “Food Order” web app

Use the **starting project** attached to this lecture

Add **components** for displaying **products**, the **cart** (in a **modal**) and a **checkout form** (also in a **modal**)

Fetch the (dummy) meals data from the **backend** & show it on the screen (GET /meals)

Allow users to **add & remove** products to / from the **cart**

Send cart data along with **user data** (full name, email, street, postal code, city) to the **backend** (POST /orders)

Handle **loading & error** states

We Need A Plan!

1

Add the **Header** component

2

Add the **Meals-related** components & the logic to fetch meals data from a **backend**

3

Add **Cart** logic (add items to cart, edit cart items) & **Checkout** page logic

Feel free to **pause** this section & **try continuing on your own** anytime → It'll always be a good practice, even if you're not able to build everything

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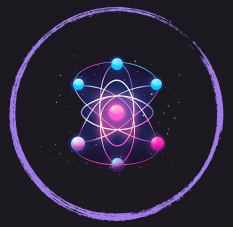

Animating React Apps

Using Framer Motion To Bring Things To Life

- "**Just CSS**" Might Be Enough!
- Building More **Complex Animations** with **Framer Motion**
- Animating Elements **In & Out**
- **Scroll-based** Animations

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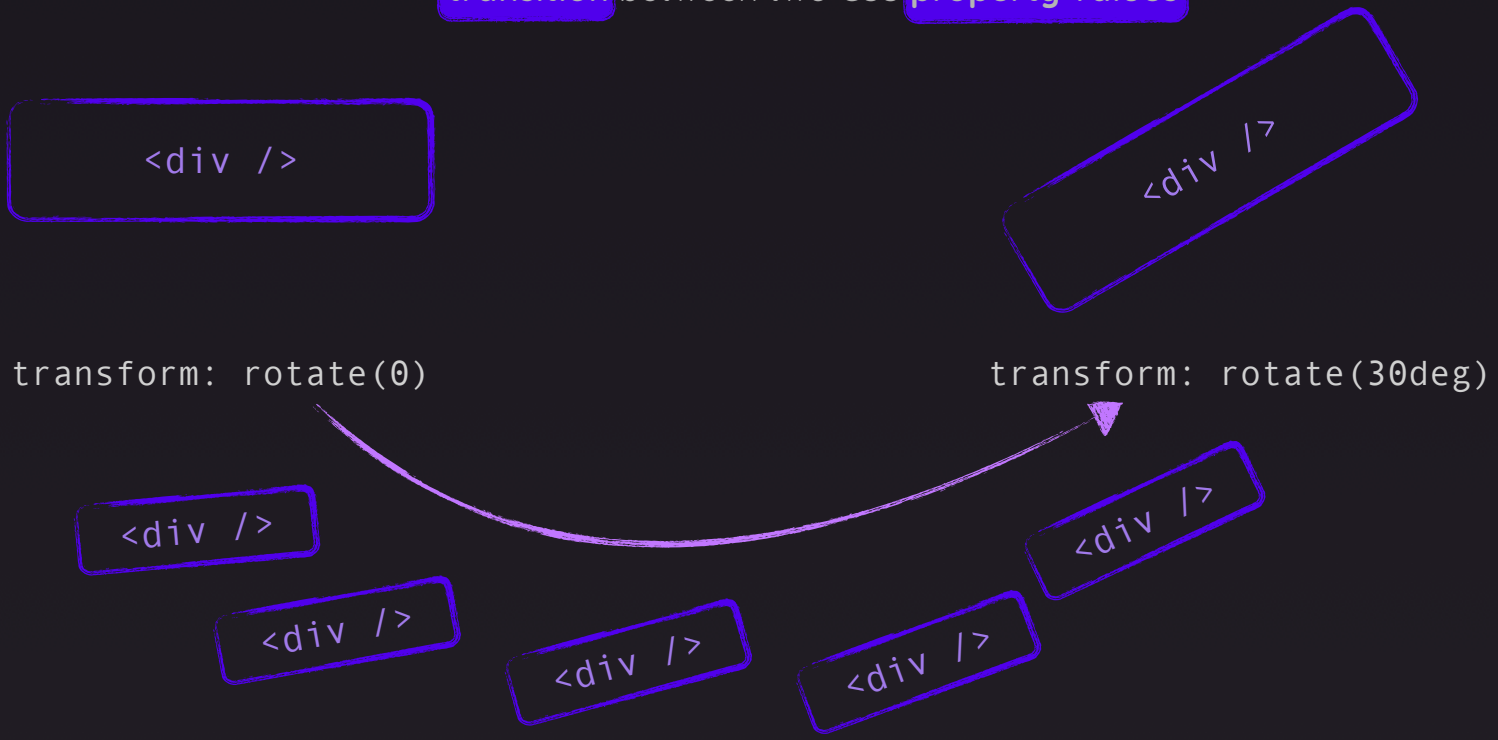
You Might Not Need An Animation Library

CSS Transitions & Animations Might Be Enough

CSS Transitions

CSS Transitions allow you to "tell" CSS to **smoothly transition** between two CSS **property values**



Animate via "transition" property

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Framer Motion Allows You To Build Good-Looking & Complex Animations With Realistic Motion

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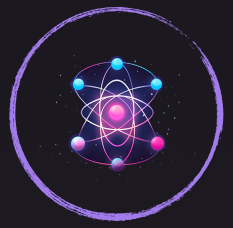
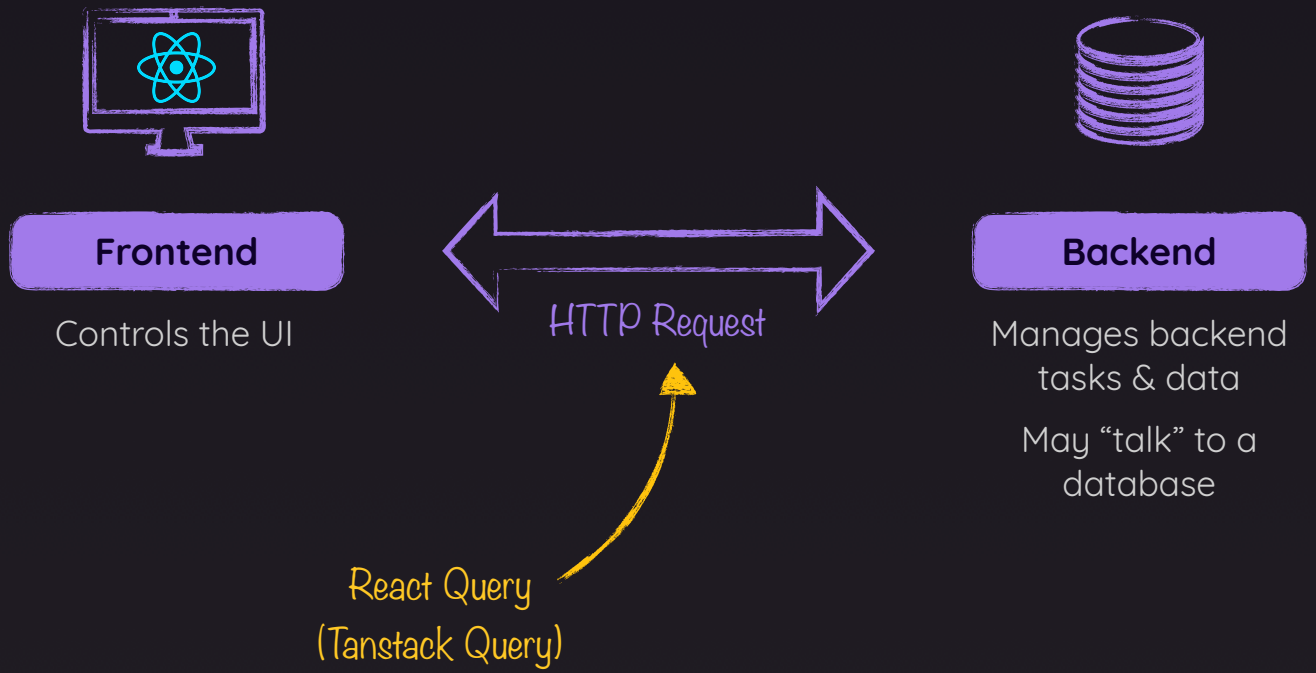
formerly React Query



Data Fetching with Tanstack Query

Sending HTTP Requests With Ease

- **What** Is Tanstack Query & **Why** Would You Use It?
- **Fetching** & **Mutating** Data
- **Configuring** Tanstack Query
- **Advanced Concepts:** Cache Invalidation, Optimistic Updating & More


Frontend
Controls the UI
HTTP Request
Backend
Manages backend tasks & data
May "talk" to a database
React Query
(Tanstack Query)

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What Is Tanstack Query?

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What Is Tanstack Query?

A library that helps with sending HTTP requests & keeping your frontend UI in sync

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You Don’t Need Tanstack Query!

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You Don't Need Tanstack Query!

But it can vastly simplify your code
(and your life as a developer)

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Tanstack Query Does Not Send HTTP Requests

At least **not on its own**

You have to write the code that sends the actual HTTP request

Tanstack Query then manages the **data, errors, caching & much more!**

Tanstack Query Caches Query Data

```
useQuery({
  queryKey: ['some-key'],
  queryFn: fetchData
});
```

Called in Component A @ 10:32

`fetchData()` is executed & HTTP request is sent

Data is **received**

```
{
  id: 'd1',
  title: 'Some data'
}
```

```
useQuery({
  queryKey: ['some-key'],
  queryFn: fetchData
});
```

Called in Component B @ 10:34

Cached data is reused & shown on the screen immediately

Cached (stored) by Tanstack Query

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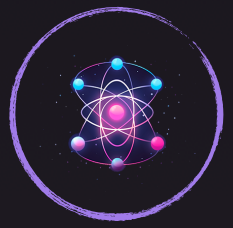

React + TypeScript

Adding Type Safety To React Apps

- What & Why?
- TypeScript Basics
- Combining React & TypeScript

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What & Why?

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TypeScript is a superset to JavaScript

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TypeScript adds static typing to JavaScript

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JavaScript on its own is dynamically typed

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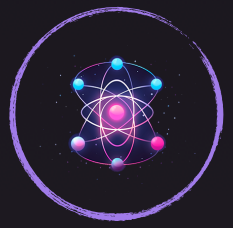

Testing React Apps

Automated Testing

- What is “Testing”? And why?
- Understanding Unit Tests
- Testing React Components & Building Blocks

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What is “Testing”?

Manual Testing

Write Code → Preview & Test in Browser → Improve Code → Repeat

Very important: You see what your users will see

Error-prone: It’s hard to always test all possible combinations & scenarios

Automated Testing

Write code that automatically tests your code

You test the individual building blocks of your app

Requires extra knowledge (→ how to write tests) but allows you to test all building blocks of your app

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Different Kinds Of Automated Tests

Unit Tests

Test the **individual building blocks** (functions, components) in **isolation**

Projects typically contain dozens or hundreds of unit tests

The most common / important kind of test

Integration Tests

Test the **combination** of multiple building blocks

Projects typically contain a couple of integration tests

Also important, but focus on unit tests in most cases

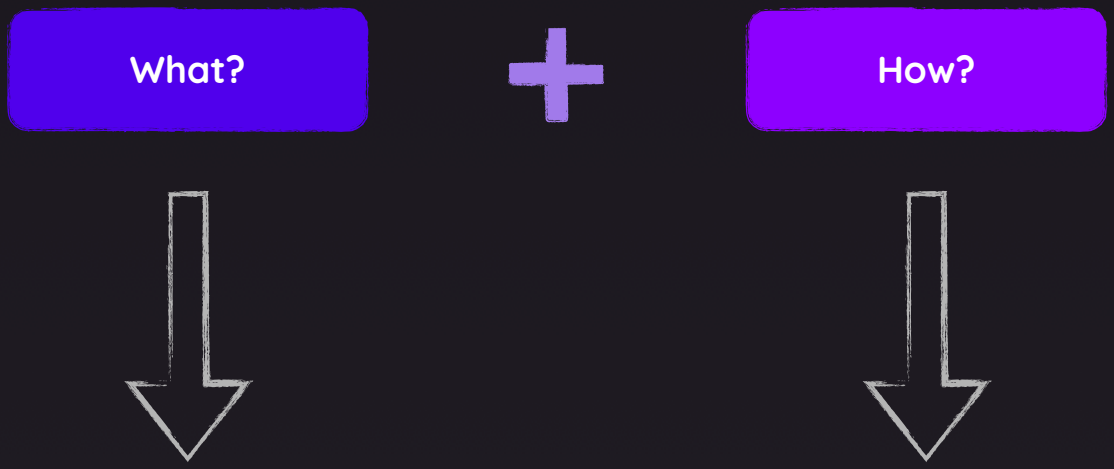
End-to-End (E2E) Tests

Test **complete scenarios / user flows** in your app (as the user would experience them)

Projects typically contain only a few E2E tests

Important but can also be done manually (partially)

What Should You Test?



Test the different app building blocks

Unit tests: The smallest building blocks that make up your app

Test success and error cases, also test rare (but possible) results

Required Tools & Setup

We need a tool for running our tests and asserting the results

+

We need a tool for "simulating" (rendering) our React app / components

Jest

React Testing Library

Both tools are already set up for you when using create-react-app

For Vite & CodeSandbox, you find appropriate project setups attached!

Writing Tests — The Three "A"s