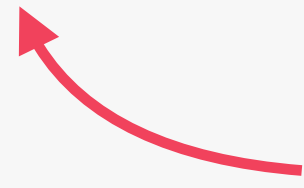




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THE ULTIMATE REACT COURSE



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SLIDES FOR THEORY LECTURES

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



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**WELCOME, WELCOME,
WELCOME!**



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SECTION

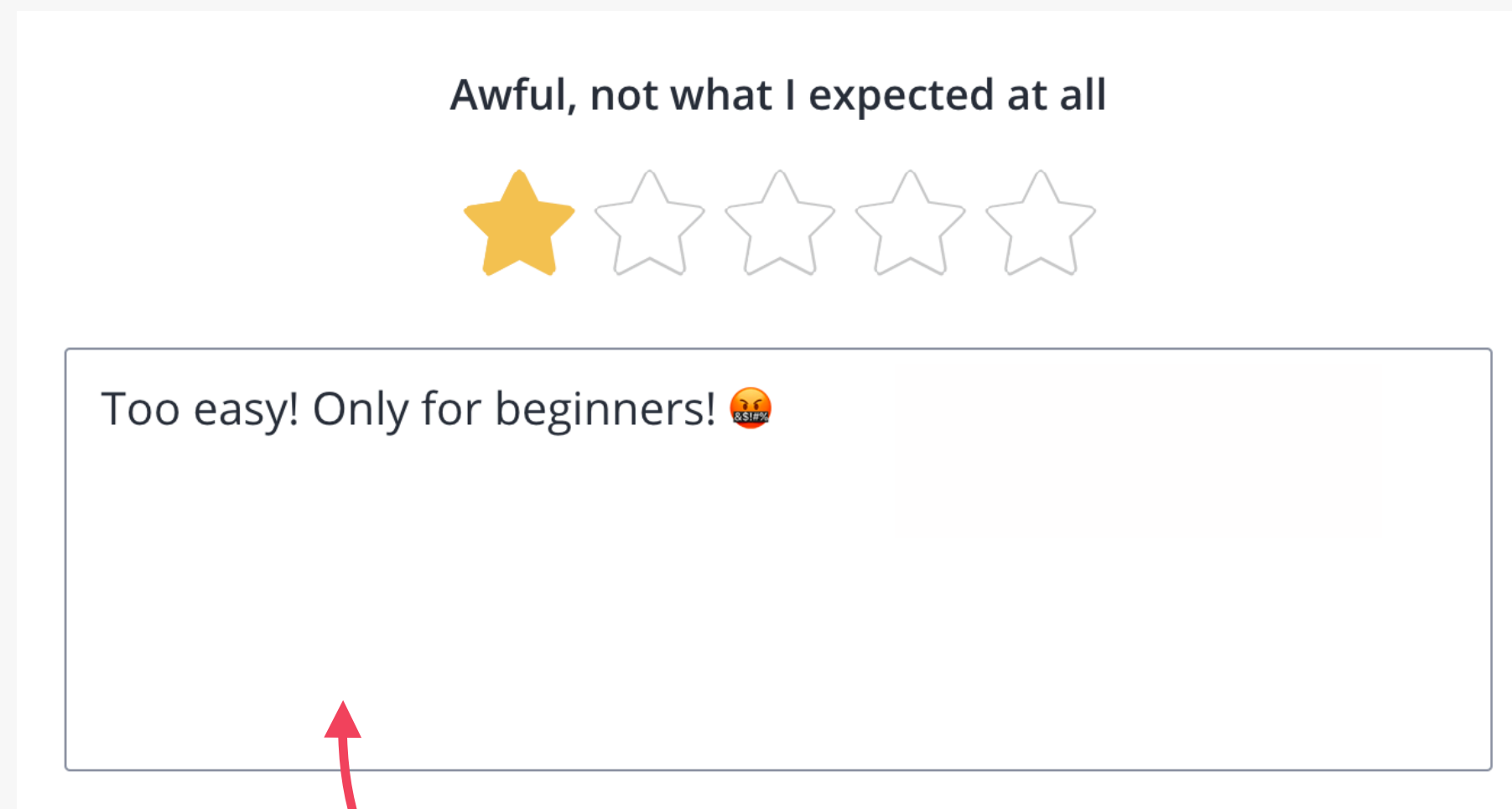
WELCOME, WELCOME, WELCOME!

LECTURE

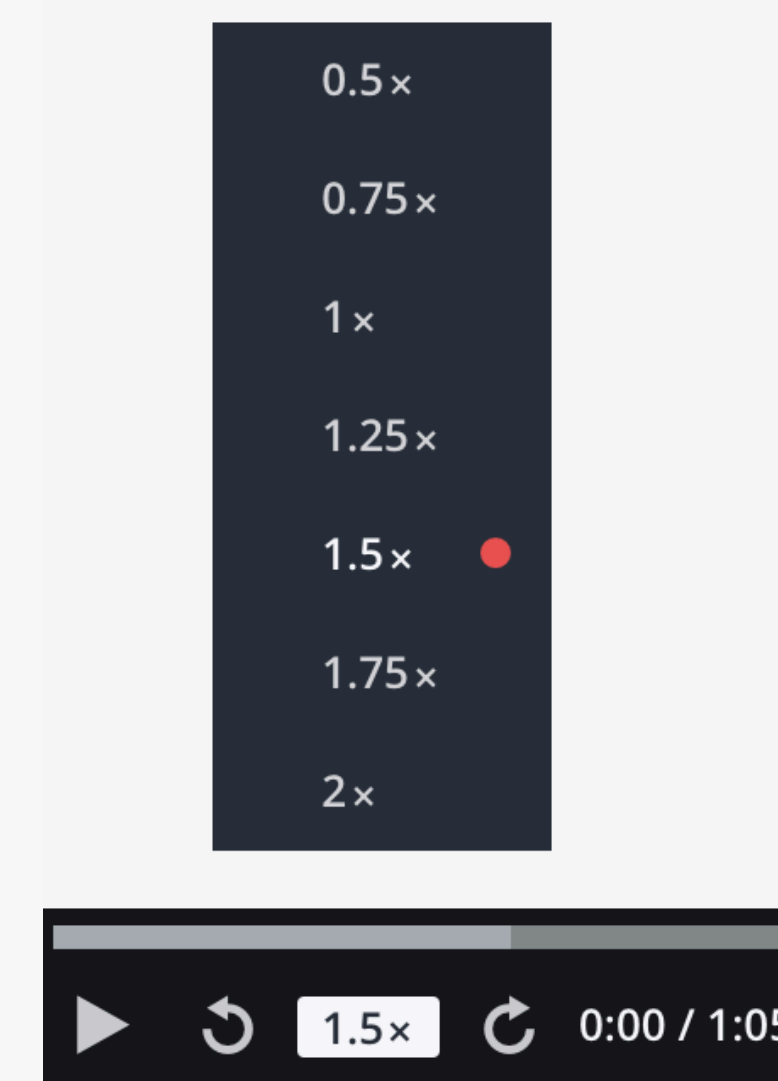
WATCH BEFORE YOU START!

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

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



Please don't be that person. Everyone is different... Unless the course is truly terrible (it's not 🤔)

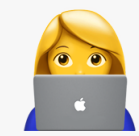


SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

😱 You don't need to watch the entire course in order to learn React! If you are in a hurry, can cut the course length in **HALF** by skipping optional sections and practice parts

✓	A First Look at React	7 lectures • 1hr 8min
→	✓ [Optional] Review of Essential JavaScript for React	14 lectures • 1hr 51min
	✓ Working With Components, Props, and JSX	23 lectures • 2hr 53min
	✓ State, Events, and Forms: Interactive Components	20 lectures • 2hr 54min
	✓ Thinking In React: State Management	16 lectures • 2hr 41min
→	✓ [Optional] Practice Project: Eat-'N-Split	8 lectures • 1hr 28min
	✓ Thinking in React: Components, Composition, and Reusability	16 lectures • 2hr 38min
	✓ How React Works Behind the Scenes	17 lectures • 2hr 36min
	✓ Effects and Data Fetching	18 lectures • 3hr 12min
	✓ Custom Hooks, Refs, and More State	14 lectures • 2hr 1min
→	✓ [Optional] React Before Hooks: Class-Based React	9 lectures • 1hr 21min

SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

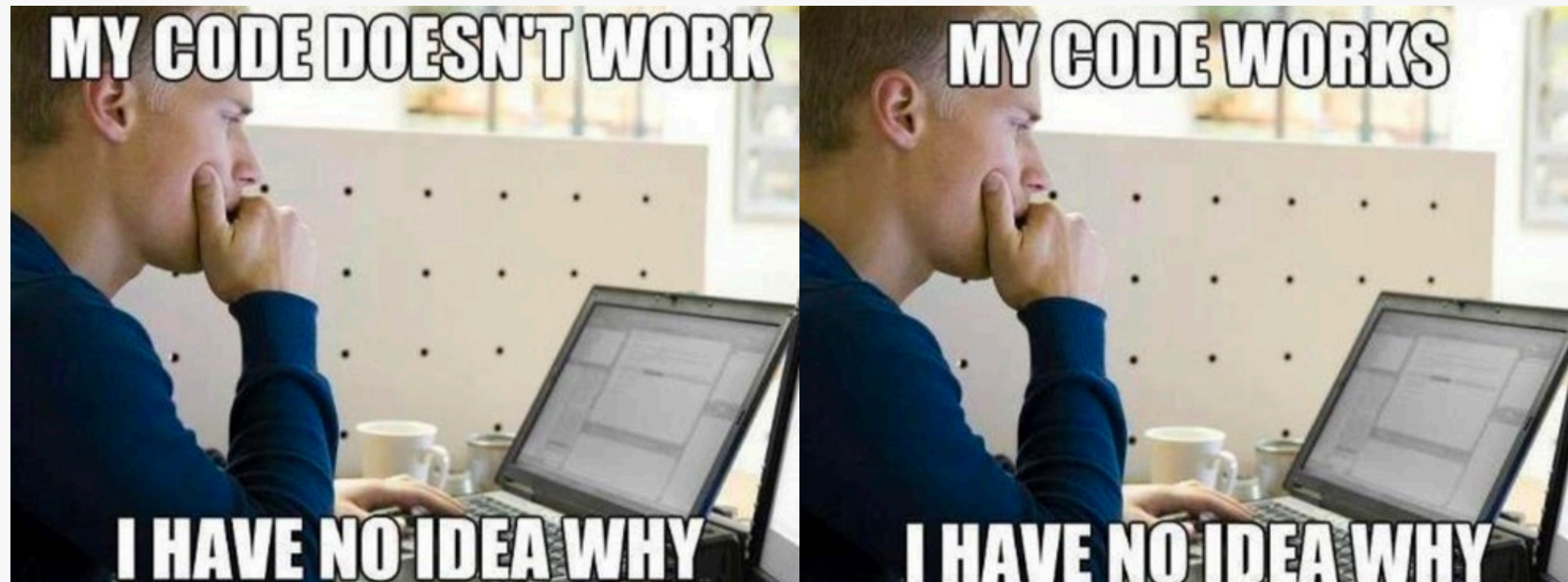


You need to code along with me! You will learn **ZERO** React skills by just sitting and watching me code. You really have to write code **YOURSELF!**



SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

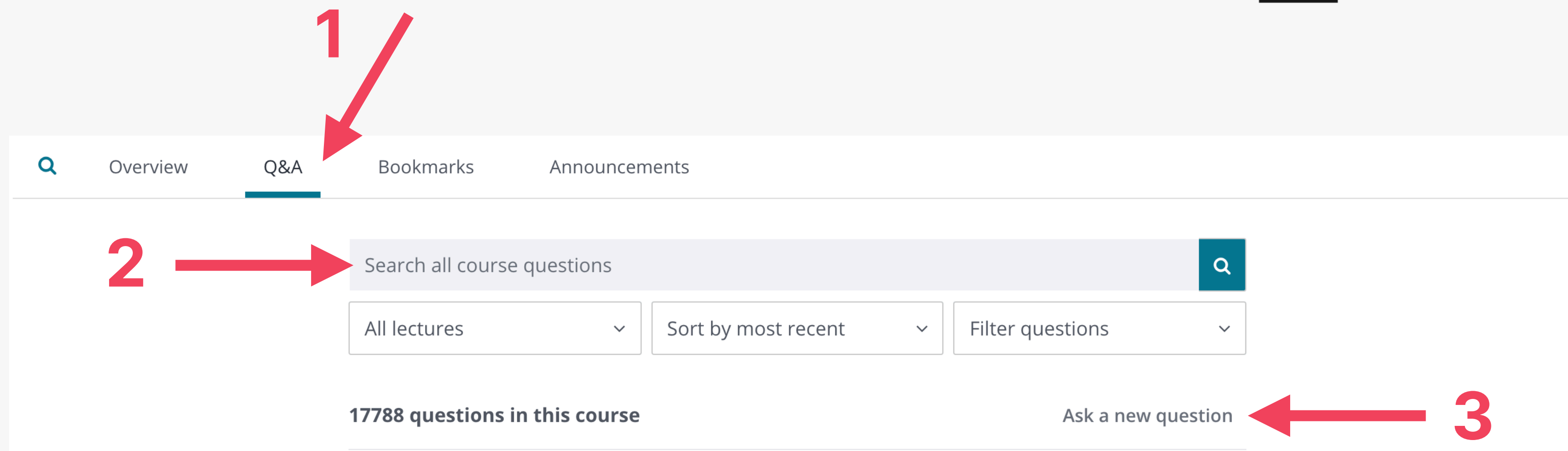
😅 In the first sections of the course, don't worry about **WHY** and **HOW** things work, or about React "best practices". While learning, we just want to make things **WORK**. We will worry about everything else later in the course



SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

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

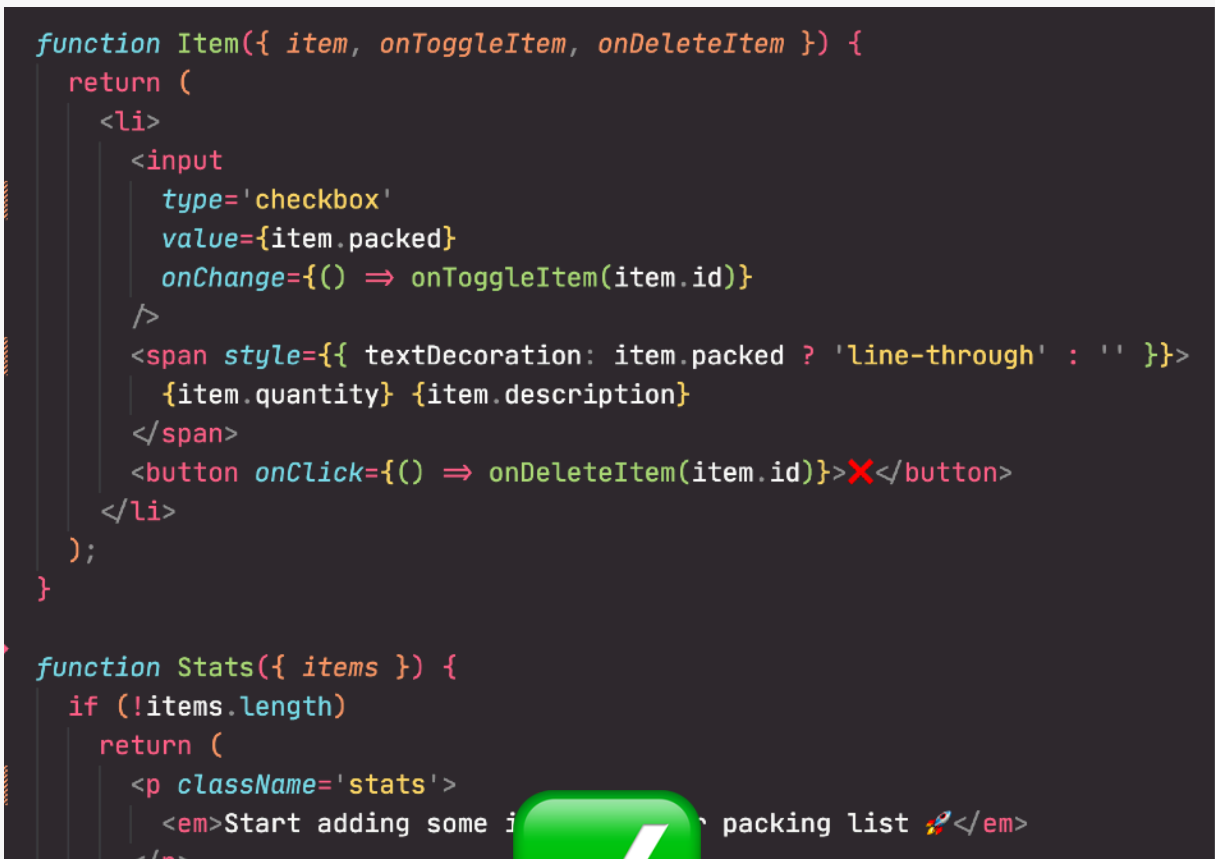
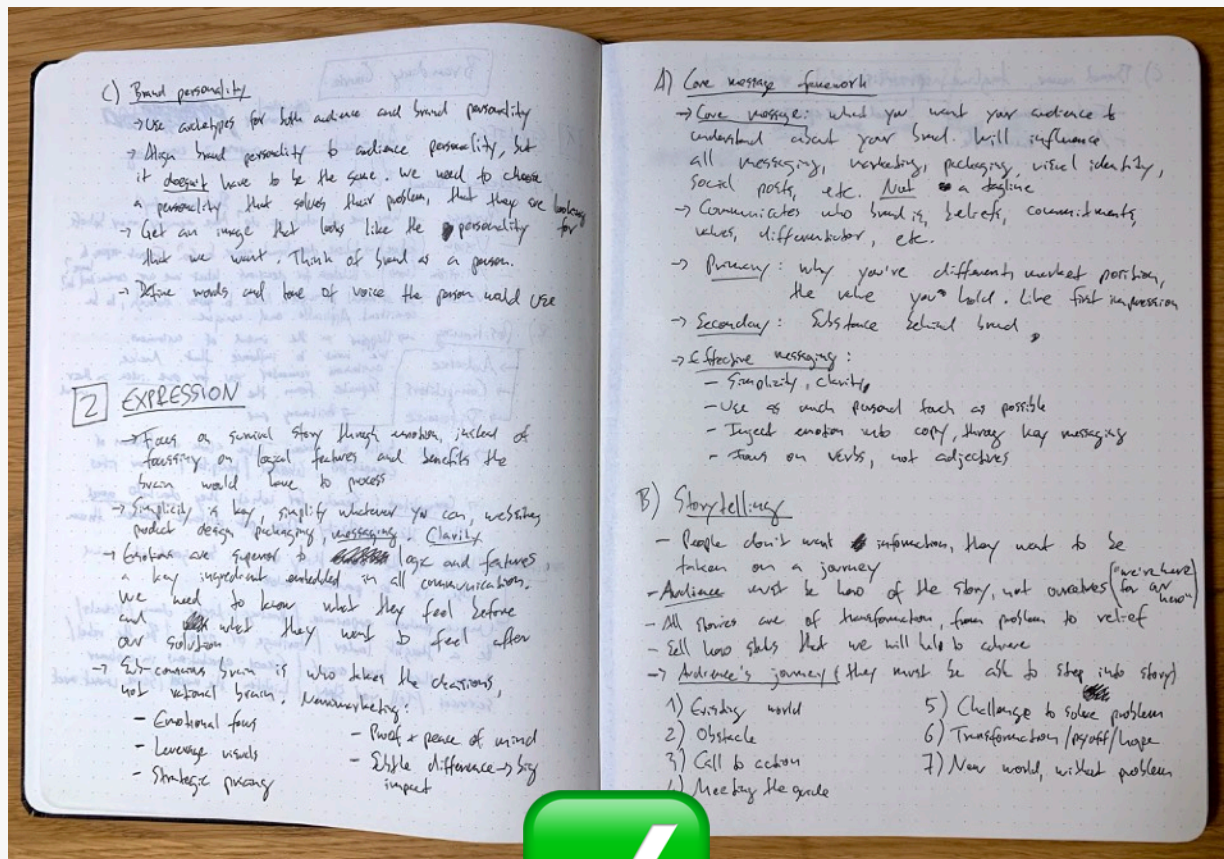
 CodeSandbox



SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

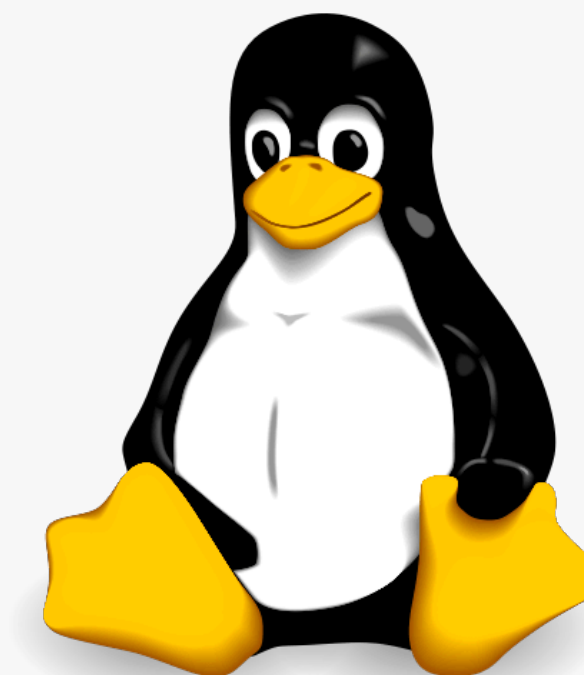
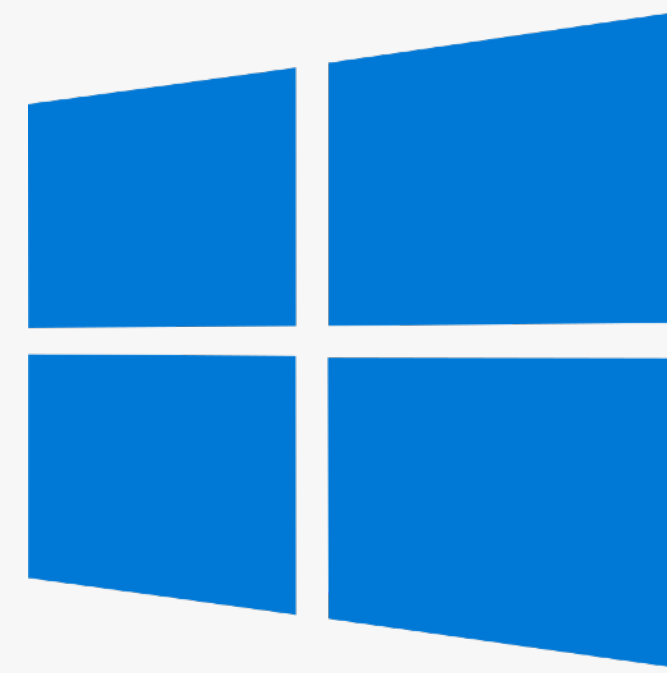


Before moving on from a section, make sure that you understand exactly what was covered. Take a break, review the code we wrote, review your notes, review the projects we built, and maybe even write some code yourself



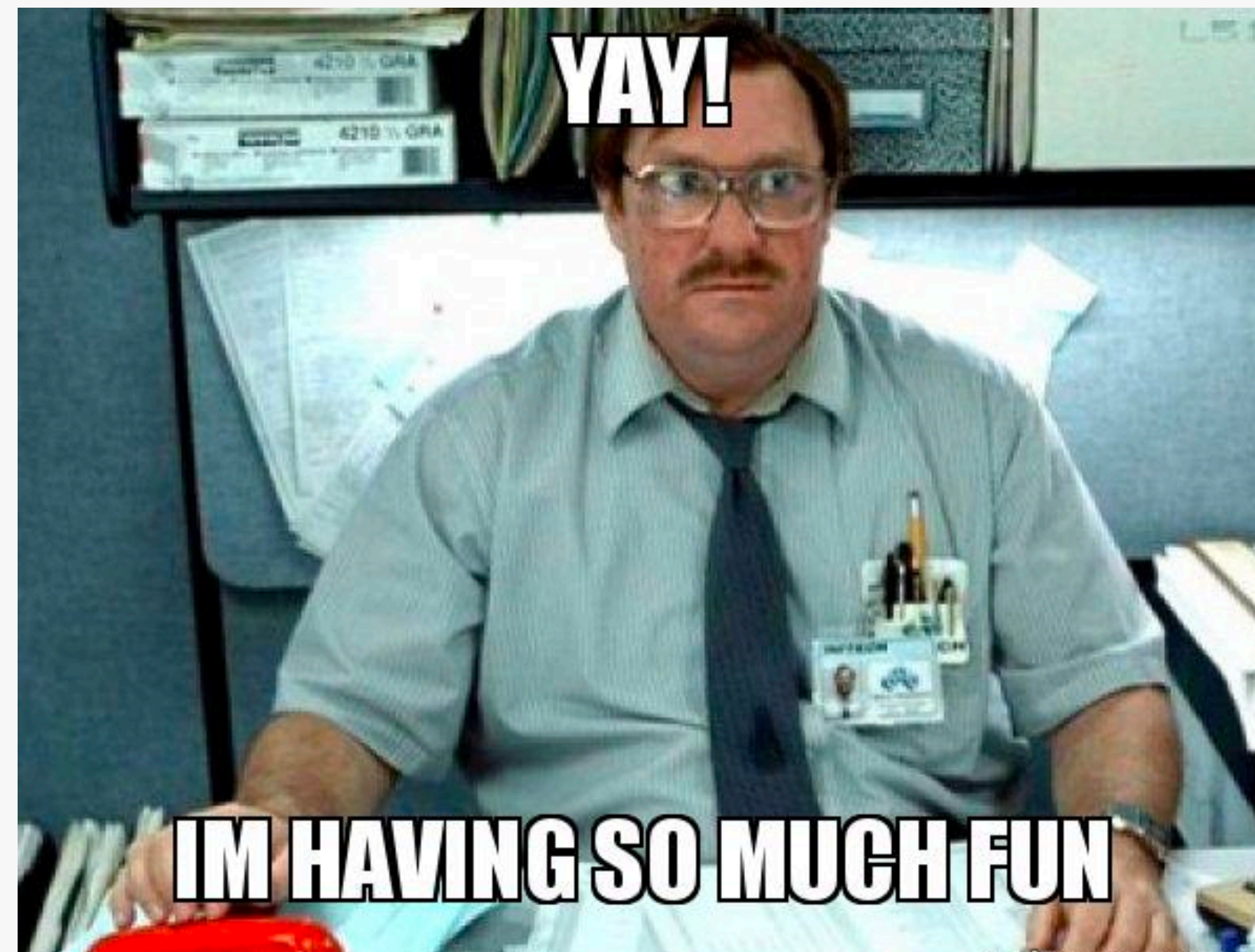
SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

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



SOME QUICK CONSIDERATIONS BEFORE WE START... 🚀

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



And I mean **REAL** fun 😅

PART 01

—

REACT

FUNDAMENTALS

A FIRST LOOK AT REACT



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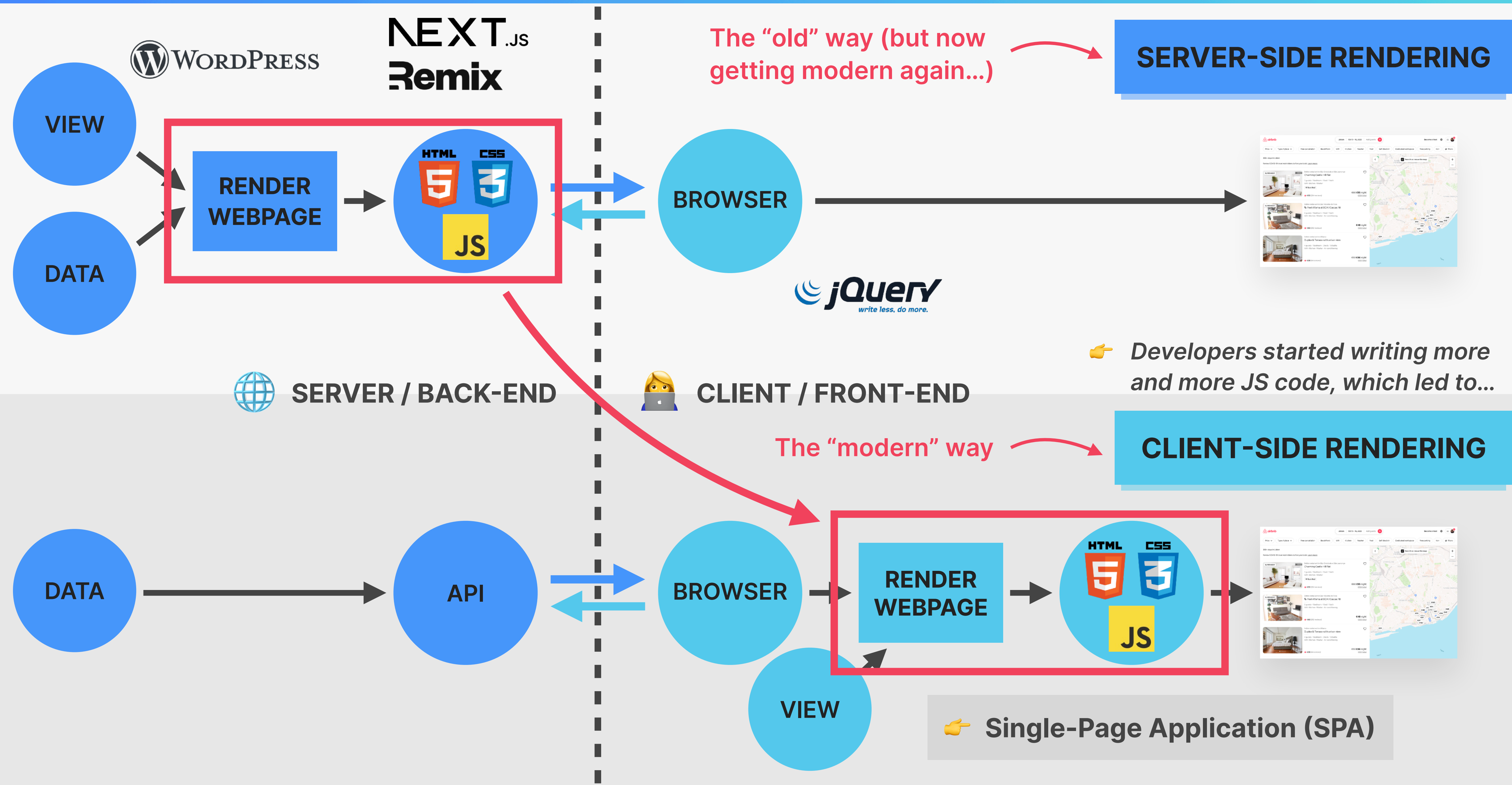
SECTION

A FIRST LOOK AT REACT

LECTURE

WHY DO FRONT-END
FRAMEWORKS EXIST?

THE RISE OF SINGLE-PAGE APPLICATIONS



SINGLE-PAGE APPLICATIONS WITH VANILLA JAVASCRIPT?

👉 *Front-end web applications are all about...*

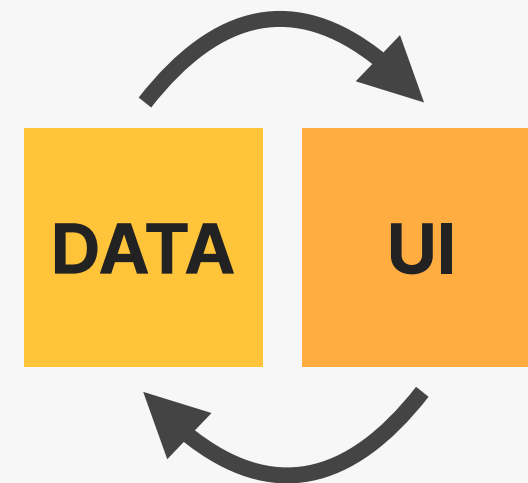
**Handling data + displaying
data in a user interface**



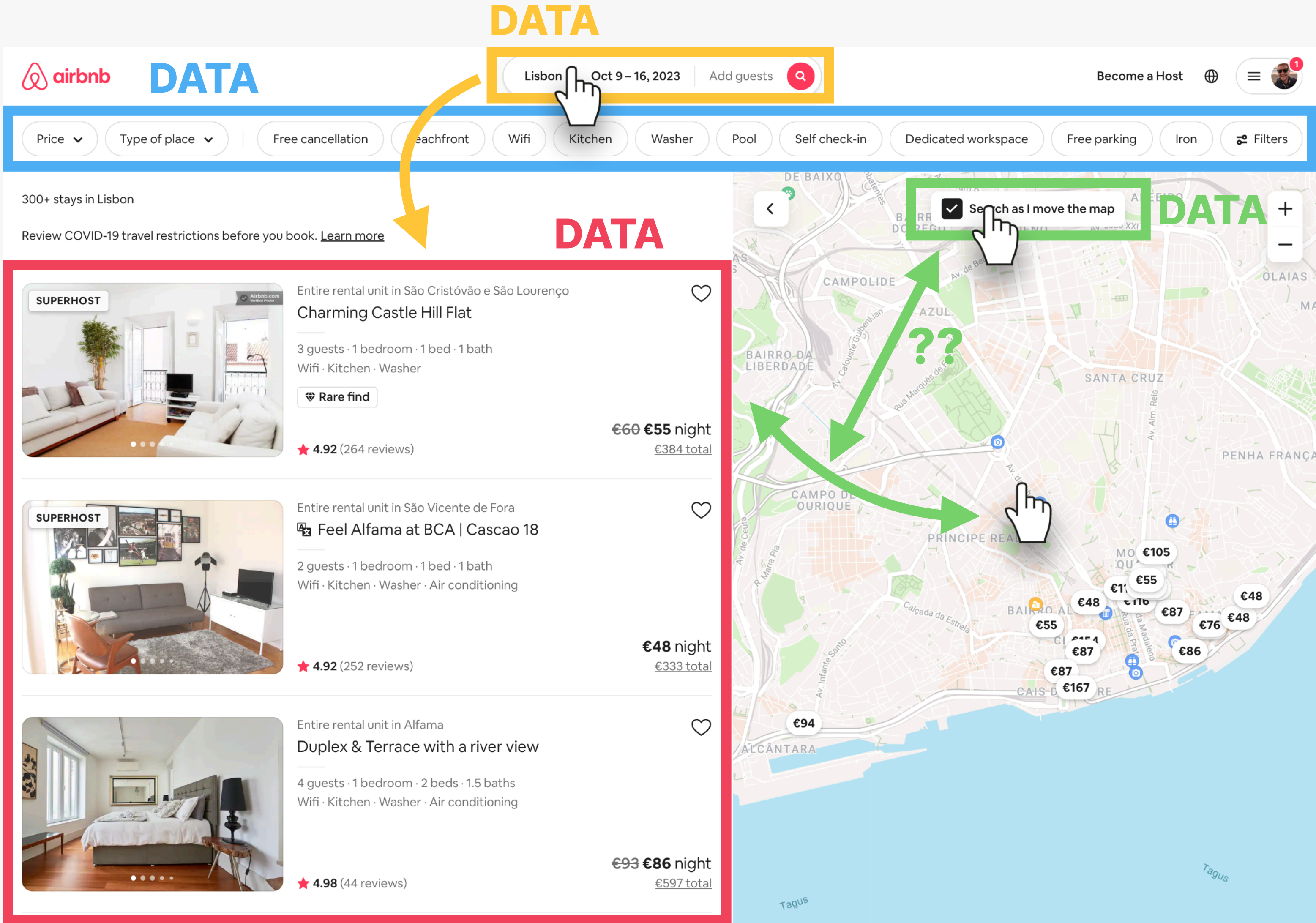
**User interface needs to
stay in sync with data**



Very hard problem to solve!



KEEPING UI IN SYNC WITH DATA



👉 Keeping UI
and data in sync
would be **virtually
impossible with
just vanilla
JavaScript**

**Piece of data
=
Piece of *state***

```
const data = {
  currency: {
    currencyCountries: [],
    currencySelectorExpanded: false,
    selectedCurrencyCode: 'EUR',
    loadingCurrencies: false,
  },
  footer: {
    footerExpanded: false,
  },
  map: {
    hoveredListingId: null,
    hoveredDestinationPlaceId: null,
    clickedListingId: null,
    expandMapToFitLocations: null,
  },
  saveToListModal: {
    entity: null,
    entityId: null,
    entityType: null,
    fetchListsError: false,
    isCreatingList: false,
    isFetchingLists: false,
    isListsCacheValid: true,
    entityMap: {
      Listing-36189352: {},
      Listing-34888453: {},
      Listing-13357289: {},
      Listing-29842619: {},
      Listing-21693919: {},
      Listing-443808963: {},
      Listing-45885968: {},
    },
  },
  lastError: null,
  lastListSavedTo: null,
  lastListSavedToOperation: null,
  lists: [
    {
      id: 878854853,
      name: 'Bons',
      listing_ids: [
        36189352, 34888453, 13357289, 29842619, 21693919, 443808963, 45885968,
      ],
      mt_template_ids: [],
      place_activity_ids: [],
      place_ids: [],
      article_ids: [],
      mt_scheduled_template_ids: [],
      is_china_wishlist_home_collection: false,
      settings_disabled: false,
      airbnb_canonical_place_ids: [],
      listing_ids_str: [
        '36189352',
        '34888453',
        '13357289',
        '29842619',
        '21693919',
        '443808963',
        '45885968',
      ],
    },
  ],
  newListName: null,
  newToast: {
    actionText: '',
    listHref: null,
    message: null,
  },
  requiresSignup: false,
  savingFrom: null,
  visible: false,
}
}
ui: {
  hideMap: true,
  openedFilterId: null,
  openedSearchInputField: null,
  shouldLoadInterceptSurvey: false,
  visiblePromos: {},
},
header: {
  user: {
    isLoggedInIn: true,
    profilePicUrl:
      'https://a8.muscache.com/im/pictures/user/9ed2794f-a4fe-4c5e-b347-959a7f...',
    name: 'Jonas',
    currency: 'EUR',
    isHost: false,
    guidebooksCount: 0,
  },
  dynamicColorTheme: null,
  activeNavItem: null,
  navigationItemsWithNotifications: {},
  flyoutMenuIsOpen: false,
};
```


SINGLE-PAGE APPLICATIONS WITH VANILLA JAVASCRIPT?

👉 Front-end web applications are all about...

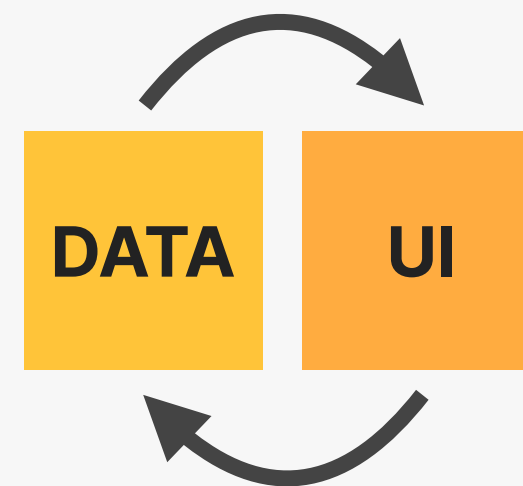
Handling data + displaying
data in a user interface



User interface needs to
stay in sync with data



Very hard problem to solve!



PROBLEMS WITH



1

Requires lots of direct **DOM** manipulation and
traversing (*imperative*) 👉 “Spaghetti code” 🍝

```
const guestsEl = document.querySelector('.guests');
const guestsPickerEl = document.querySelector('.picker');

guestsEl.addEventListener('click', function () {
  guestsEl.classList.toggle('inactive');
  guestsEl.classList.toggle('active');

  if (guestsPickerEl.style.display === 'block') {
    guestsPickerEl.style.display = 'none';
    guestsEl.firstChild.textContent = 'Add guests';
  } else {
    guestsPickerEl.style.display = 'block';
    guestsEl.firstChild.textContent = '';
  }
});
```

2

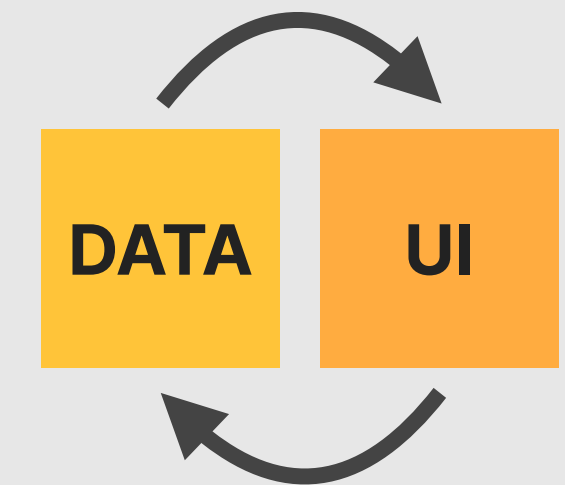
Data (state) is usually **stored in the DOM**, shared
across entire app 👉 Hard to reason + bugs 🐛

WHY DO FRONT-END FRAMEWORKS EXIST?

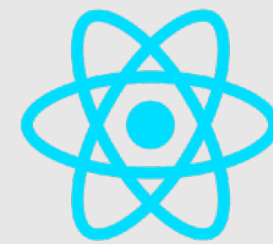
1

JavaScript front-end frameworks exist because...

KEEPING A USER INTERFACE IN SYNC WITH DATA
IS REALLY HARD AND A LOT OF WORK



Front-end frameworks **solve this problem** and take hard work away from developers 🎉



← Different approaches, same goal

2

They enforce a “**correct**” way of structuring and writing code (therefore contributing to solving the problem of “spaghetti code” 🍝)

3

They give developers and teams a **consistent** way of building front-end applications



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SECTION

A FIRST LOOK AT REACT

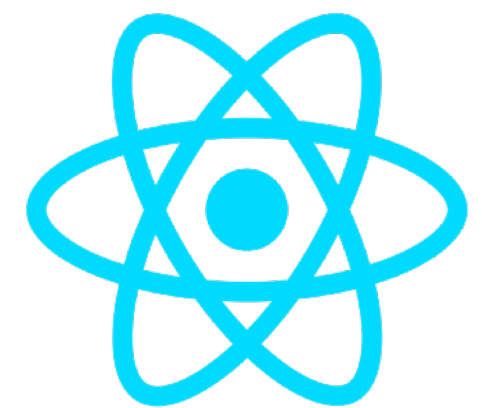
LECTURE

WHAT IS REACT?

WHAT IS REACT?

REACT

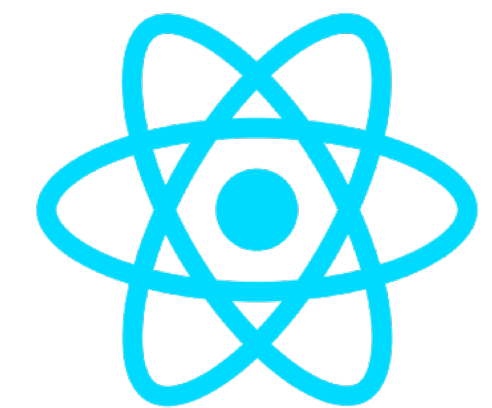
**JAVASCRIPT LIBRARY FOR BUILDING
USER INTERFACES**



WHAT IS REACT?

REACT

EXTREMELY POPULAR DECLARATIVE,
COMPONENT-BASED STATE-DRIVEN JAVASCRIPT
LIBRARY FOR BUILDING USER INTERFACES,
CREATED BY FACEBOOK 🤔 🧠 😂



REACT IS BASED ON COMPONENTS

Based on components

Declarative

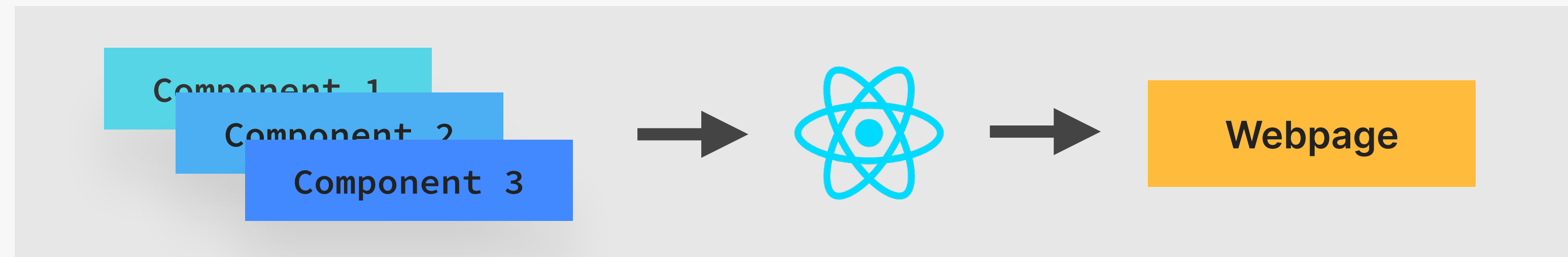
State-driven

JavaScript library

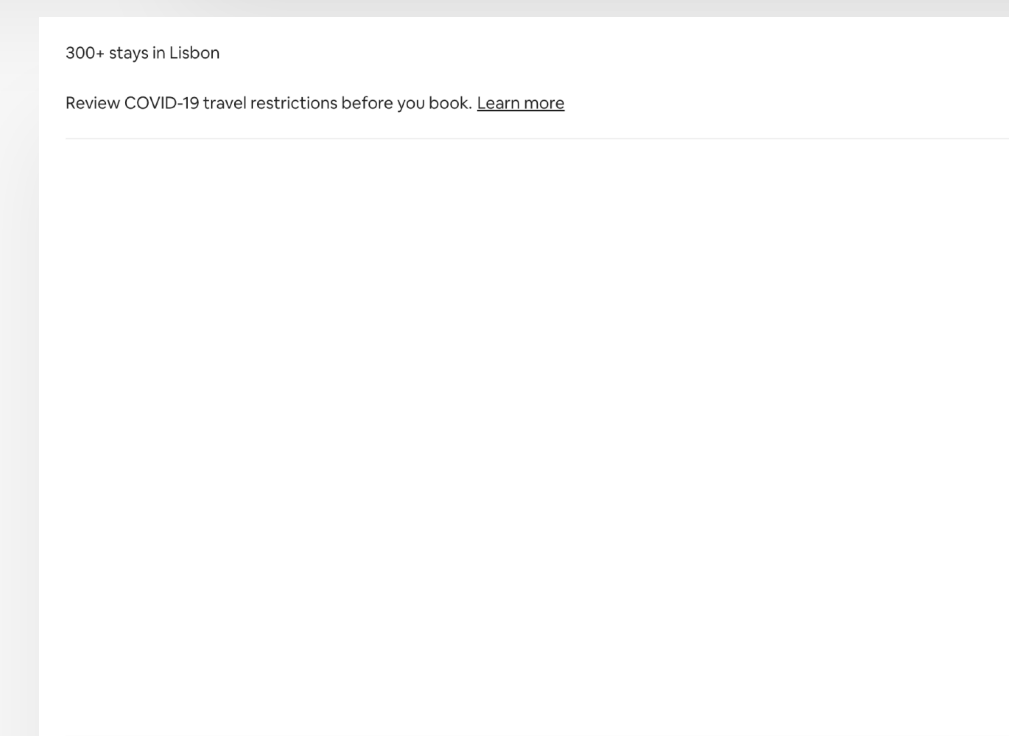
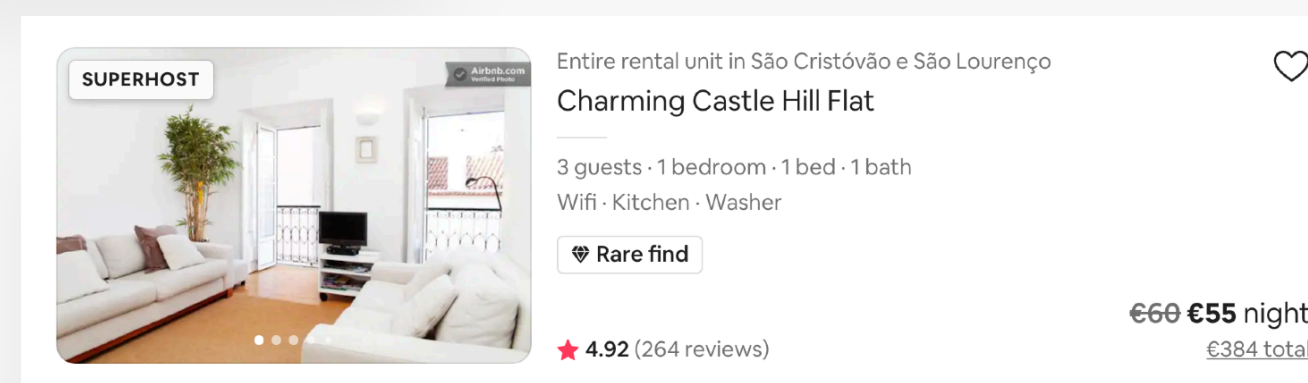
Extremely popular

Created by facebook

👉 Components are the **building blocks** of user interfaces in React



👉 We build complex UIs by **building and combining multiple components**



REACT IS BASED ON COMPONENTS

Based on components

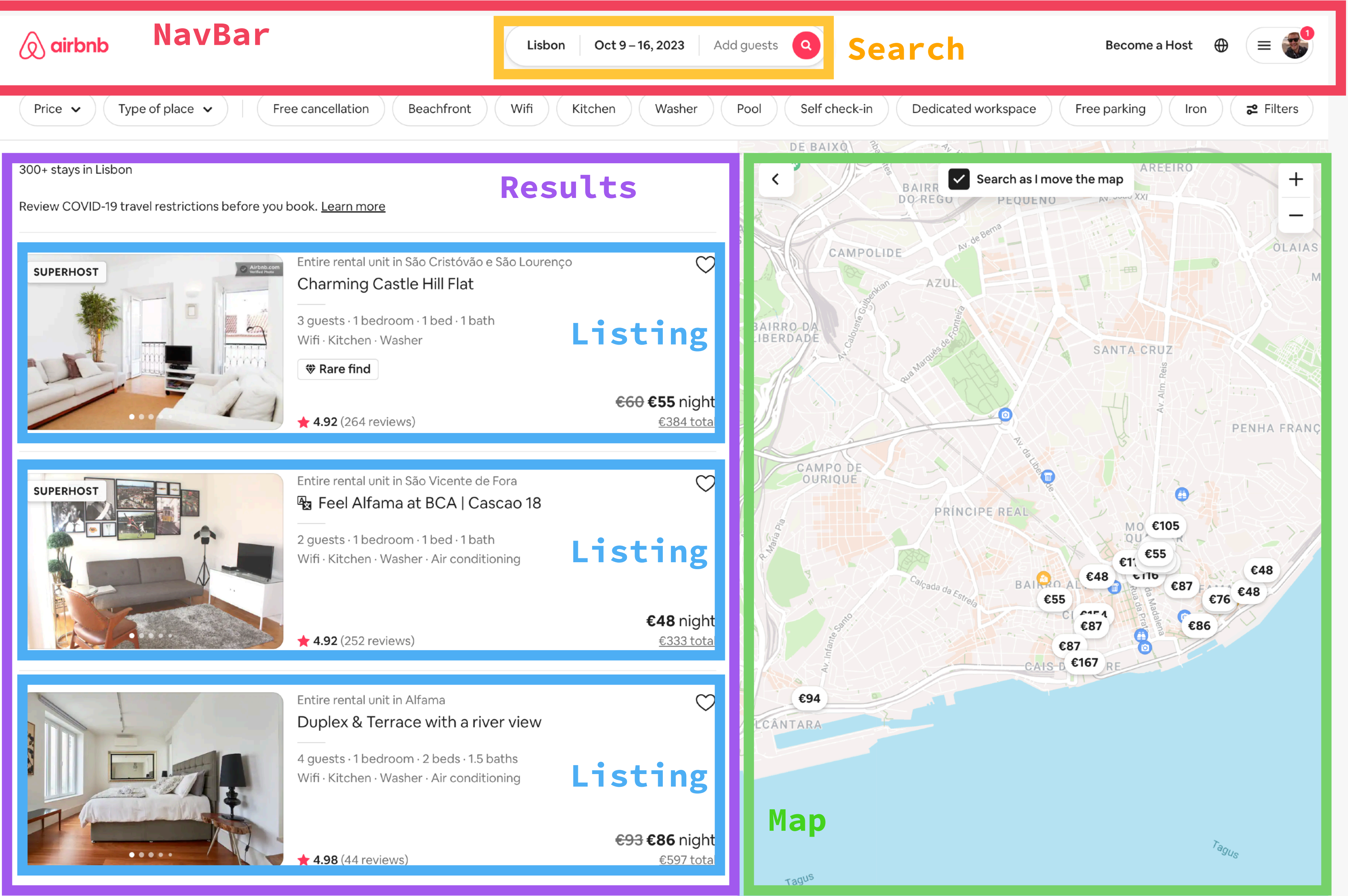
Declarative

State-driven

JavaScript library

Extremely popular

Created by facebook



REACT IS DECLARATIVE

Based on components

Declarative

State-driven

JavaScript library

Extremely popular

Created by facebook

- 👉 We **describe** how components look like and how they work using a **declarative syntax called JSX**
- 👉 **Declarative:** telling React what a component should look like, **based on current data/state**
- 👉 React is **abstraction** away from DOM: we **never touch the DOM**
- 👉 **JSX:** a syntax that **combines** **HTML** **CSS** **JavaScript** as well as referencing **other components**

JSX returned from a component

```
return (
  <main>
    <NavBar>
      <h1 style={ { fontSize: '3.2rem' } }>AirBnB</h1>
      <Search />
      <a href='#>Become a host</a>
    </NavBar>
    <Results>
      <p style={ { fontSize: '1.6rem', margin: '1.2rem' } }>
        {numListings} stays in Lisbon
      </p>
      <Listing listing={listings[0]} />
      <Listing listing={listings[1]} />
      <Listing listing={listings[2]} />
    </Results>
    <Map listings={listings} onClick={moveMap} />
  </main>
);
```

REACT IS STATE-DRIVEN

Based on components

Declarative

State-driven

JavaScript library

Extremely popular

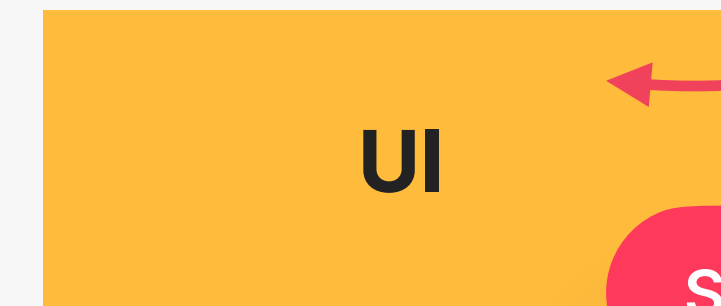
Created by facebook

Example: array
of apartments



1 RENDER

4 RE-RENDER

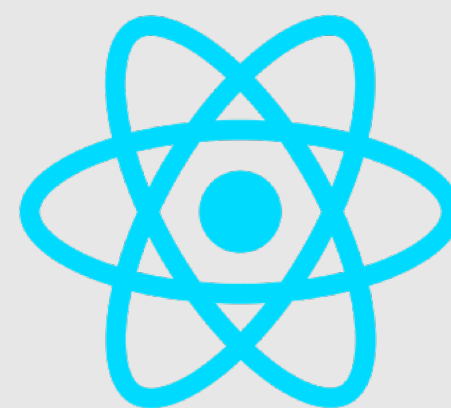


Components
written with JSX

Search apartments

2

3 UPDATE STATE



REACT *REACTS* TO STATE CHANGES
BY RE-RENDERING THE UI

REACT IS A JAVASCRIPT LIBRARY

Based on components

Declarative

State-driven

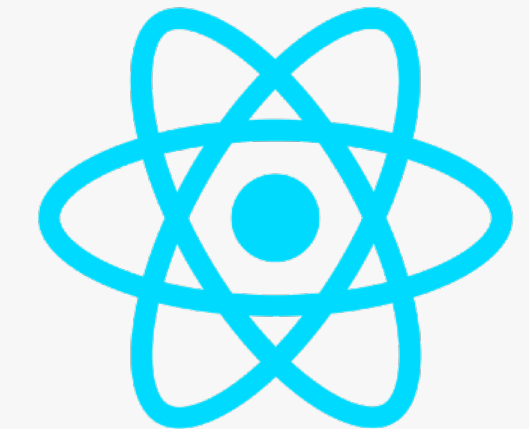
JavaScript library

Extremely popular

Created by facebook



Is React a **library** or a framework?



Because React is only the “view” layer. We need to pick multiple external libraries to build a complete application

NEXT.js

Remix

Complete frameworks built on top of React

REACT IS EXTREMELY POPULAR

Based on components

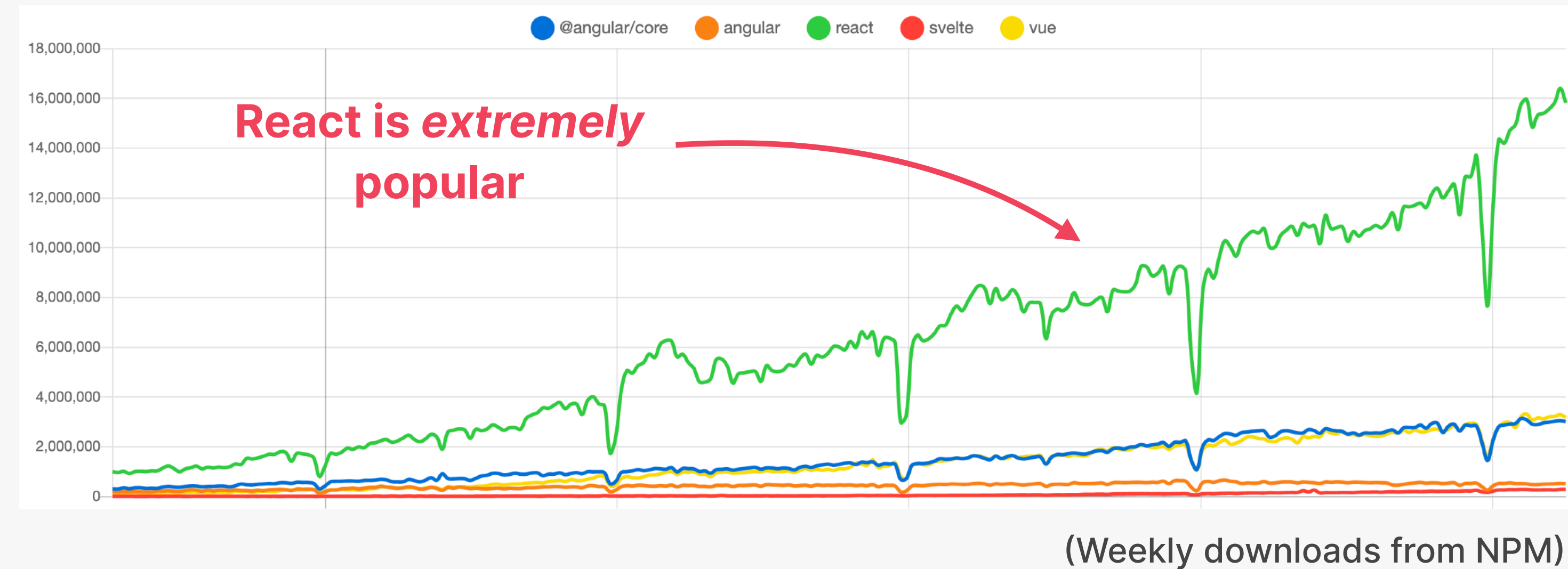
Declarative

State-driven

JavaScript library

Extremely popular

Created by facebook



✓ Many large companies have adopted React



✓ Huge job market with high demand for React developers 💰

✓ Large and vibrant React developer community

✓ Gigantic third-party library ecosystem

REACT WAS CREATED BY FACEBOOK

Based on components

Declarative

State-driven

JavaScript library

Extremely popular

Created by facebook



- 👉 React was created in **2011** by Jordan Walke, an engineer working at Facebook at the time
- 👉 React was open-sourced in **2013**, and has since then completely transformed front-end web development

facebook

Meta

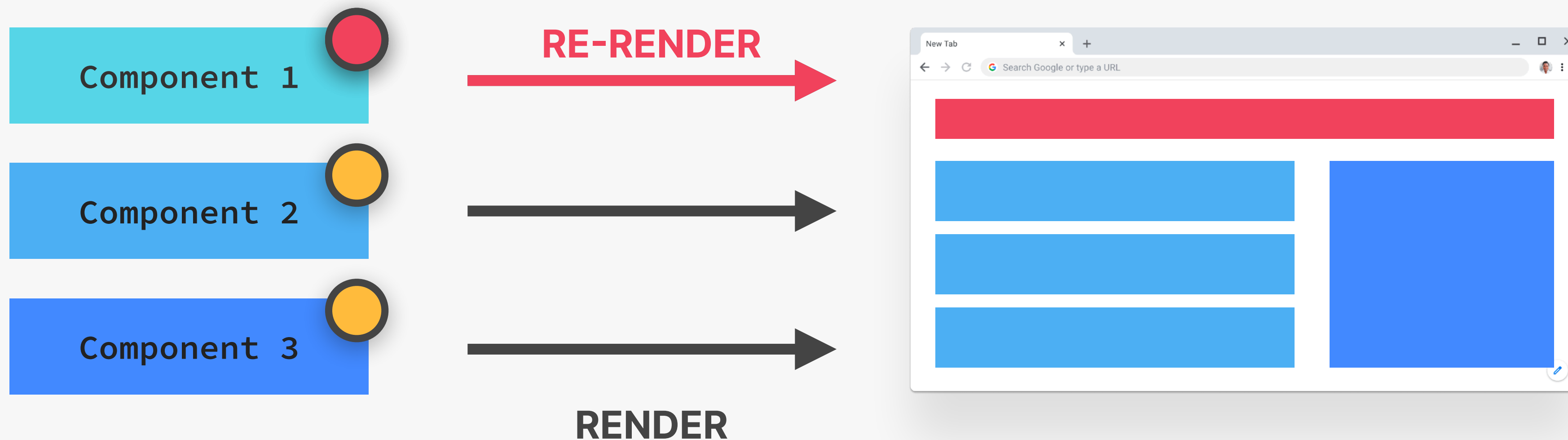
SUMMARY

1

Rendering components on a webpage (UI) based on their current state

2

Keeping the UI in sync with state, by re-rendering (*reacting*) when state changes





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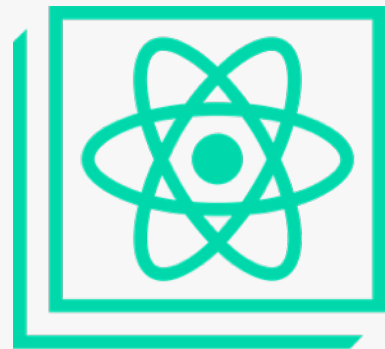
SECTION

A FIRST LOOK AT REACT




LECTURE

SETTING UP A NEW REACT
PROJECT: THE TWO OPTIONS

THE TWO OPTIONS FOR SETTING UP A RECT PROJECT



CREATE-REACT-APP

- 👉 Complete “**starter kit**” for React applications
- 👍 Everything is **already configured**: ESLint, Prettier, Jest, etc.  ESLint  Prettier  Jest
- 👎 Uses **slow and outdated** technologies (i.e. webpack)



Most of the course

- ✅ Use for **tutorials** or experiments
- ❌ Don't use for a **real-world app**



VITE

- 👉 **Modern build tool** that contains a **template** for setting up React applications
- 👎 Need to manually set up **ESLint** (and others)
- 👍 **Extremely fast** hot module replacement (HMR) and bundling



- ✅ Use for **modern real-world apps**

By the end of the course

WHAT ABOUT REACT FRAMEWORKS?

NEXT.js Remix

- 👉 The React team now advises to use a “**React Framework**” for new projects
- 👉 Many people think that this is not the best idea: “**vanilla**” React apps are important too!
- 👉 This only makes sense for building actual products, **not for learning React**
- 👉 Of course, you still need to **learn React itself**

✌️ Don't worry about this recommendation for now. Let's just **learn React!**

LEARN REACT > INSTALLATION >

👉 react.dev

Start a New React Project

If you want to build a new app or a new website fully with React, we recommend picking one of the React-powered frameworks popular in the community. Frameworks provide features that most apps and sites eventually need, including routing, data fetching, and generating HTML.

Production-grade React frameworks

Next.js

Next.js is a full-stack React framework. It's versatile and lets you create React apps of any size—from a mostly static blog to a complex dynamic application. To create a new Next.js project, run in your terminal:

Terminal

Copy

```
npx create-next-app
```

If you're new to Next.js, check out the [Next.js tutorial](#).

Next.js is maintained by [Vercel](#). You can [deploy a Next.js app](#) to any Node.js or serverless hosting, or to your own server. [Fully static Next.js apps](#) can be deployed to any static hosting.

Remix

Remix is a full-stack React framework with nested routing. It lets you break your app into nested parts that can load data in parallel and refresh in response to the user actions. To create a new Remix project, run:

WORKING WITH COMPONENTS, PROPS, AND JSX



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SECTION

WORKING WITH COMPONENTS,
PROPS, AND JSX

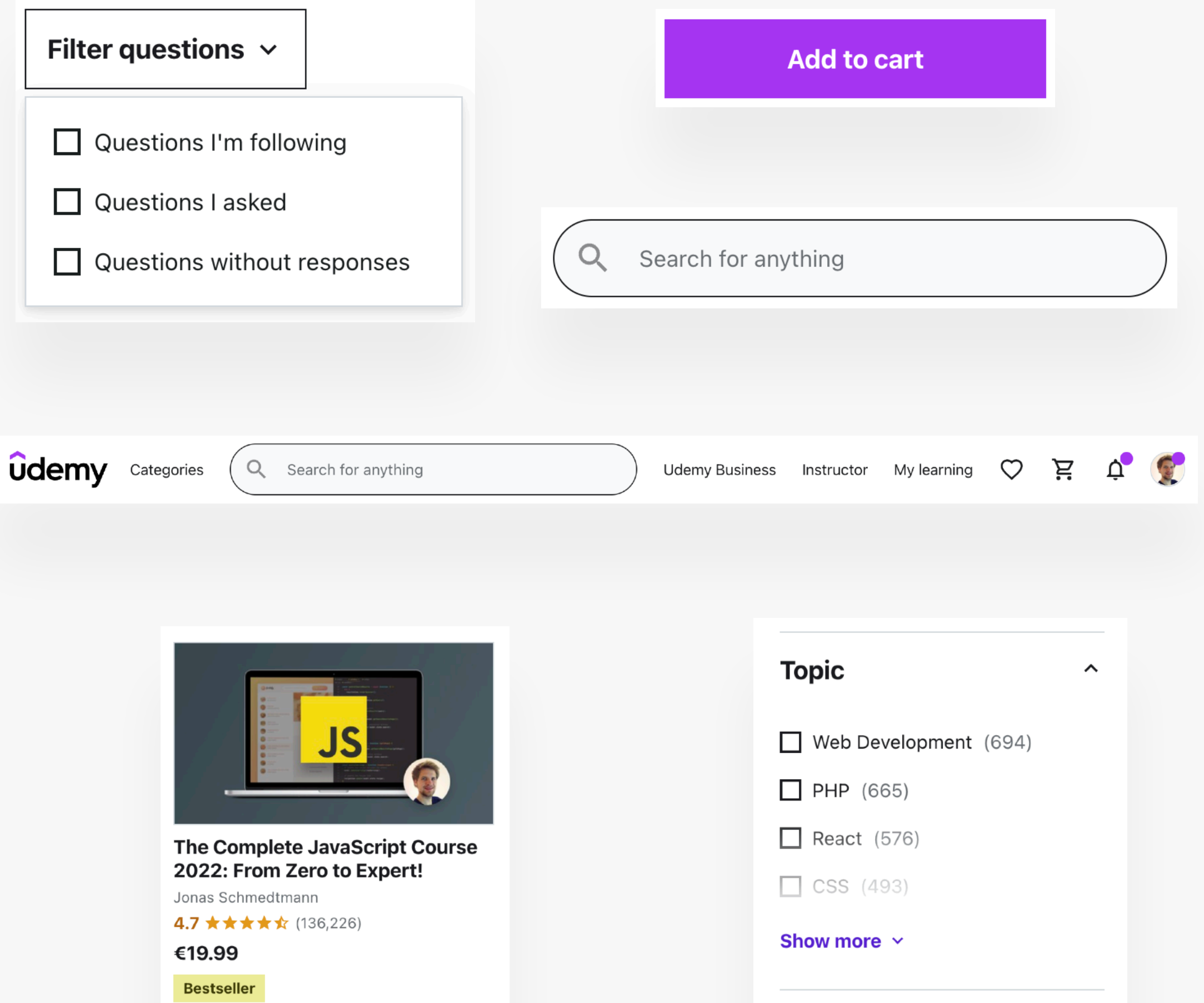
LECTURE

COMPONENTS AS BUILDING
BLOCKS

COMPONENTS AS BUILDING BLOCKS

COMPONENTS

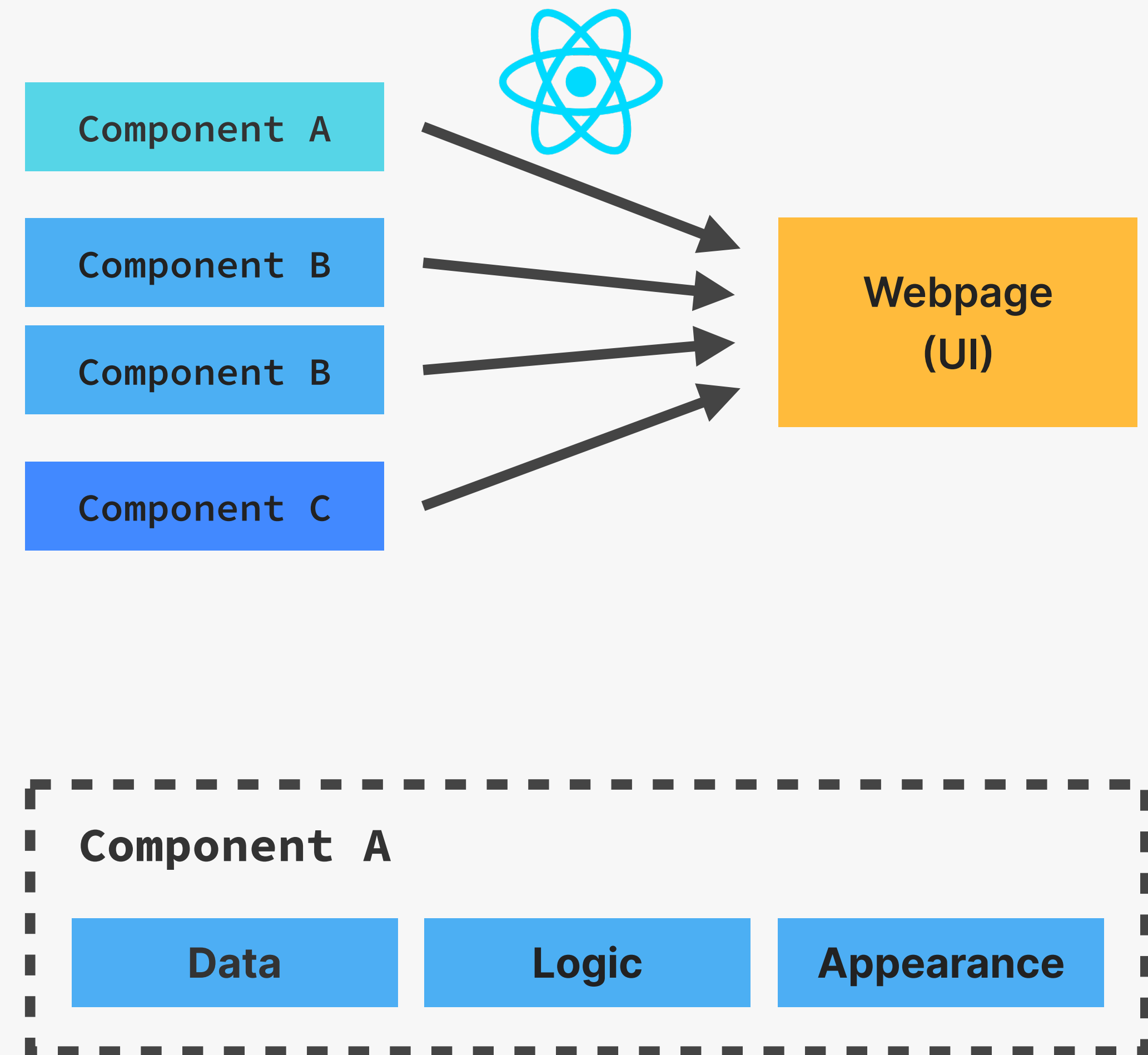
- 👉 React applications are entirely made out of components
- 👉 **Building blocks** of user interfaces in React



COMPONENTS AS BUILDING BLOCKS

COMPONENTS

- 👉 React applications are entirely made out of components
- 👉 **Building blocks** of user interfaces in React
- 👉 Piece of UI that has its own **data**, **logic**, and **appearance** (*how it works and looks*)
- 👉 We build complex UIs by **building multiple components** and **combining** them



COMPONENTS AS BUILDING BLOCKS

COMPONENTS

- 👉 React applications are entirely made out of components
- 👉 **Building blocks** of user interfaces in React
- 👉 Piece of UI that has its own **data**, **logic**, and **appearance** (*how it works and looks*)
- 👉 We build complex UIs by **building multiple components** and **combining** them
- 👉 Components can be **reused**, **nested** inside each other, and **pass data** between them

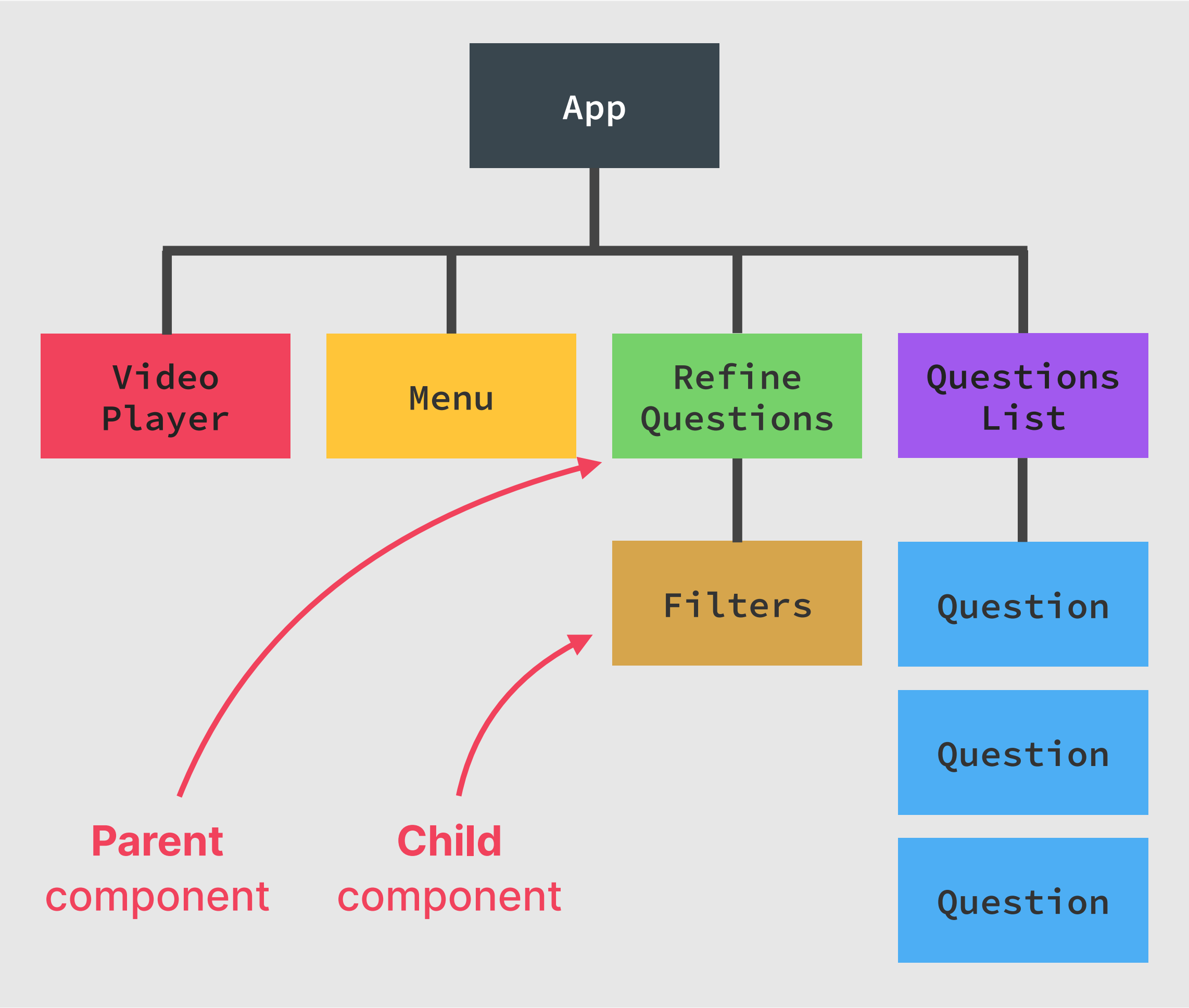
The screenshot shows a web application interface with several components highlighted by colored boxes:

- VideoPlayer**: A black video player with a white play button, highlighted by a red box.
- Navigation Bar**: A yellow bar containing a search icon, links for "Course content", "Overview", "Q&A", "Notes", and "Announcements", and a "Menu" button.
- RefineQuestions**: A green box containing a search input field with the placeholder "Search all course questions" and a search icon.
- Filters**: An orange box containing three dropdown menus: "All lectures", "Sort by most recent", and "Filter questions".
- QuestionList**: A purple box containing a list of three questions, each with a profile picture, title, content, and a "Question" label.

The questions listed are:

- Question 2 on Challenge 2** by Darryl (Lecture 115, 13 hours ago). Content: "My solution was similar to Jonas' however the answer was incorrect. Is it po...".
- Elegant alternative for loading markers from localStorage** by Vincent Giovanni (Lecture 242, 14 hours ago). Content: "A Jonas explained, we are trying to add a marker to the map right at the beg...".
- How to not violate the "Do not repeat yourself" principle** by Marinela (Lecture 45, 15 hours ago). Content: "Hello!Could you please post a solution to this part, but in a way that we do n...".

COMPONENT TREES



VideoPlayer

Course content Overview **Q&A** Notes Announcements **Menu**

RefineQuestions

Search all course questions

All lectures ▾ Sort by most recent ▾ Filter questions ▾ **Filters**

All questions in this course (41683)

DL

Question 2 on Challenge 2

My solution was similar to Jonas' however the answer was incorrect. Is it po...

0

0

Darryl · Lecture 115 · 13 hours ago

Question

VF

Elegant alternative for loading markers from localStorage

A Jonas explained, we are trying to add a marker to the map right at the beg...

0

0

Vincent Giovanni · Lecture 242 · 14 hours ago

Question

How to not violate the "Do not repeat yourself" principle

Hello!Could you please post a solution to this part, but in a way that we do n...

0

1

Marinela · Lecture 45 · 15 hours ago

Question

QuestionList



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SECTION

WORKING WITH COMPONENTS,
PROPS, AND JSX

LECTURE

WHAT IS JSX?

WHAT IS JSX?

JSX

- 👉 **Declarative** syntax to **describe** what components **look like** and **how they work**
- 👉 Components must **return** a block of JSX
- 👉 Extension of JavaScript that allows us to **embed** **JavaScript** **CSS** and React **components** into **HTML**

```
function Question(props) {  
  const question = props.question;  
  const [upvotes, setUpvotes] = useState(0);  
  
  const upvote = () => setUpvotes((v) => v + 1);  
  const openQuestion = () => {}; // Todo  
  
  return 

<h4 style={{ fontSize: "2.4rem" }}>  
      {question.title}</h4>  
    <p>{question.text}</p>  
    <p>{question.hours} hours ago</p>  
    <UpvoteBtn onClick={upvote} />  
    <Answers  
      numAnswers={question.num}  
      onClick={openQuestion}</Answers>  
    </div>  
  );  
}


```

JSX returned from component

WHAT IS JSX?

JSX

- 👉 **Declarative** syntax to **describe** what components **look like** and **how they work**
- 👉 Components must **return** a block of JSX
- 👉 Extension of JavaScript that allows us to **embed JavaScript, CSS, and React components into HTML**
- 👉 Each JSX element is **converted** to a `React.createElement` function call
- 👉 We could use React **without JSX**

```
<header>  
  <h1 style="color: red">  
    Hello React!  
  </h1>  
</header>
```

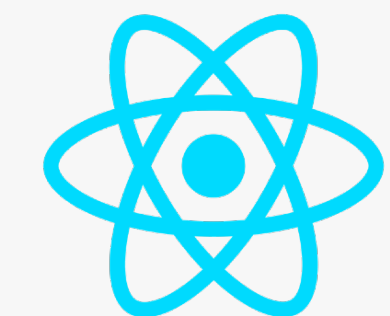


BABEL

```
React.createElement(  
  'header',  
  null,  
  React.createElement(  
    'h1',  
    { style: { color: 'red' } },  
    'Hello React!'  
  )  
)
```



Hello React!



JSX IS DECLARATIVE

IMPERATIVE

“How to do things”

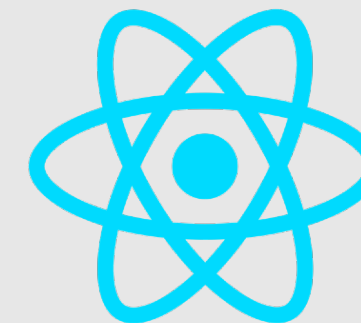


- 👉 Manual DOM element selections and DOM traversing
- 👉 Step-by-step DOM mutations until we reach the desired UI

```
const title = document.querySelector("title")
const upvoteBtn = document.querySelector("btn")
title.textContent = `[0] ${question.title}`;
let upvotes = 0;
upvoteBtn.addEventListener("click", function(){
  upvotes++;
  title.textContent =
    `[${upvotes}] ${question.title}`;
  title.classList.add("upvoted");
});
```

DECLARATIVE

“What we want”



- 👉 Describe what UI should look like using JSX, based on current data
- 👉 React is an **abstraction** away from DOM: **we never touch the DOM**
- 👉 Instead, we think of the UI as a **reflection of the current data**

```
function Question(props) {
  const question = props.question;
  const [upvotes, setUpvotes] = useState(0);
  const upvote = () => setUpvotes((v) => v + 1);

  return (
    <div>
      <h4>question.title</h4>
      <p>question.text</p>
      <UpvoteBtn
        onClick=upvote
        upvotes=upvotes
      />
    </div>
  );
}
```




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WORKING WITH COMPONENTS,
PROPS, AND JSX

LECTURE

SEPARATION OF CONCERNS

SEPARATION OF CONCERNS?

ONE TECHNOLOGY PER FILE

“Traditional” separation
of concerns

JS

```
let upvotes = 0;
title textContent = question.title;
const upvote = () => upvotes++;
upvoteBtn addEventListener("click", upvote);

if (question.num > 0) {
  answer classList toggle("hidden");
  firstAnswer classList toggle("hidden");
}
```



```
<div>
  <h4 class="title"></h4>
  <button class="btn">Upvote</button>

  <div class="answer"></div>
  <div class="first hidden"></div>
</div>
```

Rise of
interactive
SPAs

JavaScript is in
charge of HTML

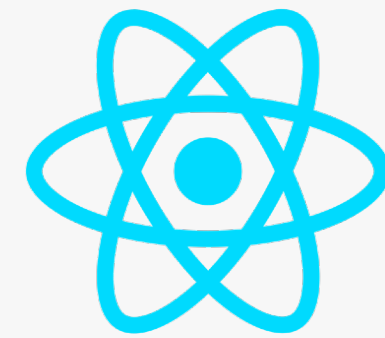
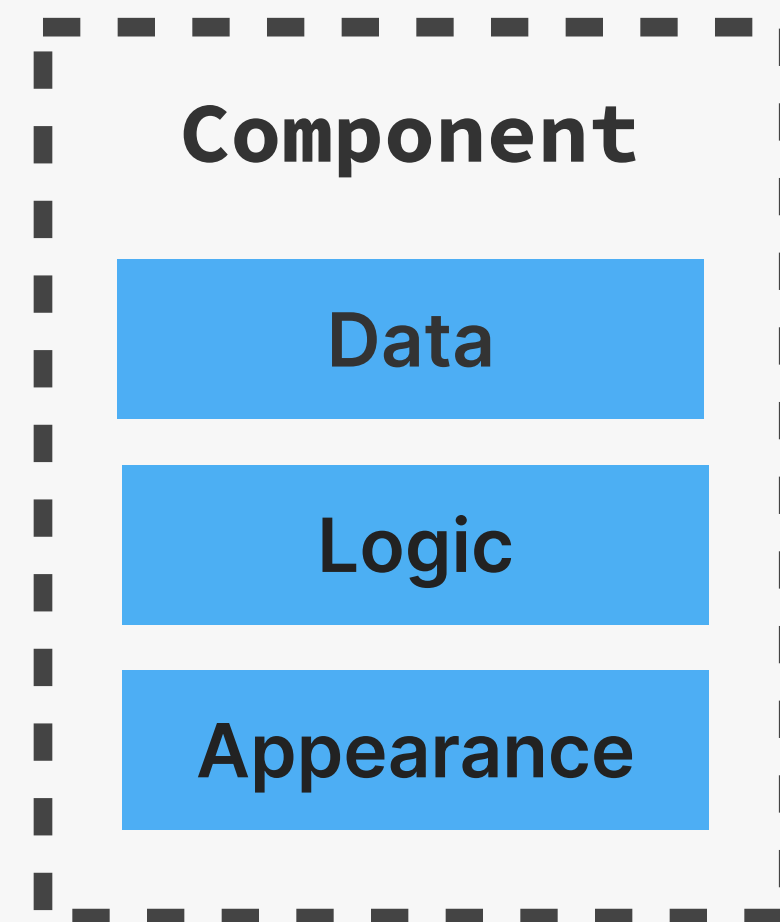
Logic and UI are
tightly coupled

Why keep them
separated?

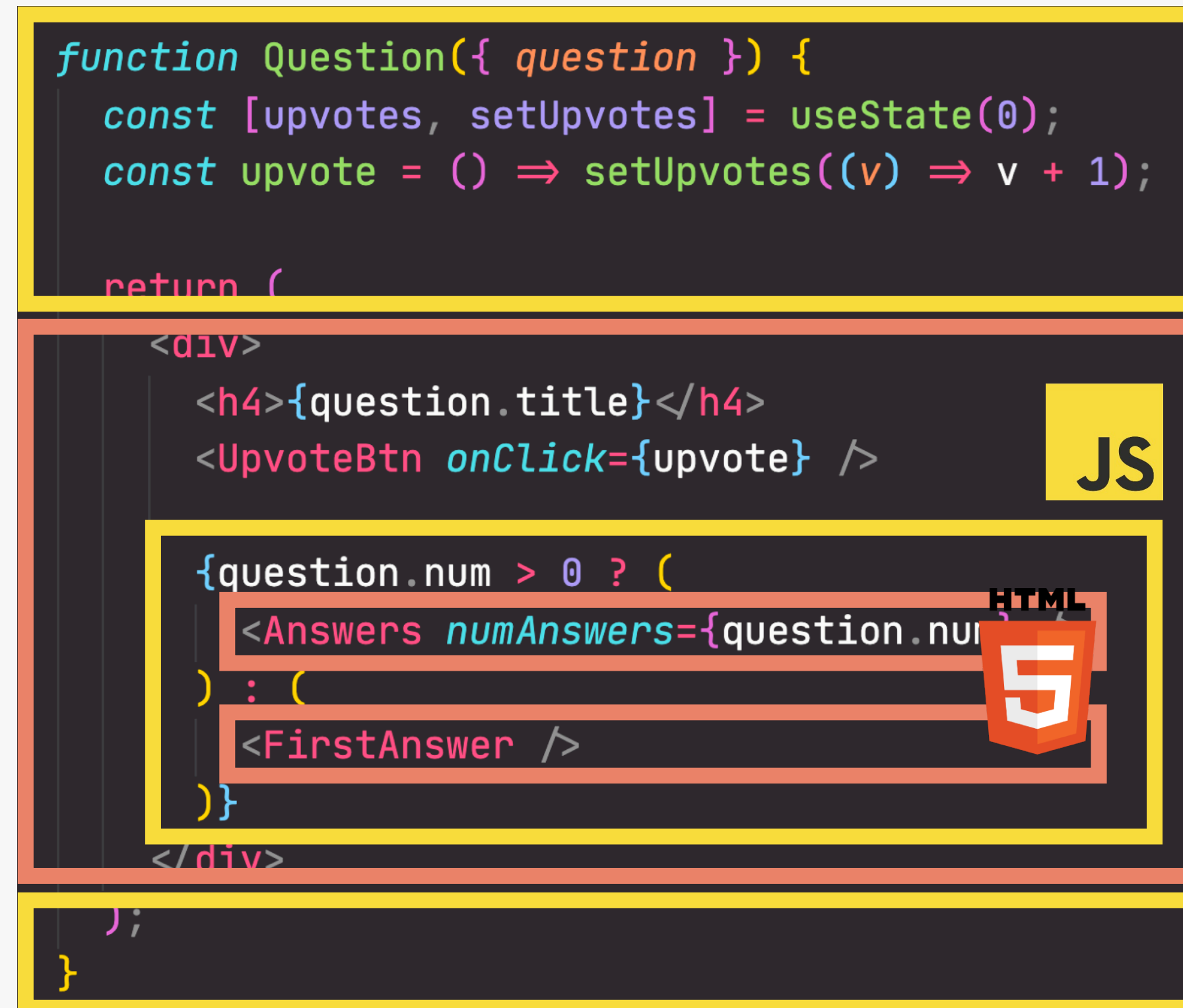
React
Components +
JSX

SEPARATION OF CONCERNS?

ONE COMPONENT PER FILE



HTML and JS
are *colocated*



JS

JS



JS

Fundamental reason for **components**

Rise of
interactive
SPAs

JavaScript is in
charge of HTML

Logic and UI are
tightly coupled

Why keep them
separated?

React
Components +
JSX

SEPARATION OF CONCERNS!

ONE TECHNOLOGY PER FILE

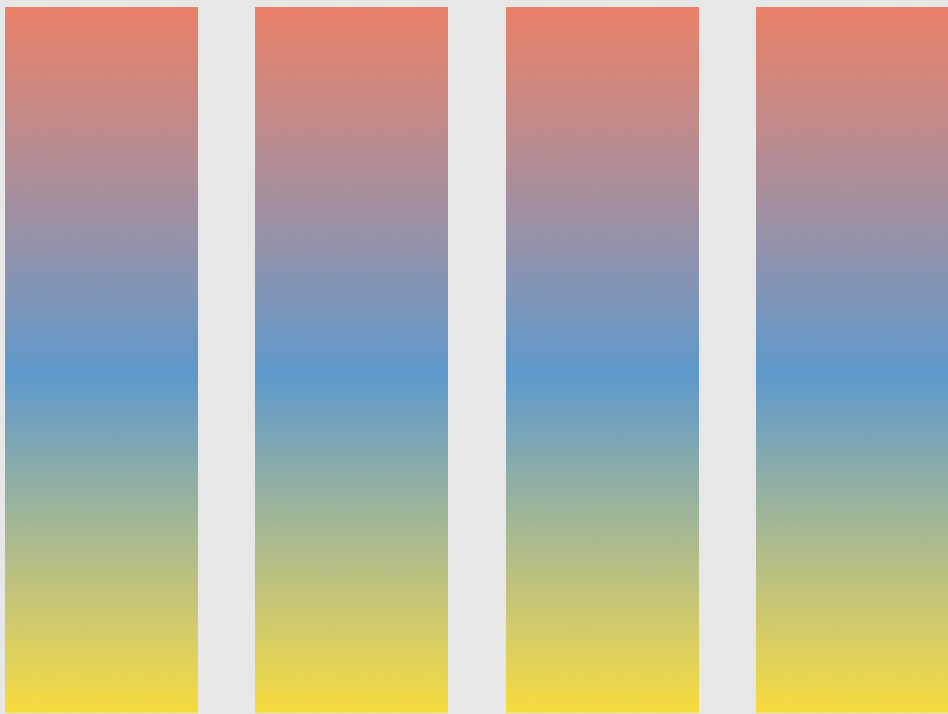
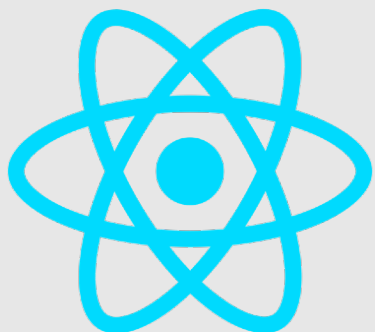


“Traditional”
separation of
concerns



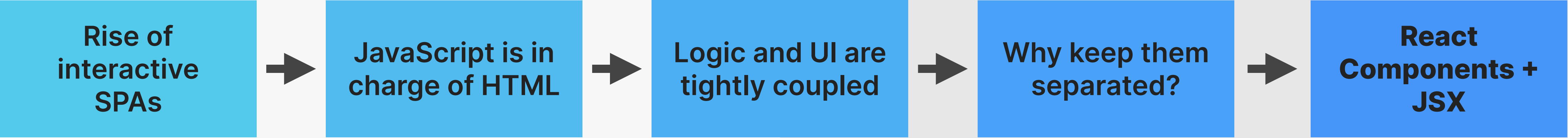
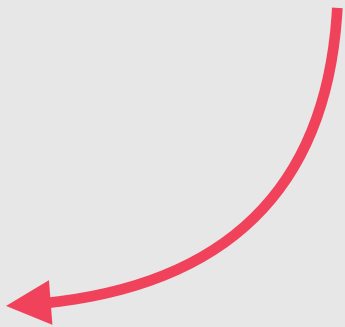
COMPLETELY
NEW PARADIGM

ONE COMPONENT PER FILE



Question
Menu
Filters
Player

Each component
is concerned
with one piece
of the UI





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WORKING WITH COMPONENTS,
PROPS, AND JSX

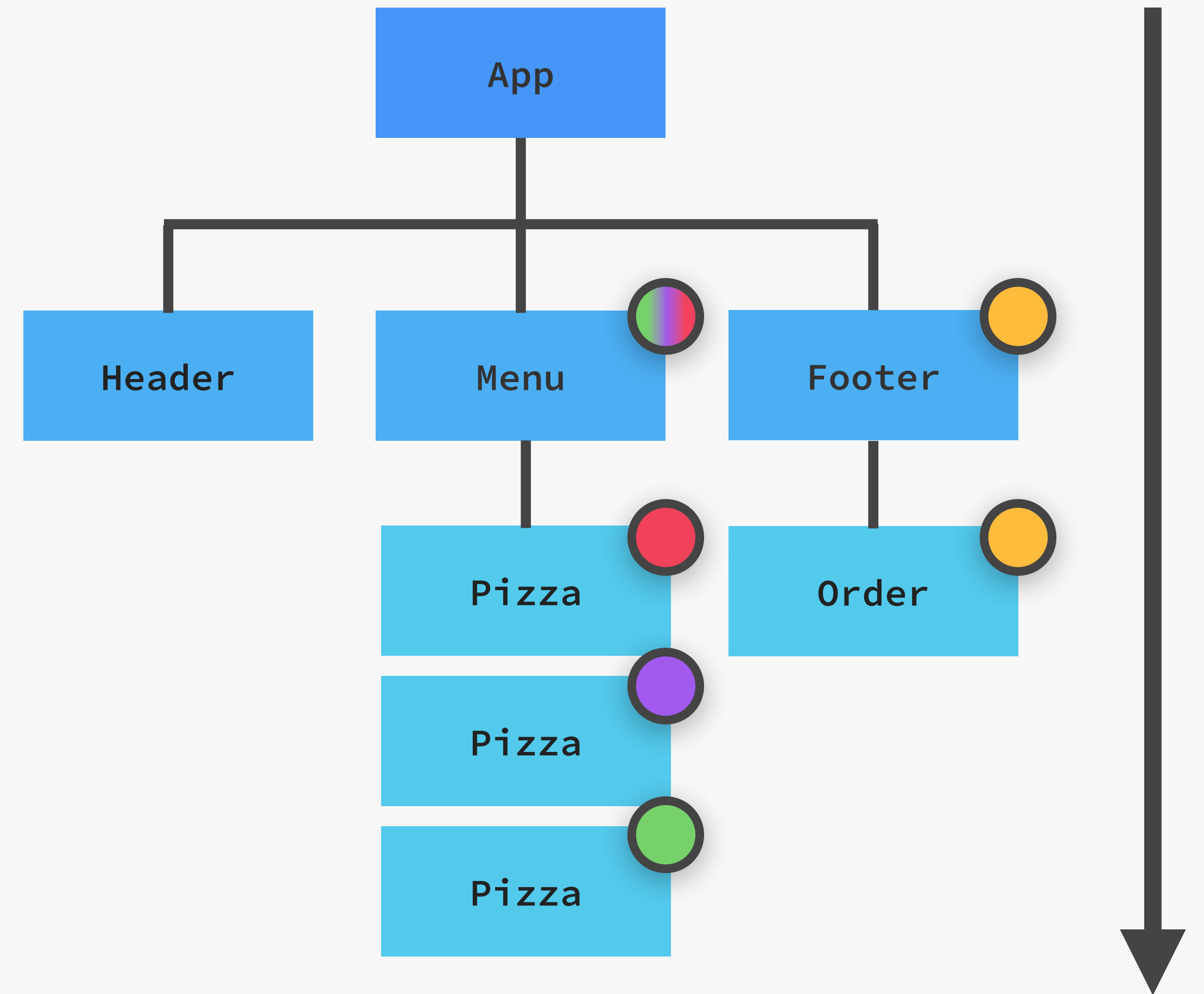
LECTURE

PROPS, IMMUTABILITY, AND ONE-
WAY DATA FLOW

REVIEWING PROPS

PROPS

- 👉 Props are used to pass data from **parent components to child components** (down the component tree)



REVIEWING PROPS

PROPS

- 👉 Props are used to pass data from **parent components to child components** (down the component tree)
- 👉 Essential tool to **configure** and **customize** components (like function parameters)
- 👉 With props, parent components **control** how child components look and work

```
<Menu>  
  <Button bgColor="blue" text="New" />  
  <Button bgColor="green" text="Edit" />  
  <Button bgColor="red" text="Delete" />  
</Menu>
```



REVIEWING PROPS

PROPS

- 👉 Props are used to pass data from **parent components to child components** (down the component tree)
- 👉 Essential tool to **configure** and **customize** components (like function parameters)
- 👉 With props, parent components **control** how child components look and work
- 👉 **Anything** can be passed as props: single values, arrays, objects, functions, even other components

```
function CourseRating() {
  const [rating, setRating] = useState(0);

  return (
    <Rating
      text="Course rating"
      currentRating={rating}
      numOptions={3}
      options={["Terrible", "Okay", "Amazing"]}
      allRatings={{ num: 2390, avg: 4.8 }}
      setRating={setRating}
      component={Star}
    />
  );
}

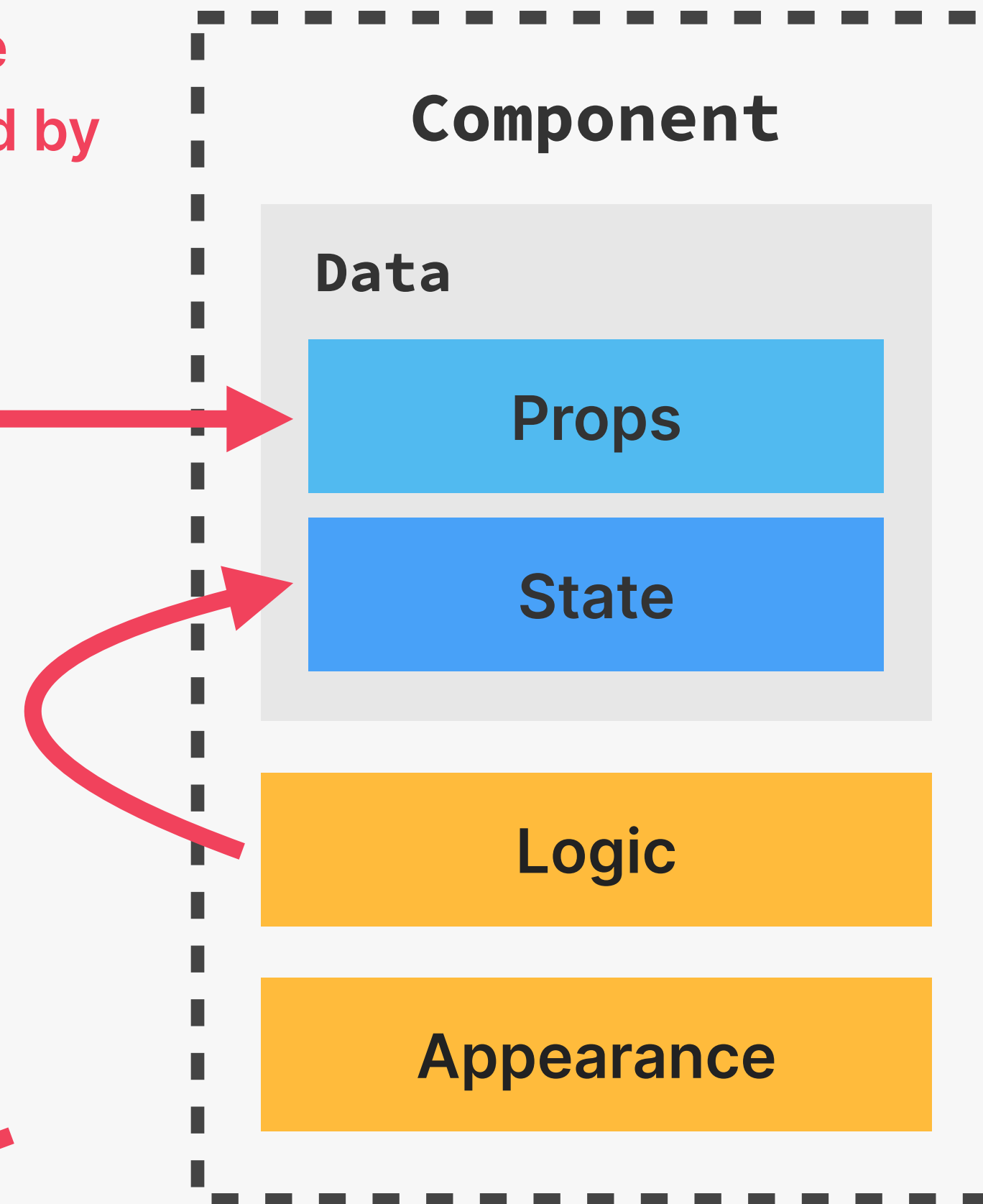
function Star() {
  // To do
}
```


PROPS ARE READ-ONLY!

Props is data coming from the **outside**, and can **only** be updated by the **parent component**



State is internal data that can be updated by the **component's logic**



```
let x = 7;  
  
function Component(){  
  x = 23;  
  return <h1>Number {x}</h1>  
}
```

Don't do this!

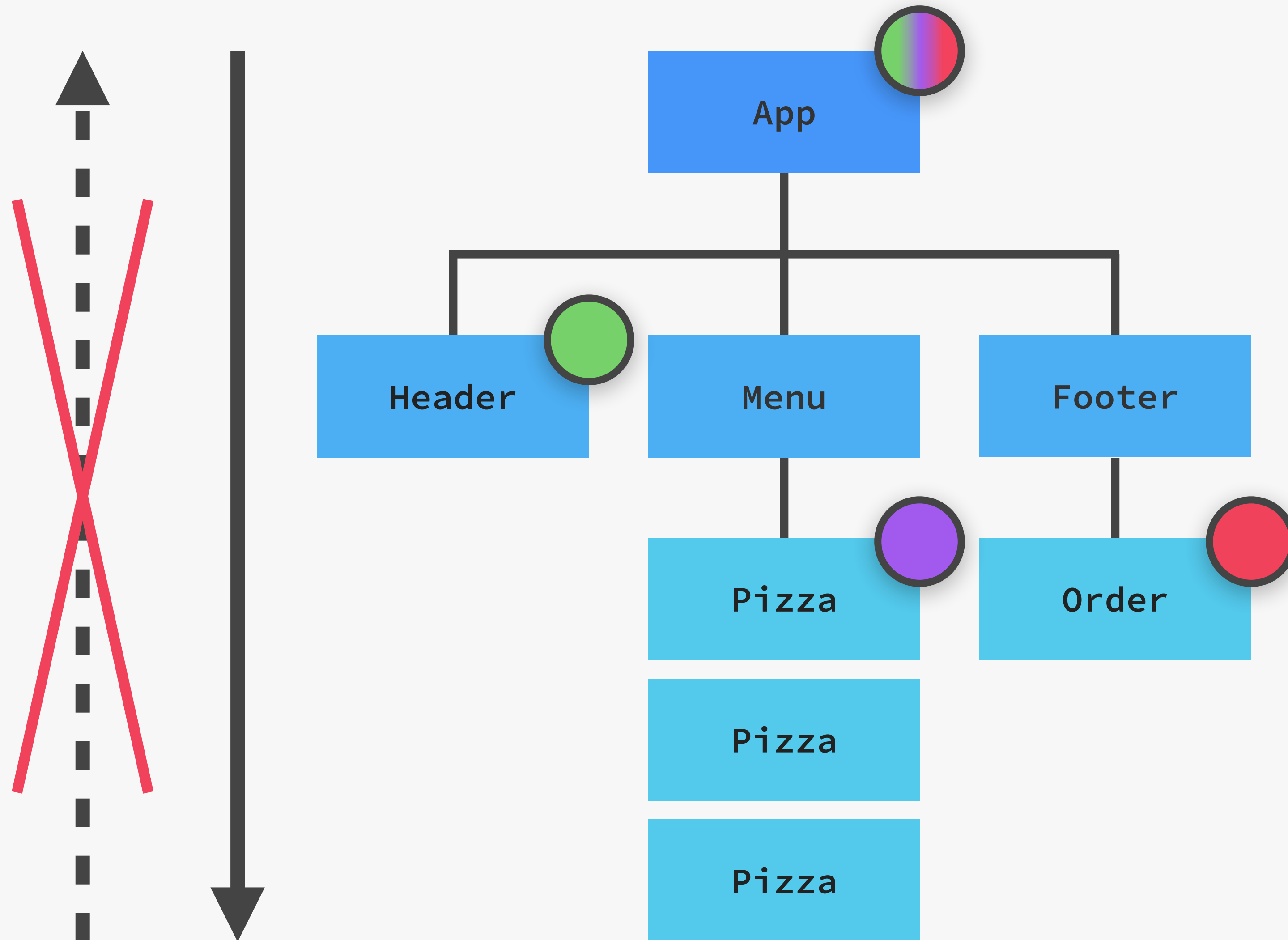
👉 Props are read-only, they are **immutable**! This is one of React's strict rules.

👉 If you need to mutate props, you actually **need state**

↓ WHY?

- 👉 Mutating props would affect parent, creating **side effects** (not pure)
- 👉 Components have to be **pure functions** in terms of props and state
- 👉 This allows React to optimize apps, avoid bugs, make apps predictable

ONE-WAY DATA FLOW



ONE-WAY DATA FLOW...

- 👍 ... makes applications more predictable and easier to understand
- 👍 ... makes applications easier to debug, as we have more control over the data
- 👍 ... is more performant



Angular has **two-way** data flow



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SECTION

WORKING WITH COMPONENTS,
PROPS, AND JSX

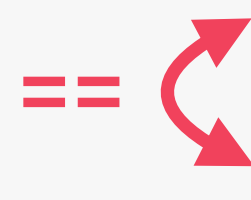
LECTURE

THE RULES OF JSX

RULES OF JSX

GENERAL JSX RULES

- 👉 JSX works essentially like HTML, but we can enter **"JavaScript mode"** by using `{}` (for text or attributes)
- 👉 We can place **JavaScript expressions** inside `{}`.
Examples: reference variables, create arrays or objects, `[] .map()`, ternary operator
- 👉 Statements are **not allowed** (`if/else`, `for`, `switch`)
- 👉 JSX produces a **JavaScript expression**

== 

```
const el = <h1>Hello React!</h1>;  
const el = React.createElement("h1", null, "Hello React!");
```

- 1 We can place **other pieces of JSX** inside `{}`
 - 2 We can write JSX **anywhere** inside a component (in `if/else`, assign to variables, pass it into functions)
- 👉 A piece of JSX can only have **one root element**. If you need more, use `<React.Fragment>` (or the short `<>`)

DIFFERENCES BETWEEN JSX AND HTML

- 👉 `className` instead of HTML's `class`
- 👉 `htmlFor` instead of HTML's `for`
- 👉 Every tag needs to be **closed**. Examples: `` or `
`
- 👉 All event handlers and other properties need to be **camelCased**. Examples: `onClick` or `onMouseOver`
- 👉 **Exception**: `aria-*` and `data-*` are written with dashes like in HTML
- 👉 CSS inline styles are written like this: `{{<style>}}` (to reference a variable, and then an object)
- 👉 CSS property names are also **camelCased**
- 👉 Comments need to be in `{}` (because they are JS)



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SECTION

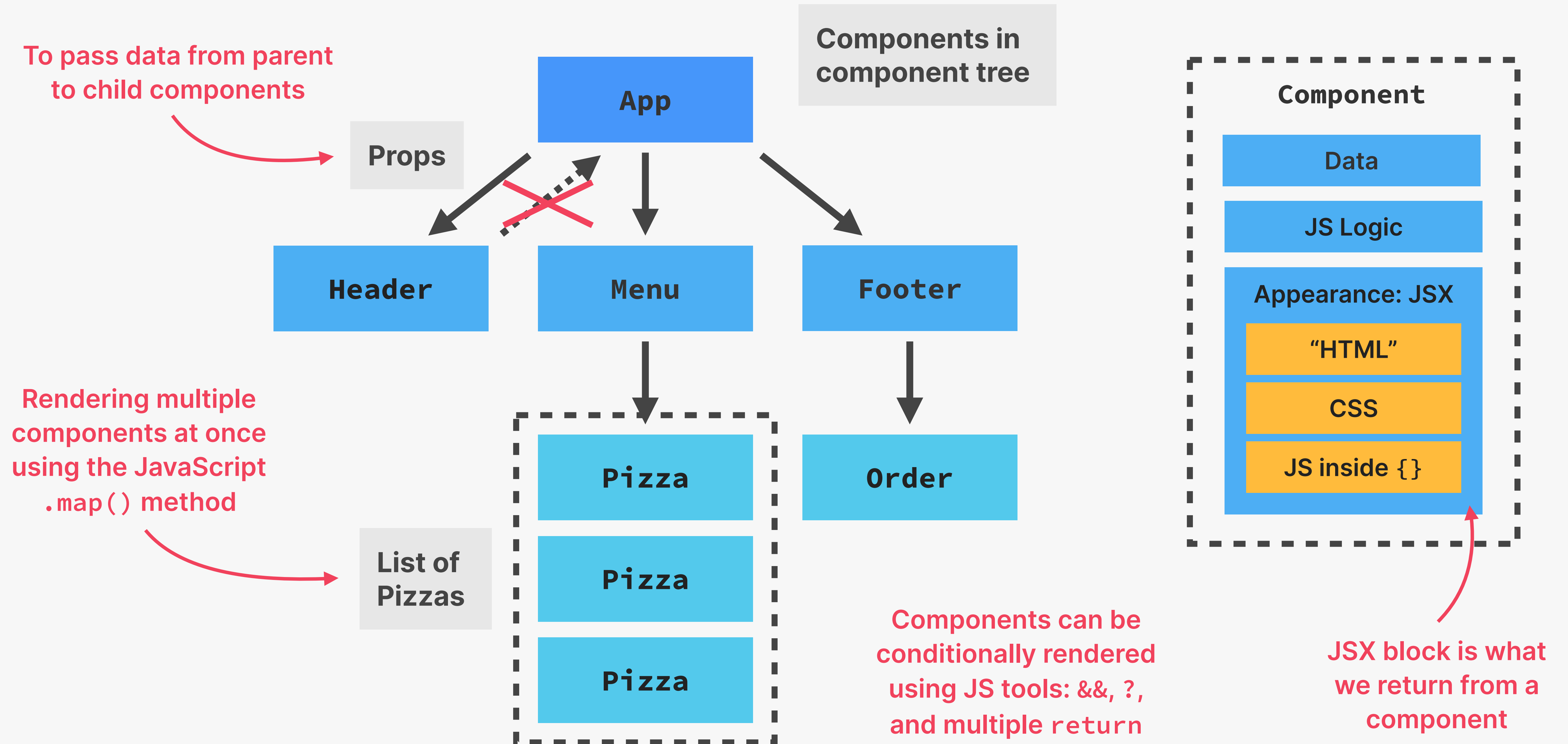
WORKING WITH COMPONENTS,
PROPS, AND JSX

LECTURE

SECTION SUMMARY



SECTION SUMMARY



STATE, EVENTS, AND FORMS: INTERACTIVE COMPONENTS



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SECTION

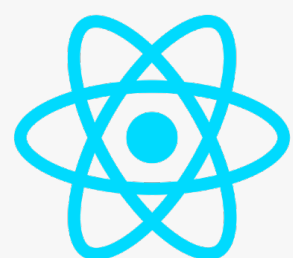
STATE, EVENTS, AND FORMS:
INTERACTIVE COMPONENTS

LECTURE

WHAT IS STATE IN REACT?



WHAT WE NEED TO LEARN



WHAT REACT DEVELOPERS NEED TO LEARN ABOUT STATE:

1 What is **state** and **why** do we need it?

This section

2 How to use state in **practice**?

- 👉 useState
- 👉 useReducer
- 👉 Context API

Rest of the
course...

3 **Thinking** about state

- 👉 When to use state
- 👉 Where to place state
- 👉 Types of state



State is the most important
concept in React

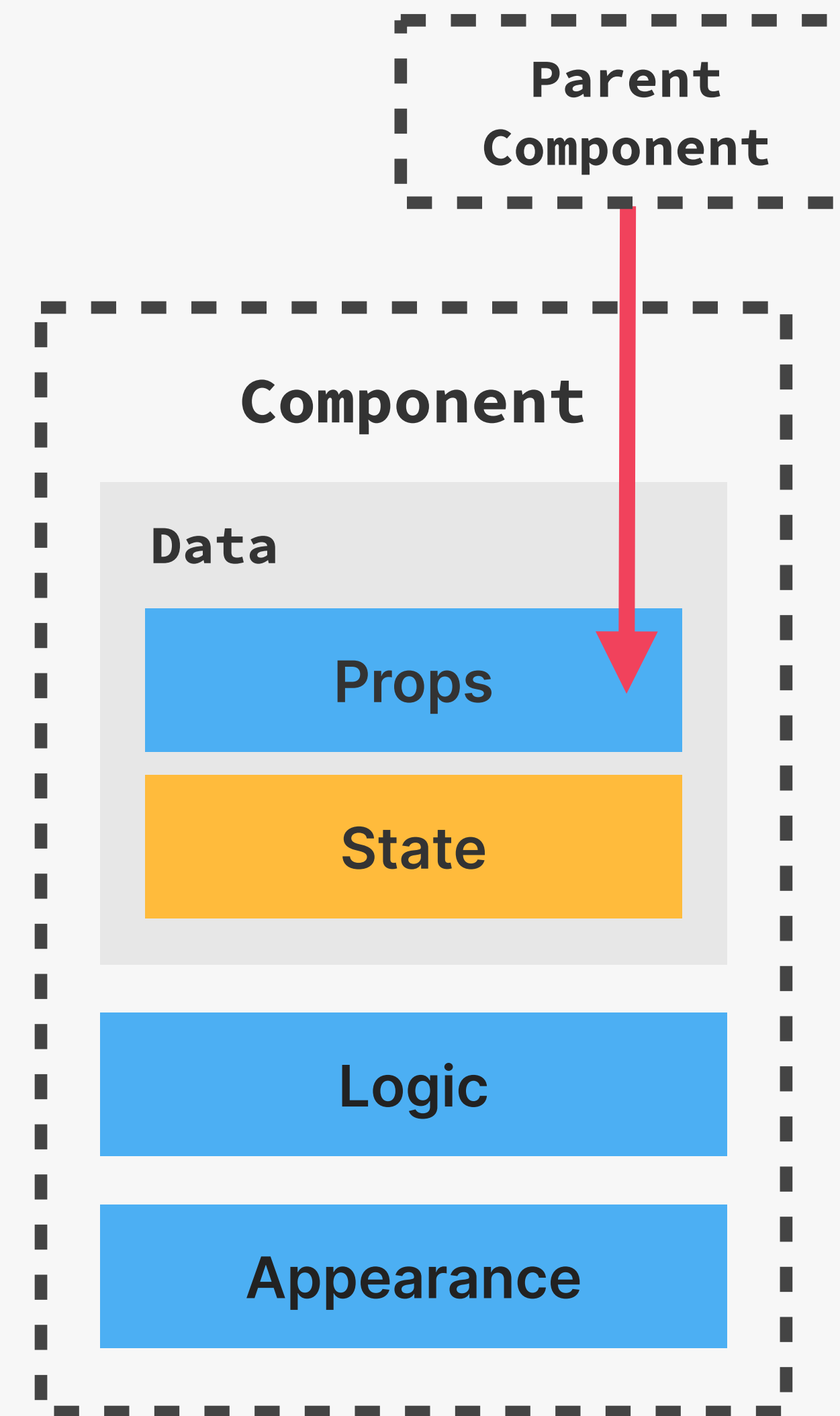
*(So we will keep learning about state
throughout the entire course...)*

WHAT IS STATE?

STATE

👉 Data that a component **can hold over time**, necessary for information that it needs to **remember** throughout the app's lifecycle

👉 “Component’s memory”



WHAT IS STATE?

STATE

👉 Data that a component **can hold over time**, necessary for information that it needs to **remember** throughout the app's lifecycle

👉 “Component's memory”



👉 “State variable” / “piece of state”: A single variable in a component (component state)

We use these terms interchangeably

Notifications

9+

Messages

9+

Q javascr

Overview

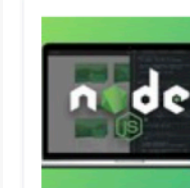
Q&A

Notes

Announcements

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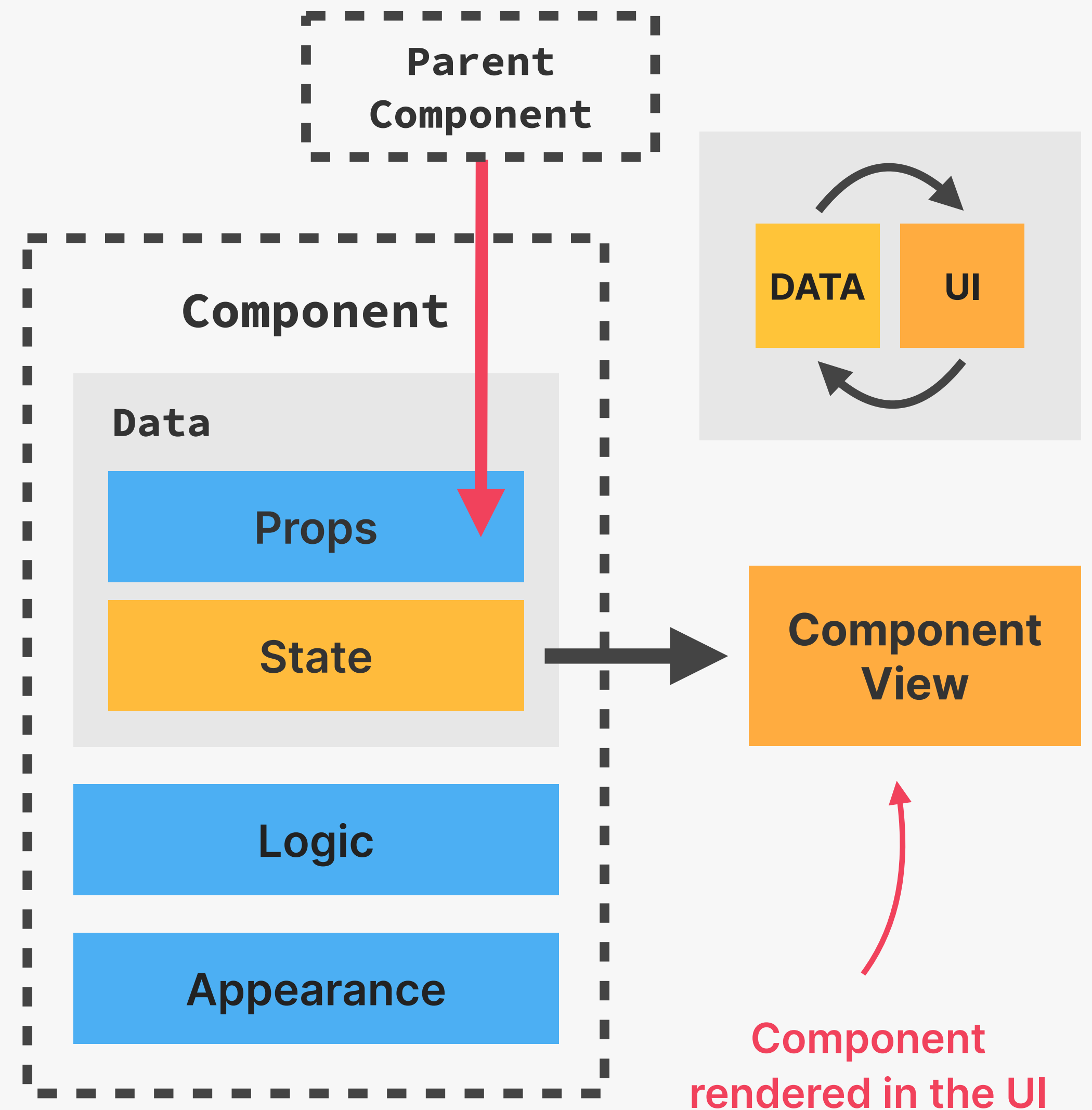
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WHAT IS STATE?

STATE

- 👉 Data that a component **can hold over time**, necessary for information that it needs to **remember** throughout the app's lifecycle
- 👉 “Component's memory” 
- 👉 **Component state**: Single local component variable (“Piece of state”, “state variable”)
- 👉 Updating **component state** triggers React to **re-render** the component



WHAT IS STATE?

STATE

👉 Data that a component **can hold over time**, necessary for information that it needs to **remember** throughout the app's lifecycle

👉 “Component’s memory”



👉 **Component state**: Single local component variable (“Piece of state”, “state variable”)

👉 Updating **component state** triggers React to **re-render the component**

STATE ALLOWS DEVELOPERS TO:

1

Update the component’s view (by re-rendering it)

2

Persist local variables between renders



*State is a **tool**. Mastering state will unlock the power of React development*



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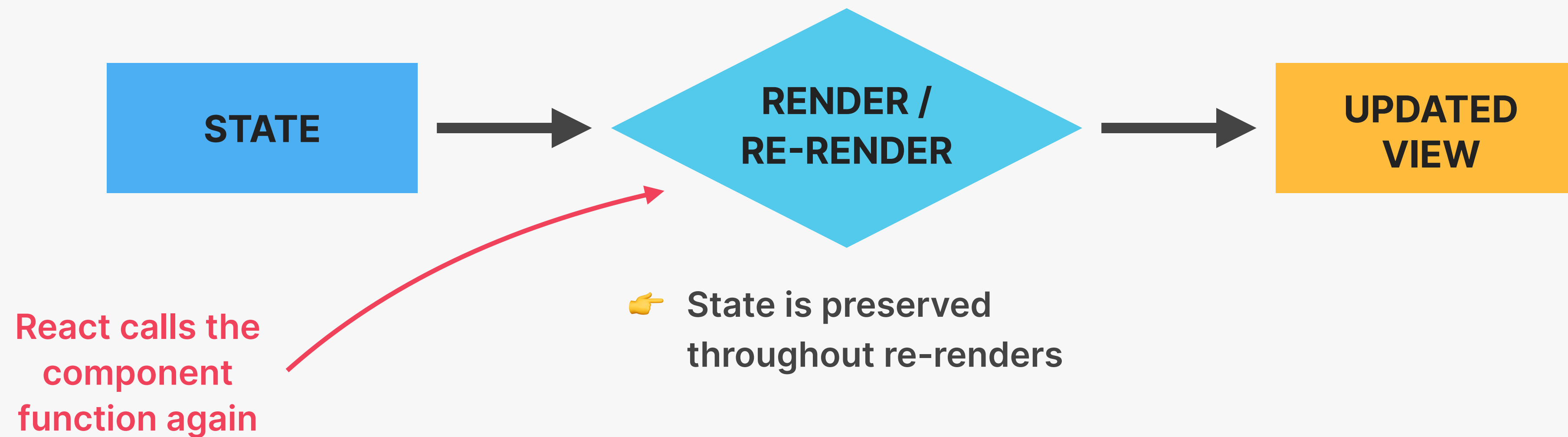
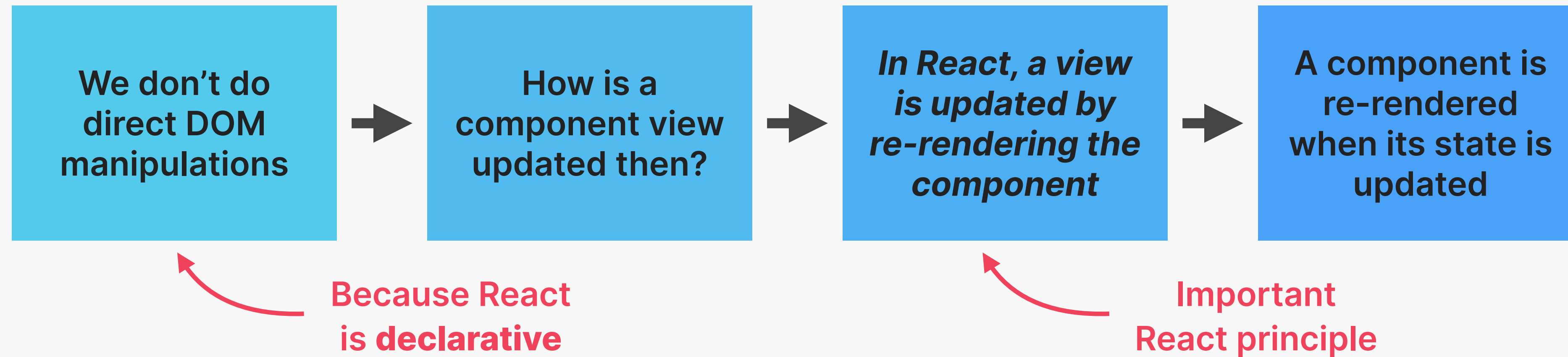
SECTION

STATE, EVENTS, AND FORMS:
INTERACTIVE COMPONENTS

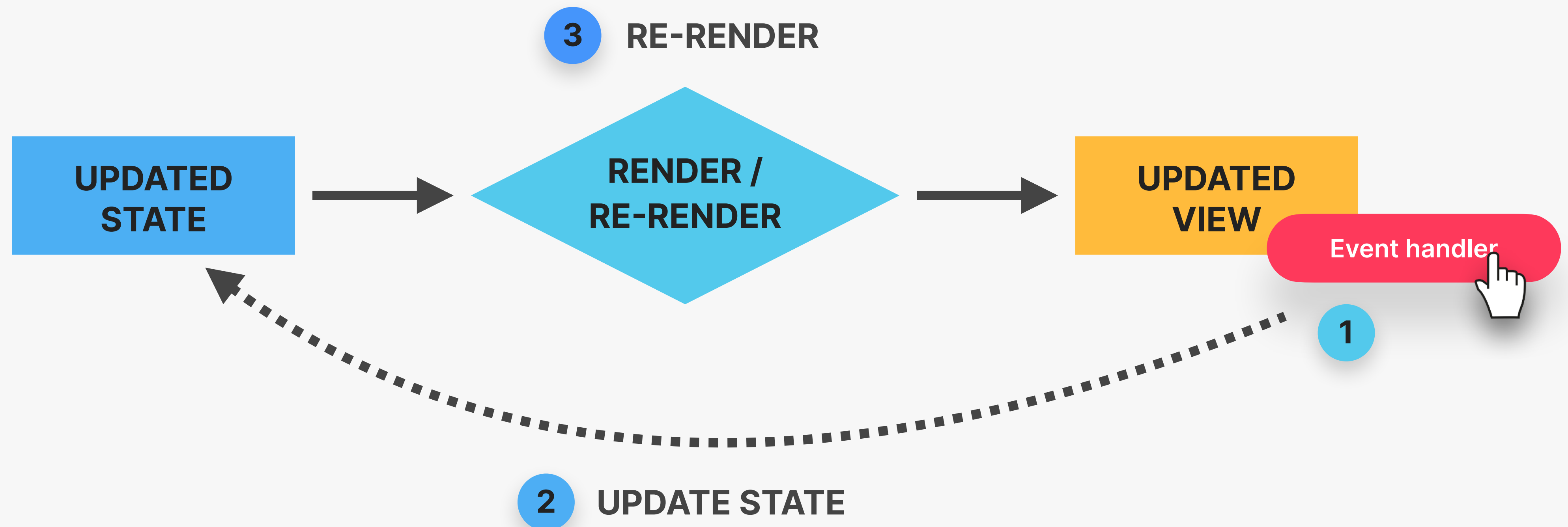
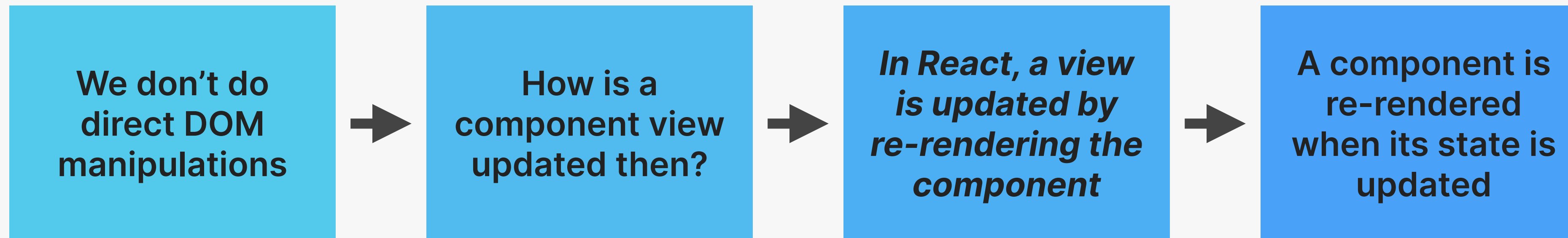
LECTURE

THE MECHANICS OF STATE

THE MECHANICS OF STATE IN REACT

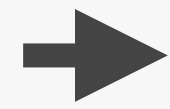


THE MECHANICS OF STATE IN REACT

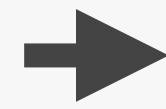


THE MECHANICS OF STATE IN REACT

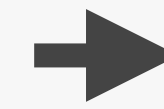
We don't do direct DOM manipulations



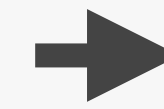
How is a component view updated then?



In React, a view is updated by re-rendering the component



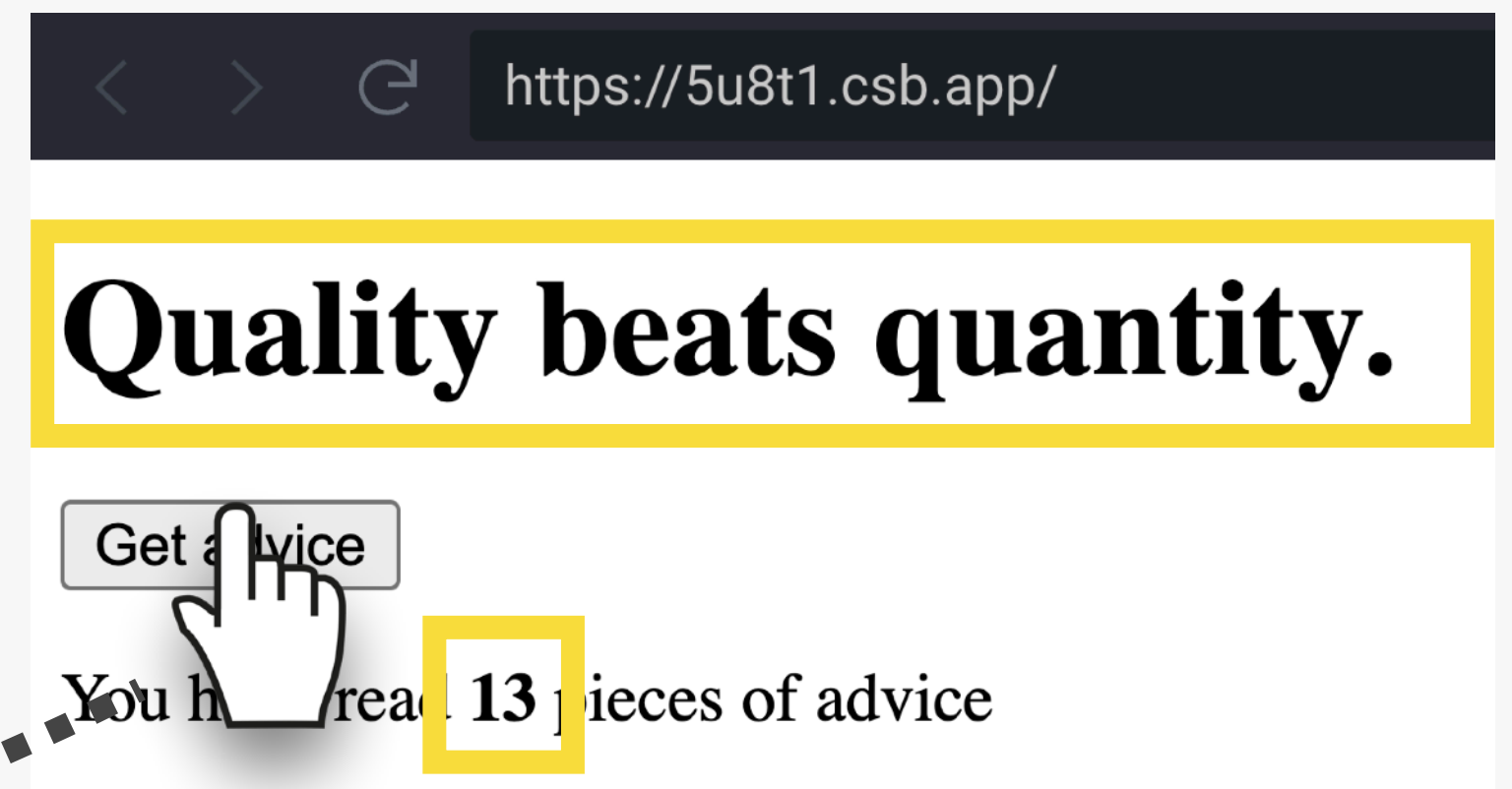
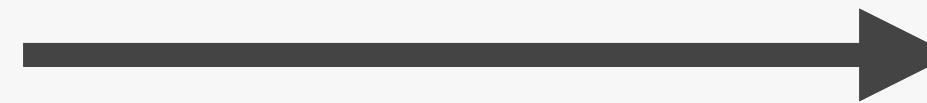
A component is re-rendered when its state is updated



So to update a view, we update state

```
const [advice, setAdvice] =  
  useState("Quality beats quantity.");  
const [countAdvice, setCountAdvice] =  
  useState(13);
```

RE-RENDER

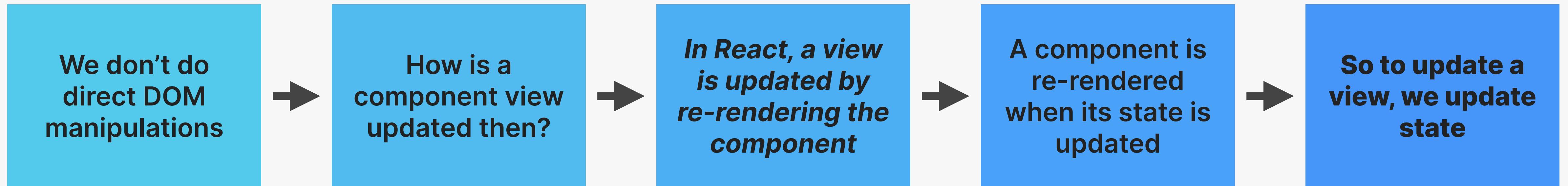


UPDATE STATE

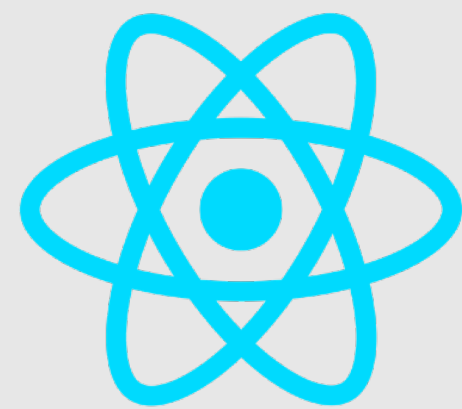


```
setAdvice(data.slip.advice);  
setCountAdvice((count) => count + 1);
```

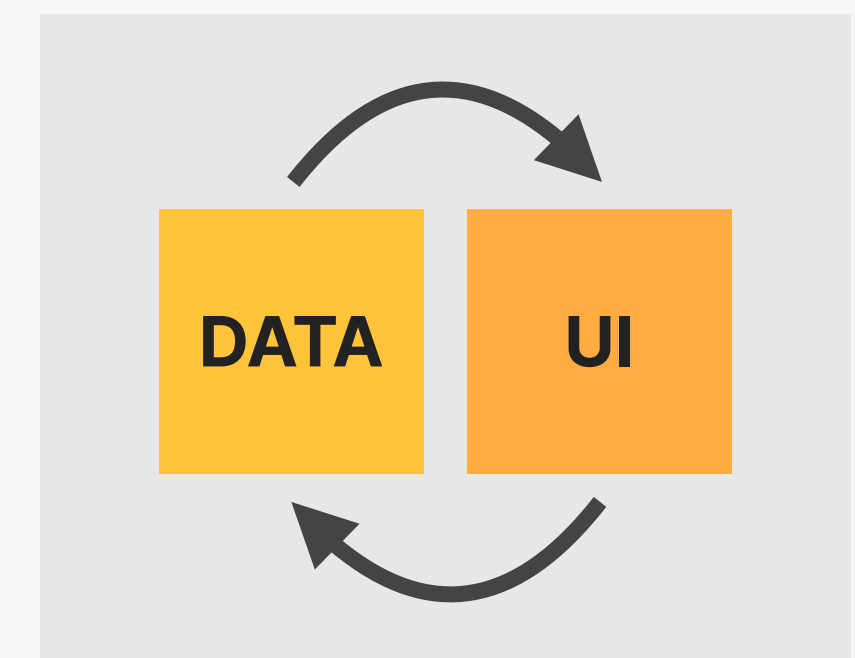
THE MECHANICS OF STATE IN REACT



👉 *React is called "React" because...*



REACT REACTS TO STATE CHANGES
BY RE-RENDERING THE UI





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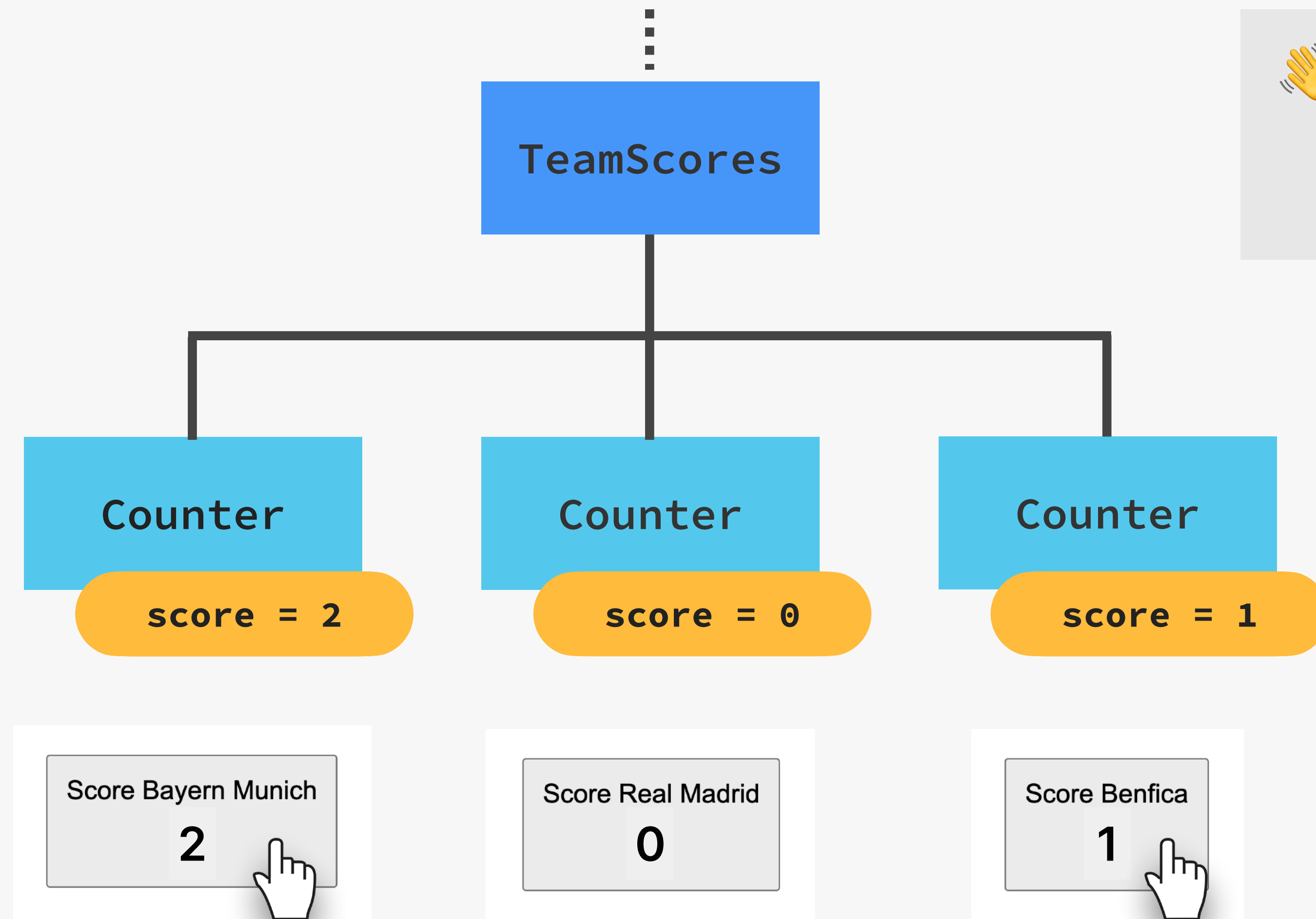
SECTION

STATE, EVENTS, AND FORMS:
INTERACTIVE COMPONENTS

LECTURE

MORE THOUGHTS ABOUT STATE
+ STATE GUIDELINES

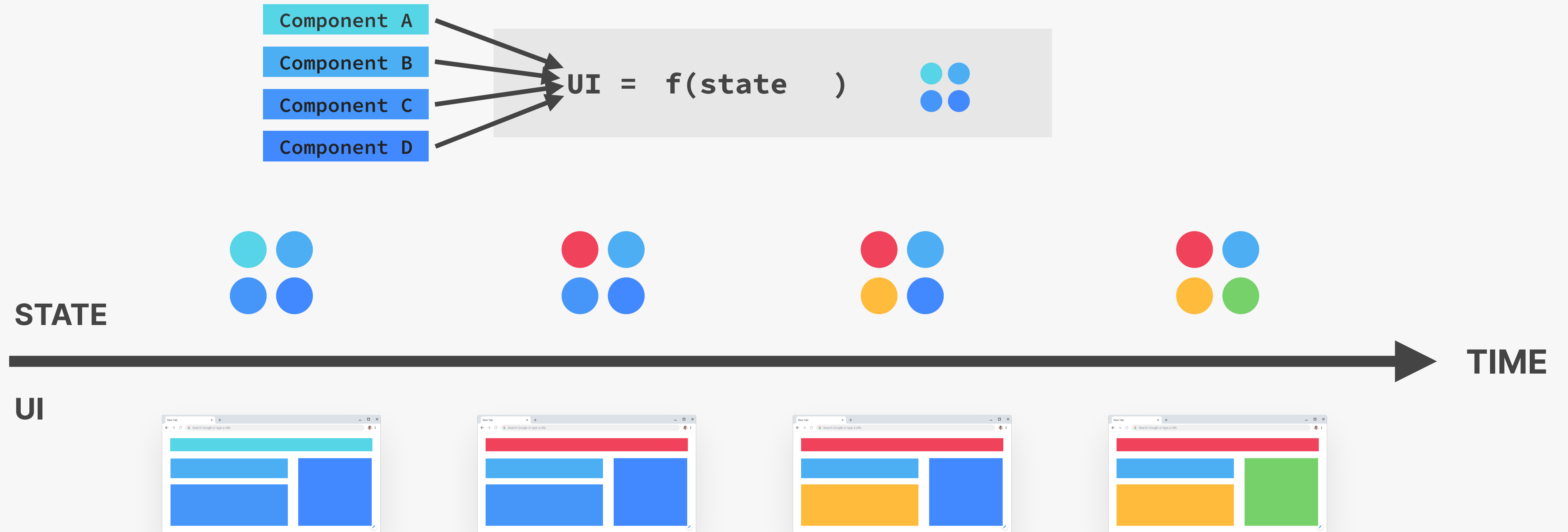
ONE COMPONENT, ONE STATE



Each component has and manages **its own state**, no matter how many times we render the same component

Multiple *instances* of the Counter component

UI AS A FUNCTION OF STATE



DECLARATIVE, REVISITED

- 👉 With state, we view UI as a **reflection of data changing over time**
- 👉 We ***describe*** that reflection of data using state, event handlers, and JSX



IN PRACTICAL TERMS...

PRACTICAL GUIDELINES ABOUT STATE

- 👉 Use a state variable for any data that the component should keep track of (“remember”) over time. **This is data that will change at some point.** In Vanilla JS, that’s a `let` variable, or an `[]` or `{}`
- 👉 Whenever you want something in the component to be **dynamic**, create a piece of state related to that “thing”, and update the state when the “thing” should change (aka “be dynamic”)
 - 👉 ***Example:** A modal window can be open or closed. So we create a state variable `isOpen` that tracks whether the modal is open or not. On `isOpen = true` we display the window, on `isOpen = false` we hide it.*
- 👉 If you want to change the way a component looks, or the data it displays, **update its state.** This usually happens in an **event handler** function.
- 👉 When building a component, imagine its view as a **reflection of state changing over time**
- 👉 For data that should not trigger component re-renders, **don’t use state.** Use a regular variable instead. This is a common **beginner mistake.**



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SECTION

STATE, EVENTS, AND FORMS:
INTERACTIVE COMPONENTS

LECTURE

STATE VS. PROPS

STATE VS. PROPS

STATE

- 👉 Internal data, owned by component
- 👉 Component “memory”
- 👉 Can be updated by the component itself
- 👉 Updating state causes component to re-render
- 👉 Used to make components interactive

```
function Question() {  
  const [upvotes, setUpvotes] = useState(0);  
  
  return (  
    <div>  
      { /* ... */ }  
      <Button upvotes={upvotes} bgColor="blue" />  
    </div>  
  );  
}
```

The diagram illustrates the flow of state from the parent component `Question()` to the child component `Button`. A solid blue arrow points from the `upvotes` state variable in `Question()` to the `upvotes` prop in `Button`. A circular arrow labeled "Parent state update" indicates that when `upvotes` is updated in `Question()`, it triggers a re-render of the `Button` component.

```
function Button(upvotes, bgColor) {  
  const [hovered, setHovered] = useState(false);  
  
  return (  
    <div>  
      { /* ... */ }  
      <button  
        onMouseEnter={() => setHovered(true)}  
        onMouseLeave={() => setHovered(false)}  
        style={{ background: bgColor }}  
      >  
        {hovered ? "Upvote" : `👍 ${upvotes}`}  
      </button>  
    </div>  
  );  
}
```

The diagram illustrates the flow of state within the `Button` component and back to the parent. A circular arrow indicates that updates to the `hovered` state within `Button` cause it to re-render. A dashed blue arrow points from the `upvotes` prop back to the `upvotes` state in the `Question()` component, indicating that when the parent's state is updated, the child component receives new props and re-renders.

PROPS

- 👉 External data, owned by parent component
- 👉 Similar to function parameters
- 👉 Read-only
- 👉 Receiving new props causes component to re-render. Usually when the parent's state has been updated
- 👉 Used by parent to configure child component (“settings”)

THINKING IN REACT: STATE MANAGEMENT



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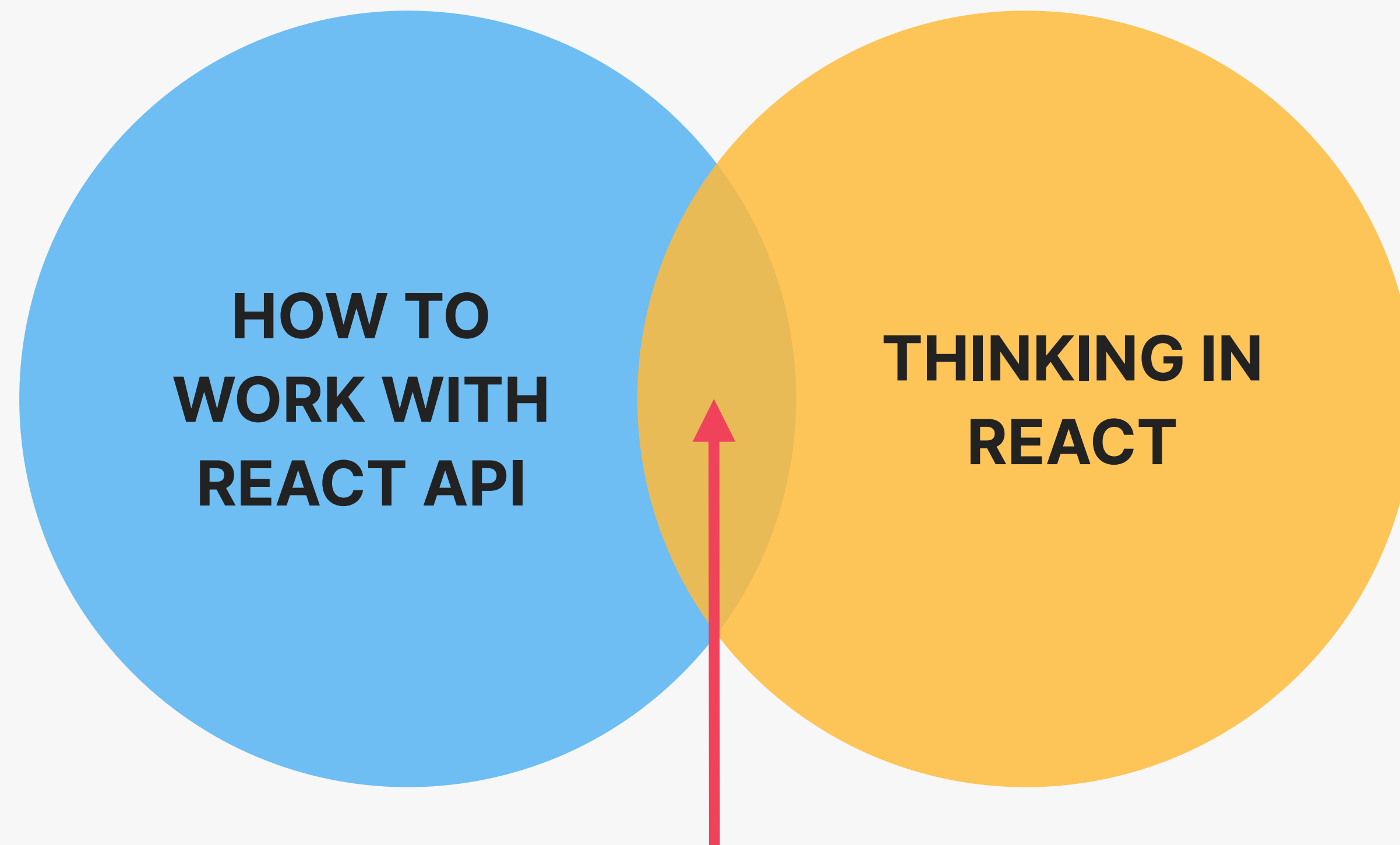
SECTION

THINKING IN REACT: STATE
MANAGEMENT

LECTURE

WHAT IS "THINKING IN REACT"?

“THINKING IN REACT” IS A CORE SKILL



This is where professional
React apps are built

THINKING IN REACT

- 👉 *“React Mindset”*
- 👉 Thinking about components, state, data flow, effects, etc.
- 👉 Thinking in **state transitions**, not element mutations

“THINKING IN REACT” AS A PROCESS

Not a rigid process

THE “THINKING IN REACT” PROCESS:

- 1 Break the desired UI into **components** and establish the **component tree**
- 2 Build a **static** version in React (without state)
- 3 Think about **state**:
 - 👉 When to use state
 - 👉 Types of state: local vs. global
 - 👉 Where to place each piece of state
- 4 Establish **data flow**:
 - 👉 One-way data flow
 - 👉 Child-to-parent communication
 - 👉 Accessing global state

State
management

WHEN YOU KNOW HOW TO “THINK IN REACT”, YOU WILL BE ABLE TO ANSWER:

- 🤔 How to break up a UI design into components?
- 🤔 How to make some components reusable?
- 🤔 How to assemble UI from reusable components?
- 🤔 What pieces of state do I need for interactivity?
- 🤔 Where to place state? (What component should "own" each piece of state?)
- 🤔 What types of state can or should I use?
- 🤔 How to make data flow through app?



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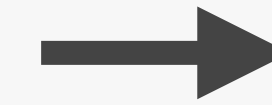
THINKING IN REACT: STATE
MANAGEMENT

LECTURE

FUNDAMENTALS OF STATE
MANAGEMENT

WHAT IS STATE MANAGEMENT?

👉 **State management:** Deciding **when** to create pieces of state, what **types** of state are necessary, **where** to place each piece of state, and how data **flows** through the app



Giving each piece of state a **home**

The screenshot shows the Udemy website with several red annotations identifying state pieces:

- searchQuery**: Points to the search bar containing "javascript".
- Shopping Cart**: Points to the shopping cart icon in the top right.
- shoppingCart**: Points to the shopping cart section on the left, which contains two courses: "Node.js, Express, MongoDB & More: The Complete Bootcamp 2022" and "The Complete JavaScript Course 2022: From Zero to Expert!".
- PIECES OF STATE (useState)**: A central label pointing to various state pieces.
- coupons**: Points to the "Promotions" section on the right, which shows a coupon "ST351022" applied.
- notifications**: Points to the "Notifications" and "Messages" sections on the right.
- language**: Points to the "Language" dropdown menu on the right, which is set to "English".
- is0pen**: Points to the "Checkout" button on the right.
- user**: Points to the user profile section on the right, which shows the user "Jonas Schmedtmann".

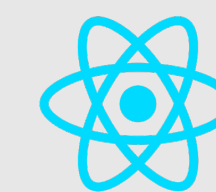
TYPES OF STATE: LOCAL VS. GLOBAL STATE

LOCAL STATE

- 👉 State needed **only by one or few components**
- 👉 State that is defined in a component and **only that component and child components** have access to it (by passing via props)
- 👉 *We should always start with local state*

GLOBAL STATE

- 👉 State that **many components** might need
- 👉 **Shared** state that is accessible to **every component** in the entire application



Context API

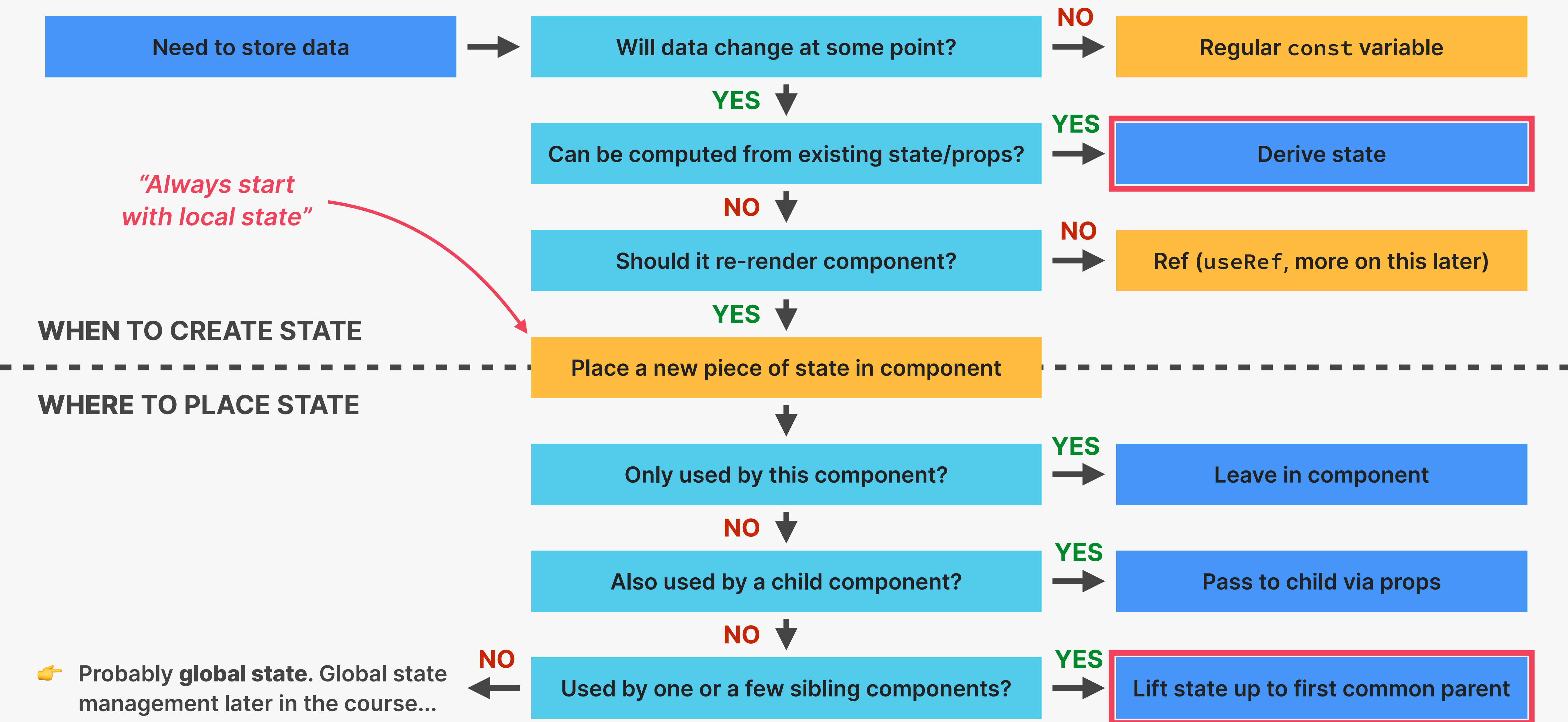


Redux

Local state

Global state

STATE: WHEN AND WHERE?





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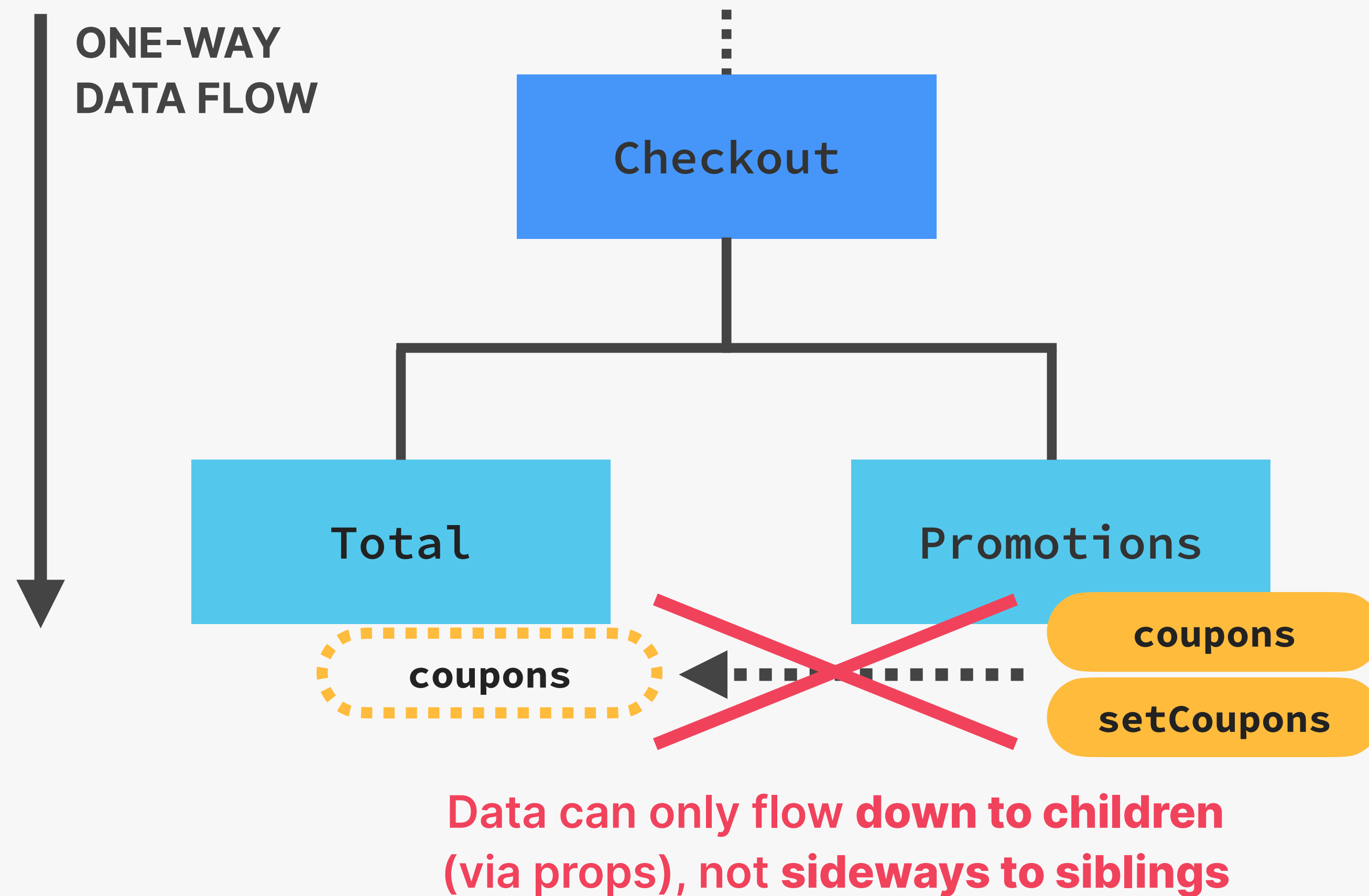
SECTION

THINKING IN REACT: STATE
MANAGEMENT

LECTURE

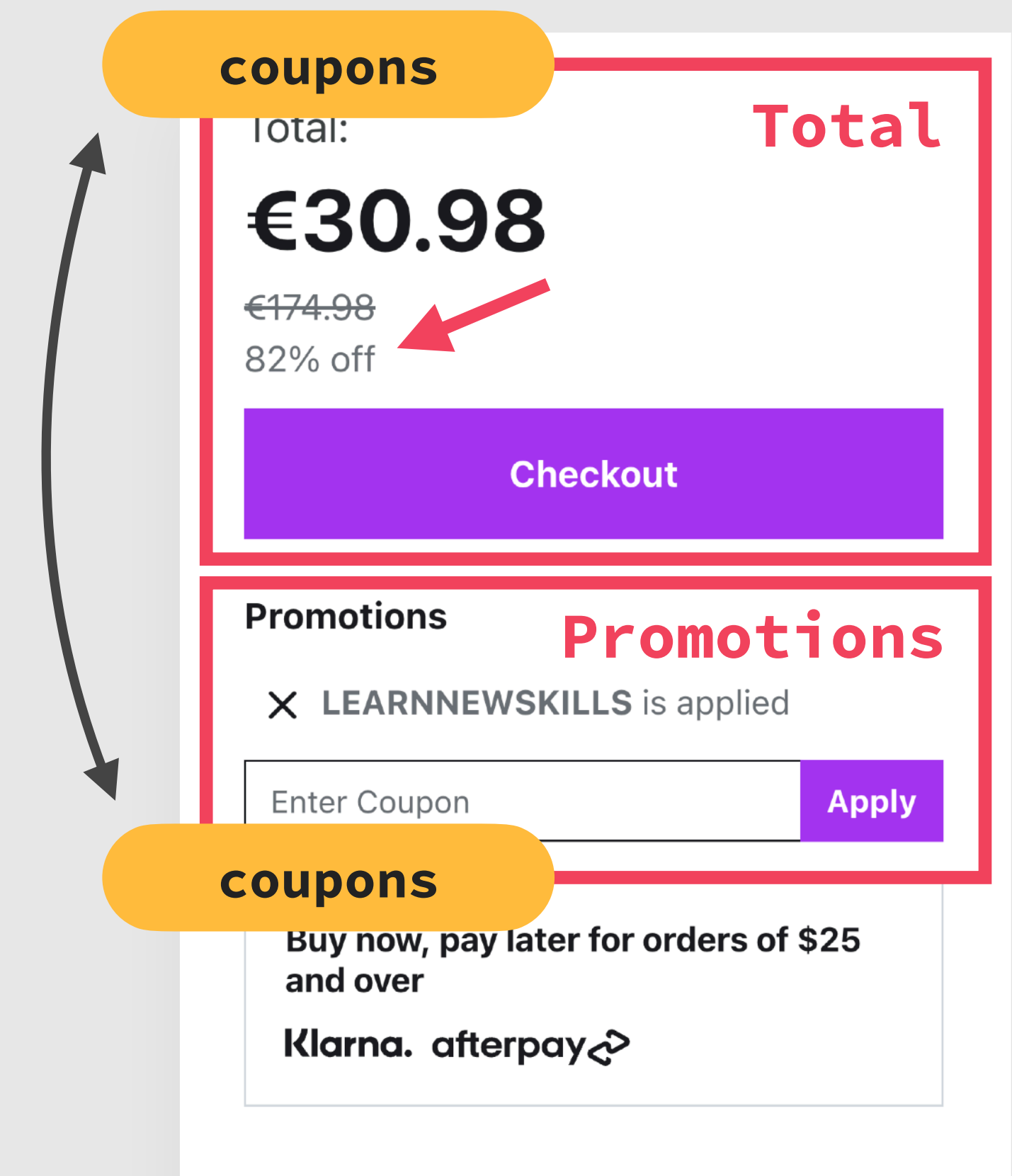
REVIEWING "LIFTING UP STATE"

PROBLEM: SHARING STATE WITH SIBLING COMPONENT

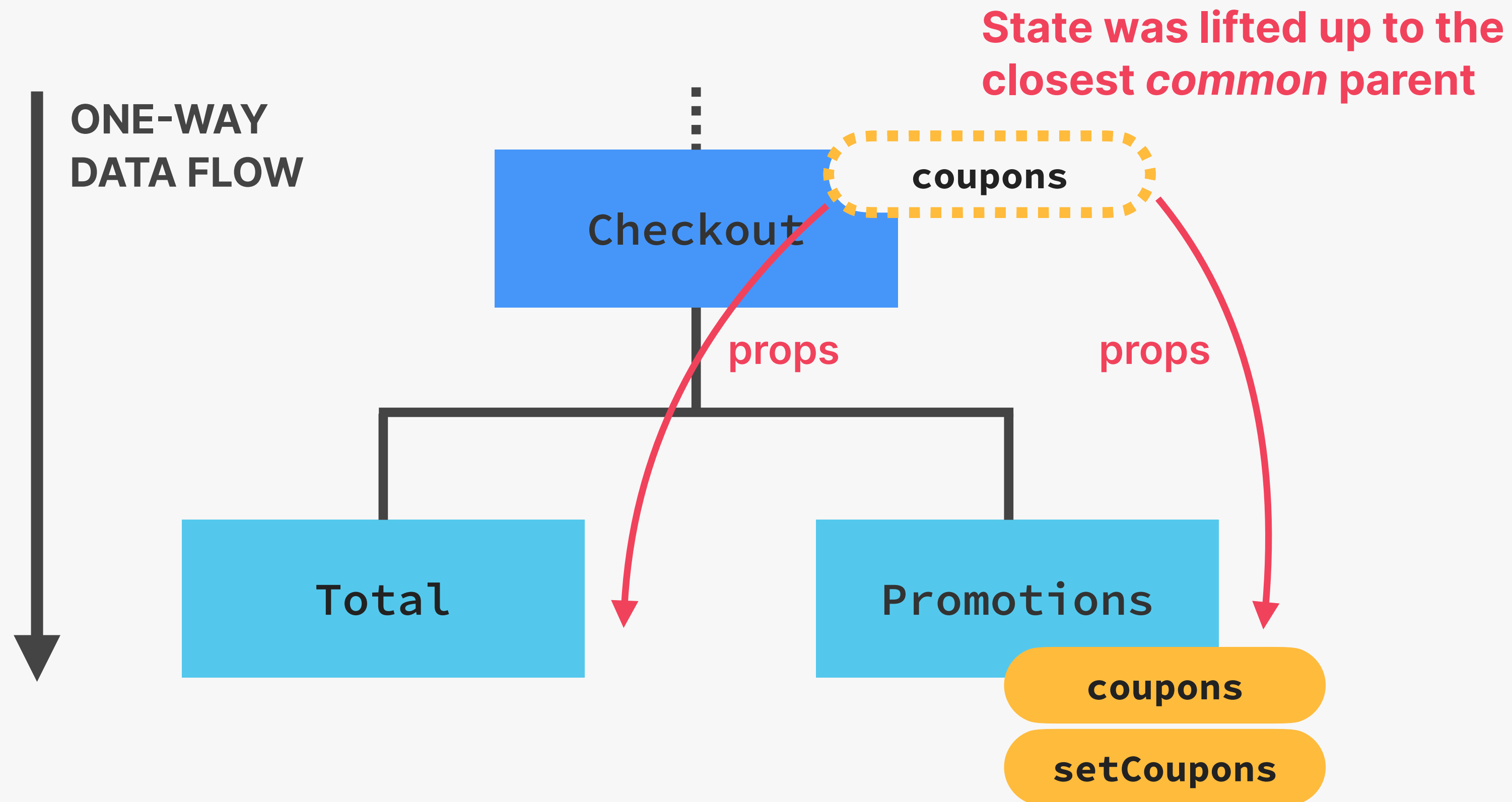


How do we share state with other components?

👉 Total component also needs access to coupons state

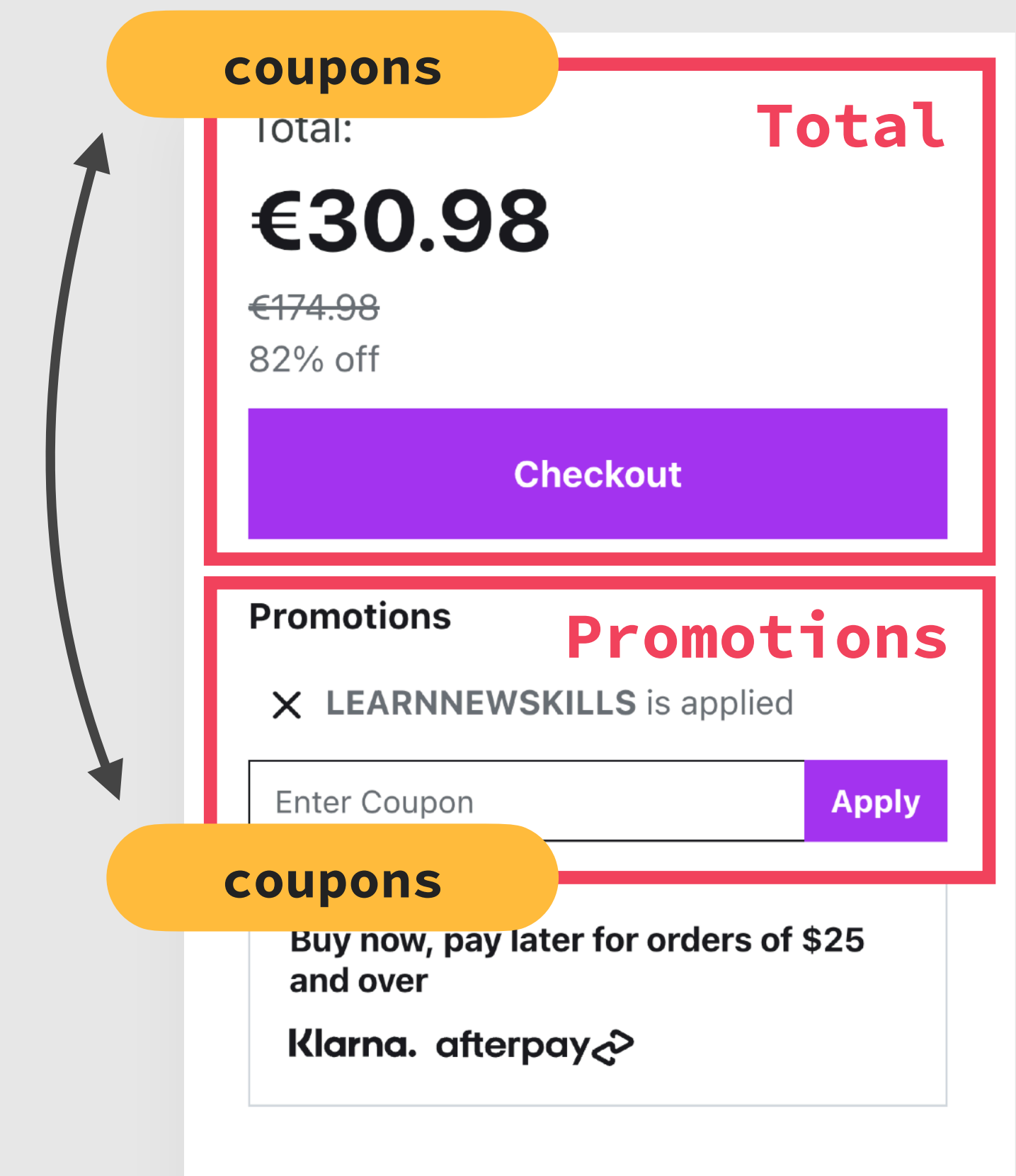


SOLUTION: LIFTING STATE UP



✌ By lifting state up, we have successfully shared one piece of state with multiple components in different positions in the component tree

👉 Total component also needs access to coupons state





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THINKING IN REACT: STATE
MANAGEMENT

LECTURE

DERIVED STATE

DERIVING STATE

- 👎 Three separate pieces of state, even though numItems and totalPrice depend on cart
- 👎 Need to keep them in sync (update together)
- 👎 3 state updates will cause 3 re-renders

👍 **Derived state:** state that is computed from an existing piece of state or from props

- 👍 Just regular variables, no useState
- 👍 cart state is the **single source of truth** for this related data
- 👍 Works because re-rendering component will **automatically re-calculate** derived state

```
const [cart, setCart] = useState([
  { name: "JavaScript Course", price: 15.99 },
  { name: "Node.js Bootcamp", price: 14.99 },
]);
const [numItems, setNumItems] = useState(2);
const [totalPrice, setTotalPrice] = useState(30.98);
```



DERIVING STATE

```
const [cart, setCart] = useState([
  { name: "JavaScript Course", price: 15.99 },
  { name: "Node.js Bootcamp", price: 14.99 },
]);
const numItems = cart.length;
const totalPrice =
  cart.reduce((acc, cur) => acc + cur.price, 0);
```




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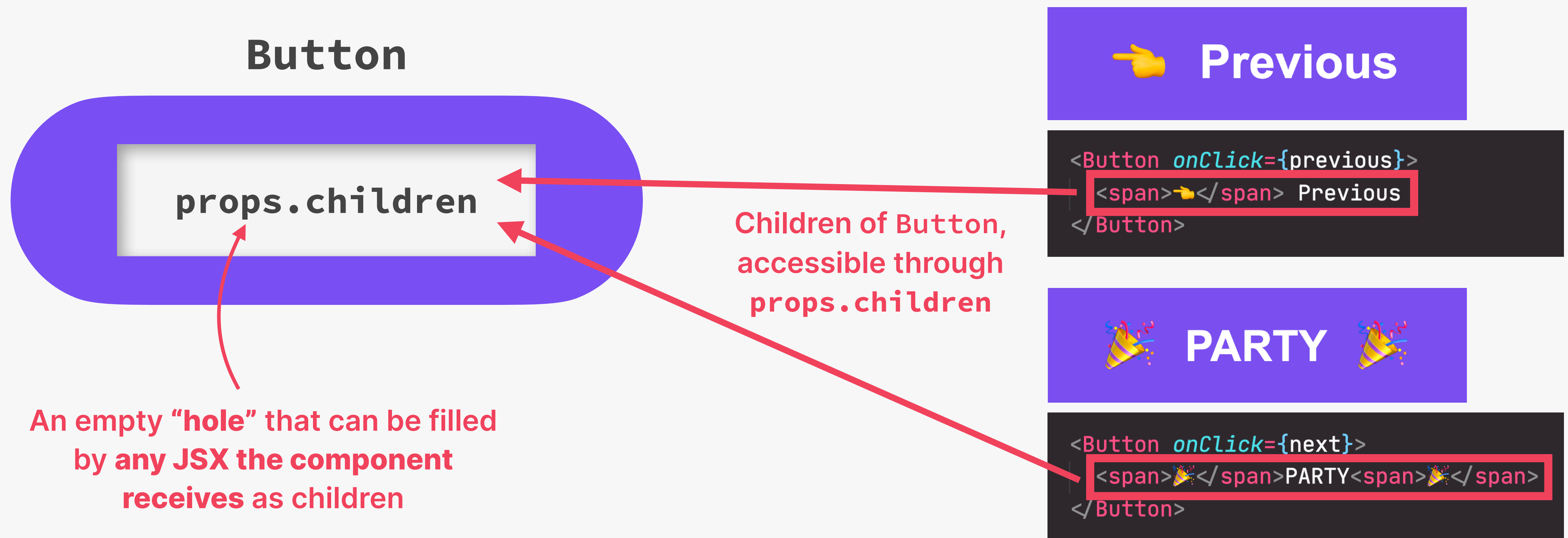
SECTION

THINKING IN REACT: STATE
MANAGEMENT

LECTURE

THE CHILDREN PROP: MAKING A
REUSABLE BUTTON

THE CHILDREN PROP



- 👉 The children prop allow us to pass JSX into an element (besides regular props)
- 👉 Essential tool to make **reusable** and **configurable** components (especially component **content**)
- 👉 Really useful for **generic** components that **don't know their content** before being used (e.g. modal)

PART 02

—

**INTERMEDIATE
REACT**

THINKING IN REACT:
COMPONENTS,
COMPOSITION, AND
REUSABILITY



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THINKING IN REACT:
COMPONENTS, COMPOSITION,
AND REUSABILITY

LECTURE

HOW TO SPLIT A UI INTO
COMPONENTS

COMPONENT SIZE MATTERS



Just one huge
component

COMPONENT SIZE

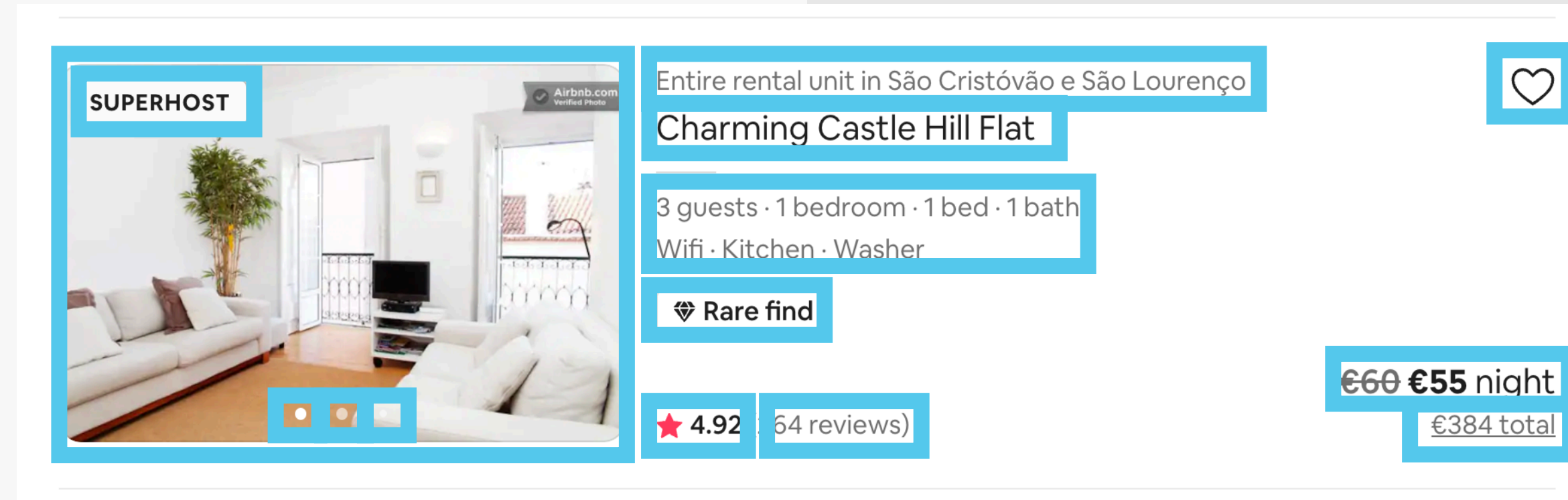
SMALL

HUGE

- 👉 Too many **responsibilities**
- 👉 Might need too many **props**
- 👉 Hard to **reuse**
- 👉 **Complex** code, hard to understand

COMPONENT SIZE MATTERS

Many small components



COMPONENT SIZE

SMALL

Generally, we need to find the right balance between too specific and too broad

HUGE

- 👉 We end up with 100s of mini-components
- 👉 Confusing codebase
- 👉 Too **abstracted**

Creating something new to hide the implementation details of that thing

- 👉 Too many **responsibilities**
- 👉 Might need too many **props**
- 👉 Hard to **reuse**
- 👉 Complex code, hard to understand

HOW TO SPLIT A UI INTO COMPONENTS

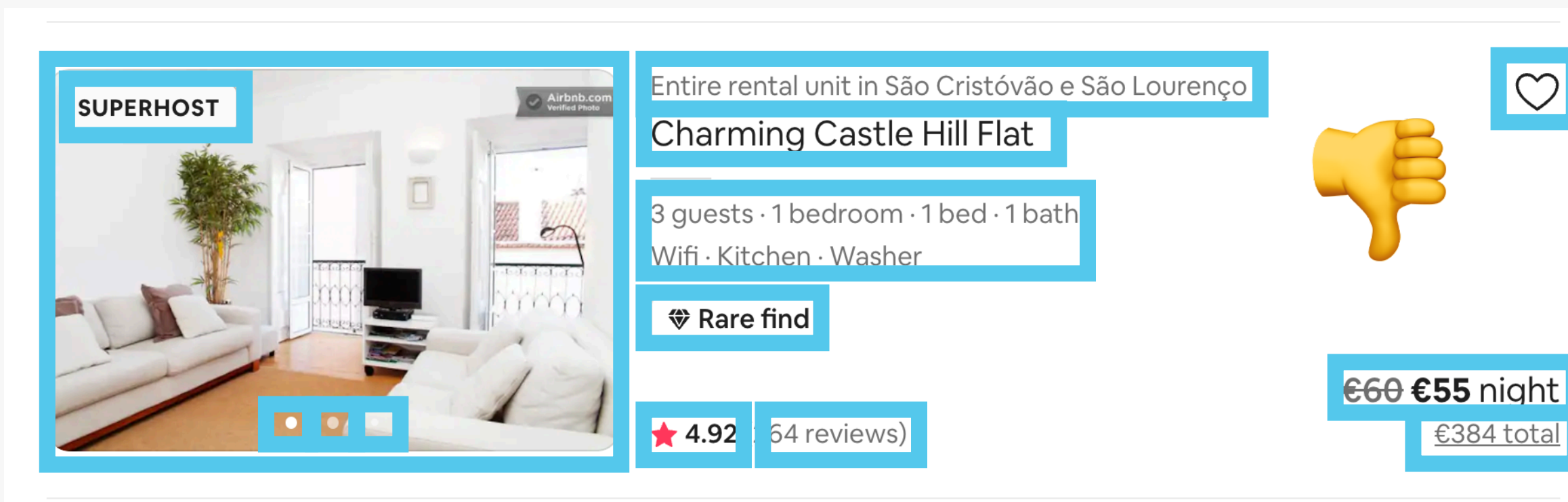
👉 The 4 criteria for splitting a UI into components:

1. Logical separation of content/layout

2. Reusability

3. Responsibilities / complexity

4. Personal coding style



- ✓ Logical separation
- ✓ Some are reusable
- ✓ Low complexity

FRAMEWORK: WHEN TO CREATE A NEW COMPONENT?

💡 **SUGGESTION:** When in doubt, start with a relatively big component, then split it into smaller components as it becomes necessary

Skip if you're sure you need to reuse. But otherwise, you don't need to focus on reusability and complexity early on

1. Logical separation of content/layout

👉 Does the component contain pieces of content or layout that **don't belong together**?

2. Reusability

👉 Is it possible to reuse part of the component?

👉 Do you **want** or **need** to reuse it?

3. Responsibilities / complexity

👉 Is the component doing too **many different things**?

👉 Does the component rely on too **many props**?

👉 Does the component have too **many pieces of state** and/or effects?

👉 Is the code, including JSX, too **complex/confusing**?

4. Personal coding style

👉 Do you prefer **smaller** functions/components?

You might need a new component

👏 *These are all guidelines... It will become intuitive over time!*

SOME MORE GENERAL GUIDELINES



Be aware that creating a new component **creates a new abstraction**. Abstractions have a **cost**, because **more abstractions require more mental energy** to switch back and forth between components. So try not to create new components too early



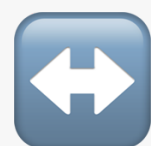
Name a component according to **what it does** or **what it displays**. Don't be afraid of using long component names



Never declare a new component **inside another component**!

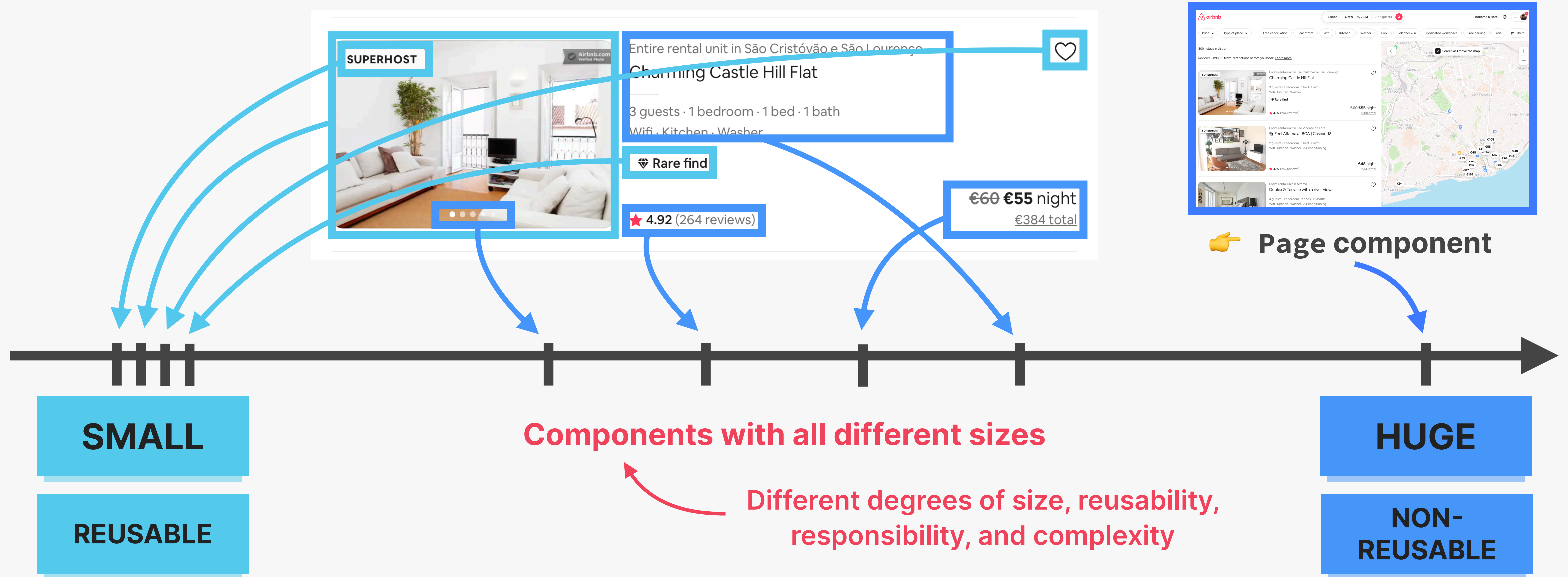


Co-locate related components inside the same file. Don't separate components into different files too early



It's completely normal that an app has components of **many different sizes**, including very small and huge ones (*See next slide...* 🙌)

ANY APP HAS COMPONENTS OF DIFFERENT SIZES AND REUSABILITY



👉 Some very small components are necessary!

👉 Highly reusable

👉 Very low complexity

👉 Most apps will have a few huge components

👉 Not meant to be reused (not a problem!)



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COMPONENTS, COMPOSITION,
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LECTURE

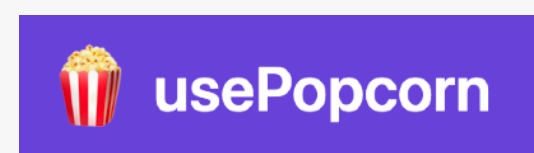
COMPONENT CATEGORIES

COMPONENT CATEGORIES

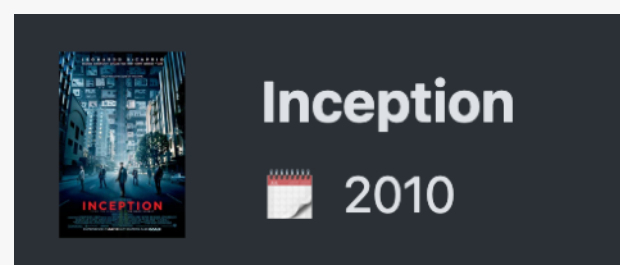
👉 Most of your components will **naturally** fall into **one of three categories**:

**Stateless /
presentational
components**

- 👉 **No state**
- 👉 Can receive props and simply *present* received data or other content
- 👉 Usually **small and reusable**

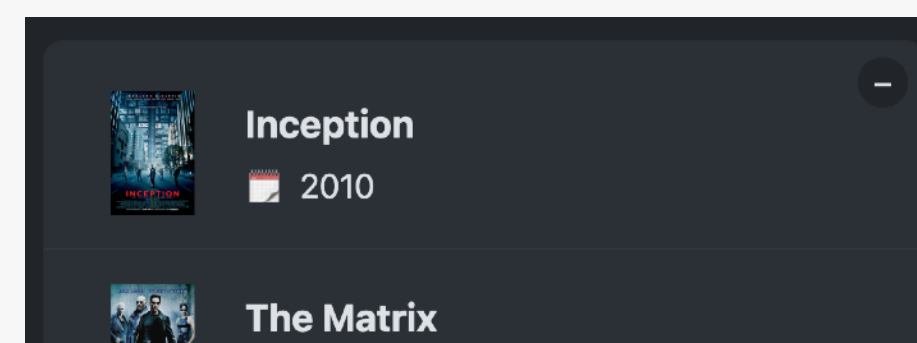
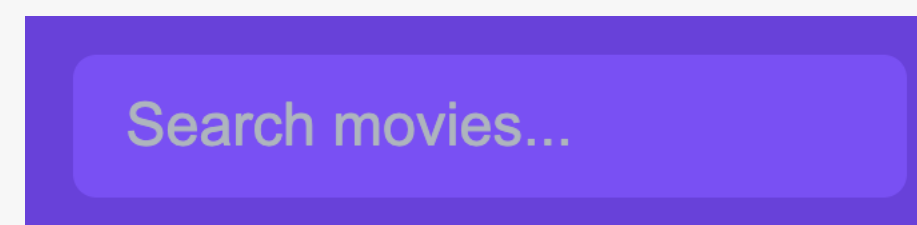


Found **3** results



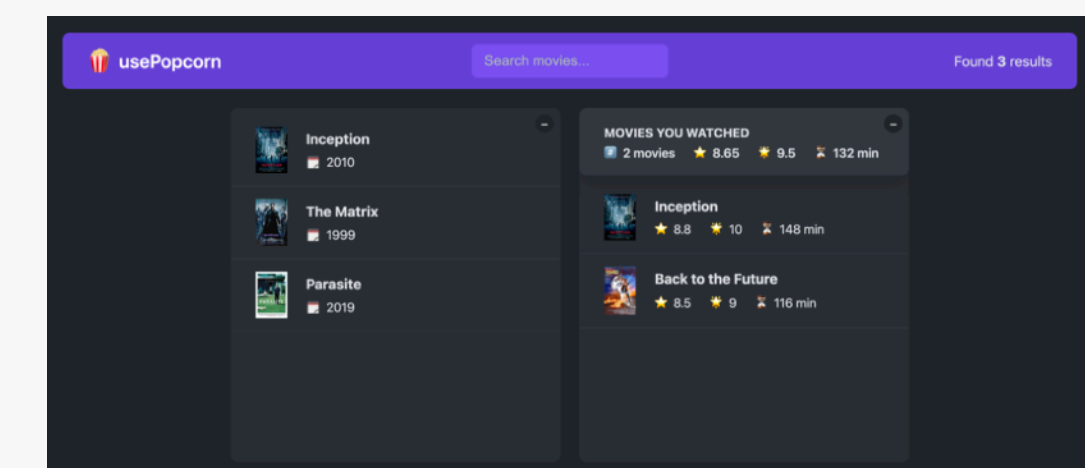
**Stateful
components**

- 👉 **Have state**
- 👉 Can still be **reusable**



**Structural
components**

- 👉 **"Pages", "layouts", or "screens"** of the app
- 👉 Result of **composition**
- 👉 Can be **huge and non-reusable** (but don't have to)





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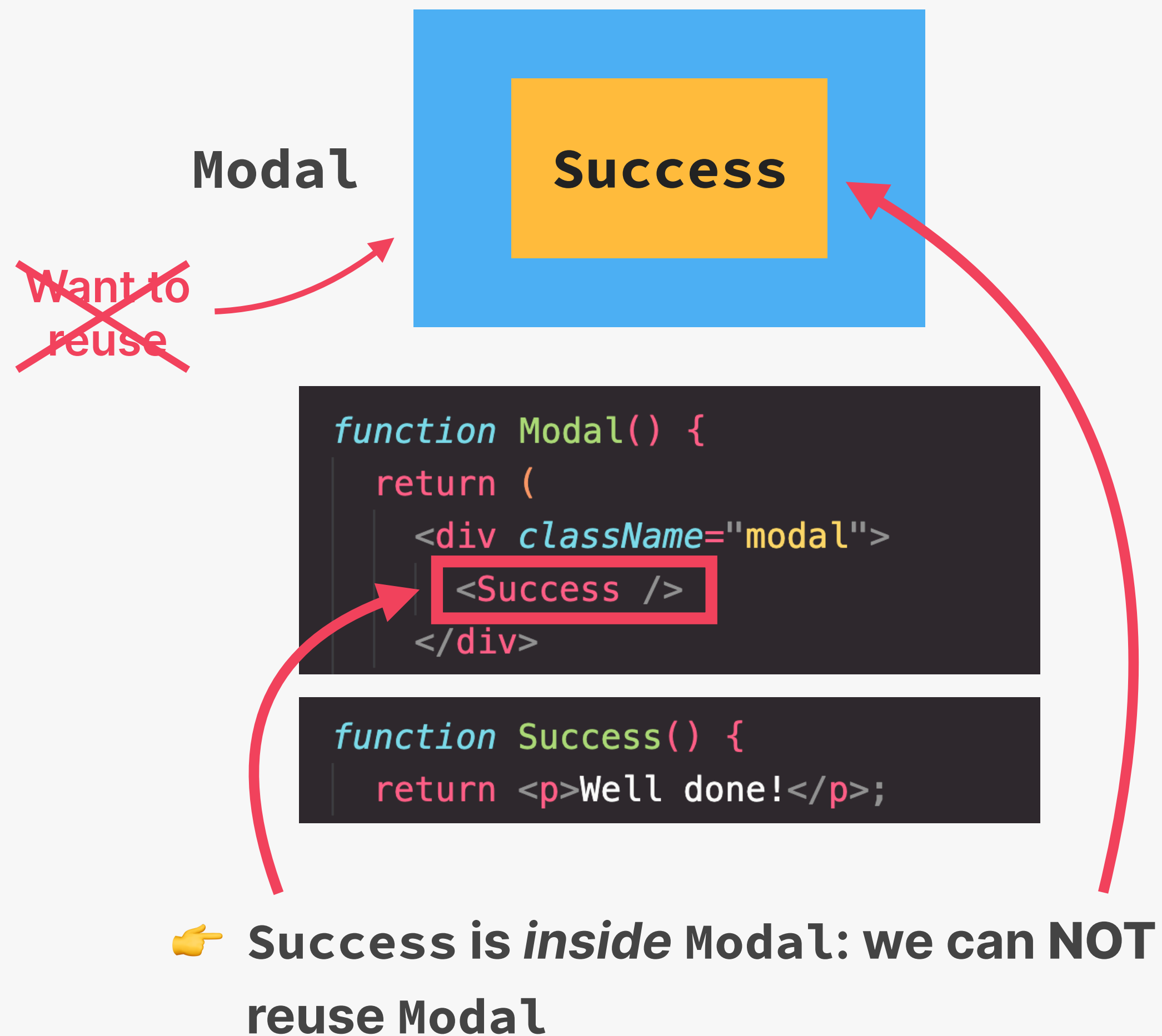
THINKING IN REACT:
COMPONENTS, COMPOSITION,
AND REUSABILITY

LECTURE

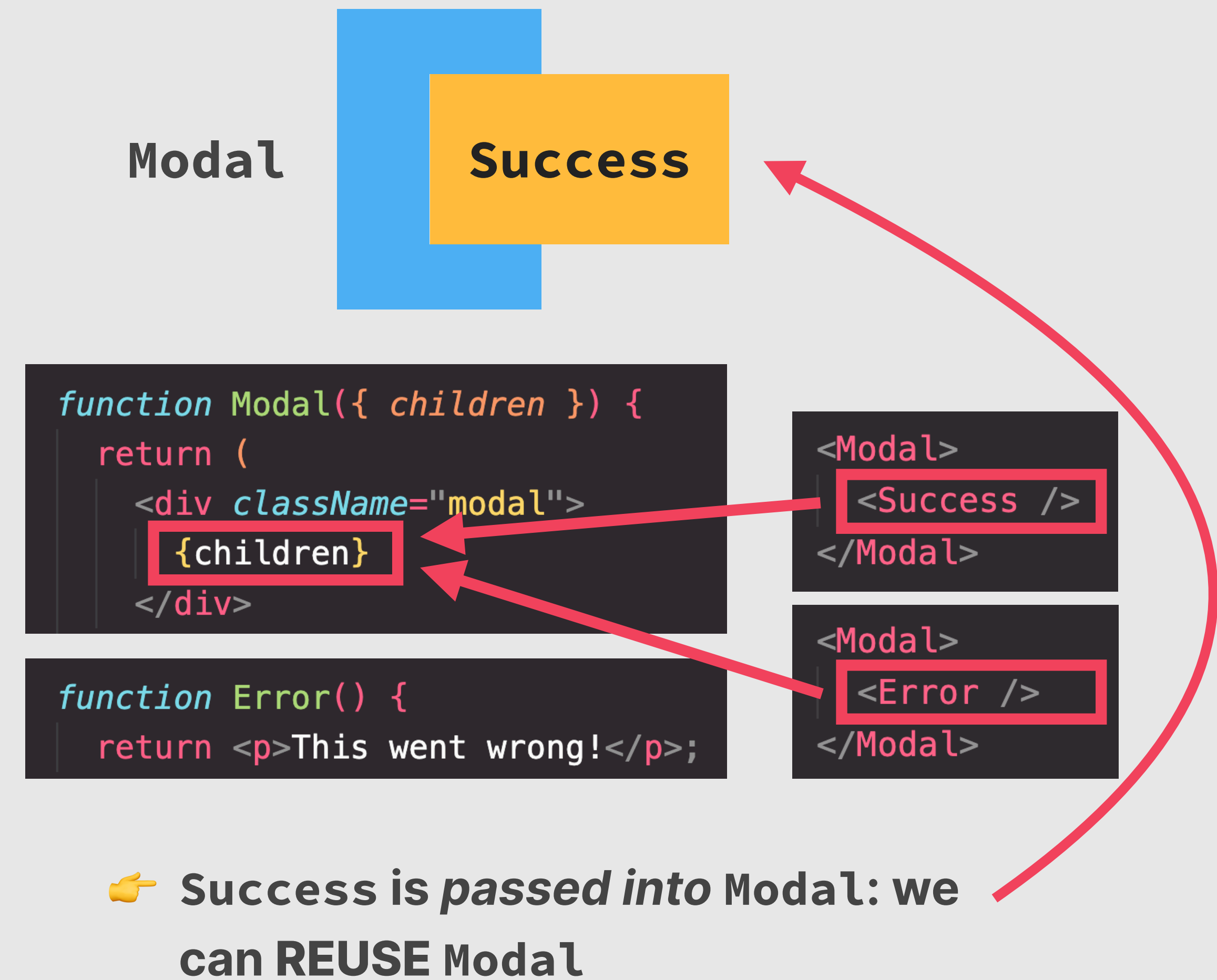
COMPONENT COMPOSITION

WHAT IS COMPONENT COMPOSITION?

"USING" A COMPONENT



COMPONENT COMPOSITION



WHAT IS COMPONENT COMPOSITION?

COMPONENT COMPOSITION

Modal

Error

```
function Modal({ children }) {  
  return (  
    <div className="modal">  
      {children}  
    </div>  
  )  
}
```

```
function Error() {  
  return <p>This went wrong!</p>;  
}
```

```
<Modal>  
  <Success />  
</Modal>  
  
<Modal>  
  <Error />  
</Modal>
```

👉 Success is *passed into* Modal: we can **REUSE** Modal

👉 **Component composition:** combining different components using the `children` prop (or explicitly defined props)

WE COMPONENT COMPOSITION, WE CAN:

- 1 Create highly reusable and flexible components
- 2 Fix prop drilling (great for layouts)

Possible because components don't need to know their children in advance



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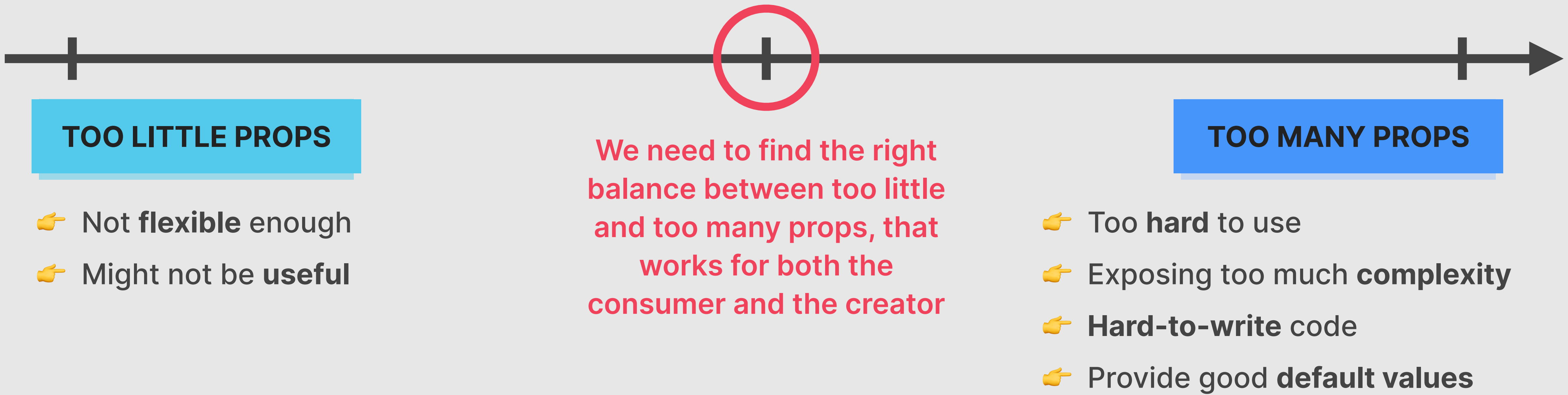
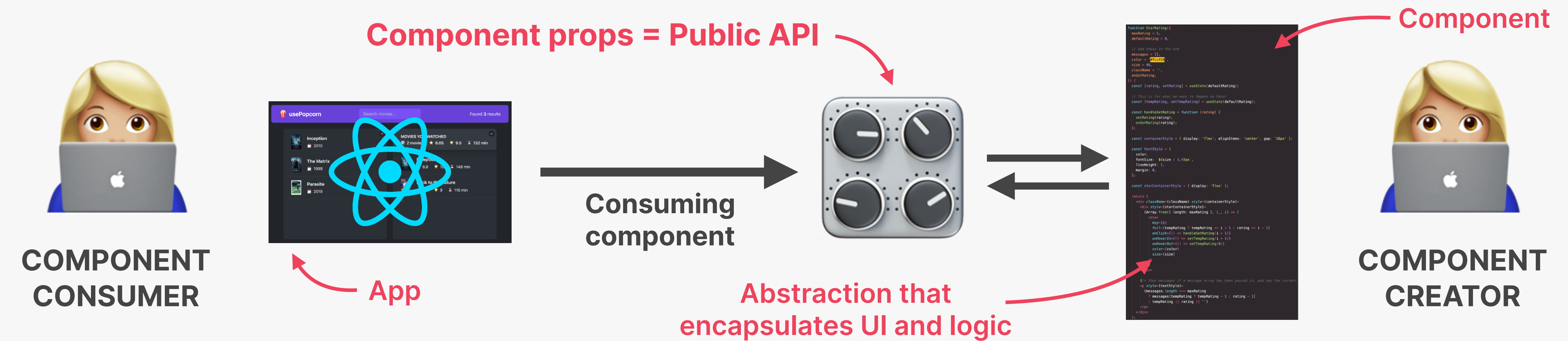
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LECTURE

PROPS AS A COMPONENT API

PROPS AS AN API





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GOT QUESTIONS? FEEDBACK?

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

HOW REACT WORKS BEHIND THE SCENES



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HOW REACT WORKS BEHIND THE
SCENES

LECTURE

COMPONENTS, INSTANCES, AND
ELEMENTS

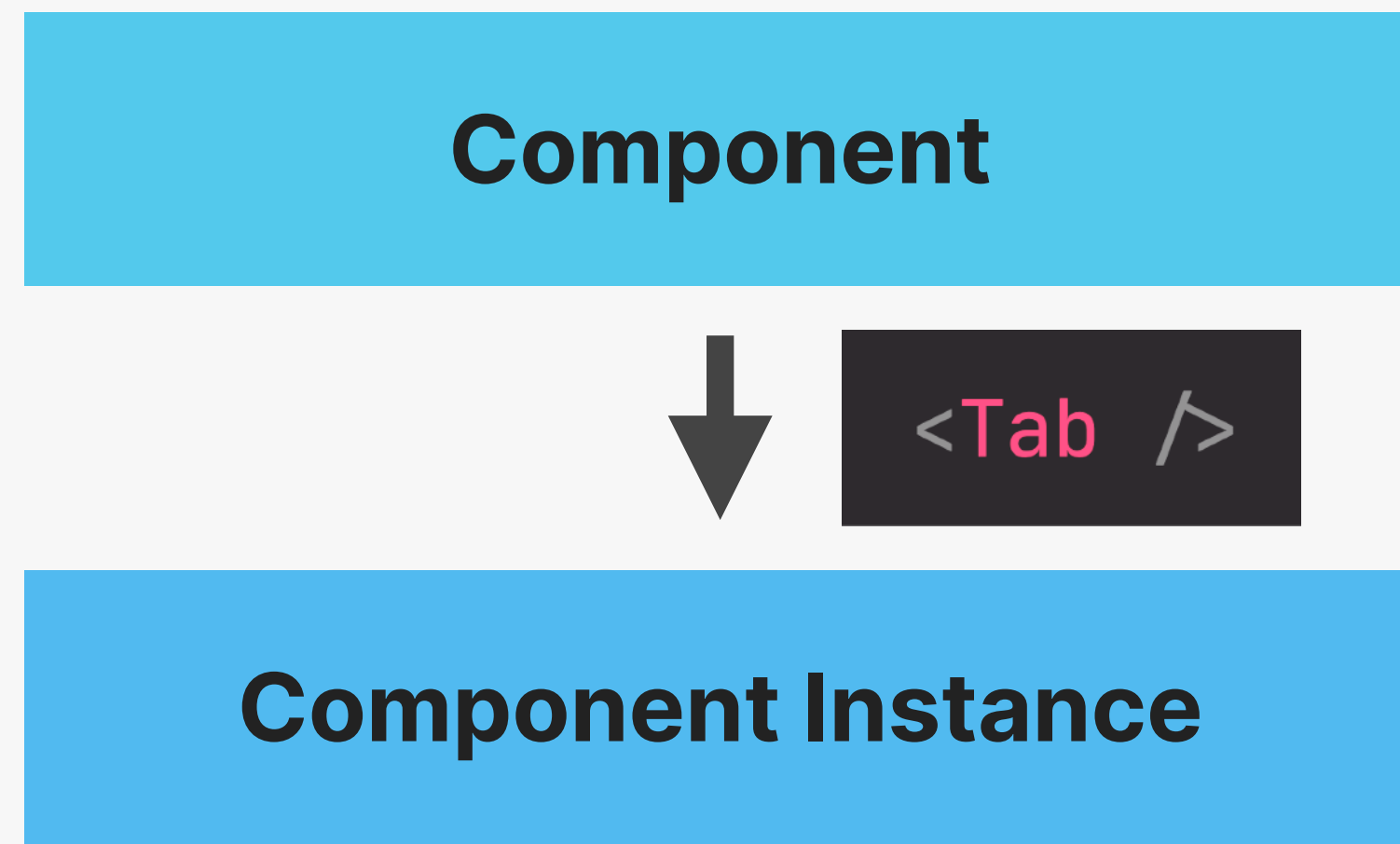
COMPONENT VS. INSTANCE VS. ELEMENT

Component

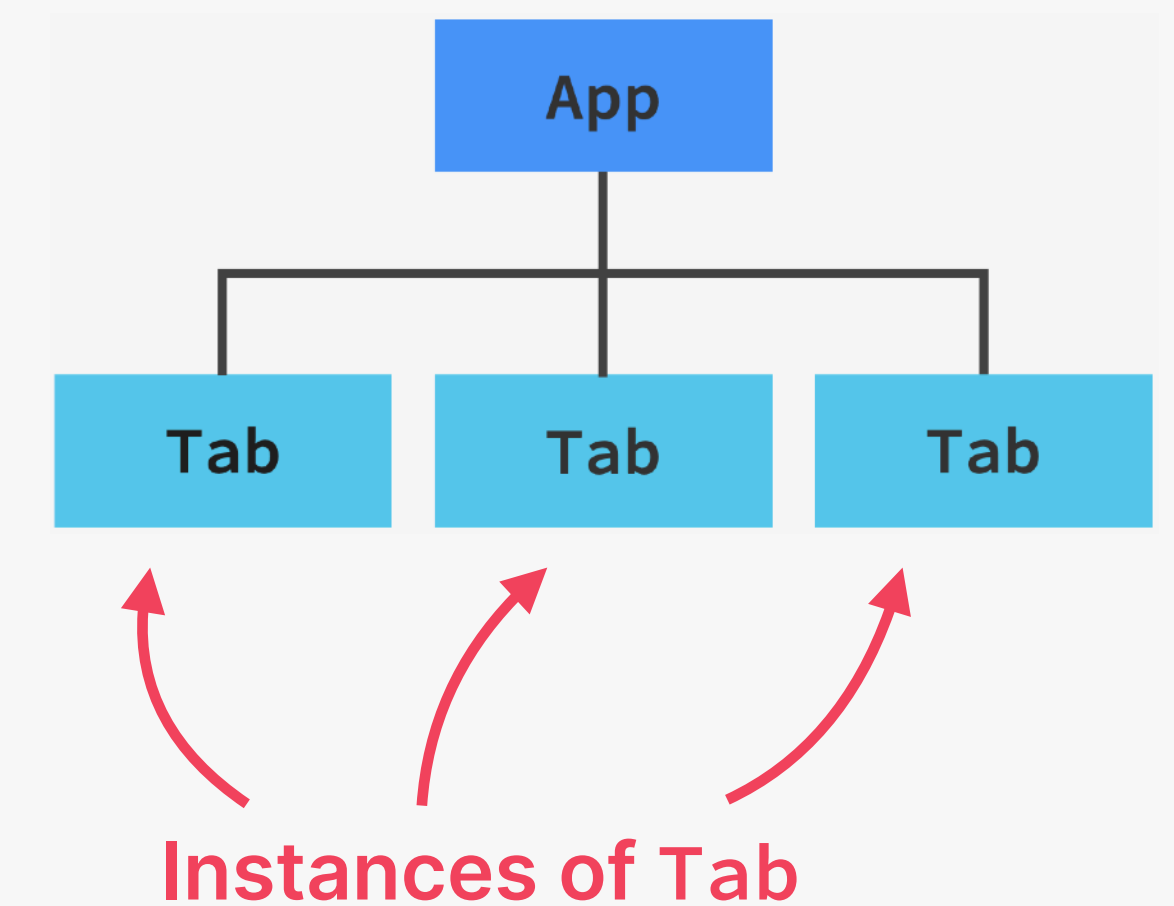
```
function Tab({ item }) {  
  return (  
    <div className='tab-content'>  
      <h4>All contacts</h4>  
      <p>Your post will be visible</p>  
    </div>  
  );  
}
```

- 👉 Description of a piece of UI
- 👉 A component is a function that **returns React elements** (element tree), usually written as JSX
- 👉 “Blueprint” or “Template”

COMPONENT VS. INSTANCE VS. ELEMENT

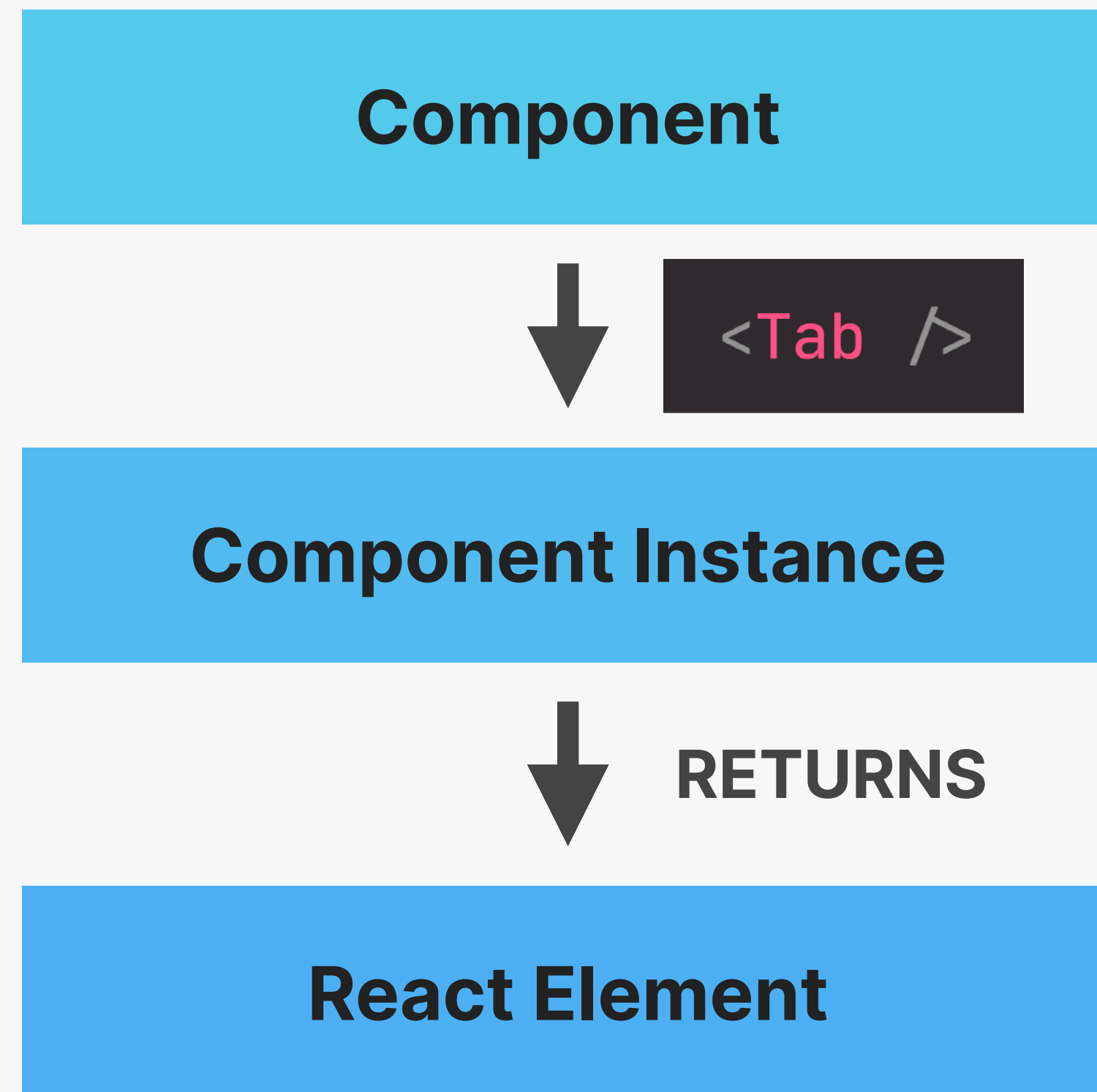


```
function App() {  
  return (  
    <div className='tabs'>  
      <Tab item={content[0]} />  
      <Tab item={content[1]} />  
      <Tab item={content[2]} />  
    </div>  
  )  
}
```



- 👉 Instances are created when we “**use**” components
- 👉 React internally calls `Tab()`
- 👉 Actual “**physical**” manifestation of a component
- 👉 Has its own state and props
- 👉 Has a **lifecycle** (can “be born”, “live”, and “die”)

COMPONENT VS. INSTANCE VS. ELEMENT



```
function Tab({ item }) {  
  return (  
    <div className='tab-content'>  
      <h4>All contacts</h4>  
      <p>Your post will be visible</p>  
    </div>  
  );  
}
```

```
React.createElement(  
  'div',  
  {  
    className: 'tab-content'  
  },  
  React.createElement('h4', null, 'All contacts'),  
  React.createElement(  
    'p',  
    null,  
    'Your post will be visible'  
  )  
);
```

```
Object  
$$typeof: Symbol(react.element)  
key: null  
▼ props:  
  ▼ children: Array(2)  
    ► 0: {$$typeof: Symbol(react.element), type: 'h4',  
      length: 2  
    ► 1: {$$typeof: Symbol(react.element), type: 'p',  
      length: 2  
    ► [[Prototype]]: Array(0)  
  className: "tab-content"  
  ► [[Prototype]]: Object  
  ref: null  
  type: "div"  
  _owner: null  
  ► _store: {validated: false}
```

REACT ELEMENT

- 👉 JSX is converted to `React.createElement()` function calls
- 👉 A React element is the **result of these function calls**
- 👉 Information necessary to create **DOM elements**

COMPONENT VS. INSTANCE VS. ELEMENT

Component



```
<Tab />
```

Component Instance



RETURNS

React Element



INSERTED TO DOM

DOM Element (HTML)

```
<div class="tab-content">  
  <h4>All contacts</h4>  
  <p>Your post will be visible</p>  
</div>
```

All contacts

Your post will be visible to all your contacts

👉 Actual **visual representation** of the component instance in the browser



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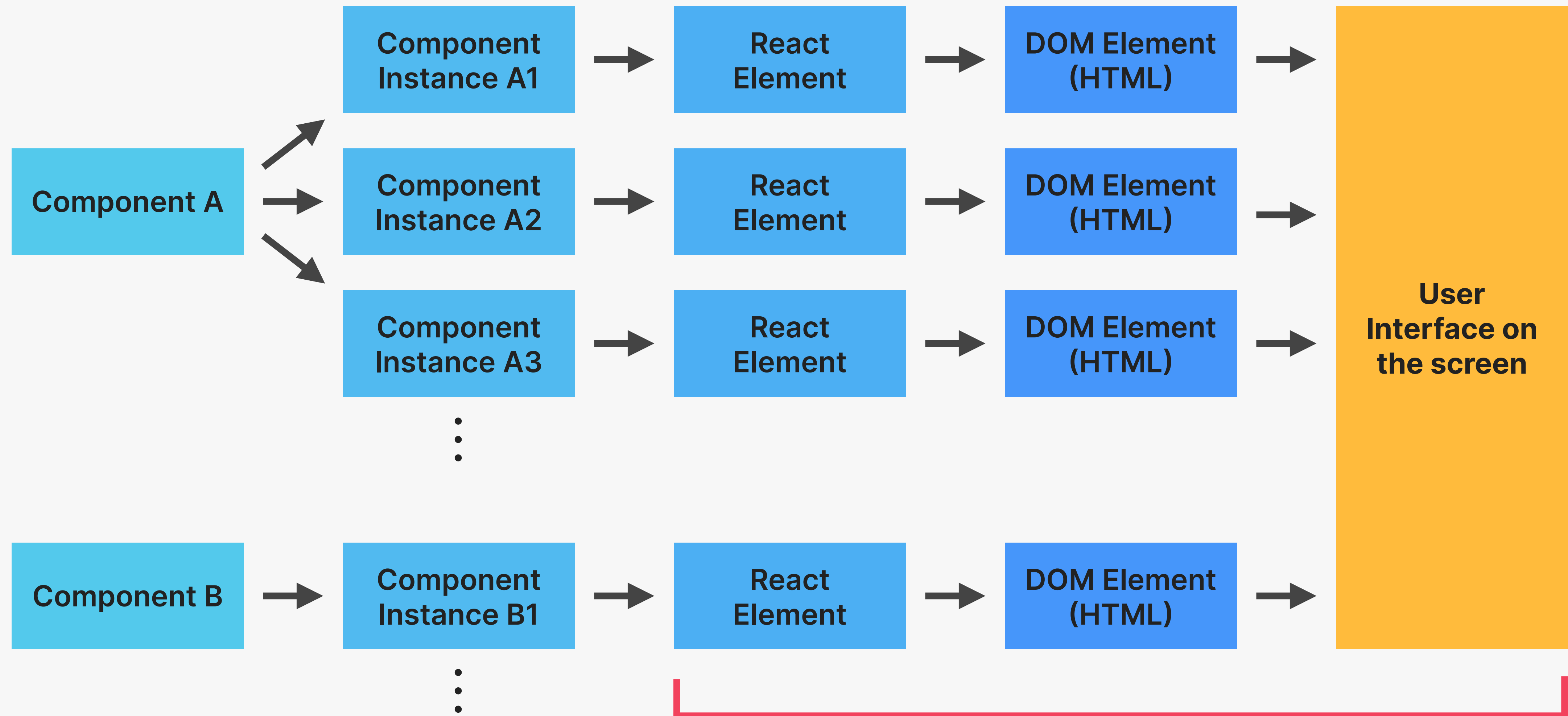
SECTION

HOW REACT WORKS BEHIND THE
SCENES

LECTURE

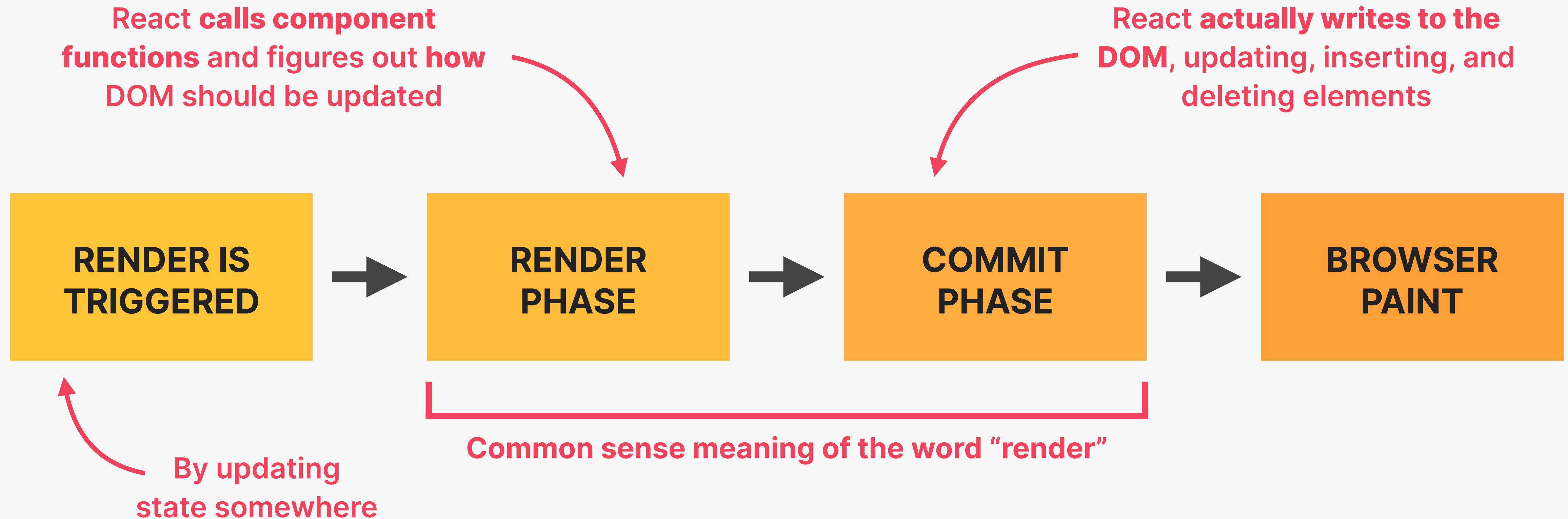
HOW RENDERING WORKS:
OVERVIEW

QUICK RECAP BEFORE WE GET STARTED



🤔 **How does this process *actually* work?**

OVERVIEW: HOW COMPONENTS ARE DISPLAYED ON THE SCREEN



In React, rendering is **NOT** updating the DOM or displaying elements on the screen. Rendering only happens **internally** inside React, it does not **produce visual changes**.

HOW RENDERS ARE TRIGGERED

[1] RENDER IS TRIGGERED

THE TWO SITUATIONS THAT TRIGGER RENDERS:

- 1 Initial render of the application
- 2 State is updated in one or more component instances (re-render)

- 👉 The render process is triggered for the **entire application**
- 👉 **In practice**, it looks like React only re-renders the component where the state update happens, but that's not how it **works behind the scenes**
- 👉 Renders are **not** triggered immediately, but **scheduled** for when the JS engine has some "free time". There is also batching of multiple `setState` calls in event handlers



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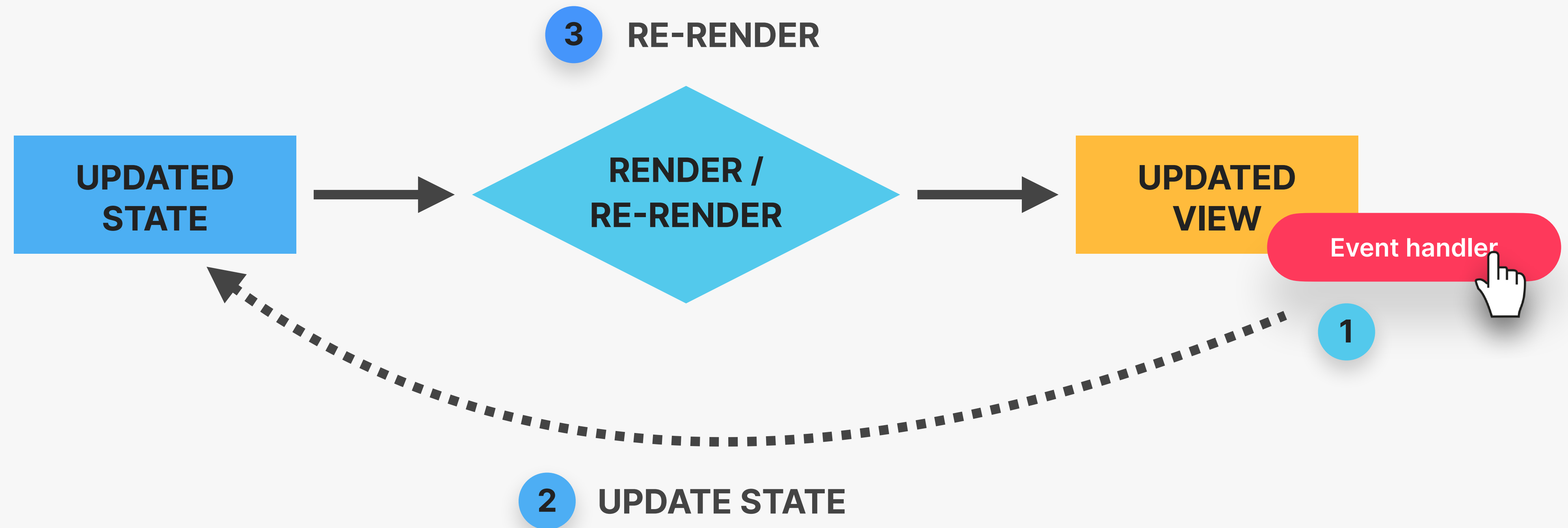
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LECTURE

HOW RENDERING WORKS: THE
RENDER PHASE

REVIEW: THE MECHANICS OF STATE IN REACT

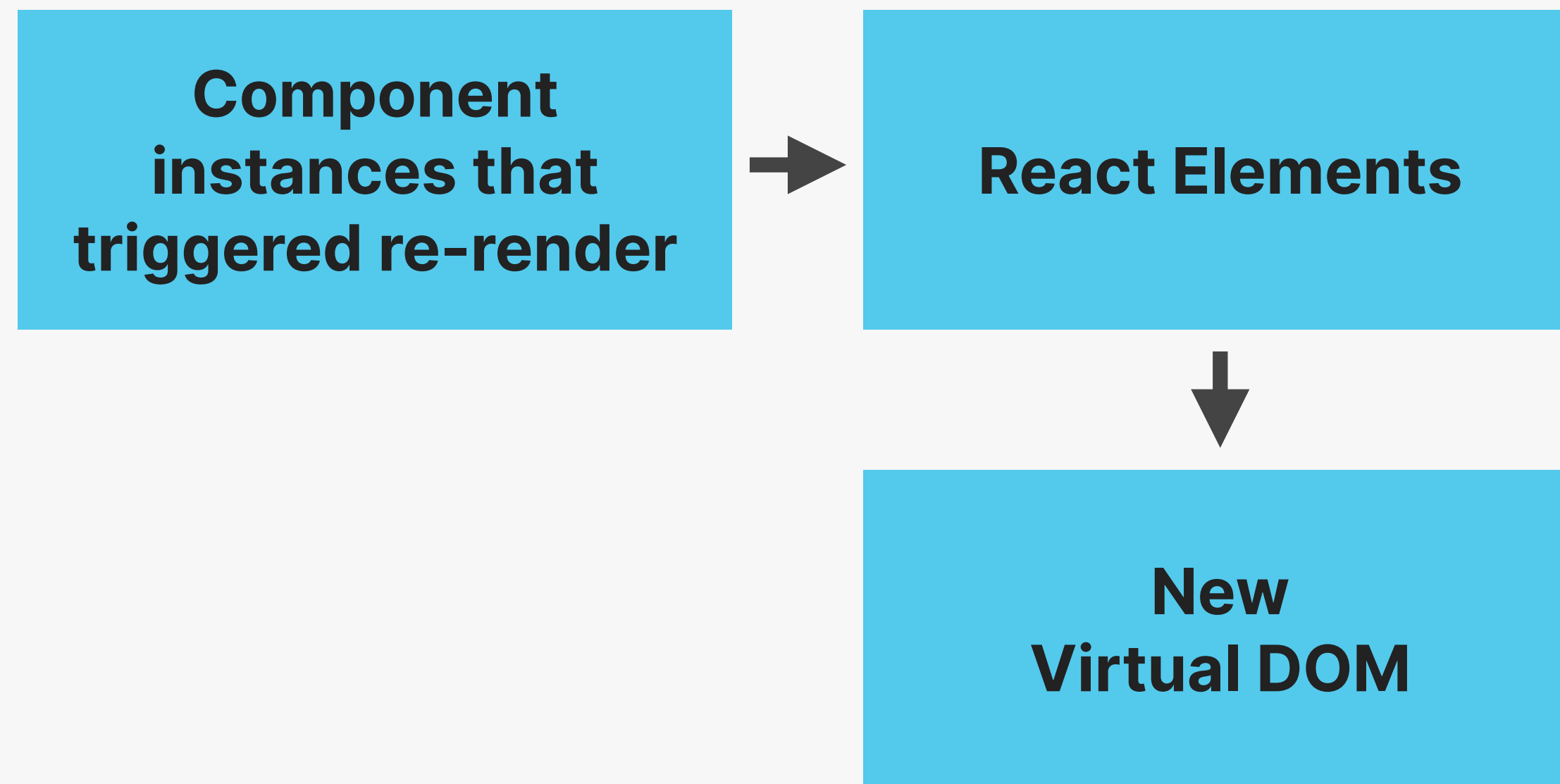


NOT TRUE #1: RENDERING IS UPDATING THE SCREEN / DOM

NOT TRUE #2: REACT COMPLETELY DISCARDS OLD VIEW (DOM) ON RE-RENDER

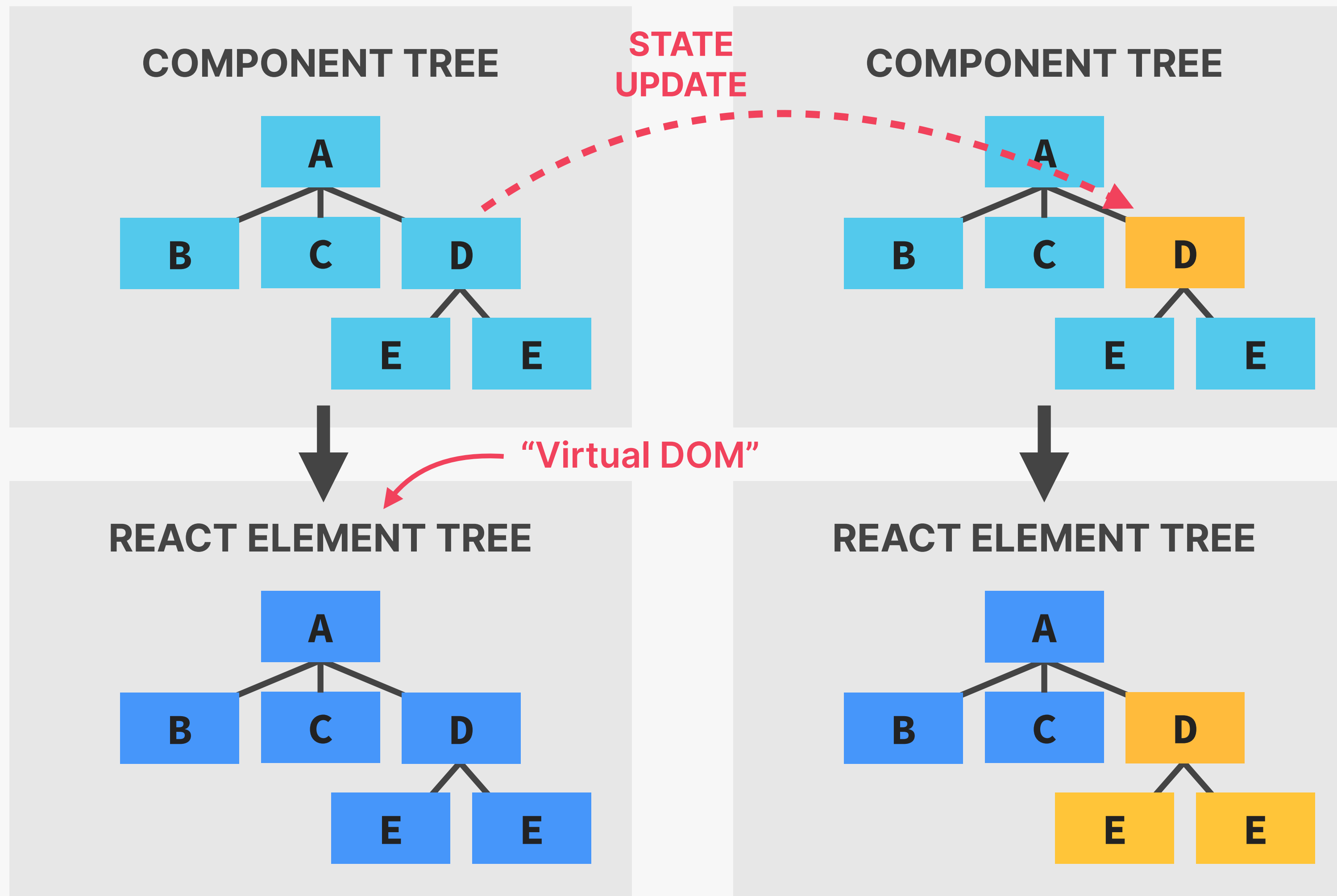
THE RENDER PHASE

[2] RENDER PHASE



THE VIRTUAL DOM (REACT ELEMENT TREE)

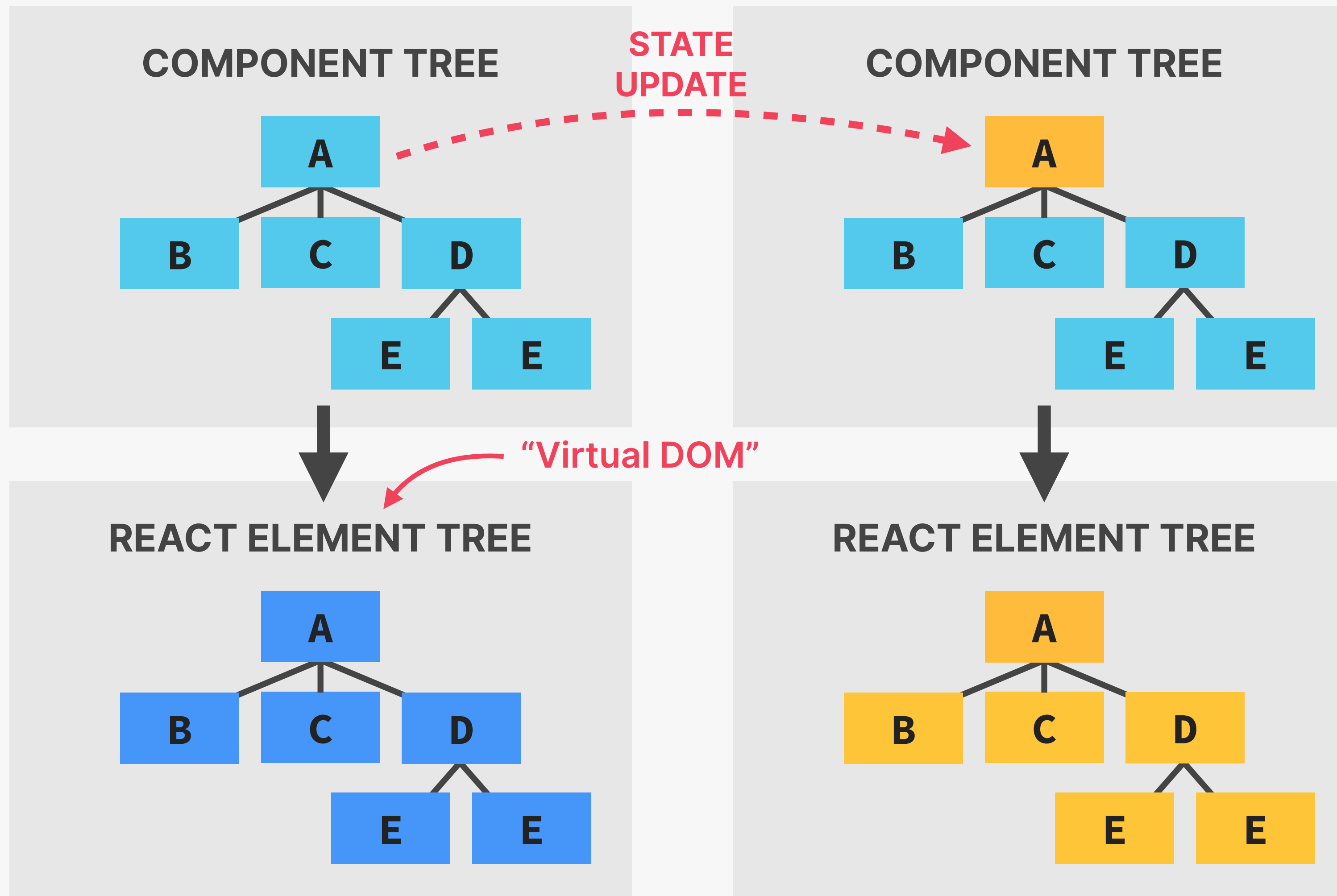
1 INITIAL RENDER → RE-RENDERS



- 👉 **Virtual DOM:** Tree of all React elements created from all instances in the component tree
- 👉 Cheap and fast to create multiple trees
- 👉 Nothing to do with "shadow DOM"
- 💣 Rendering a component will **cause all of its child components to be rendered as well** (no matter if props changed or not)

THE VIRTUAL DOM (REACT ELEMENT TREE)

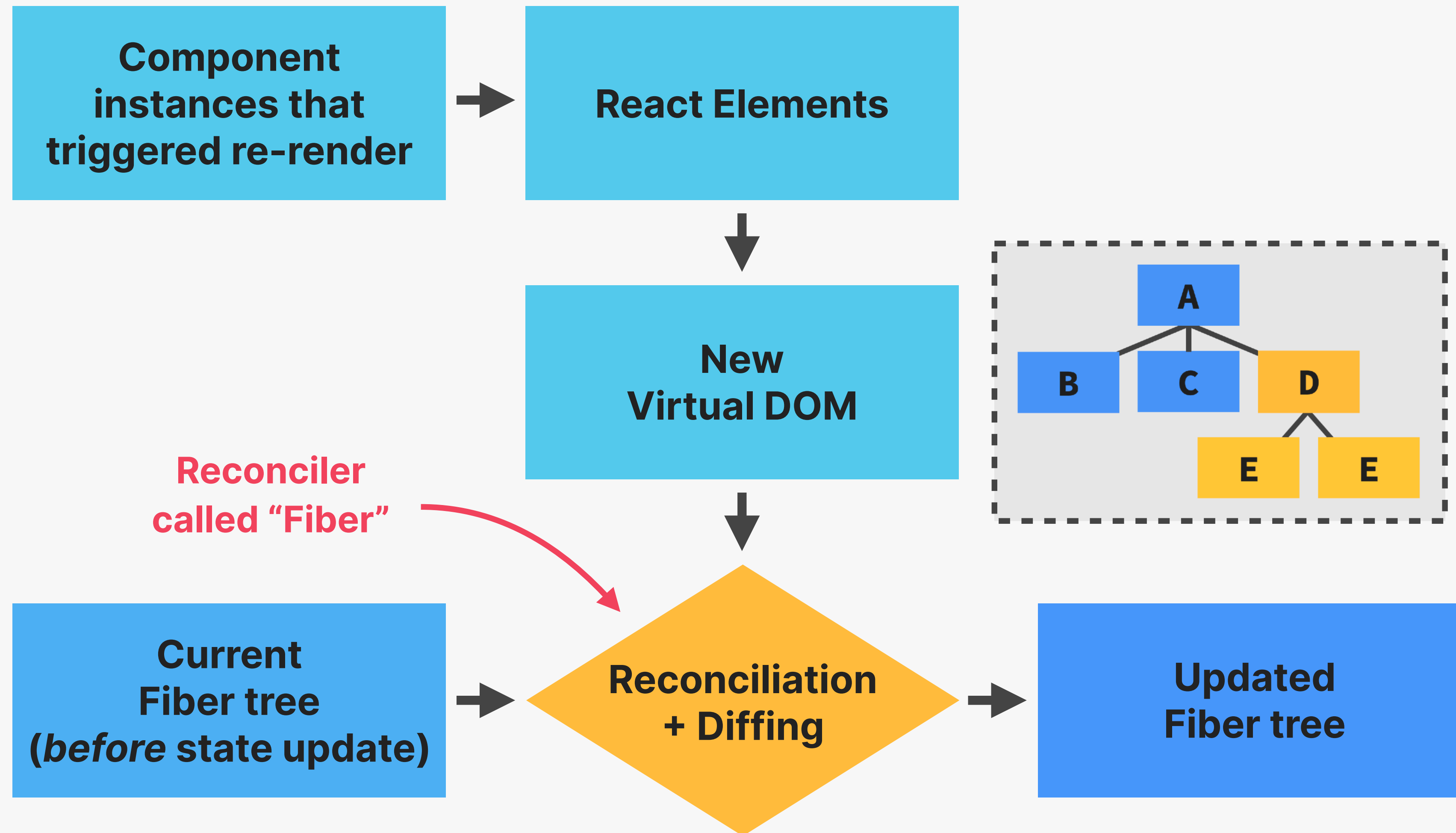
1 INITIAL RENDER → RE-RENDERS



- 👉 **Virtual DOM:** Tree of all React elements created from all instances in the component tree
- 👉 Cheap and fast to create multiple trees
- 👉 Nothing to do with "shadow DOM"
- 💣 Rendering a component will **cause all of its child components to be rendered as well** (no matter if props changed or not)
 - ↓
 - Necessary because React doesn't know whether children will be affected

THE RENDER PHASE

[2] RENDER PHASE



WHAT IS RECONCILIATION AND WHY DO WE NEED IT?

🤔 Why not update the entire DOM whenever state changes somewhere in the app?

↓ BECAUSE

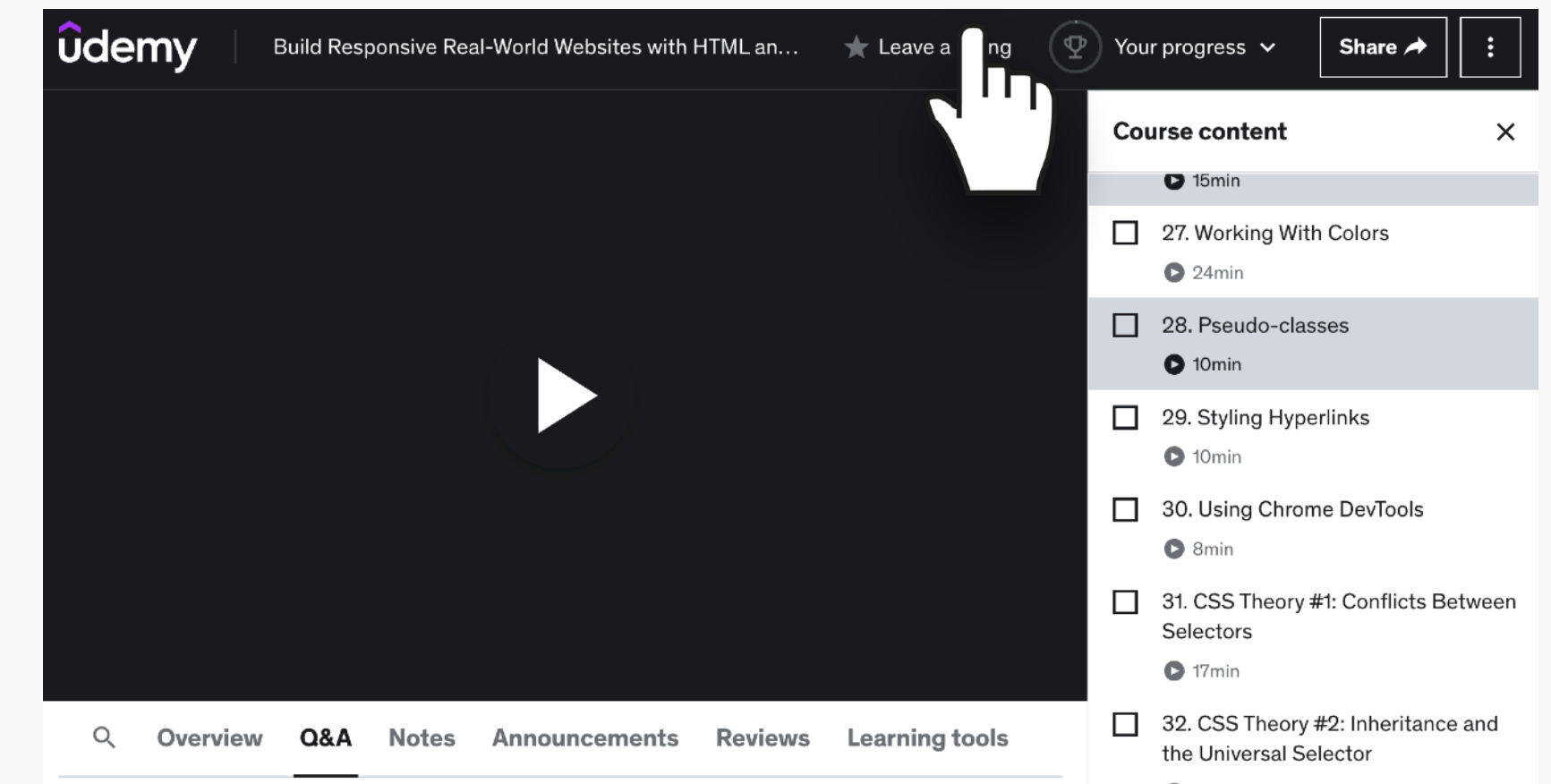
👉 That would be inefficient and wasteful:

- 1 Writing to the DOM is (relatively) **slow**
- 2 Usually only a **small part of the DOM** needs to be updated

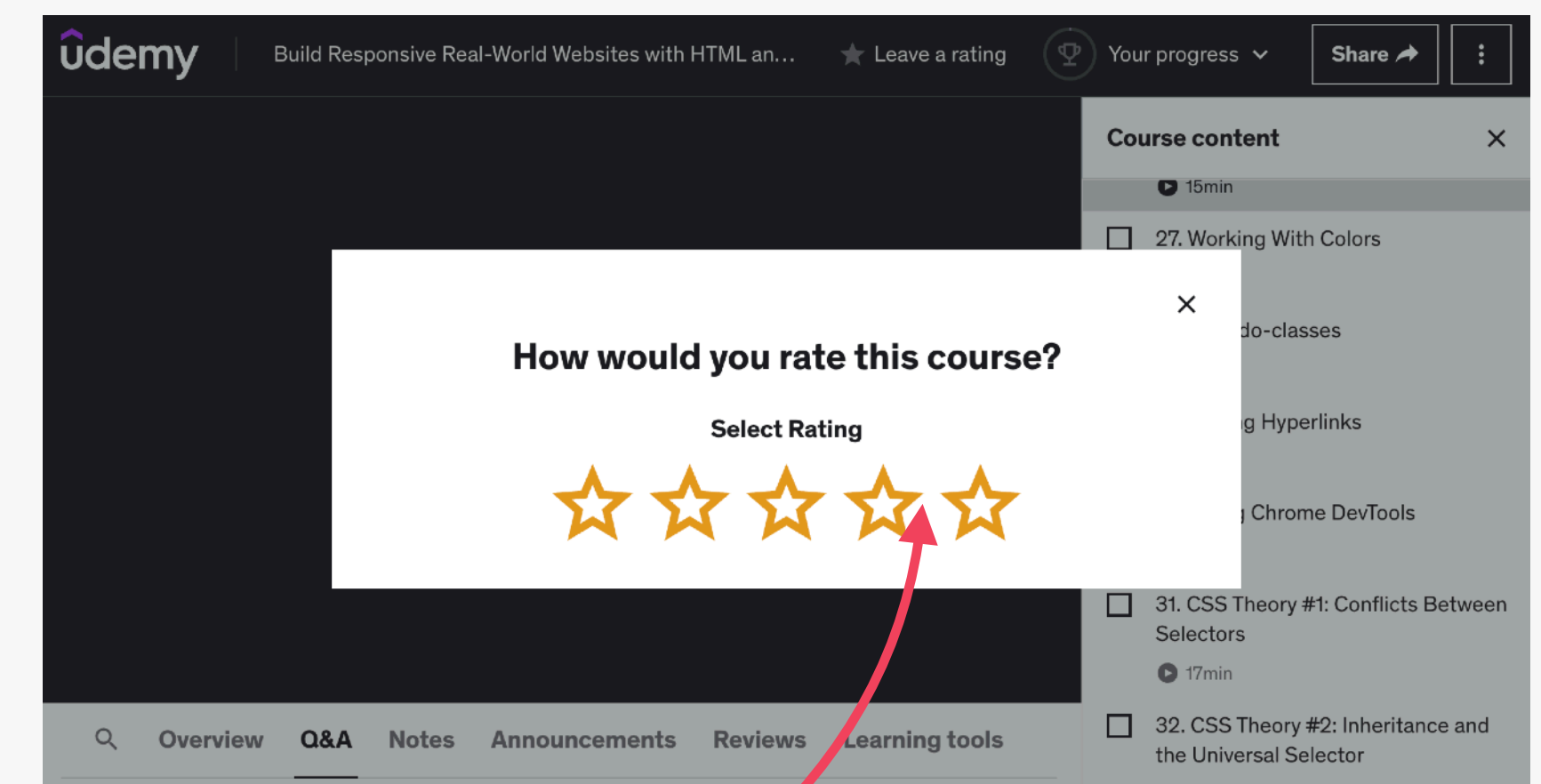
👉 React **reuses** as much of the existing DOM as possible

↓ HOW?

❤️ **Reconciliation:** Deciding which DOM elements actually need to be inserted, deleted, or updated, in order to reflect the latest state changes



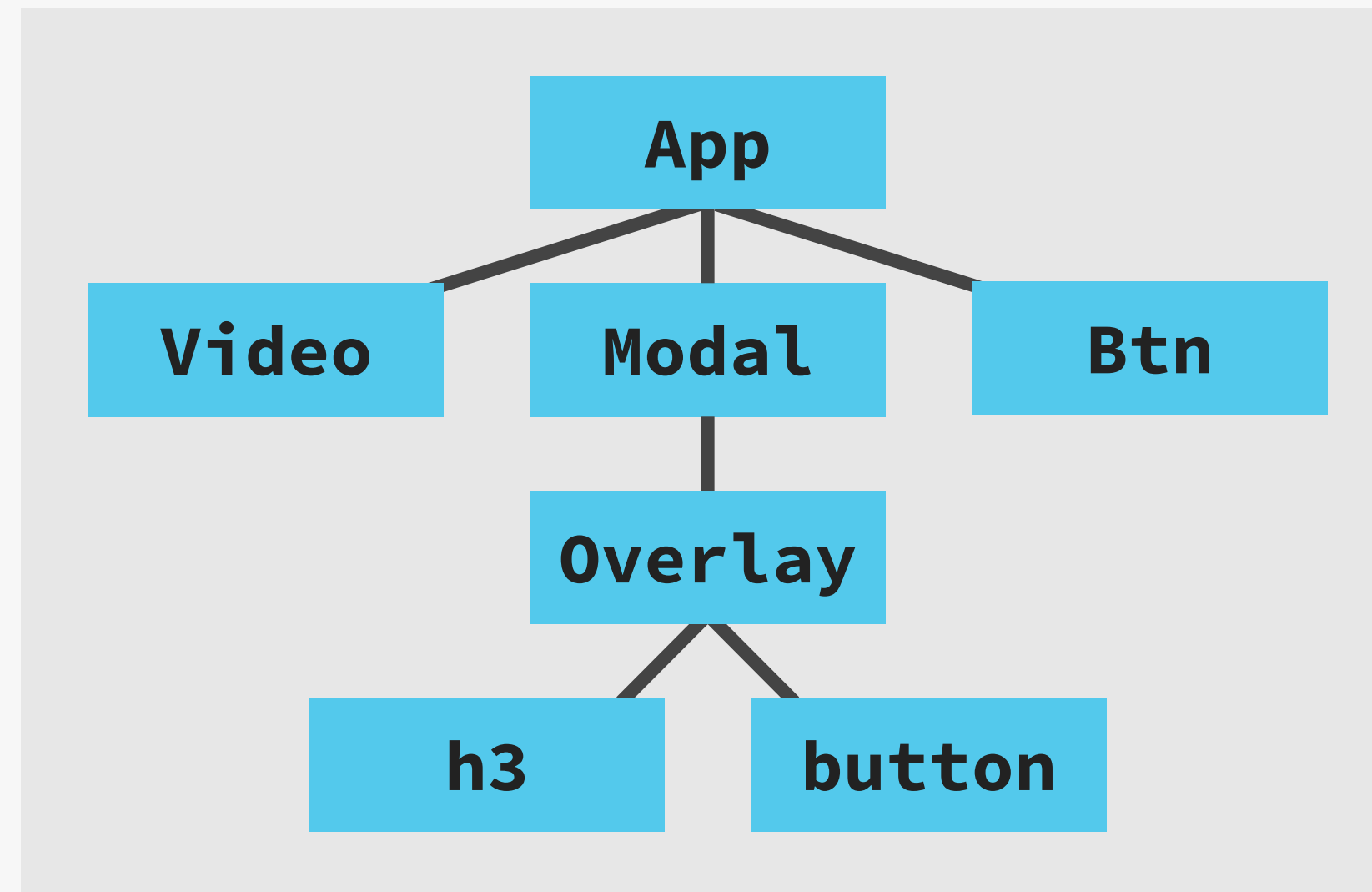
showModal = true



Only these new DOM elements are created

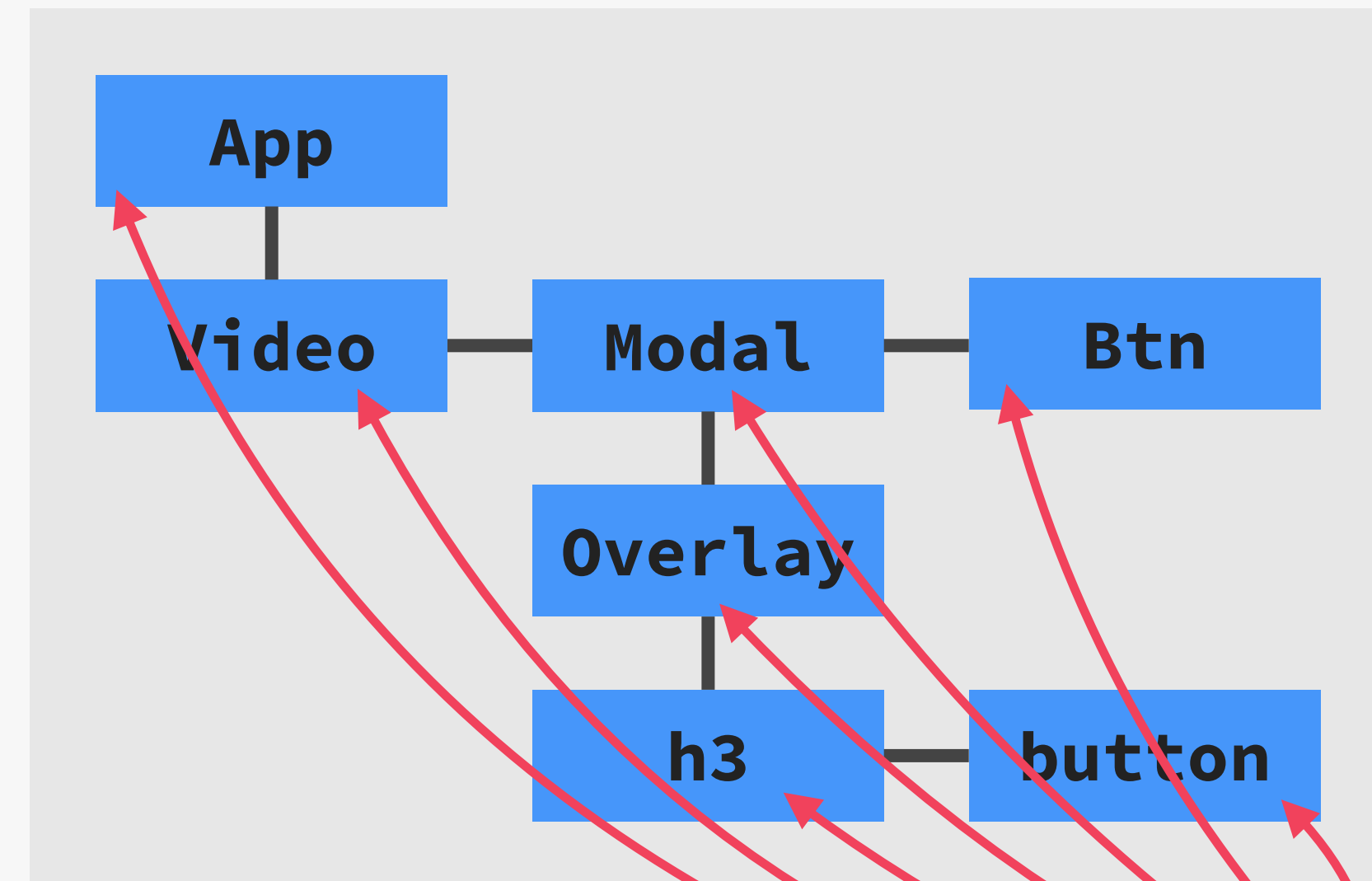
THE RECONCILER: FIBER

REACT
ELEMENT
TREE
(VIRTUAL
DOM)



ON INITIAL
RENDER

FIBER
TREE



- 👉 **Fiber tree:** internal tree that has a “fiber” for each component instance and DOM element
- 👉 Fibers are **NOT** re-created on every render
- 👉 Work can be done **asynchronously**

- 👉 Rendering process can be split into chunks, tasks can be prioritized, and work can be **paused, reused, or thrown away**
- 👉 Enables **concurrent features** like Suspense or transitions
- 👉 Long renders **won't block** JS engine

FIBER

“Unit of work”

Current state

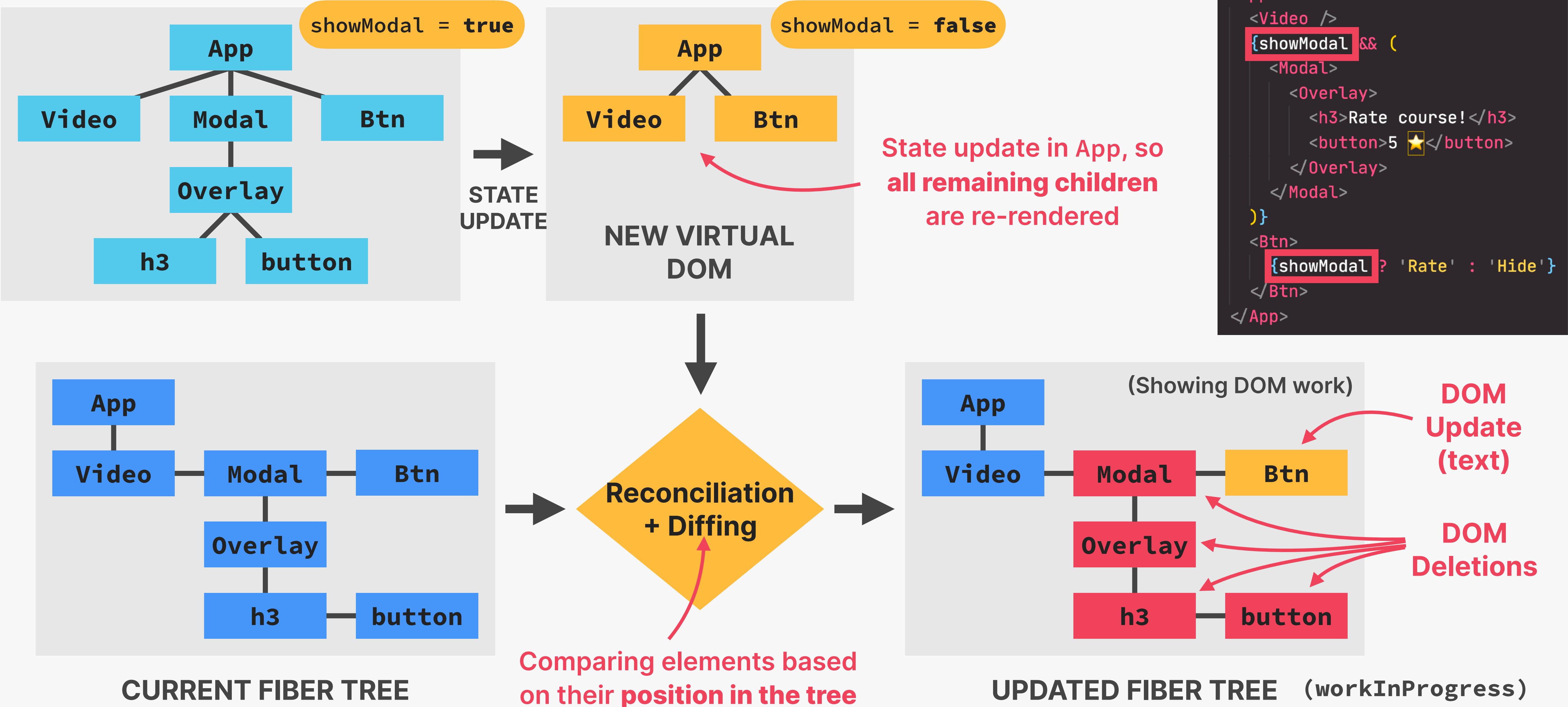
Props

Side effects

Used hooks

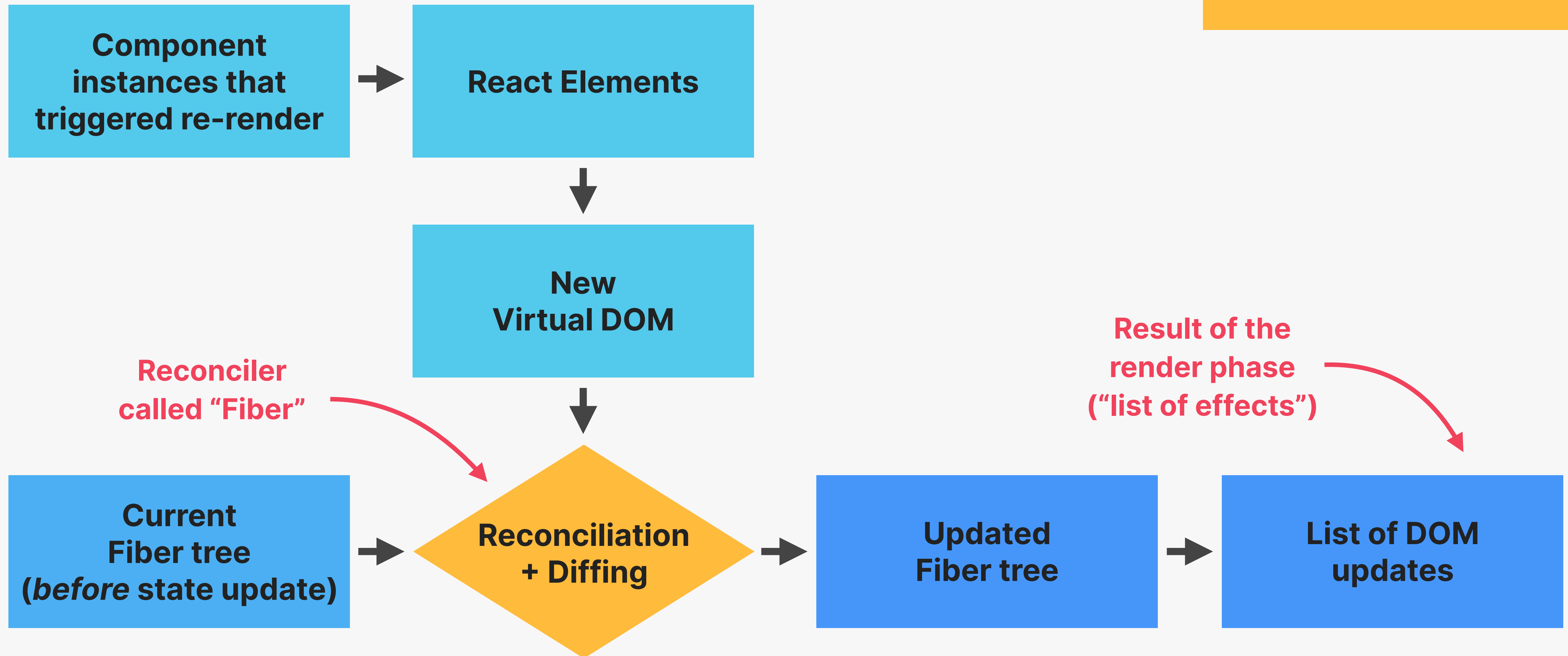
Queue of work

RECONCILIATION IN ACTION



THE RENDER PHASE

[2] RENDER PHASE





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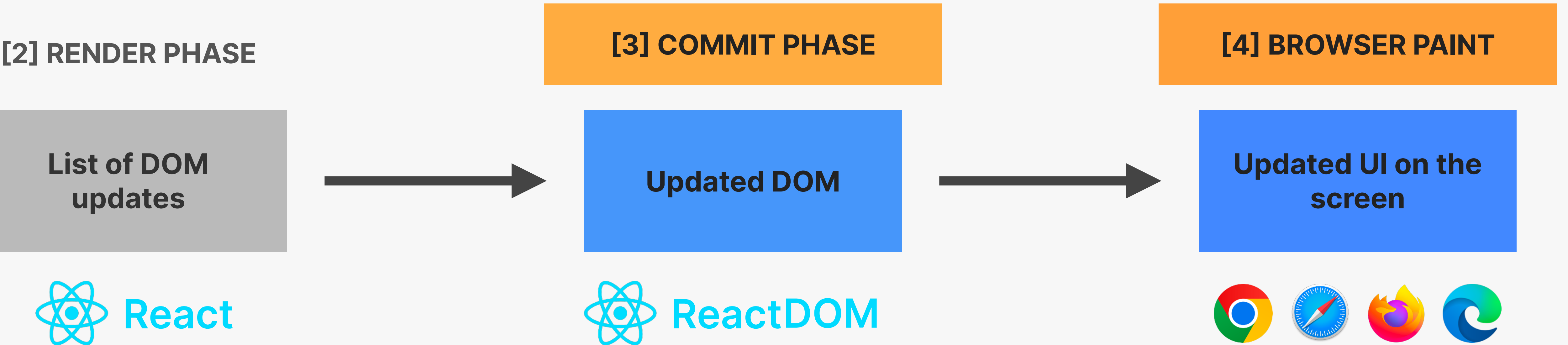
SECTION

HOW REACT WORKS BEHIND THE
SCENES

LECTURE

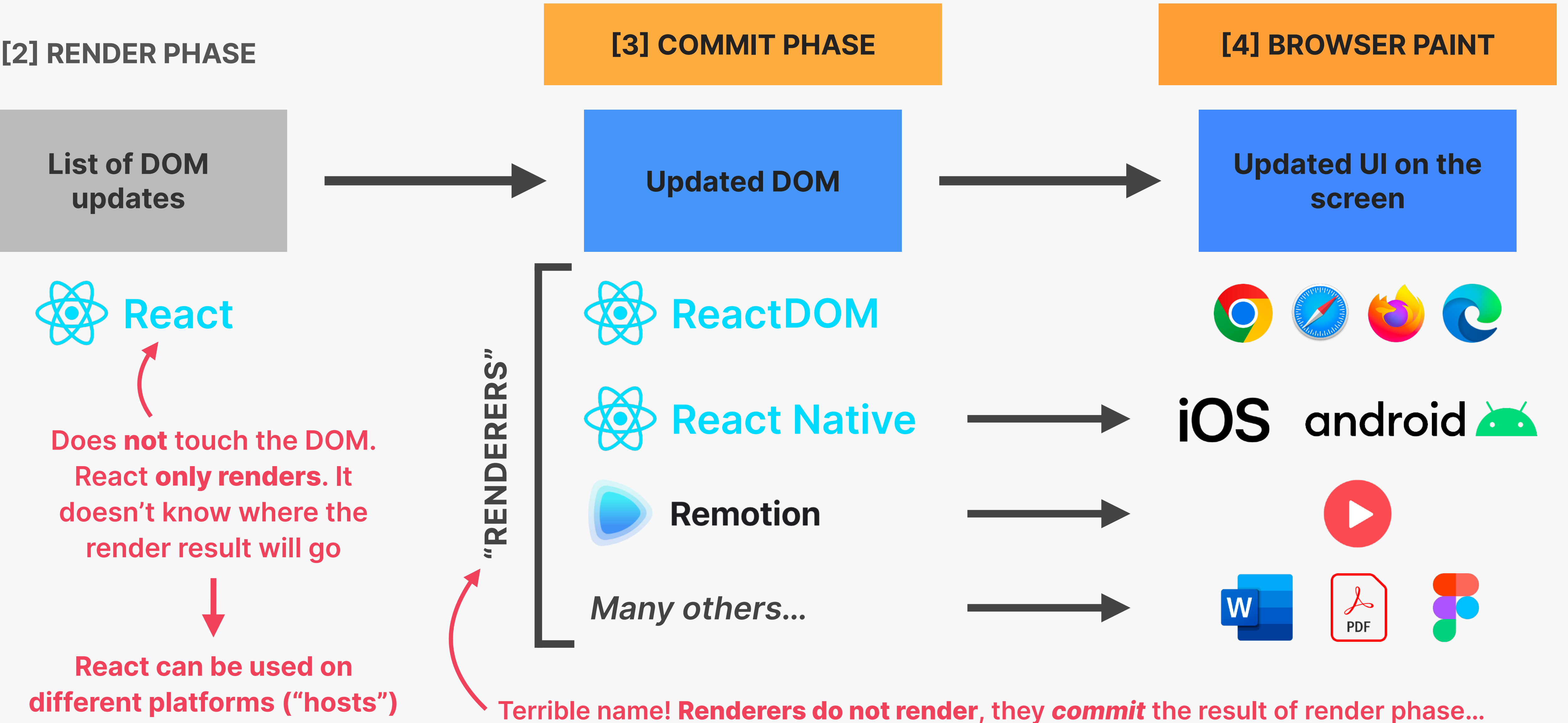
HOW RENDERING WORKS: THE
COMMIT PHASE

THE COMMIT PHASE AND BROWSER PAINT

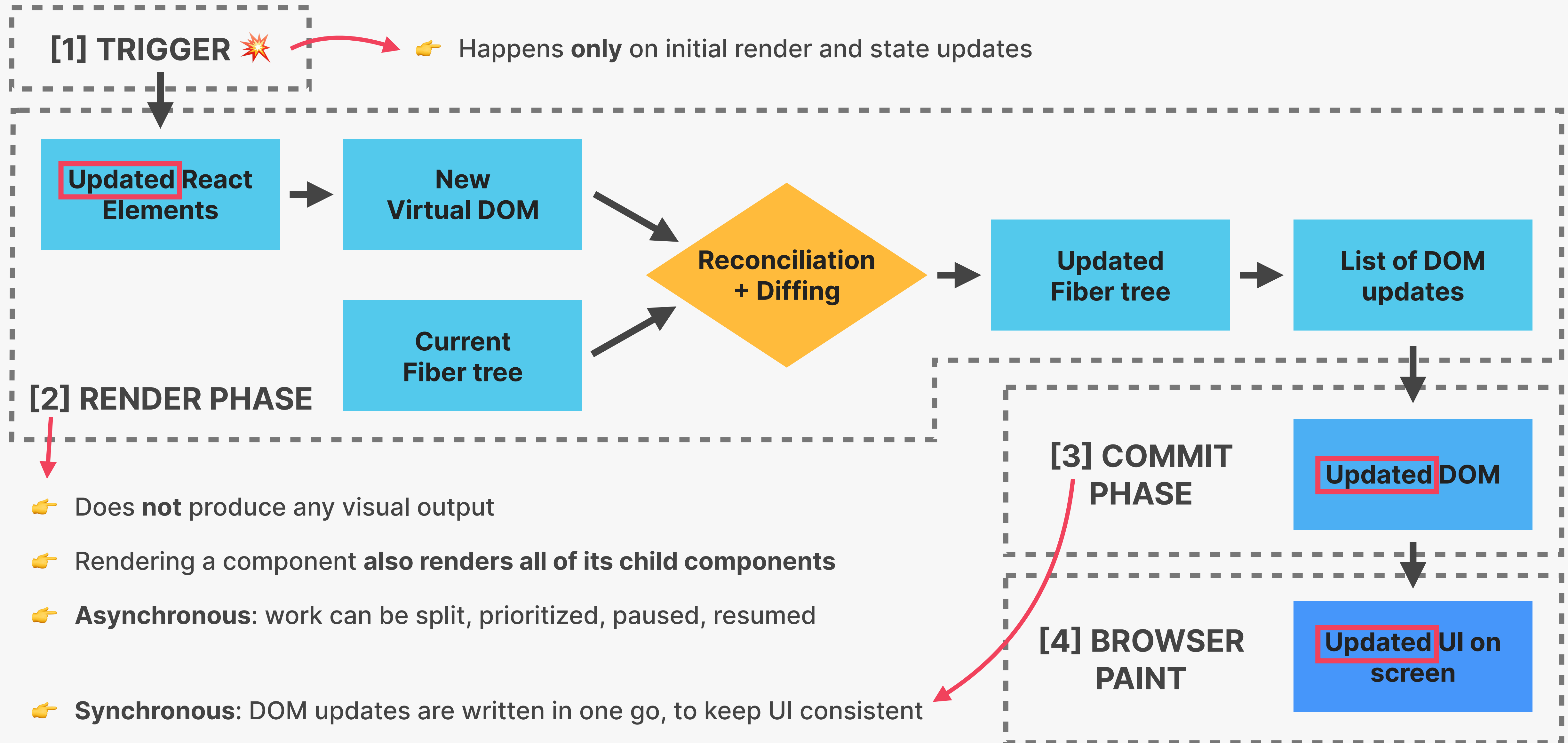


- 👉 **React writes to the DOM:** insertions, deletions, and updates (list of DOM updates are “flushed” to the DOM)
- 👉 **Committing is synchronous:** DOM is updated in one go, it can’t be interrupted. This is necessary so that the DOM never shows partial results, ensuring a consistent UI (in sync with state at all times)
- 👉 After the commit phase completes, the `workInProgress` fiber tree becomes the current tree **for the next render cycle**

THE COMMIT PHASE AND BROWSER PAINT



RECAP: PUTTING IT ALL TOGETHER





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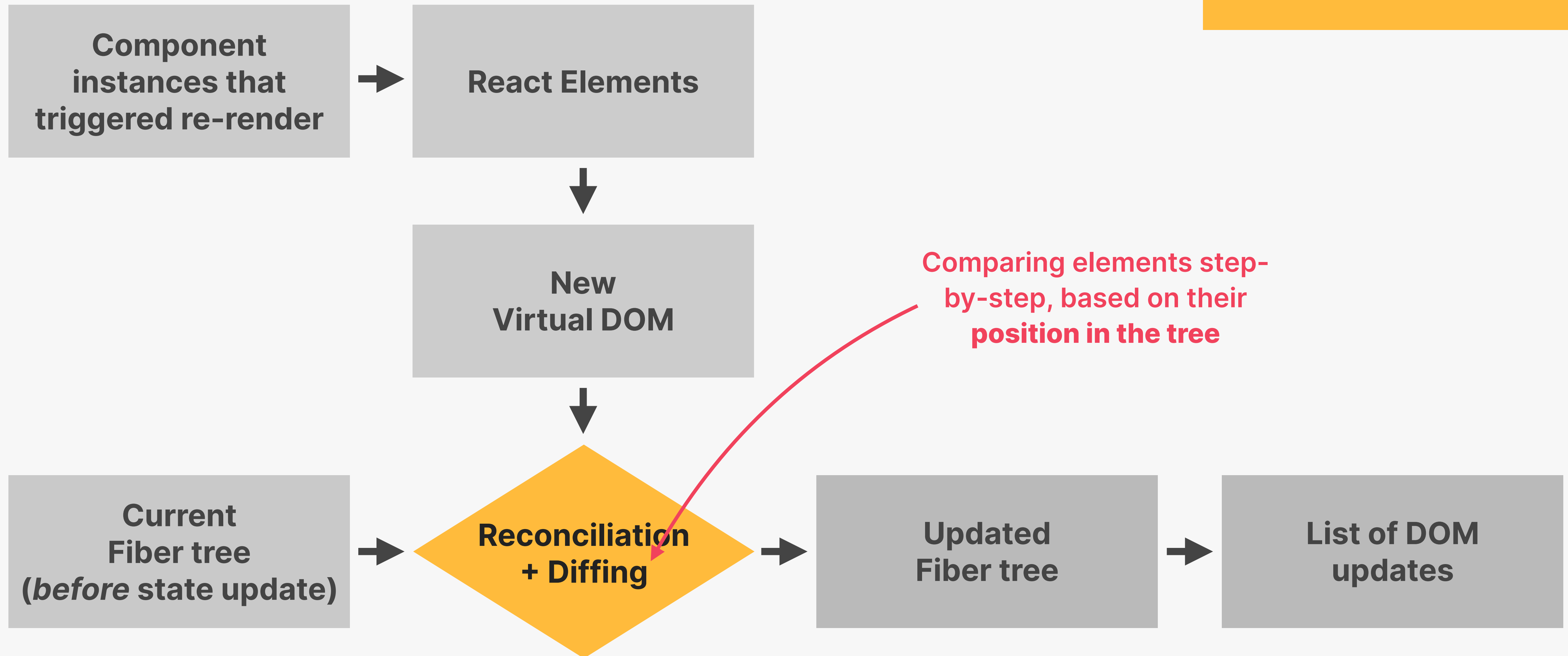
HOW REACT WORKS BEHIND THE
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HOW DIFFING WORKS

THE RENDER PHASE

[2] RENDER PHASE



HOW DIFFING WORKS

👉 Diffing uses 2 fundamental assumptions (rules):

1

Two elements of different types will produce different trees

2

Elements with a stable key prop stay the same across renders

👉 This allows React to go from 1,000,000,000 [$O(n^3)$] to 1000 [$O(n)$] operations per 1000 elements

1. SAME POSITION, DIFFERENT ELEMENT

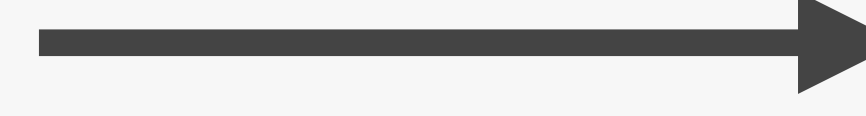
```
<div>  
| <SearchBar />  
</div>  
<main> ... </main>
```



Different
DOM element

```
<header>  
| <SearchBar />  
</header>  
<main> ... </main>
```

```
<div>  
| <SearchBar />  
</div>  
<main> ... </main>
```



Different React
element (component
instance)

```
<div>  
| <ProfileMenu />  
</div>  
<main> ... </main>
```

- 👉 React assumes **entire sub-tree is no longer valid**
- 👉 Old components are destroyed and removed from DOM, **including state**
- 👉 Tree might be rebuilt if children stayed the same (**state is reset**)

HOW DIFFING WORKS

👉 Diffing uses 2 fundamental assumptions (rules):

1

Two elements of different types will produce different trees

2

Elements with a stable key prop stay the same across renders

👉 This allows React to go from 1,000,000,000 [O(n³)] to 1000 [O(n)] operations per 1000 elements

2. SAME POSITION, SAME ELEMENT

```
<div className="hidden">
  <SearchBar />
</div>
<main> ... </main>
```



Same DOM element

```
<div className="active">
  <SearchBar />
</div>
<main> ... </main>
```

```
<div>
  <SearchBar wait={1} />
</div>
<main> ... </main>
```



Same React element
(component instance)

```
<div>
  <SearchBar wait={5} />
</div>
<main> ... </main>
```

- 👉 Element will be kept (as well as child elements), including state
- 👉 New props / attributes are passed if they changed between renders
- 👉 Sometimes this is **not** what we want... Then we can use the key prop



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THE KEY PROP

WHAT IS THE KEY PROP?

KEY PROP

- 👉 Special prop that we use to tell the diffing algorithm that an element is **unique**
- 👉 Allows React to **distinguish** between multiple instances of the same component type
- 👉 When a key **stays the same across renders**, the element will be kept in the DOM
(*even if the position in the tree changes*)

1 *Using keys in lists*

- 👉 When a key **changes between renders**, the element will be destroyed and a new one will be created (*even if the position in the tree is the same as before*)

2 *Using keys to reset state*

1. KEYS IN LISTS [STABLE KEY]



NO KEYS

```
<ul>
  <Question question={q[1]} />
  <Question question={q[2]} />
</ul>
```



ADDING NEW LIST ITEM

```
<ul>
  <Question question={q[0]} />
  <Question question={q[1]} />
  <Question question={q[2]} />
</ul>
```



👉 Same elements, but **different position in tree**, so they are removed and recreated in the DOM (*bad for performance*)



WITH KEYS

```
<ul>
  <Question key='q1' question={q[1]} />
  <Question key='q2' question={q[2]} />
</ul>
```



ADDING NEW LIST ITEM

```
<ul>
  <Question key='q0' question={q[0]} />
  <Question key='q1' question={q[1]} />
  <Question key='q2' question={q[2]} />
</ul>
```



👉 Different position in the tree, but the **key stays the same**, so the elements will be kept in the DOM 👉 **Always use keys!**

2. KEY PROP TO RESET STATE [CHANGING KEY]

👉 If we have the same element at the same position in the tree, the **DOM element and state** will be kept

```
<QuestionBox>
  <Question
    question={{
      title: 'React vs JS',
      body: 'Why should we use React?',
    }}
    key="q23"
  />
</QuestionBox>
```

➡
NEW QUESTION IN
SAME POSITION

```
<QuestionBox>
  <Question
    question={{
      title: 'Best course ever :D',
      body: 'This is THE React course!',
    }}
  />
</QuestionBox>
```

Question state (answer):

React allows us to build apps faster |

Question state (answer):

React allows us to build apps faster |

State was
preserved. NOT
what we want

2. KEY PROP TO RESET STATE [CHANGING KEY]



WITH KEY

👉 If we have the same element at the same position in the tree, the **DOM element** and **state** will be kept

```
<QuestionBox>
  <Question
    question={{
      title: 'React vs JS',
      body: 'Why should we use React?',
    }}
    key="q23"
  />
</QuestionBox>
```

NEW QUESTION IN
SAME POSITION

```
<QuestionBox>
  <Question
    question={{
      title: 'Best course ever :D',
      body: 'This is THE React course!',
    }}
    key="q89"
  />
</QuestionBox>
```

Question state (answer):

React allows us to build apps faster |

Question state (answer):

State was
RESET



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HOW REACT WORKS BEHIND THE
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RULES FOR RENDER LOGIC: PURE
COMPONENTS

THE TWO TYPES OF LOGIC IN REACT COMPONENTS

1. RENDER LOGIC

- 👉 Code that lives at the **top level** of the component function
- 👉 Participates in **describing** how the component view looks like
- 👉 Executed **every time** the component renders

2. EVENT HANDLER FUNCTIONS

- 👉 Executed as a **consequence of the event** that the handler is listening for (change event in this example)
- 👉 Code that actually **does things**: update state, perform an HTTP request, read an input field, navigate to another page, etc.

```
function Question({ question }) {  
  const [newAnswer, setNewAnswer] = useState('');  
  const numAnswers = question.answers.length ?? 0;  
  
  const handleNewAnswer = function (e) {  
    if (question.closed) return;  
    setNewAnswer(e.target.value);  
  };  
  
  const createList = function () {  
    return (  
      <ul>  
        {question.answers.map((q) => (  
          <li>{q}</li>  
        ))}  
      </ul>  
    );  
  };  
  
  return (  
    <div>  
      <h3>{question.title}</h3>  
      <p>{question.body}</p>  
      {question.hasAnswer ? (  
        createList()  
      ) : (  
        <input  
          value={newAnswer}  
          onChange={handleNewAnswer}  
        />  
      )}  
    </div>  
  );  
}
```


REFRESHER: FUNCTIONAL PROGRAMMING PRINCIPLES

👉 **Side effect:** dependency on or modification of any data outside the function scope. *“Interaction with the outside world”*. Examples: mutating external variables, HTTP requests, writing to DOM.



Side effects are not bad! A program can only be useful if it has some interaction with the outside world

👉 **Pure function:** a function that has **no** side effects.

👉 Does **not** change any variables outside its scope

👉 Given the **same input**, a pure function always returns the **same output**



Pure function

```
function circleArea(r) {  
  return 3.14 * r * r;  
}
```



Impure function

```
const areas = {};  
  
function circleArea(r) {  
  areas.circle = 3.14 * r * r;  
}
```

Side effect: Outside variable mutation



Impure function

```
function circleArea(r) {  
  const date = Date.now();  
  const area = 3.14 * r * r;  
  return `${date}: ${area}`;  
}
```

Unpredictable output (date changes)

RULES FOR RENDER LOGIC

👉 **Components must be pure when it comes to render logic:** given the same props (input), a component instance should always return the same JSX (output)

👉 **Render logic must produce no side effects:** no interaction with the “outside world” is allowed. So, in render logic:

👉 Do NOT perform **network requests** (API calls)

👉 Do NOT start **timers**

👉 Do NOT directly **use the DOM API**

👉 Do NOT **mutate objects or variables** outside of the function scope

👉 Do NOT **update state (or refs)**: this will create an infinite loop!

This is why we can't
mutate props!

👋 Side effects are allowed (and encouraged) in **event handler functions!**
There is also a special hook to **register side effects** (useEffect)



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STATE UPDATE BATCHING

HOW STATE UPDATES ARE BATCHED

- 👉 Renders are **not** triggered immediately, but **scheduled** for when the JS engine has some “free time”. There is also batching of multiple `setState` calls in event handlers

```
const [answer, setAnswer] = useState('');
const [best, setBest] = useState(true);
const [solved, setSolved] = useState(false);

const reset = function () {
  setAnswer('');
  console.log(answer);
  setBest(true);
  setSolved(false);
};

return (
  <div>
    <button onClick={reset}>Reset</button>
    { /* ... */ }
  </div>
);
```

**Event
handler
function**

HOW STATE UPDATES ARE BATCHED

EVENT HANDLER FUNCTION

```
const reset = function () {  
  setAnswer('')  
  console.log(answer);  
  setBest(true)  
  setSolved(false)  
};
```

NEW STATE

answer = ''

best = true

solved = false

RENDER + COMMIT

RENDER + COMMIT

RENDER + COMMIT

This is NOT how React updates
multiple pieces of state in the
same event handler

HOW STATE UPDATES ARE BATCHED

EVENT HANDLER FUNCTION

```
const reset = function () {  
  setAnswer('')  
  console.log(answer);  
  setBest(true)  
  setSolved(false)  
};
```

NEW STATE

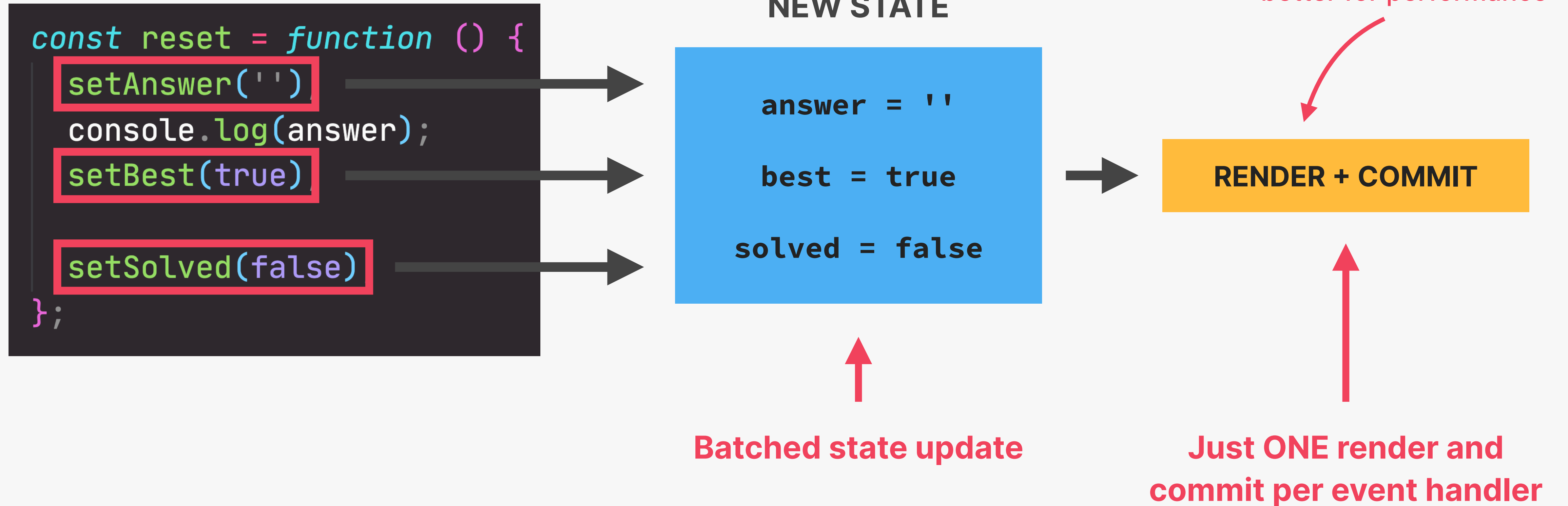
```
answer = ''  
  
best = true  
  
solved = false
```

RENDER + COMMIT

No wasted renders,
better for performance

Batched state update

Just ONE render and
commit per event handler



UPDATING STATE IS ASYNCHRONOUS

EVENT HANDLER FUNCTION

```
const reset = function () {  
  setAnswer('')  
  console.log(answer)  
  setBest(true)  
  setSolved(false)  
};
```



What will the value of answer be at this point?

State is stored in the Fiber tree during render phase



At this point, re-render has not happened yet



Therefore, answer still contains current state, not the updated state ('')



UPDATING STATE IN REACT IS ASYNCHRONOUS

"Stale state"

- 👉 Updated state variables are **not** immediately available after setState call, but only after the re-render
- 👉 This also applies when **only one** state variable is updated
- 👉 If we need to update state **based on previous update**, we use setState with callback (setAnswer(answer=>...))

BATCHING BEYOND EVENT HANDLER FUNCTIONS

👉 We can **opt out** of automatic batching by wrapping a state update in `ReactDOM.flushSync()` *(but you will never need this)*

```
const reset = function () {
  setAnswer('');
  console.log(answer);
  setBest(true);

  setSolved(false);
};
```

We now get automatic batching
at all times, everywhere

👉 **AUTOMATIC BATCHING IN...**

REACT 17

REACT 18+

EVENT HANDLERS

```
<button onClick={reset}>Reset</button>
```



TIMEOUTS

```
setTimeout(reset, 1000);
```



PROMISES

```
fetchStuff().then(reset);
```



NATIVE EVENTS

```
el.addEventListener('click', reset);
```





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HOW EVENTS WORK IN REACT

DOM REFRESHER: EVENT PROPAGATION AND DELEGATION

EVENT

1

CAPTURING PHASE

- By default, event handlers listen to events on the target **and** during the bubbling phase
- We can **prevent bubbling** with `e.stopPropagation()`

2

TARGET ELEMENT

3

BUBBLING PHASE

DOM tree (not
Fiber tree or React
element tree)

EVENT DELEGATION

- Handling events for multiple elements centrally in **one single parent element**
- Better for performance and memory, as it needs only **one handler function**

1

Add handler to **parent** (`.options`)

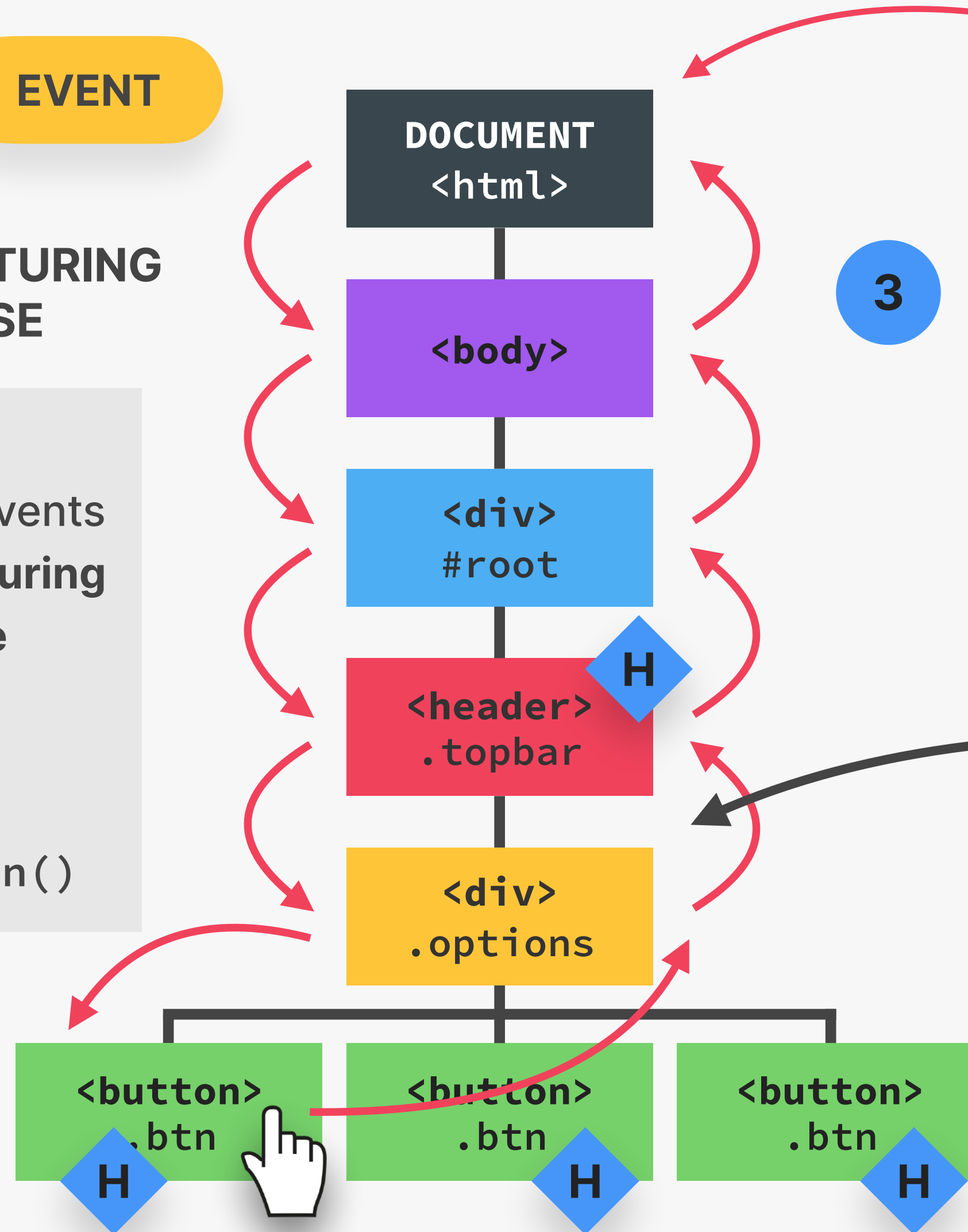
2

Check for **target** element (`e.target`)

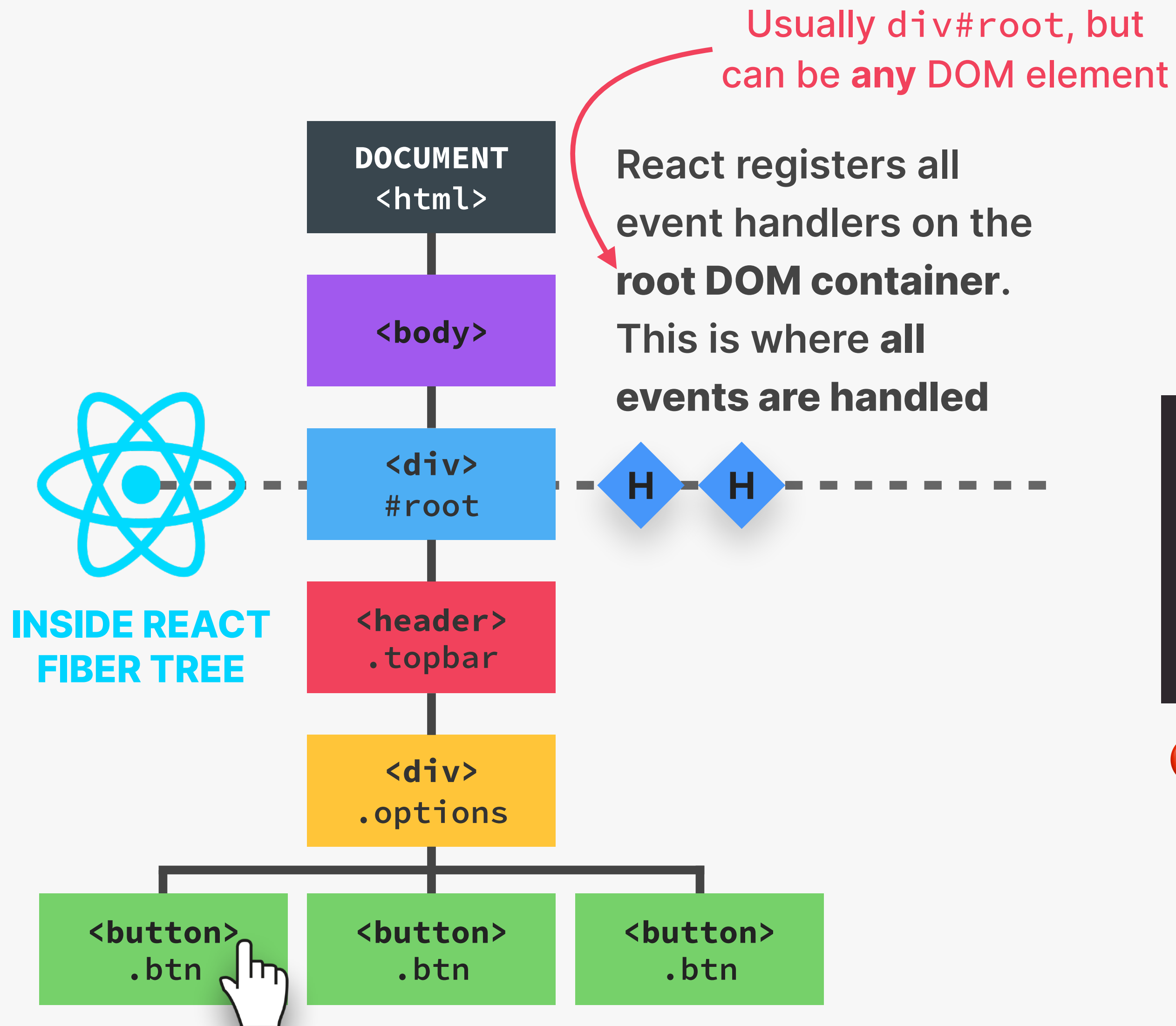
3

If **target** is one of the `<button>`s, handle the event

Very common in vanilla JS apps, but not so much in React apps



HOW REACT HANDLES EVENTS



WHEN WE ATTACH AN EVENT HANDLER...

```
<button
  className="btn"
  onClick={() => setLoading(true)}
/>
```

```
document
  .querySelector('.btn')
  .addEventListener(
    'click',
    () => setLoading(true)
  );
```



... WHAT APPEARS
TO BE HAPPENING

```
document
  .querySelector('#root')
  .addEventListener(
    'click',
    () => setLoading(true)
  );
```

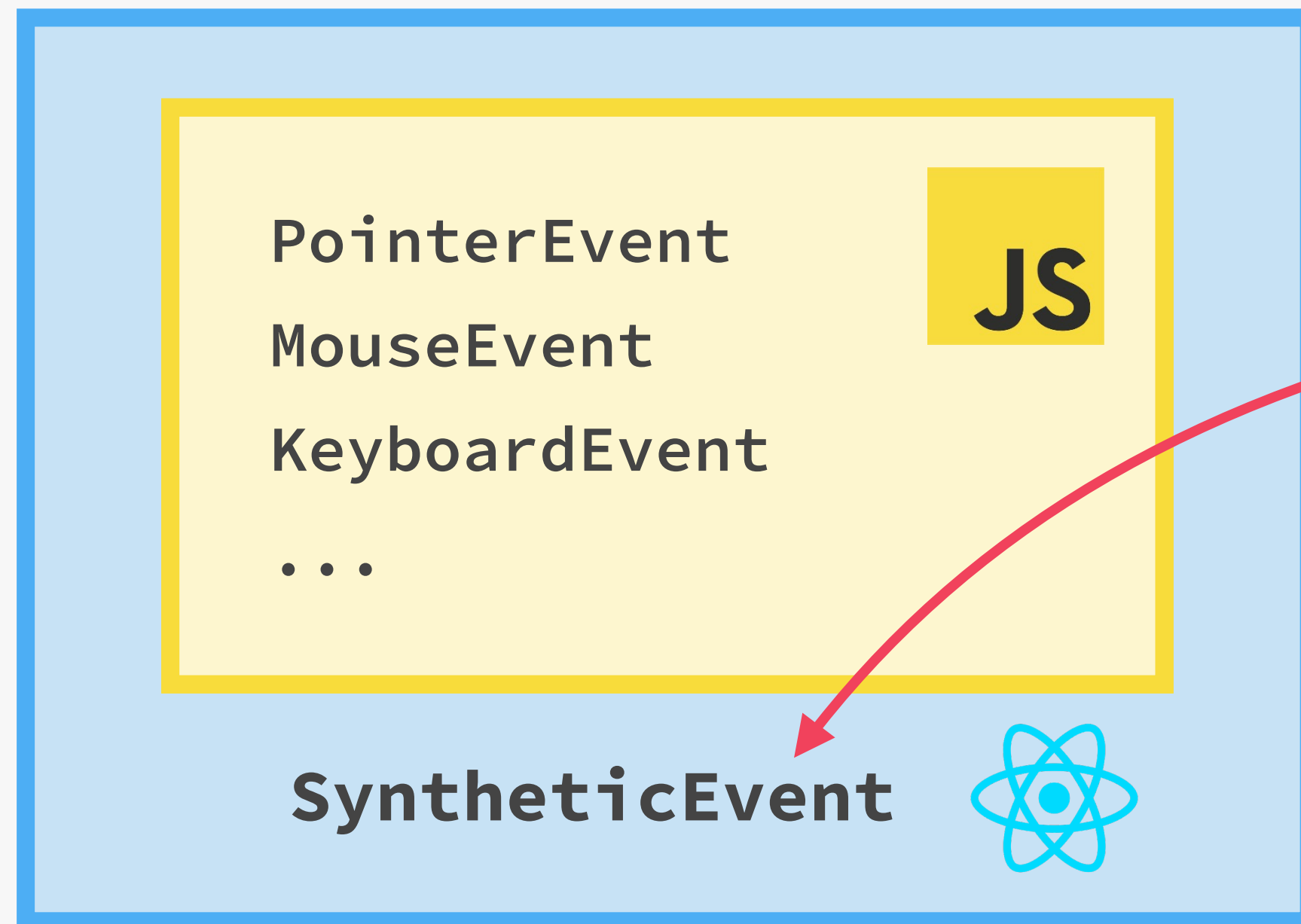


... WHAT ACTUALLY
HAPPENS INTERNALLY



Behind the scenes, React performs **event delegation** for all events in our applications

SYNTHETIC EVENTS

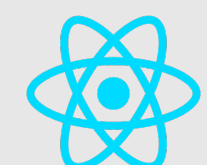


```
<input onChange={e} => setText(e.target.value)} />
```

- 👉 Wrapper around the DOM's native event object
- 👉 Has **same interface** as native event objects, like `stopPropagation()` and `preventDefault()`
- 👉 Fixes browser inconsistencies, so that events work in the exact **same way in all browsers**
- 👉 **Most synthetic events bubble** (including focus, blur, and change), except for scroll

EVENT

HANDLERS IN



VS.

JS

- 👉 Attributes for event handlers are named using **camelCase** (`onClick` instead of `onclick` or `click`)
- 👉 Default behavior can **not** be prevented by returning `false` (only by using `preventDefault()`)
- 👉 Attach "Capture" if you need to handle during **capture phase** (example: `onClickCapture`)



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LIBRARIES VS. FRAMEWORKS &
THE REACT ECOSYSTEM

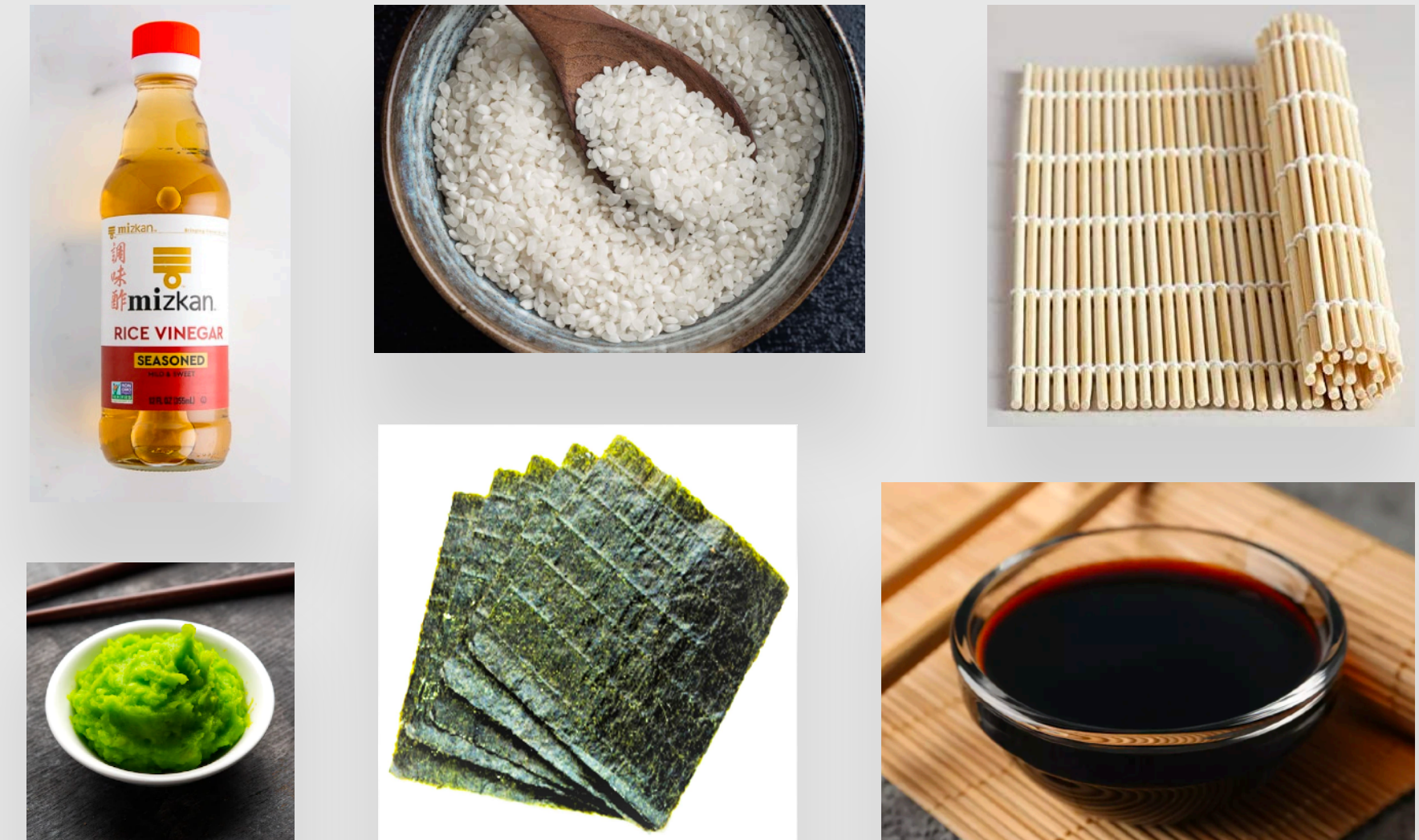
FIRST, AN ANALOGY 🍣

ALL-IN-ONE KIT



- 👍 **Ease of mind:** All ingredients are included
- 👎 **No choice:** You're stuck with the kit's ingredients

SEPARATE INGREDIENTS



- 👍 **Freedom:** You can choose the best ingredients
- 👎 **Decision fatigue:** You need to research and buy all ingredients separately

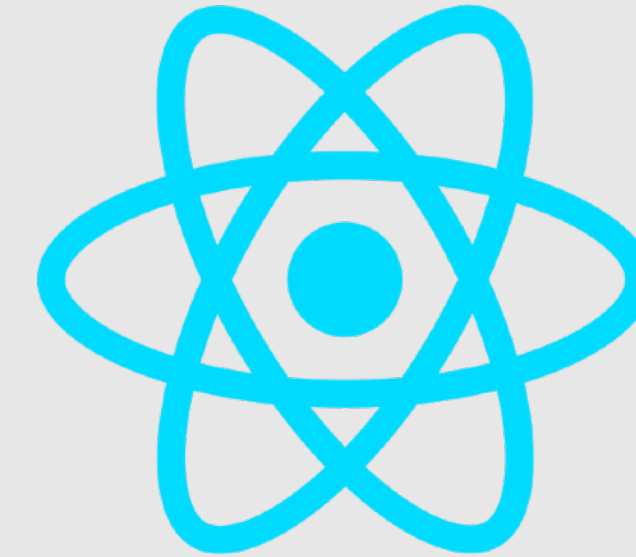
FIRST, AN ANALOGY 🍣

ALL-IN-ONE KIT



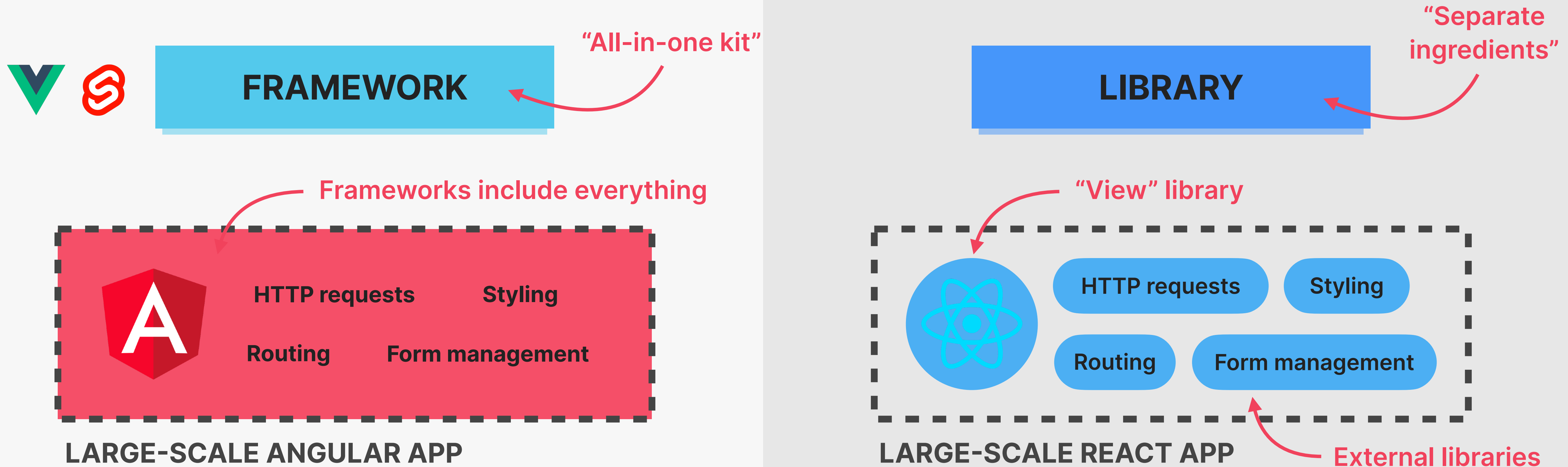
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SEPARATE INGREDIENTS



- 👍 **Freedom:** You can choose the best ingredients
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FRAMEWORK VS. LIBRARY











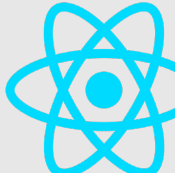


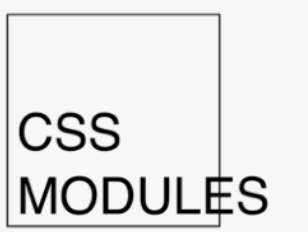
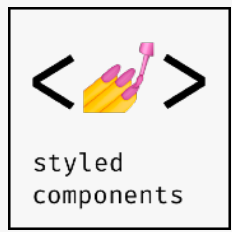




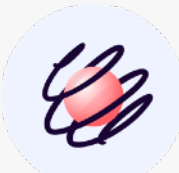



👍 **Ease of mind:** Everything you need to build a complete application **is included** in the framework ("batteries included")

👎 **No choice:** You're stuck with the framework's tools and conventions (which is not always bad!)

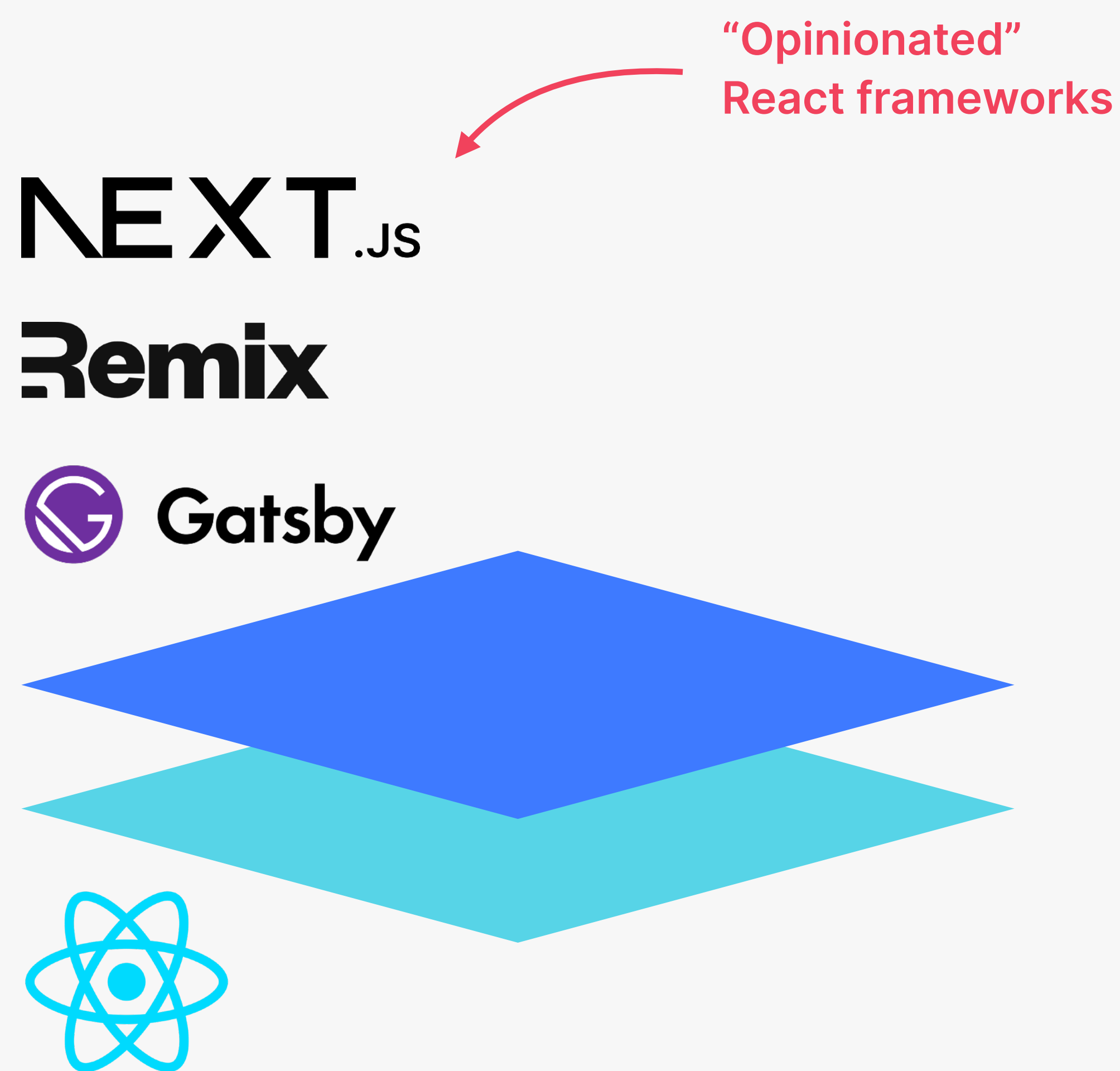
👍 **Freedom:** You can (or *need* to) **choose multiple 3rd-party libraries** to build a complete application

👎 **Decision fatigue:** You need to **research, download, learn, and stay up-to-date** with multiple external libraries

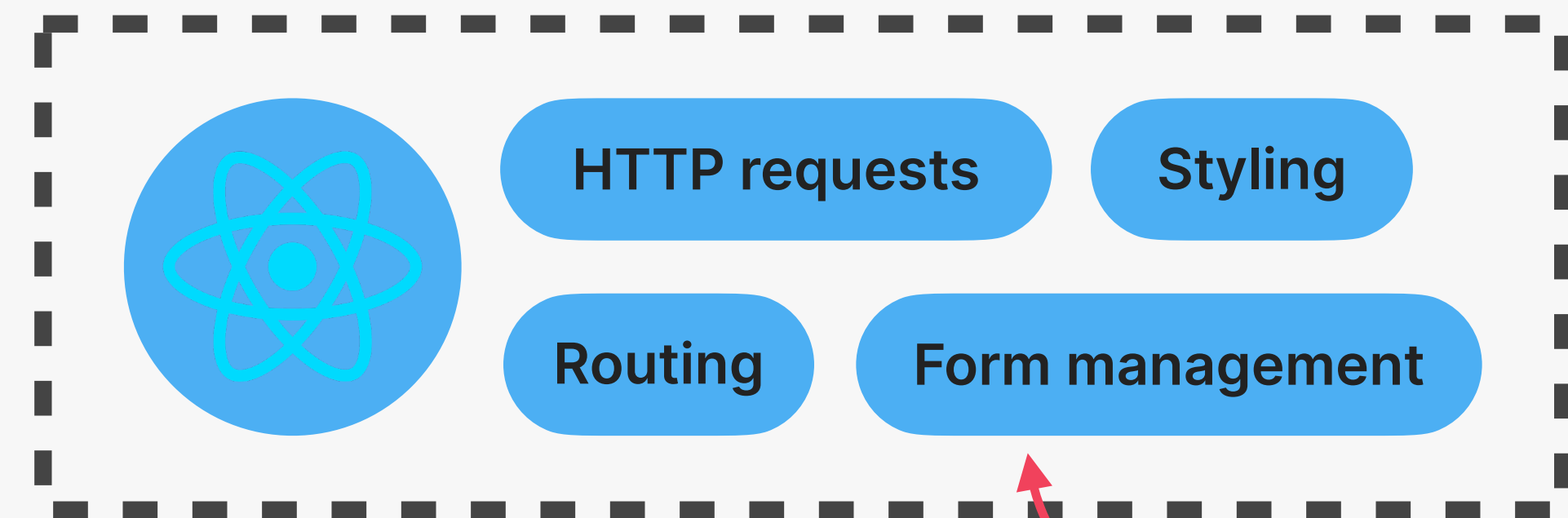
REACT 3RD-PARTY LIBRARY ECOSYSTEM

1	Routing (for SPAs)	 React Router	 React Location	 Library options for different React application needs
2	HTTP requests	 fetch()		
3	Remote state management	 React Query	 SWR	
4	Global state management	 Context API	 Redux	 Zustand
5	Styling	 CSS MODULES	 styled components	 tailwindcss
6	Form management	 React Hook Form	 FORMIK	
7	Animations/transitions	 Motion	 react-spring	
8	UI components		 chakra	 Mantine

FRAMEWORKS BUILT ON TOP OF REACT

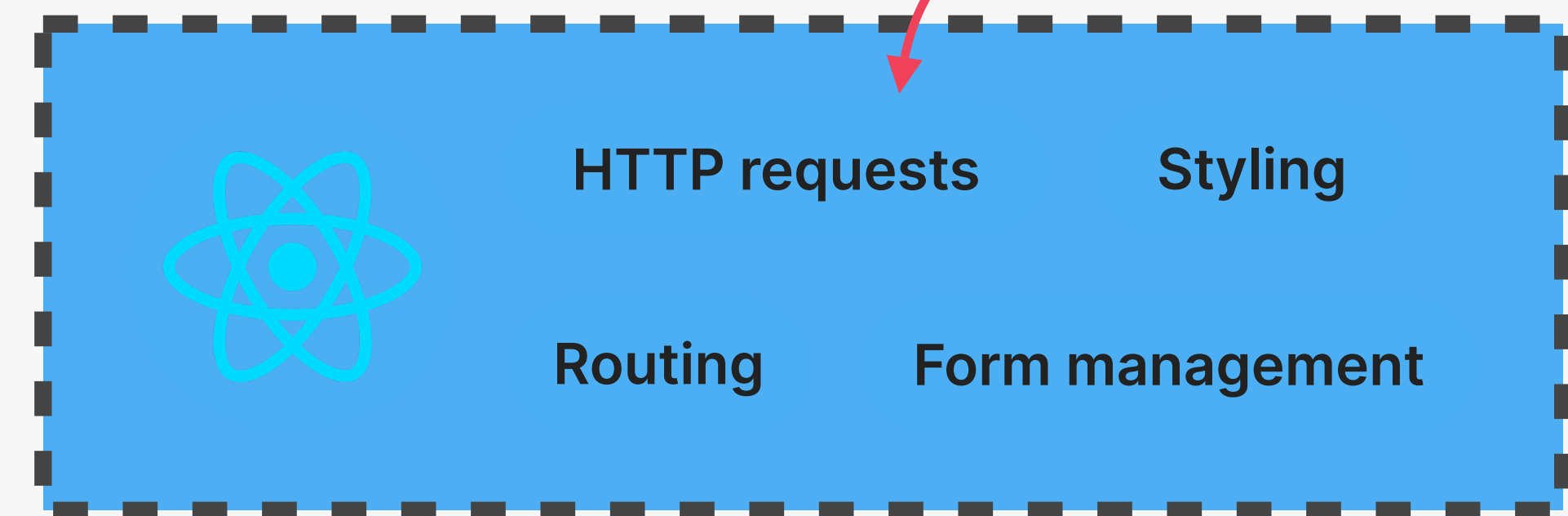


"VANILLA" REACT APP



External libraries

NEXT.js **Remix**



Included out of the box

Full-stack frameworks!

👉 **React frameworks offer many other features:** server-side rendering (SSR), static site generation (SSG), better developer experience (DX), etc.



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SECTION SUMMARY: PRACTICAL
TAKEAWAYS



PRACTICAL SUMMARY



A **component** is like a blueprint for a piece of UI that will eventually exist on the screen. When we “use” a component, React creates a **component instance**, which is like an actual physical manifestation of a component, containing props, state, and more. A component instance, when rendered, will return a **React element**

```
<Question />
```

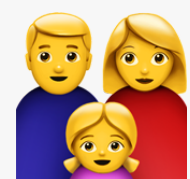
```
function Question()
```



“Rendering” only means **calling component functions** and calculating what DOM elements need to be inserted, deleted, or updated. It has nothing to do with writing to the DOM. Therefore, **each time a component instance is rendered and re-rendered, the function is called again**



Only the **initial app render** and **state updates** can cause a render, which happens for the **entire application**, not just one single component



When a component instance gets re-rendered, **all its children will get re-rendered as well**. This doesn't mean that all children will get updated in the DOM, thanks to reconciliation, which checks which elements have actually changed between two renders. But all this re-rendering can still have an impact on performance (more on that later in the course 🙏)



PRACTICAL SUMMARY



Diffing is how React decides which DOM elements need to be added or modified. If, between renders, a certain React element **stays at the same position in the element tree**, the corresponding DOM element and component state will stay the same. If the element **changed to a different position**, or if it's a **different element type**, the DOM element and state will be destroyed



Giving elements a key prop allows React to distinguish between multiple component instances. **When a key stays the same across renders**, the element is kept in the DOM. This is why we need to use keys in lists. **When we change the key between renders**, the DOM element will be destroyed and rebuilt. We use this as a **trick to reset state**



Never declare a new component inside another component! Doing so will re-create the nested component every time the parent component re-renders. React will always see the nested component as **new**, and therefore **reset its state** each time the parent state is updated



The logic that produces JSX output for a component instance ("render logic") is **not allowed to produce any side effects**: no API calls, no timers, no object or variable mutations, no state updates. **Side effects are allowed in event handlers and `useEffect`** (next section 🙌)



PRACTICAL SUMMARY



The DOM is updated in the commit phase, **but not by React, but by a “renderer” called ReactDOM**. That’s why we always need to include both libraries in a React web app project. We can use other renderers to use React on different platforms, for example to build mobile or native apps



Multiple state updates inside an event handler function are **batched**, so they happen all at once, **causing only one re-render**. This means we can **not access a state variable immediately after updating it**: state updates are **asynchronous**. Since React 18, batching also happens in timeouts, promises, and native event handlers.



When using events in event handlers, we get access to a **synthetic event object**, not the browser’s native object, so that **events work the same way across all browsers**. The difference is that **most synthetic events bubble**, including focus, blur, and change, which do not bubble as native browser events. Only the scroll event does not bubble



React is a library, not a framework. This means that you can assemble your application using your favorite third-party libraries. The downside is that you need to find and learn all these additional libraries. No problem, as you will learn about the most commonly used libraries in this course

EFFECTS AND DATA FETCHING



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SECTION

EFFECTS AND DATA FETCHING

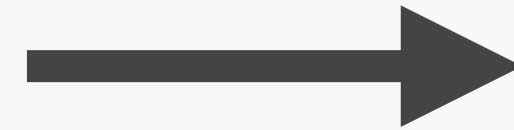
LECTURE

THE COMPONENT LIFECYCLE

COMPONENT (INSTANCE) LIFECYCLE



**MOUNT /
INITIAL RENDER**



(Optional)

RE-RENDER



UNMOUNT

- 👉 Component instance is rendered for the **first time**
- 👉 Fresh state and props are **created**

HAPPENS WHEN:

- 👉 **State** changes
- 👉 **Props** change
- 👉 **Parent** re-renders
- 👉 **Context** changes

- 👉 Component instance is **destroyed** and **removed**
- 👉 State and props are **destroyed**



*We can define code to run at these specific **points in time***



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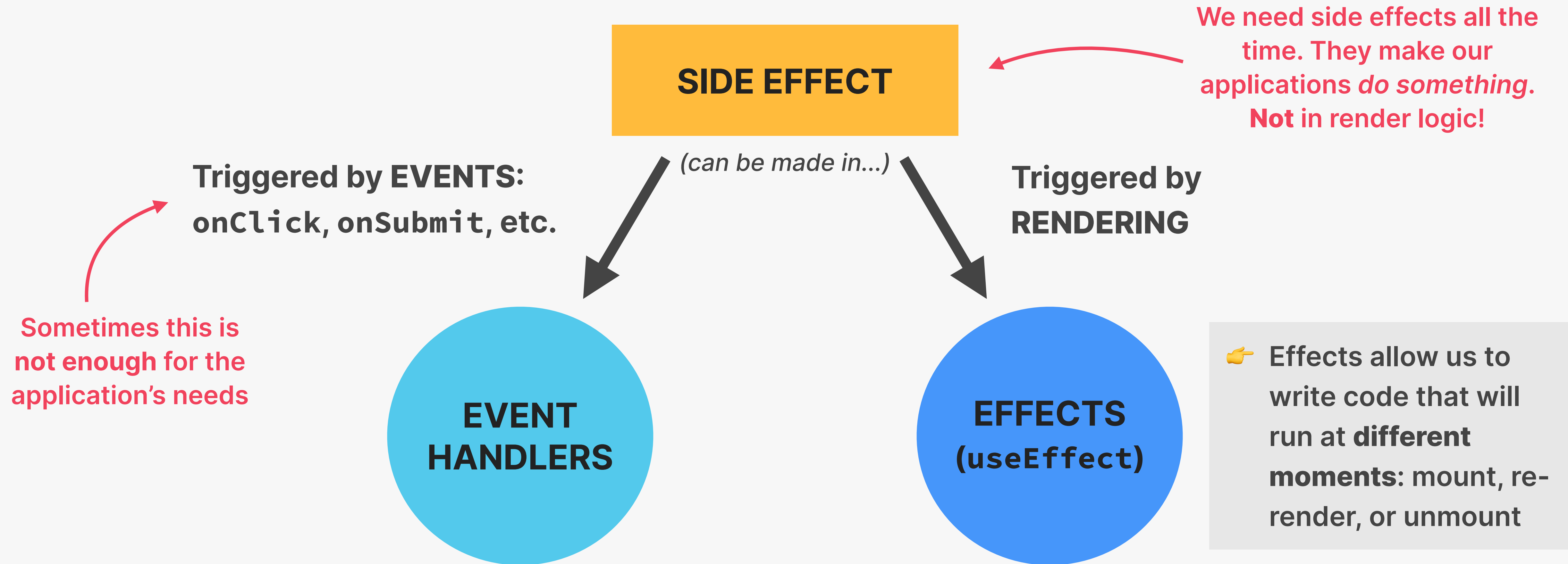
SECTION

EFFECTS AND DATA FETCHING

LECTURE

A FIRST LOOK AT EFFECTS

WHERE TO CREATE SIDE EFFECTS



👉 **REVIEW:** A **side effect** is basically any “*interaction between a React component and the world outside the component*”. We can also think of a side as “*code that actually does something*”. **Examples:** Data fetching, setting up subscriptions, setting up timers, manually accessing the DOM, etc.

EVENT HANDLERS VS. EFFECTS

EVENT HANDLERS

```
function handleClick() {  
  fetch(`http://www.omdbapi.com/?s=inception`)  
    .then((res) => res.json())  
    .then((data) => setMovies(data.Search));  
}
```

EFFECTS (useEffect)

```
useEffect(function () {  
  fetch(`http://www.omdbapi.com/?s=inception`)  
    .then((res) => res.json())  
    .then((data) => setMovies(data.Search));  
  return () => console.log('Cleanup');  
}, []);
```

Produce the same result,
but at **different moments**

Effect

Cleanup
function

Dependency array



When?

👉 Executed when the **corresponding event** happens

👉 Used to **react** to an event

👉 **Preferred way of creating side effects!**

👉 Executed **after the component mounts** (initial render), and **after subsequent re-renders** (according to dependency array)

👉 Used to keep a component **synchronized with some external system** (in this example, with the API movie data)

Thinking about
synchronization,
not lifecycles

(We'll come back to all this after using `useEffect` in practice...)



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EFFECTS AND DATA FETCHING

LECTURE

THE USEEFFECT DEPENDENCY
ARRAY

WHAT'S THE USEEFFECT DEPENDENCY ARRAY?

THE DEPENDENCY ARRAY

- 👉 By default, effects run **after every render**. We can prevent that by passing a **dependency array**
- 👉 Without the dependency array, React doesn't know **when** to run the effect
- 👉 *Each time one of the dependencies changes, the effect will be executed again*
- 👉 Every **state variable** and **prop** used inside the effect **MUST** be included in the dependency array

```
const title = props.movie.Title;
const [userRating, setUserRating] = useState('');

useEffect(
  function () {
    if (!title) return;
    document.title = `${title} ${
      userRating && `(Rated ${userRating} ⭐)`
    }`;
    return () => (document.title = 'usePopcorn');
  },
  [title, userRating]
);
```

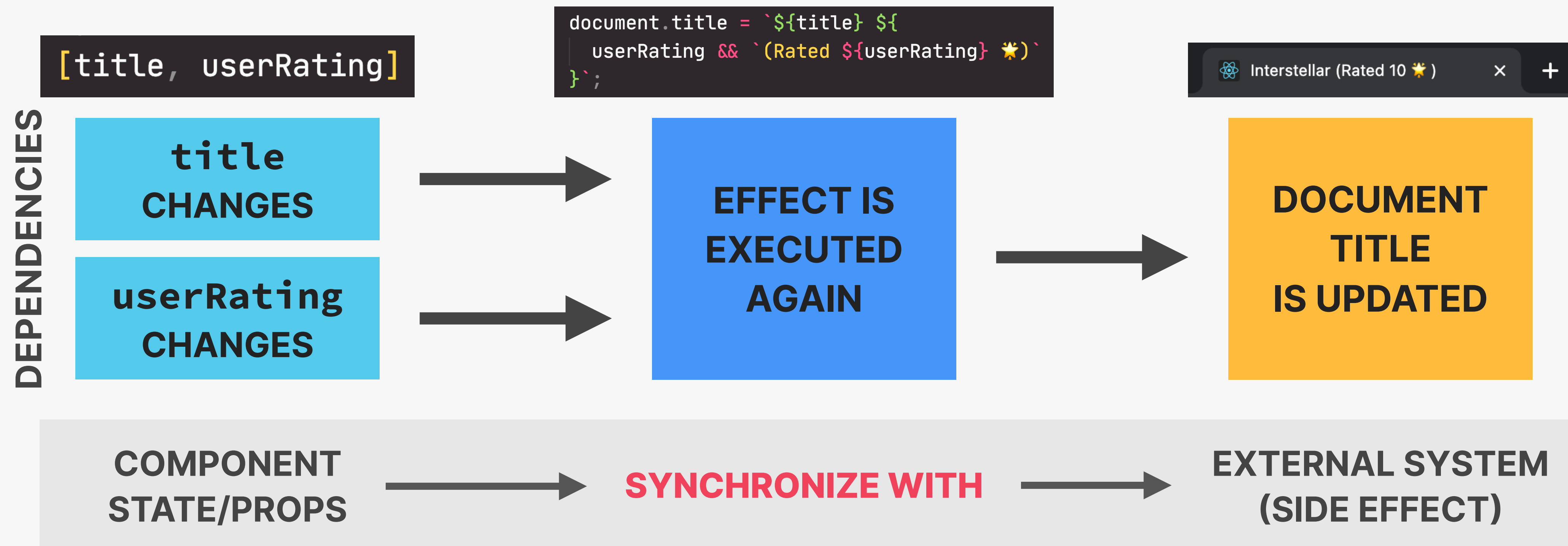
A diagram with blue arrows pointing from the dependency array `[title, userRating]` at the bottom to the variables `title` and `userRating` used within the `useEffect` function. One arrow points from `title` to the `if (!title)` check, and another points from `userRating` to the template string interpolation. A third arrow points from the `userRating` in the dependency array to the `userRating` in the template string.

Otherwise, we get a “**stale closure**”. We will go more into depth in a future section 👉

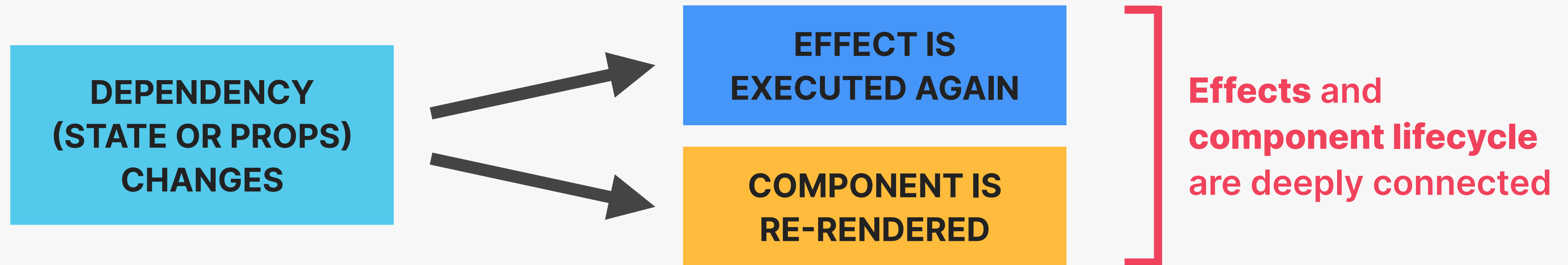
USEEFFECT IS A SYNCHRONIZATION MECHANISM

THE MECHANICS OF EFFECTS

- 👉 `useEffect` is like an **event listener** that is listening for one dependency to change. **Whenever a dependency changes, it will execute the effect again**
- 👉 Effects **react** to updates to state and props used inside the effect (the dependencies). So **effects are “reactive”** (like state updates re-rendering the UI)



SYNCHRONIZATION AND LIFECYCLE

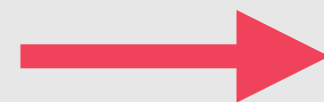


👉 We can use the dependency array to run effects **when the component renders or re-renders**



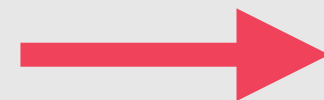
SYNCHRONIZATION

```
useEffect(fn, [x, y, z]);
```



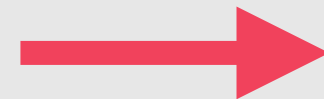
Effect synchronizes with **x, y, and z**

```
useEffect(fn, []);
```



Effect synchronizes with **no state/props**

```
useEffect(fn);
```



Effect synchronizes with **everything**



LIFECYCLE

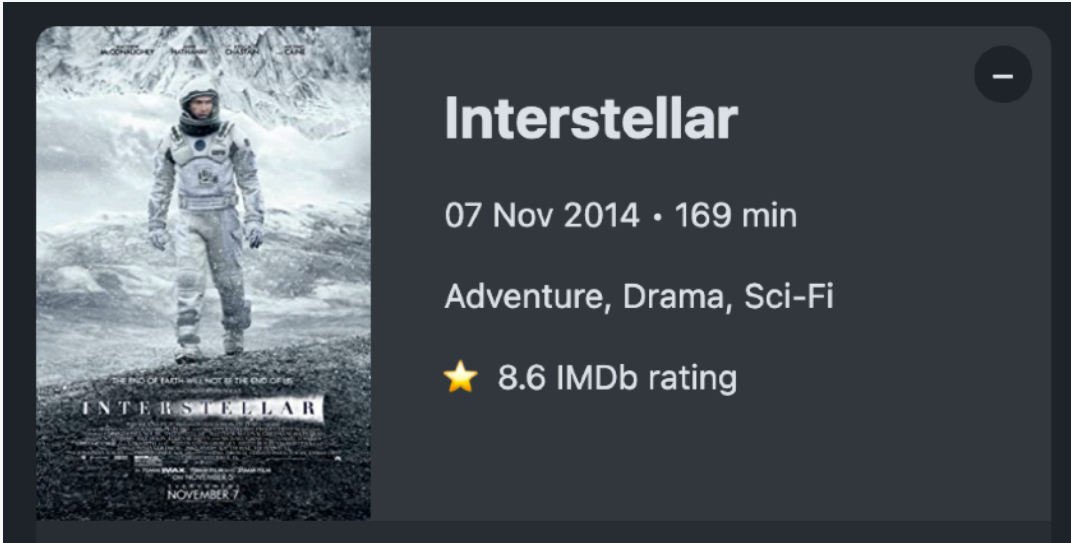
Runs on **mount** and **re-renders** triggered by updating **x, y, or z**

Runs only on **mount** (initial render)

Runs on **every render** (usually bad 🚫)

WHEN ARE EFFECTS EXECUTED?

title = 'Interstellar'



MOUNT (INITIAL RENDER)

COMMIT

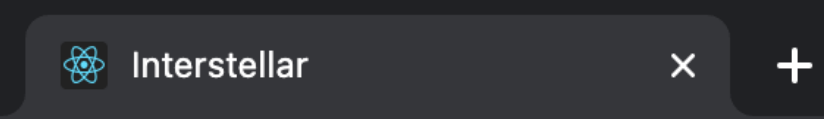
BROWSER PAINT

EFFECT ✨

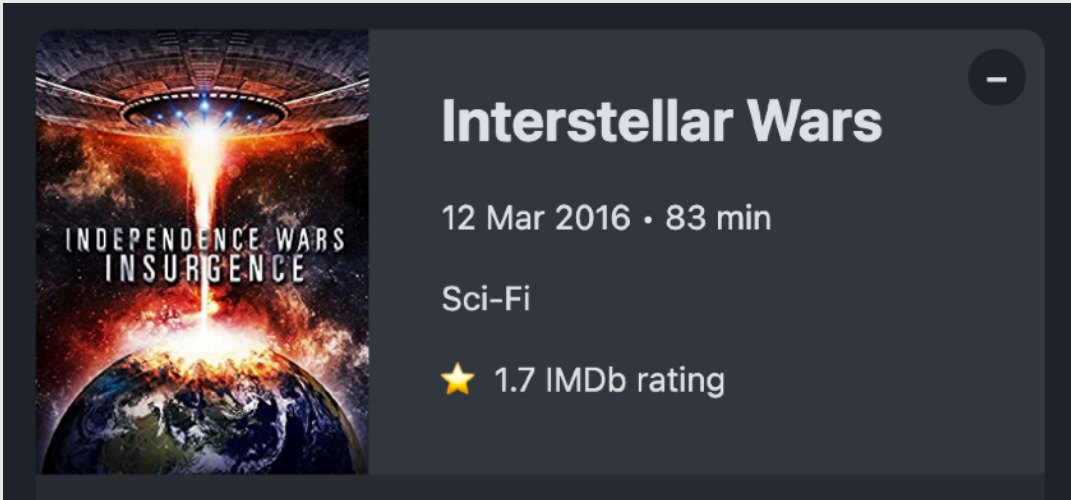
```
<MovieDetails />
```

If an effect sets state, an additional render will be required

```
document.title = `${title} ${userRating} && (Rated ${userRating} ★)`;
```



title = 'Interstellar Wars'



title CHANGES

RE-RENDER

COMMIT

LAYOUT EFFECT

BROWSER PAINT

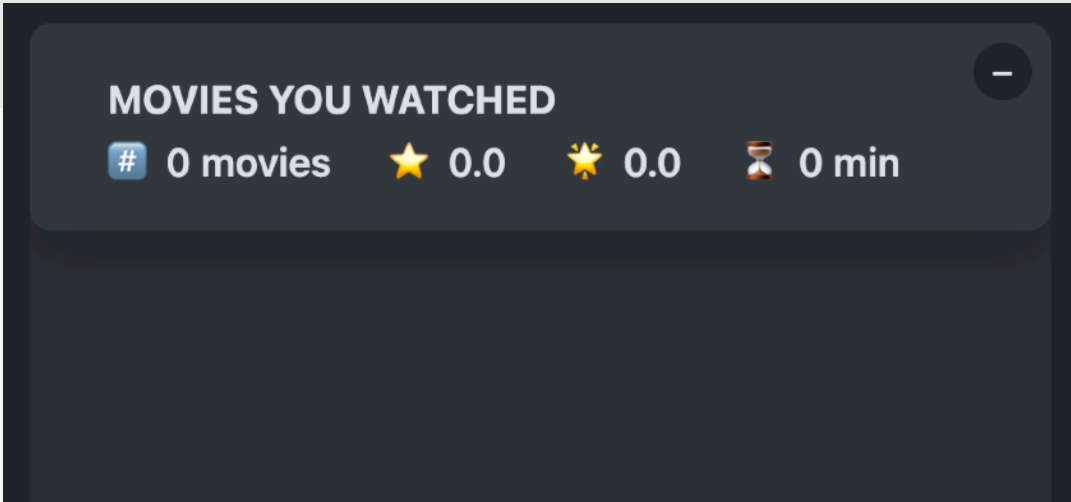
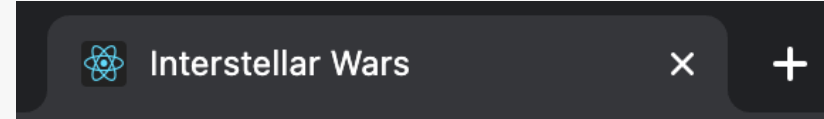


EFFECT ✨

Another type of effect that is very rarely necessary (useLayoutEffect)

```
[title, userRating]
```

```
document.title = `${title} ${userRating} && (Rated ${userRating} ★)`;
```



UNMOUNT



time



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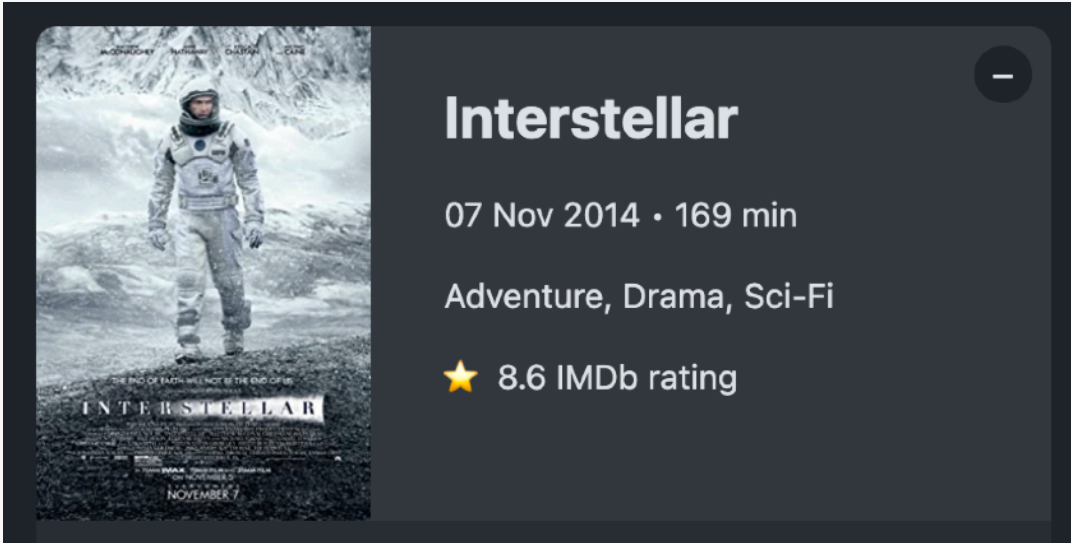
EFFECTS AND DATA FETCHING

LECTURE

THE USEEFFECT CLEANUP
FUNCTION

WHEN ARE EFFECTS EXECUTED?

title = 'Interstellar'



MOUNT (INITIAL RENDER)

COMMIT

BROWSER PAINT

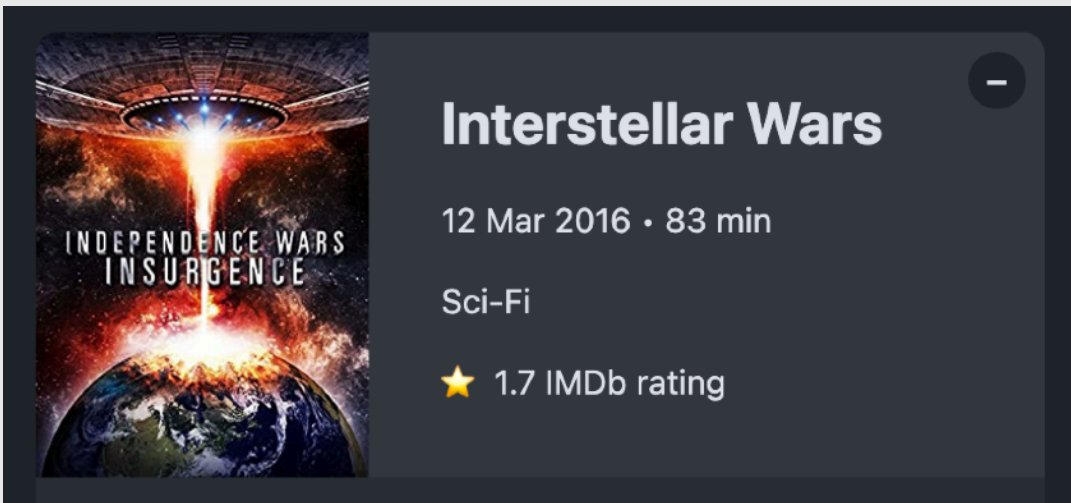
EFFECT ✨

<MovieDetails />

```
document.title = `${title} ${
  userRating && `(Rated ${userRating} ⭐)`
}`;
```



title = 'Interstellar Wars'



title CHANGES

RE-RENDER

COMMIT

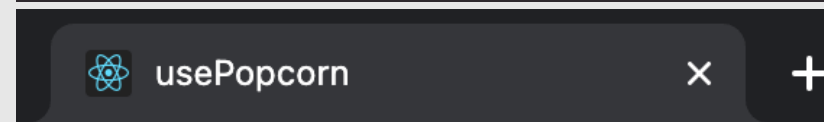
LAYOUT EFFECT

BROWSER PAINT

CLEANUP 🧹

EFFECT ✨

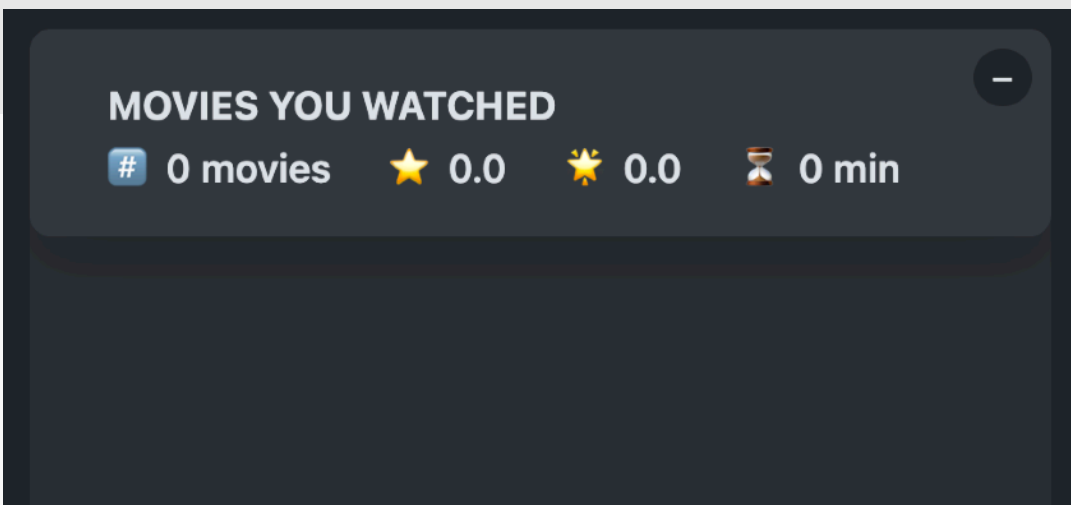
```
() => (document.title = 'usePopcorn');
```



```
document.title = `${title} ${
  userRating && `(Rated ${userRating} ⭐)`
}`;
```



```
() => (document.title = 'usePopcorn');
```



UNMOUNT

CLEANUP 🧹

time

THE CLEANUP FUNCTION

USEEFFECT CLEANUP FUNCTION

- 👉 Function that we can **return from an effect** (*optional*)
- 👉 Runs on two different occasions:
 - 1 Before the effect is **executed again**
 - 2 After a component has **unmounted**
- 👉 Necessary whenever the side effect **keeps happening after the component has been re-rendered or unmounted**
- 👉 Each effect should do **only one thing!** Use **one `useEffect` hook for each side effect**. This makes effects easier to clean up

COMPONENT
RENDERS



Execute effect if
dependency array
includes updated data

COMPONENT
UNMOUNTS



Execute
cleanup function

Examples



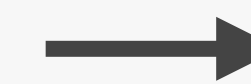
EFFECT



POTENTIAL
CLEANUP



HTTP request



Cancel request



API subscription



Cancel subscription



Start timer



Stop timer



Add event listener



Remove listener

CUSTOM HOOKS,
REFS, AND MORE
STATE



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SECTION

CUSTOM HOOKS, REFS, AND
MORE STATE

LECTURE

REACT HOOKS AND THEIR RULES

WHAT ARE REACT HOOKS?

REACT HOOKS

- 👉 Special built-in functions that allow us to “hook” into React internals:
 - 👉 Creating and accessing **state** from Fiber tree
 - 👉 Registering **side effects** in Fiber tree
 - 👉 Manual **DOM selections**
 - 👉 Many more...
- 👉 Always start with “**use**” (useState, useEffect, etc.)
- 👉 Enable easy **reusing of non-visual logic**: we can compose multiple hooks into our own **custom hooks**
- 👉 Give **function components** the ability to own state and run side effects at different lifecycle points (before v16.8 only available in class **components**)

OVERVIEW OF ALL BUILT-IN HOOKS

MOST USED

- ✅ useState
- ✅ useEffect
- 👉 useReducer
- 👉 useContext

LESS USED

- 👉 useRef
- 👉 useCallback
- 👉 useMemo
- 👉 useTransition
- 👉 useDeferredValue
- ❌ useLayoutEffect
- ❌ useDebugValue
- ❌ useImperativeHandle
- ❌ useId

ONLY FOR LIBRARIES

- ❌ useSyncExternalStore
- ❌ useInsertionEffect

👉 As of React v18.x

- ✅ Have learned
- 👉 Will learn
- ❌ Will not learn

THE RULES OF HOOKS



RULES OF HOOKS

1

Only call hooks at the top level



Do **NOT** call hooks inside **conditionals**, **loops**, **nested functions**, or after an **early return**



This is necessary to ensure that hooks are always called in the **same order** (hooks rely on this)

2

Only call hooks from React functions

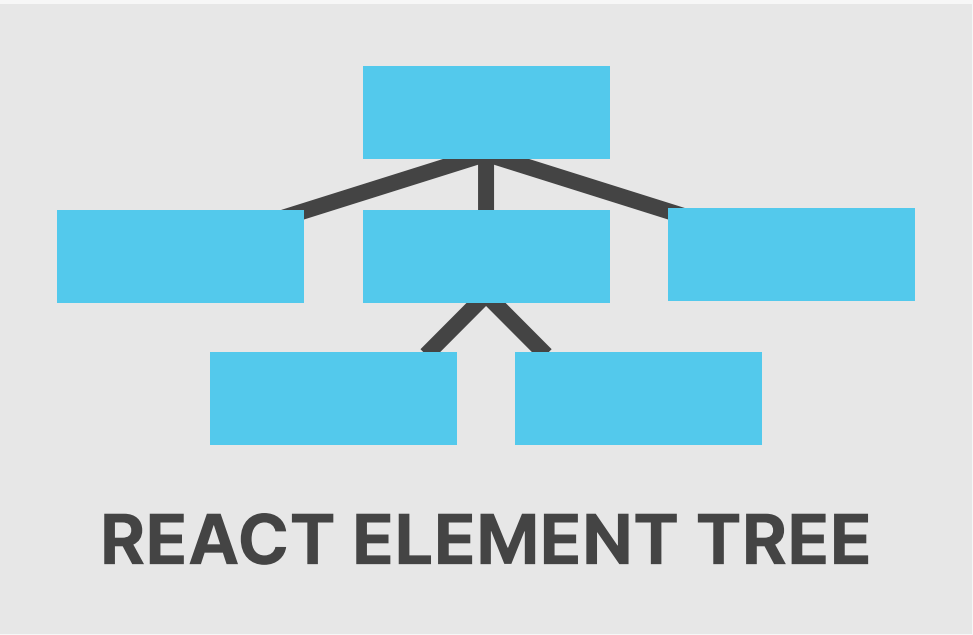


Only call hooks inside a **function component** or a **custom hook**

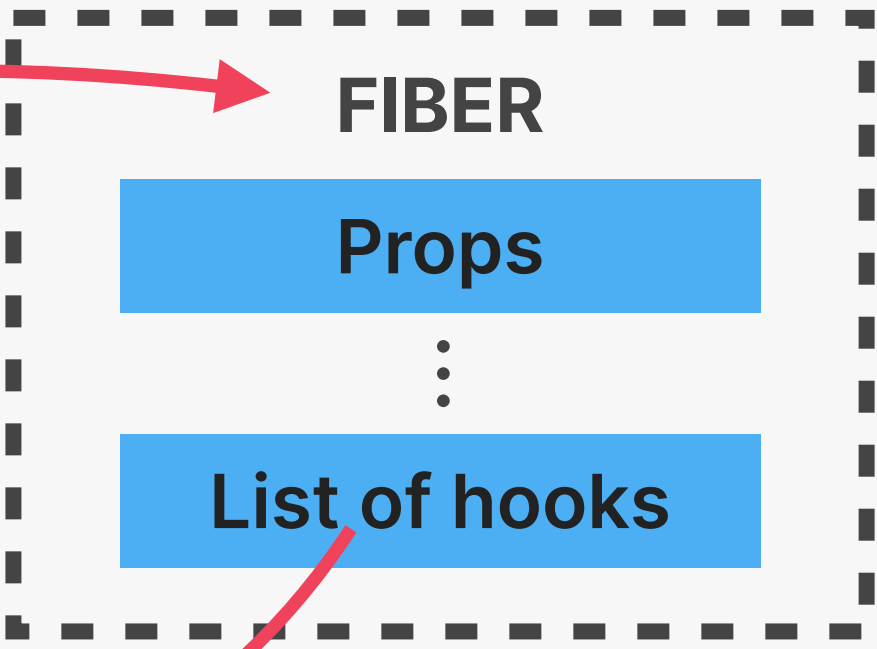
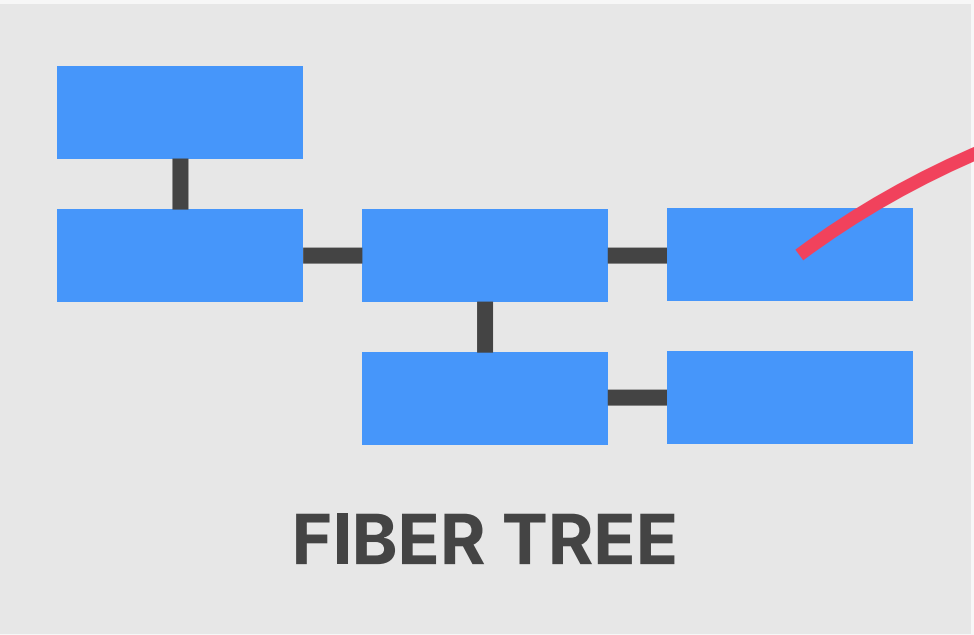


These rules are automatically enforced by React's ESLint rules

HOOKS RELY ON CALL ORDER



ON INITIAL
RENDER

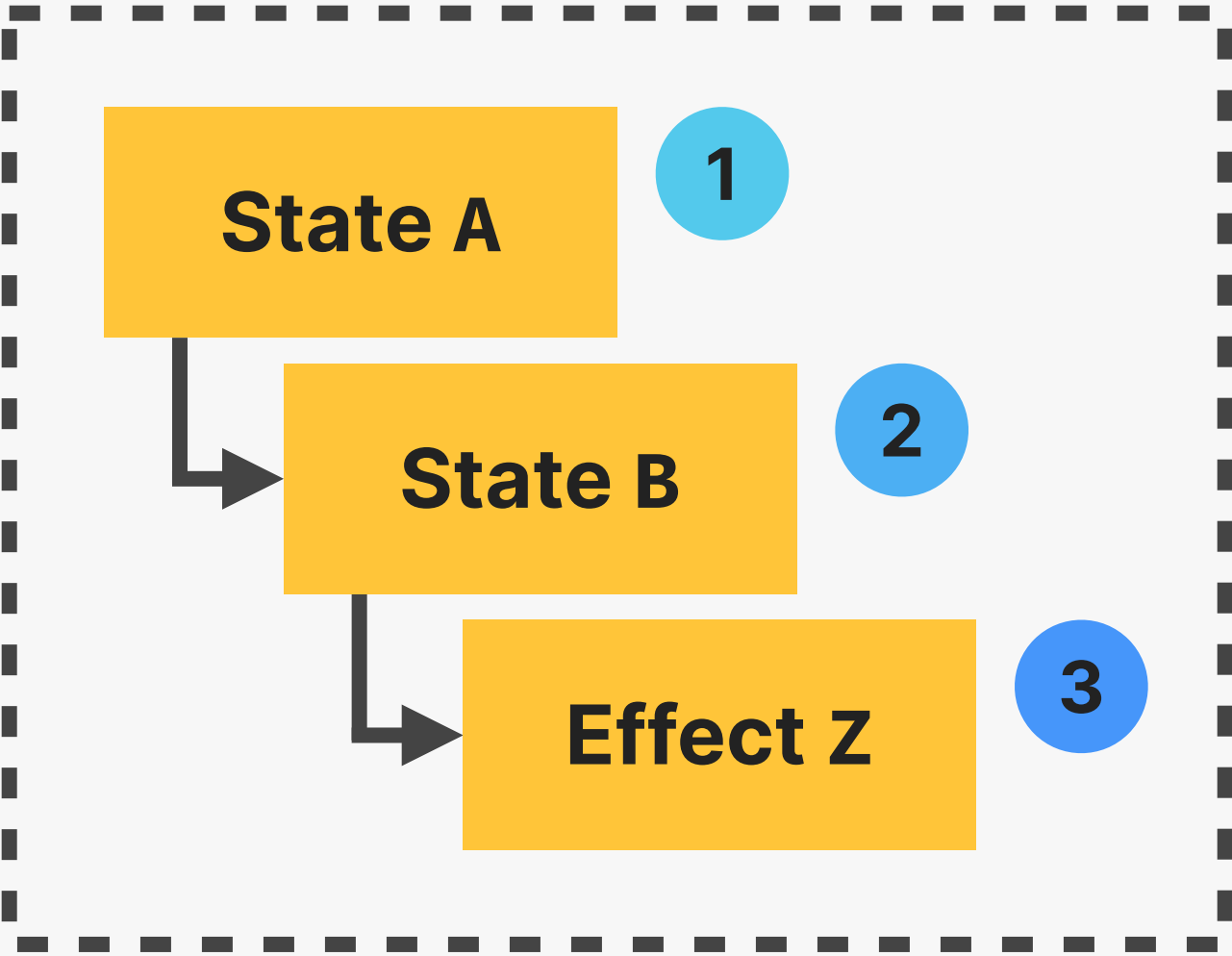


👉 *Hypothetical example! This code does **NOT** work*

```
const [A, setA] = useState(23) 1
if (A === 23) false
const [B, setB] = useState('') 2
useEffect(fnZ, []) 3
```

Violates Rule #1

List built based on hooks call order

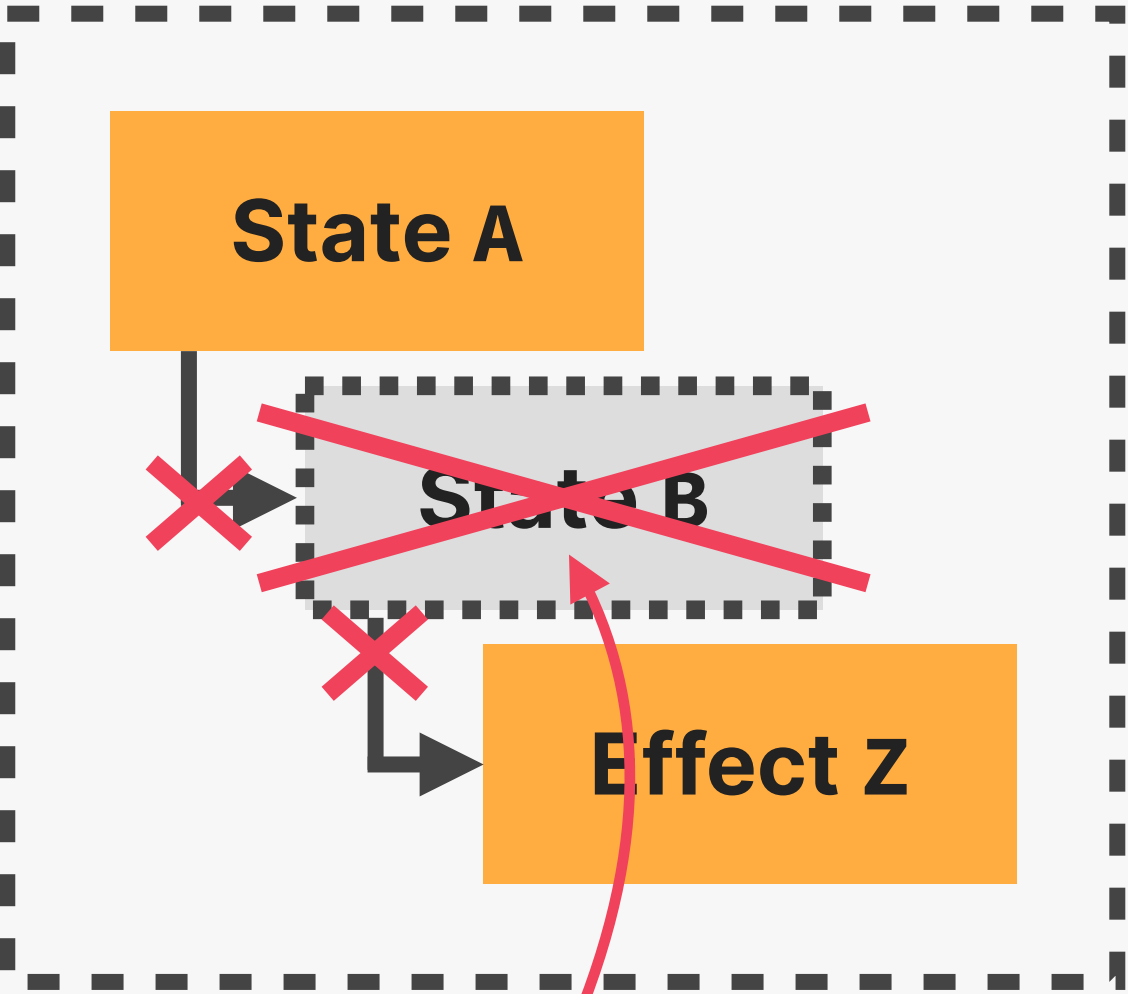


LINKED LIST OF USED HOOKS

RENDER

~~A=23~~

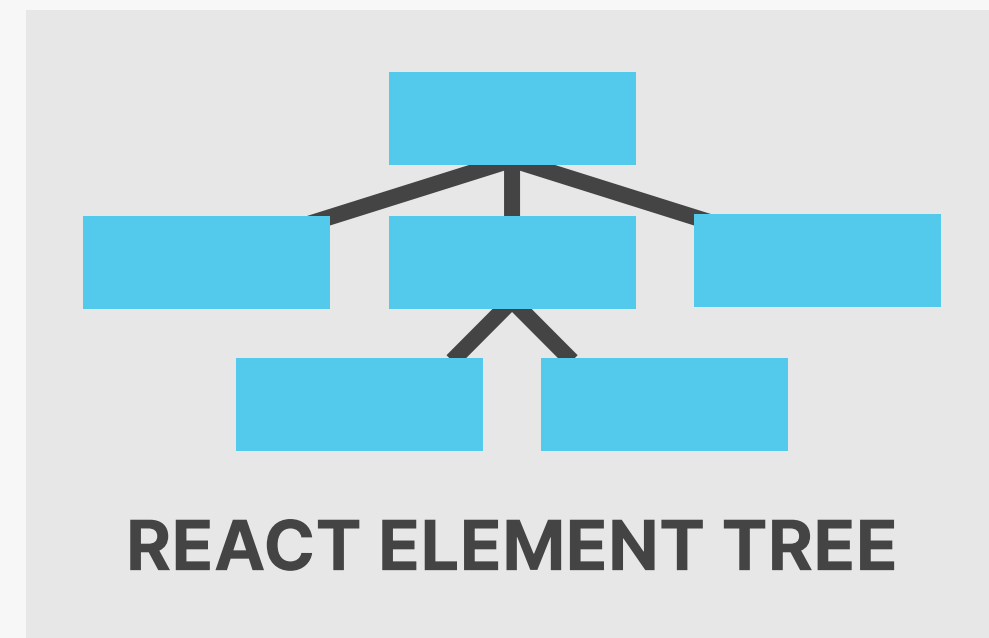
A=7



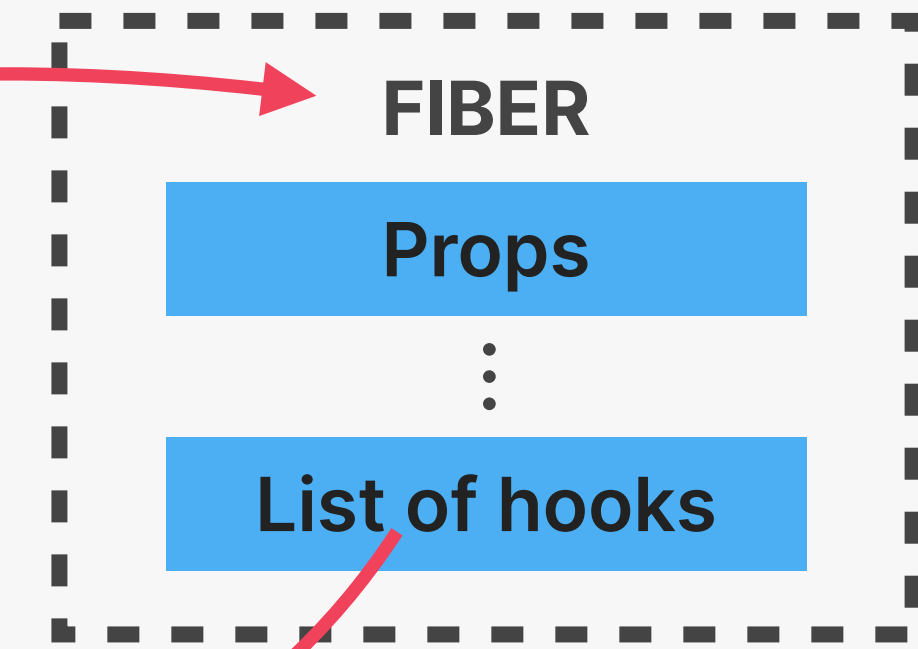
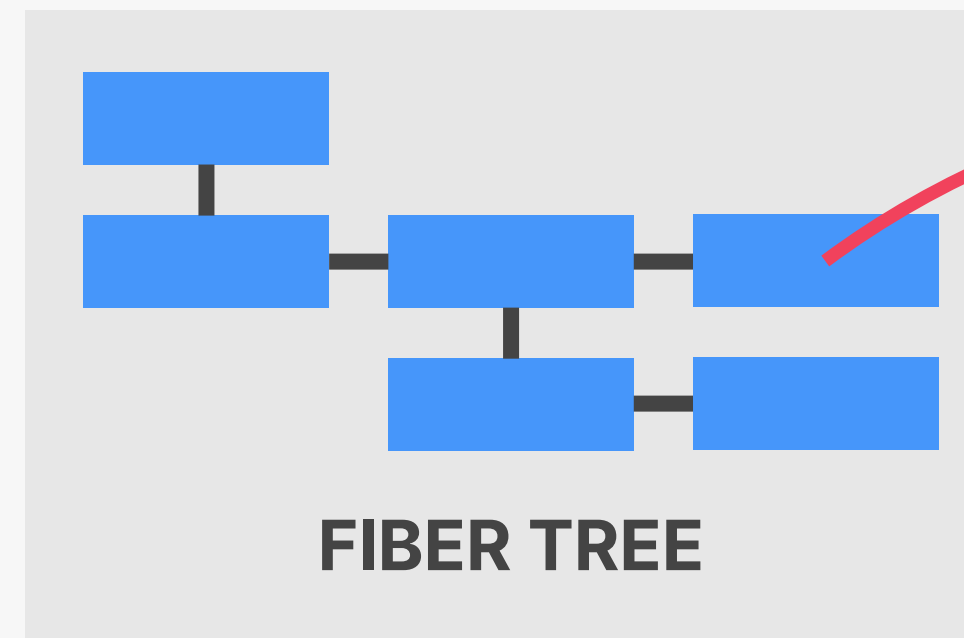
A===23 is now false, so after re-render, this hook would no longer exist, **destroying the linked list** 😭

👉 Hooks need to be called in the same order on every render

HOOKS RELY ON CALL ORDER



ON INITIAL
RENDER

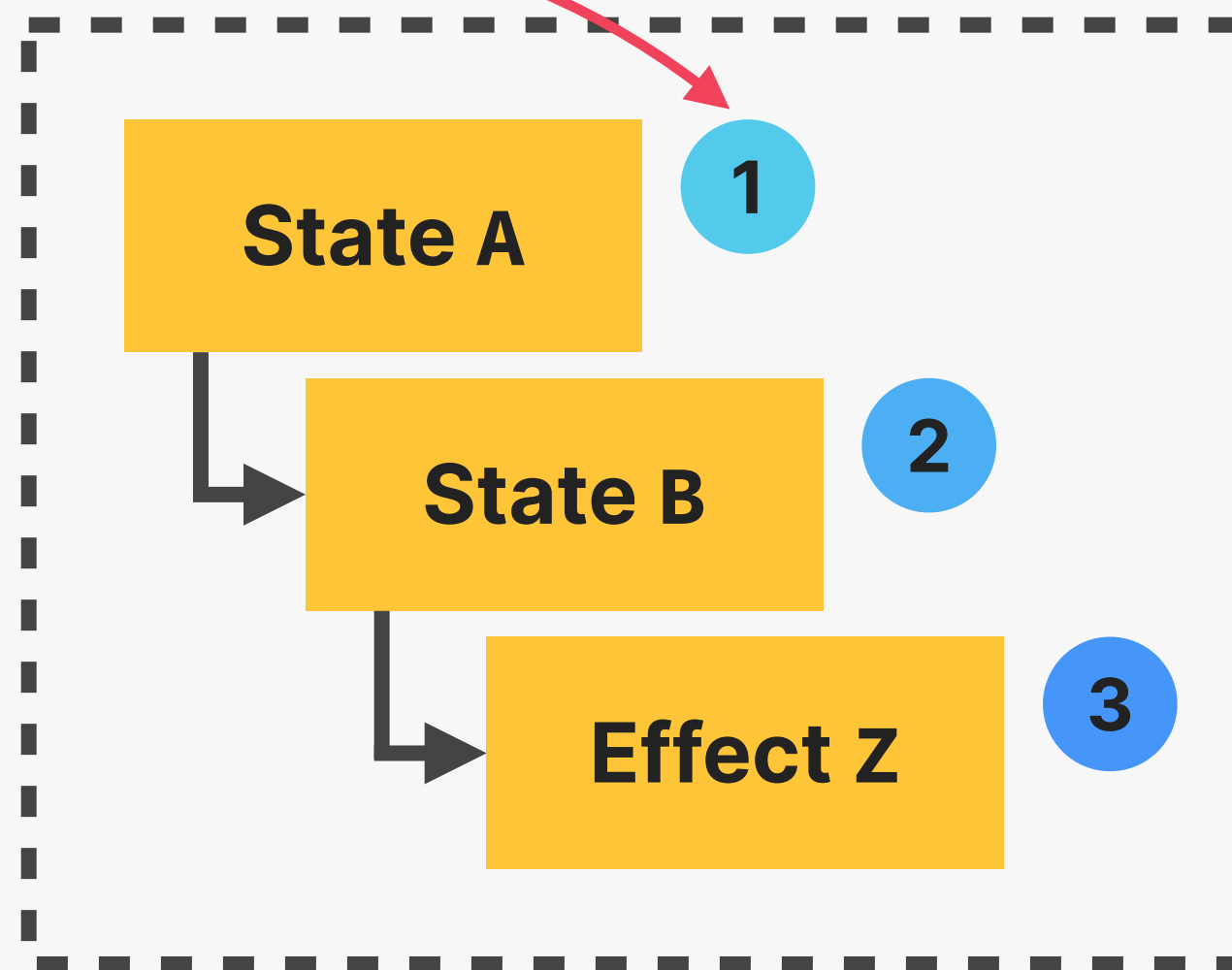


Order num uniquely identifies each hook

👍 **Correct code!**

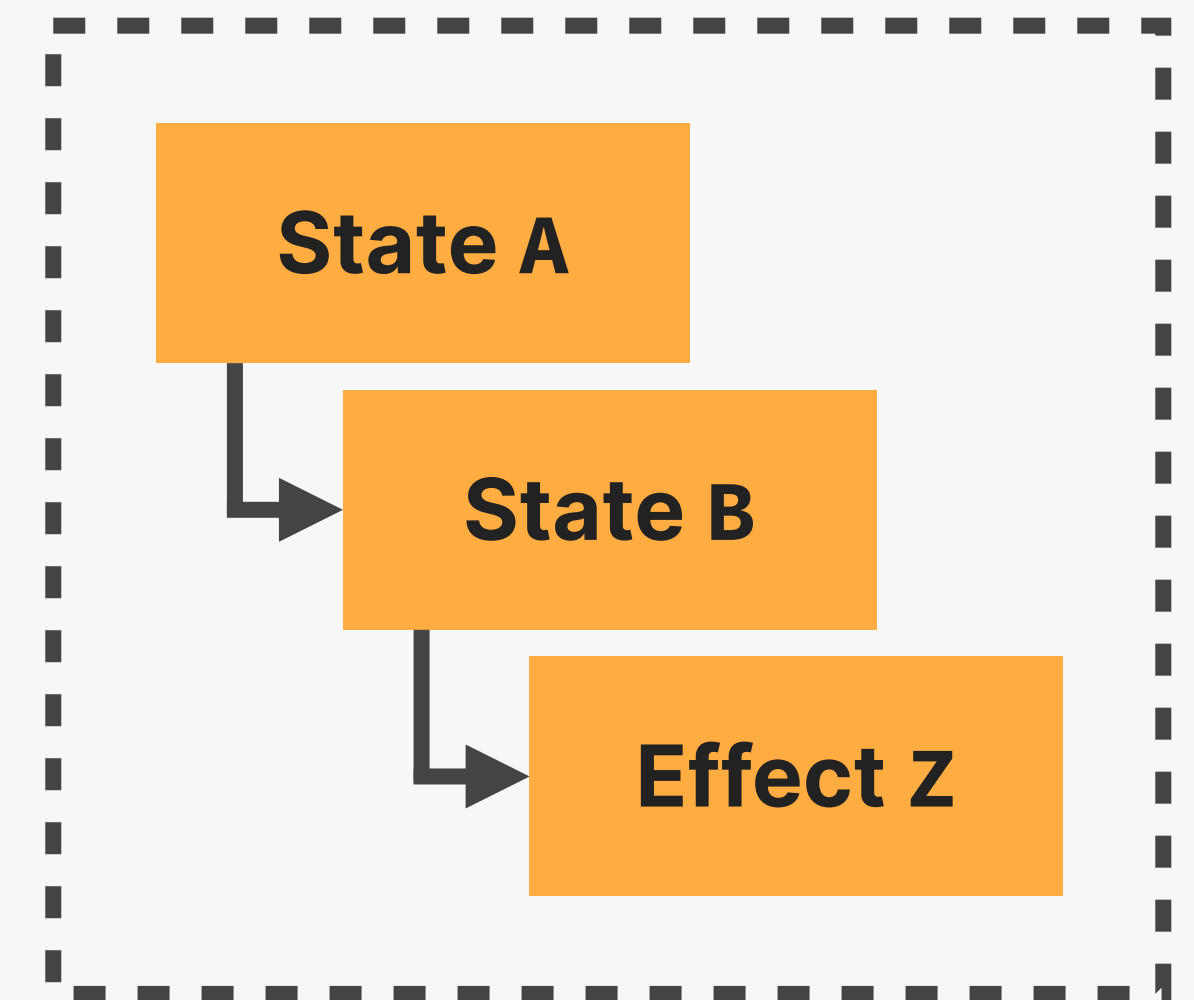
```
const [A, setA] = useState(23) 1  
  
const [B, setB] = useState('') 2  
  
useEffect(fnZ, []) 3
```

List built based on
hooks call order



LINKED LIST OF USED HOOKS

RENDER
→
SAME
ORDER



👉 Hooks need to be called in the same order on every render

👉 Hooks can only be called at top level



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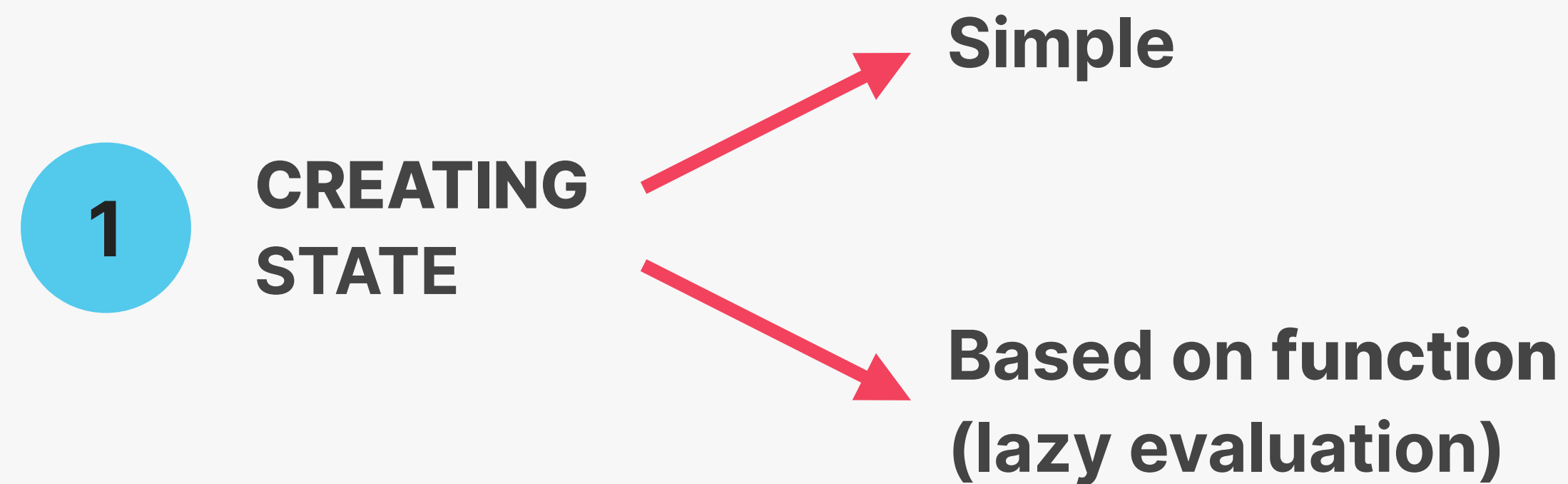
SECTION

CUSTOM HOOKS, REFS, AND
MORE STATE

LECTURE

USESTATE SUMMARY

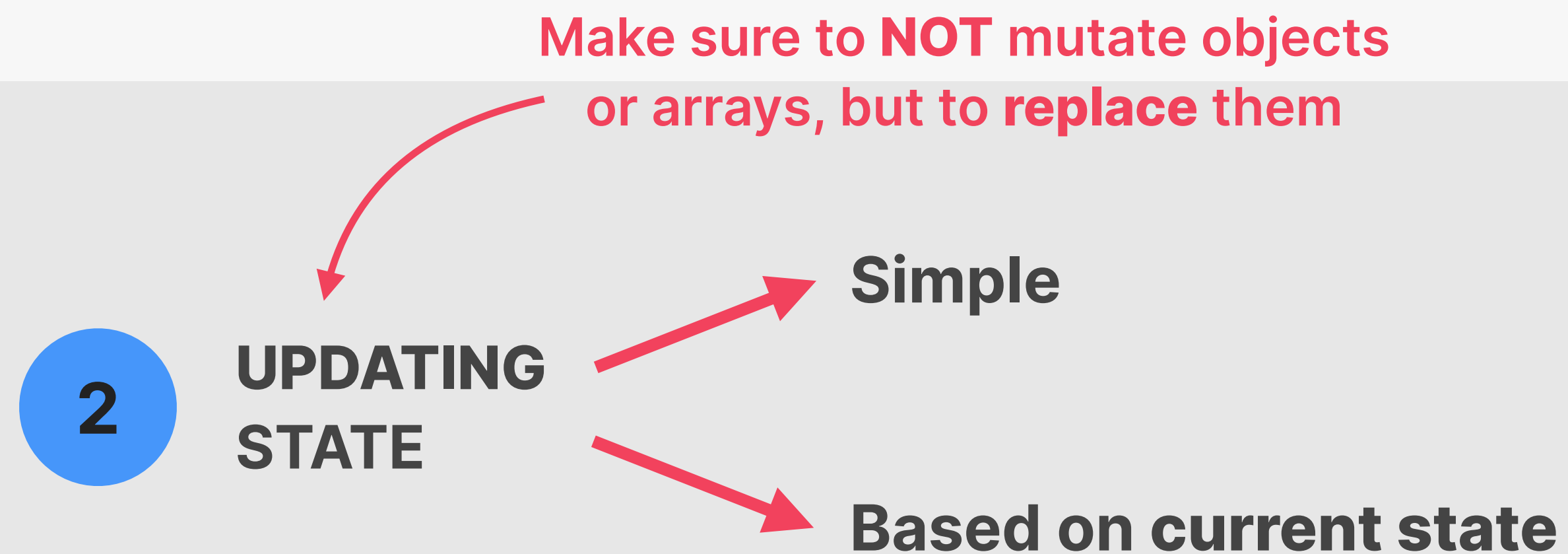
SUMMARY OF DEFINING AND UPDATING STATE



```
const [count, setCount] = useState(23);
```

```
const [count, setCount] = useState(  
  () => localStorage.getItem('count')  
);
```

👉 Function must be **pure** and accept **no arguments**. Called only on **initial render**



```
setCount(1000);
```

```
setCount((c) => c + 1)
```

👉 Function must be **pure** and return **next state**



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CUSTOM HOOKS, REFS, AND
MORE STATE

LECTURE

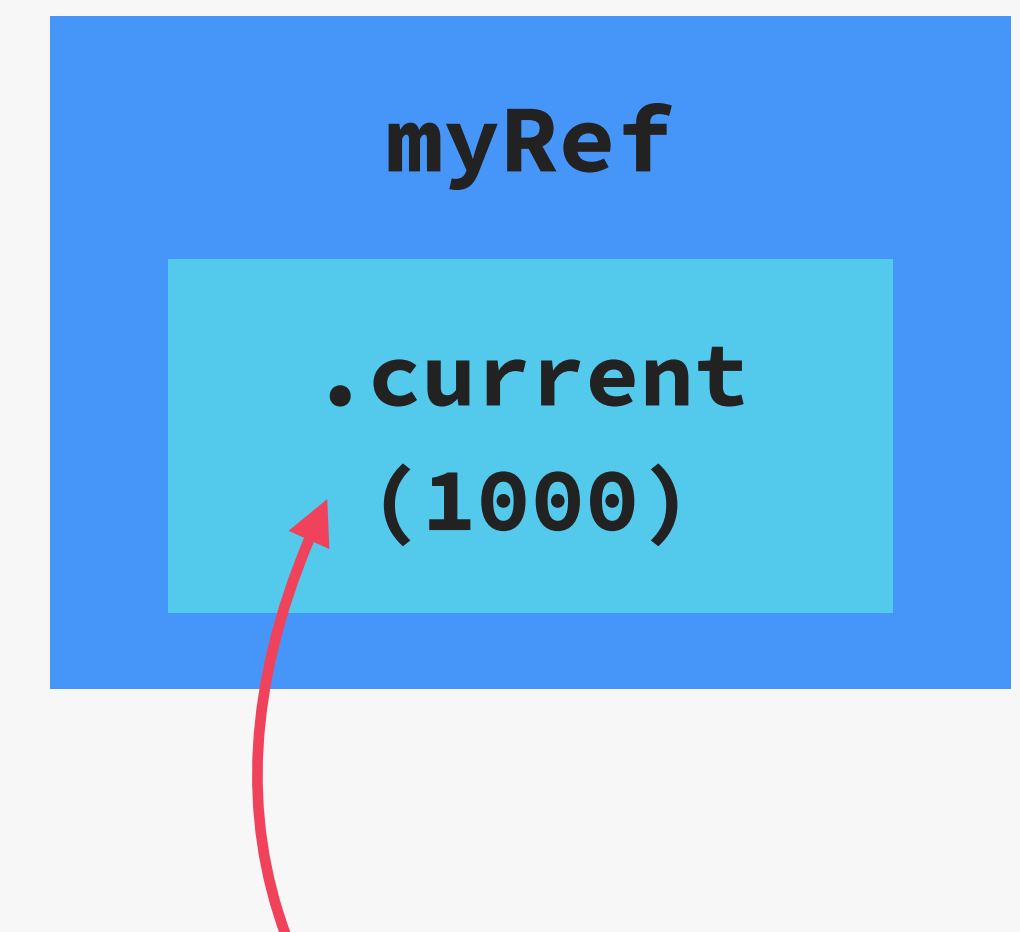
INTRODUCING ANOTHER HOOK:
USEREF

WHAT ARE REFS?

REF WITH useRef

- 👉 “Box” (object) with a **mutable** `.current` property that is **persisted across renders** (*“normal” variables are always reset*)
- 👉 Two big use cases:
 - 1 Creating a variable that stays the same between renders (e.g. previous state, `setTimeout` id, etc.)
 - 2 Selecting and storing DOM elements
- 👉 Refs are for **data that is NOT rendered**: usually only appear in event handlers or effects, not in JSX (otherwise use state)
- 👉 Do **NOT** read write or read `.current` in render logic (like state)

```
const myRef = useRef(23);
```

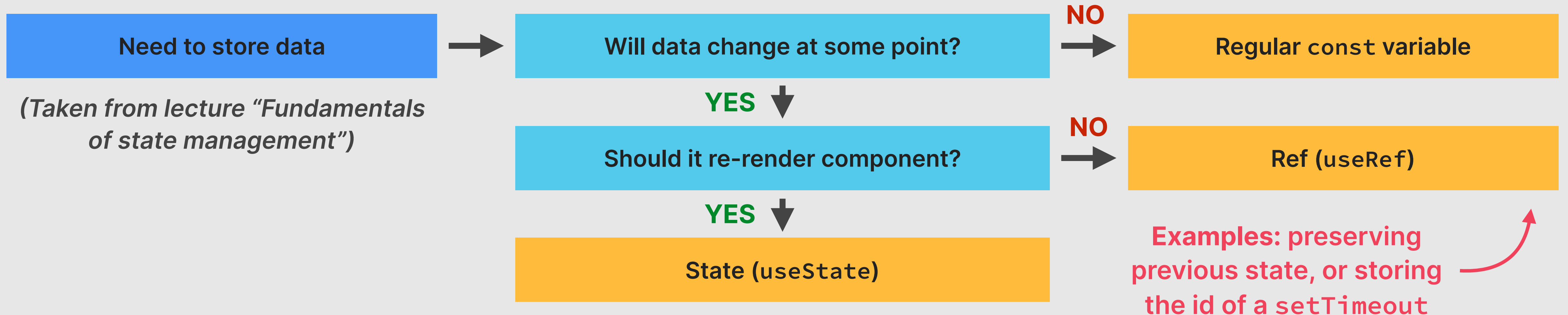


We can write to and read from the ref using `.current`

```
myRef.current = 1000;
```


STATE VS. REFS

	PERSISTS ACROSS RENDERS	UPDATING CAUSES RE-RENDER	IMMUTABLE	ASYNCHRONOUS UPDATES
STATE	✓	✓	✓	✓
REFS	✓	✗	✗	✗





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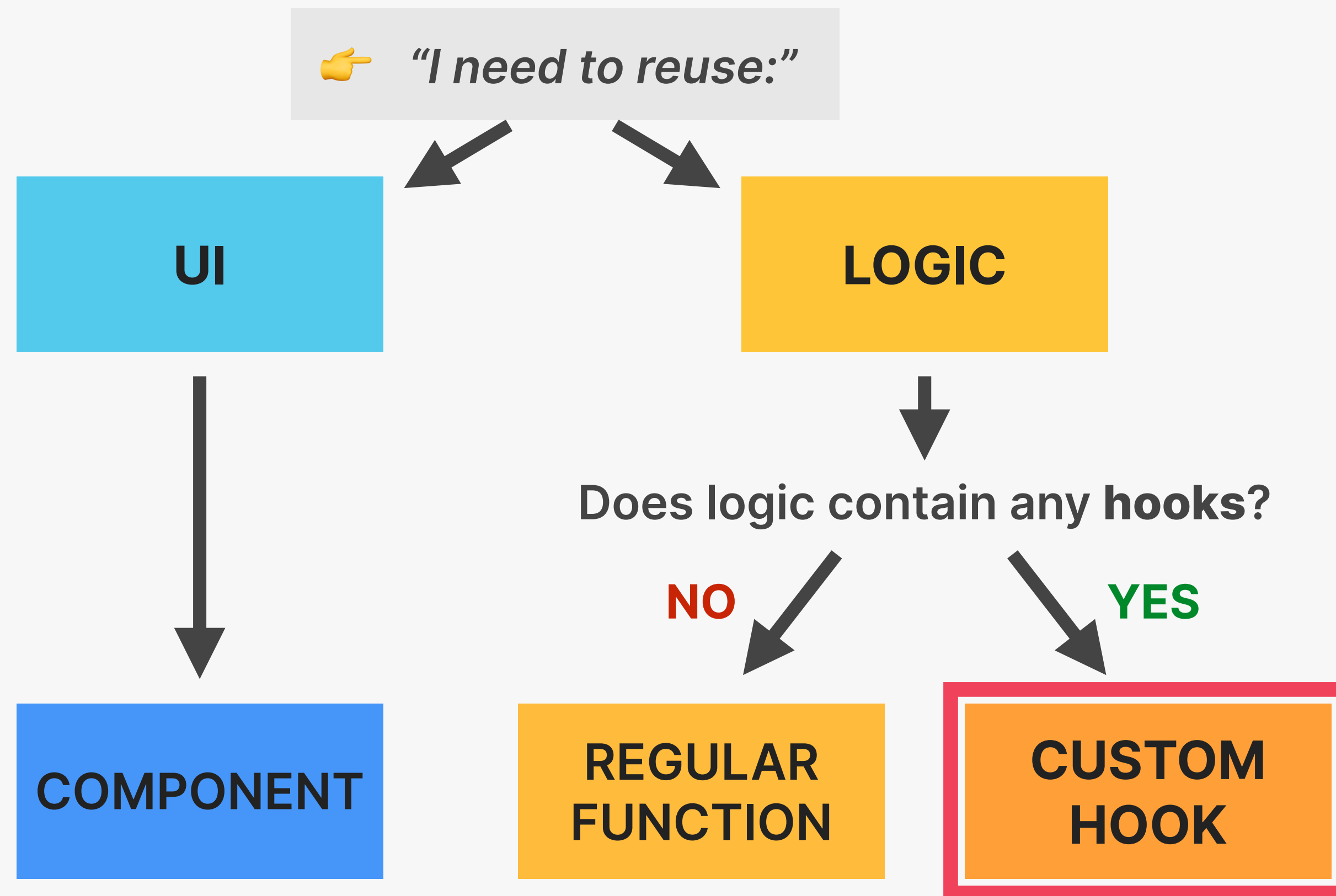
SECTION

CUSTOM HOOKS, REFS, AND
MORE STATE

LECTURE

WHAT ARE CUSTOM HOOKS?
WHEN TO CREATE ONE?

REUSING LOGIC WITH CUSTOM HOOKS



- 👉 Allow us to reuse **non-visual logic** in multiple components
- 👉 One custom hook should have **one purpose**, to make it **reusable** and **portable** (even across multiple projects)
- 👉 **Rules of hooks** apply to custom hooks too

Function name needs to start with **use**

```
function useFetch(url) {  
  const [data, setData] = useState([]);  
  const [isLoading, setIsLoading] =  
    useState(false);  
  useEffect(function () {  
    fetch(url)  
      .then((res) => res.json())  
      .then((res) => setData(res));  
  }, []);  
  return [data, isLoading];  
}
```

Needs to use **one or more hooks**

Unlike components,
can receive and
return **any relevant data** (usually [] or {})

REACT BEFORE
HOOKS: CLASS-
BASED REACT



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REACT BEFORE HOOKS: CLASS-
BASED REACT

LECTURE

CLASS COMPONENTS VS.
FUNCTION COMPONENTS

FUNCTION COMPONENTS VS. CLASS COMPONENTS

Existed since beginning,
but without hooks



FUNCTION COMPONENTS

CLASS COMPONENTS



Introduced in

v16.8 (2019, with hooks)

v0.13 (2015)



How to create

JavaScript function (any type)

ES6 class, extending `React.Component`



Reading props

Destructuring or `props.X`

`this.props.X`



Local state

`useState` hook

**Hooks are THE
big difference**

`this.setState()`



Side effects/lifecycle

`useEffect` hook

Lifecycle methods



Event handlers

Functions

Class methods



Returning JSX

Return JSX from function

Return JSX from render method



Advantages



Easier to build (less boilerplate code)



Cleaner code: `useEffect` combines all lifecycle-related code in a single place



Easier to share stateful logic



We don't need `this` keyword anymore



Lifecycle might be easier to understand for beginners

PART 03

ADVANCED REACT + REDUX

THE ADVANCED USEREDUCER HOOK



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SECTION

THE ADVANCED USEREDUCER
HOOK

LECTURE

MANAGING STATE WITH
USEREDUCER

WHY USEREDUCER?

👉 **STATE MANAGEMENT WITH `useState` IS NOT ENOUGH IN CERTAIN SITUATIONS:**

- 1 When components have a **lot of state variables and state updates**, spread across many event handlers **all over the component**
- 2 When **multiple state updates** need to happen **at the same time** (as a reaction to the same event, like “starting a game”)
- 3 When updating one piece of state **depends on one or multiple other pieces of state**

👉 **IN ALL THESE SITUATIONS, `useReducer` CAN BE OF GREAT HELP**

MANAGING STATE WITH USEREDUCER

STATE WITH `useReducer`

- 👉 An alternative way of setting state, ideal for **complex state** and **related pieces of state**
- 👉 Stores related pieces of state in a **state** object
- 👉 `useReducer` needs **reducer**: function containing **all logic** to **update state**. **Decouples state logic** from component
- 👉 **reducer**: pure function (*no side effects!*) that takes current state and action, and **returns the next state**
- 👉 **action**: object that describes **how to update state**
- 👉 **dispatch**: function to trigger state updates, by “sending” actions from **event handlers** to the **reducer**

Like `setState()` with superpowers

Instead of `setState()`

```
const [state, dispatch] =  
  useReducer(reducer, initialState);
```

```
function reducer(state, action) {  
  switch (action.type) {  
    case 'dec':  
      return state - 1;  
    case 'inc':  
      return state + 1;  
    case 'setCount':  
      return action.payload;  
    default:  
      throw new Error('Unknown');  
  }  
}
```


HOW REDUCERS UPDATE STATE

```
const [state, dispatch] = useReducer(reducer, initialState);
```

useReducer

👉 Updating state
in a component



dispatch



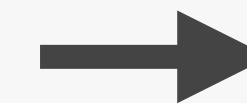
CURRENT
STATE

reducer

RETURNS



NEXT
STATE



RE-RENDER

Just like `array.reduce()`, reducers
accumulate ("reduce") actions over time

action

type = 'updateDay'
payload = 23

Object that contains information on
how the reducer should update state

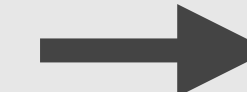
useState

setState

UPDATE



NEXT (UPDATED)
STATE



RE-RENDER

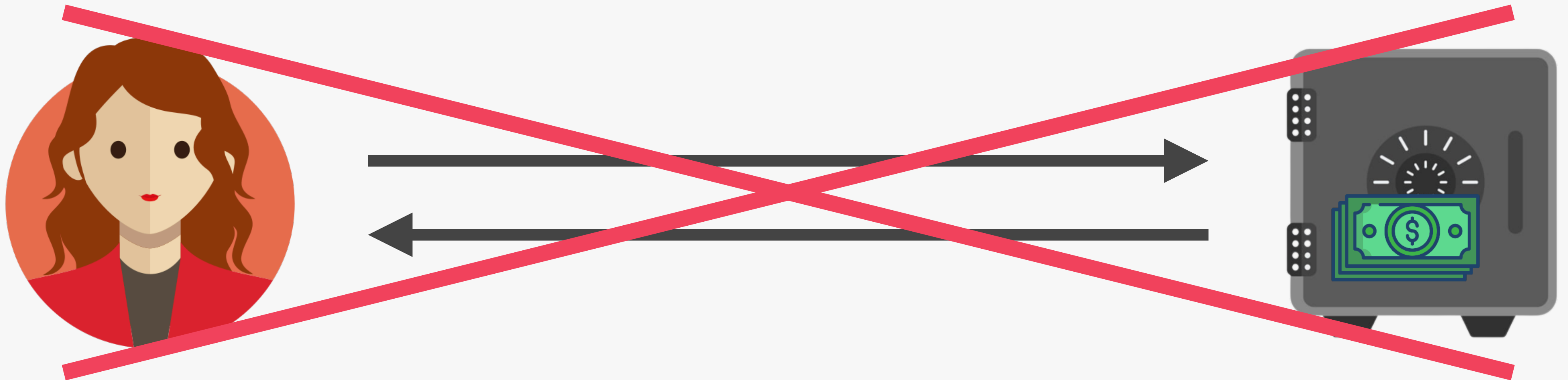
UPDATED STATE

A MENTAL MODEL FOR REDUCERS

👉 **REAL-WORLD TASK: WITHDRAWING \$5,000 FROM YOUR BANK ACCOUNT**

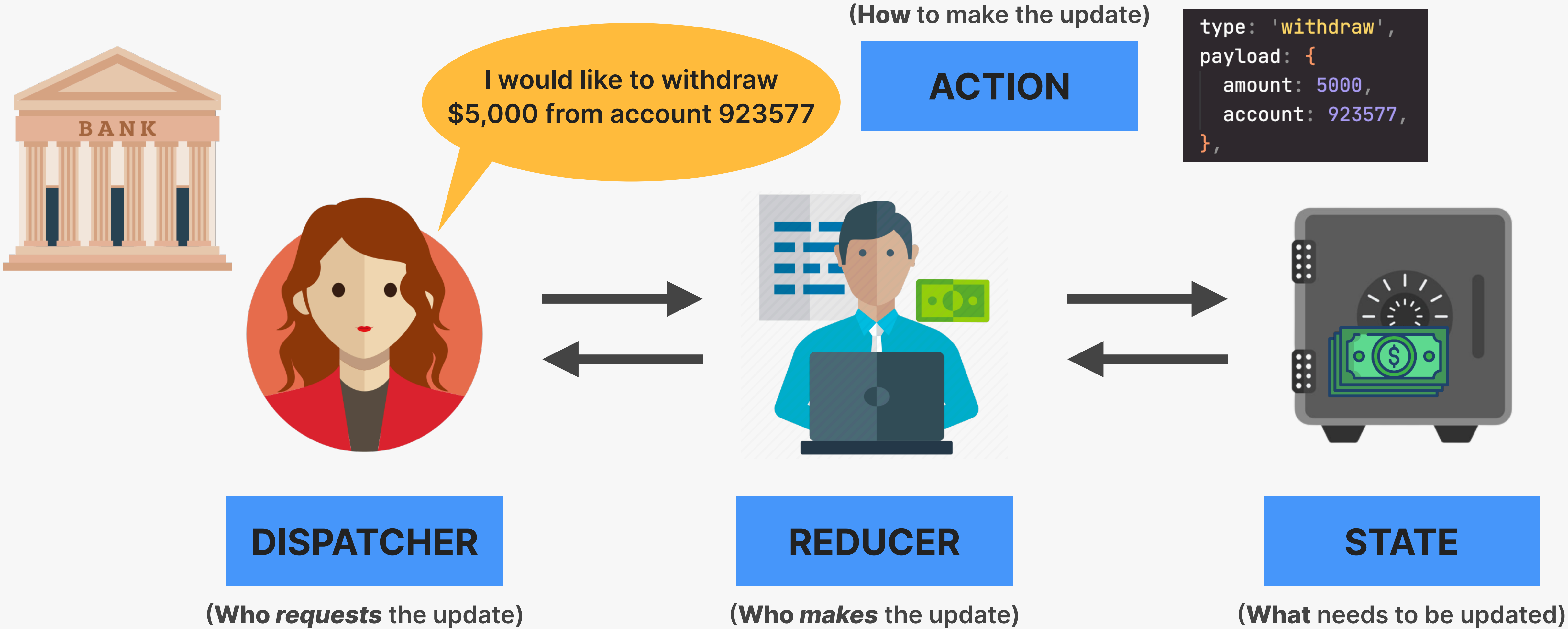


**YOU DO NOT GO TO YOUR BANK AND TAKE MONEY
STRAIGHT FROM THE BANK'S VAULT 😂**



A MENTAL MODEL FOR REDUCERS

👉 REAL-WORLD TASK: WITHDRAWING \$5,000 FROM YOUR BANK ACCOUNT





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SECTION

THE ADVANCED USEREDUCER
HOOK

LECTURE

SECTION SUMMARY: USESTATE
VS. USEREDUCER

USESTATE VS. USEREDUCER

useState

- 👉 Ideal for **single, independent pieces of state** (numbers, strings, single arrays, etc.)
- 👉 Logic to update state is placed directly in event handlers or effects, **spread all over one or multiple components**
- 👉 State is updated by **calling setState** (setter returned from useState)
- 👉 **Imperative** state updates

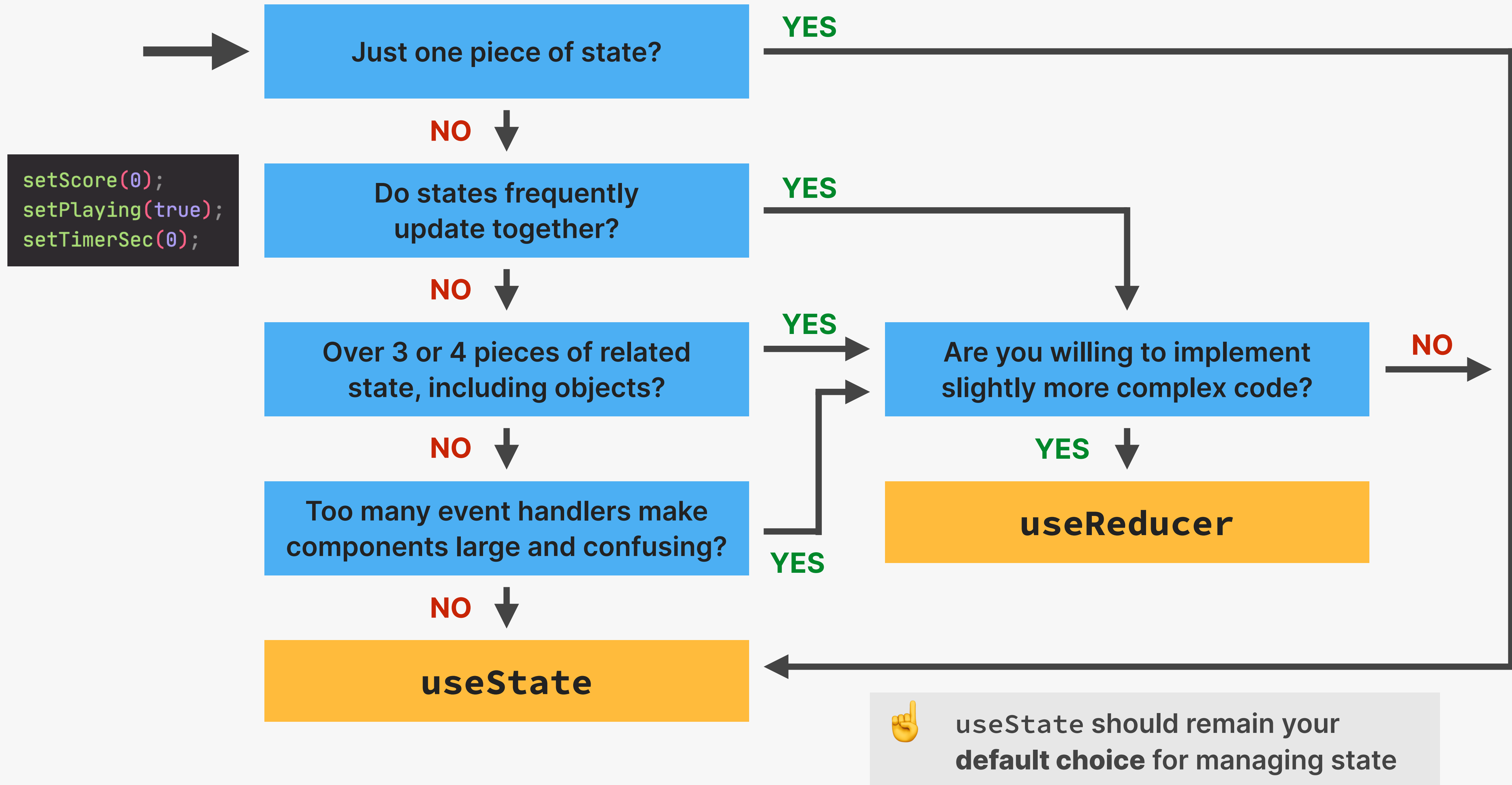
```
setScore(0);
setPlaying(true);
setTimerSec(0);
```
- 👉 **Easy** to understand and to use

useReducer

- 👉 Ideal for multiple **related pieces of state** and **complex state** (e.g. object with many values and nested objects or arrays)
- 👉 Logic to update state lives in **one central place, decoupled from components**: the reducer
- 👉 State is updated by **dispatching an action** to a reducer
- 👉 **Declarative** state updates: complex state transitions are **mapped** to actions

```
dispatch({ type: 'startGame' });
```
- 👉 More **difficult** to understand and implement

WHEN TO USE USEREDUCER?



REACT ROUTER: BUILDING SINGLE- PAGE APPLICATIONS (SPA)



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REACT ROUTER: BUILDING SINGLE
PAGE APPLICATIONS (SPA)

LECTURE

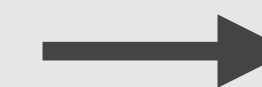
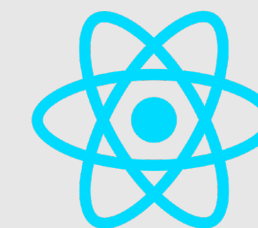
ROUTING AND SINGLE-PAGE
APPLICATIONS (SPAS)

WHAT IS ROUTING?

ROUTING

“Client-side routing”

- 👉 With routing, we match different URLs to different UI views (React components): **routes**
- 👉 This enables users to navigate between different applications screens, using the browser URL
- 👉 Keeps the UI in sync with the current browser URL
- 👉 Allows us to build Single-Page Applications

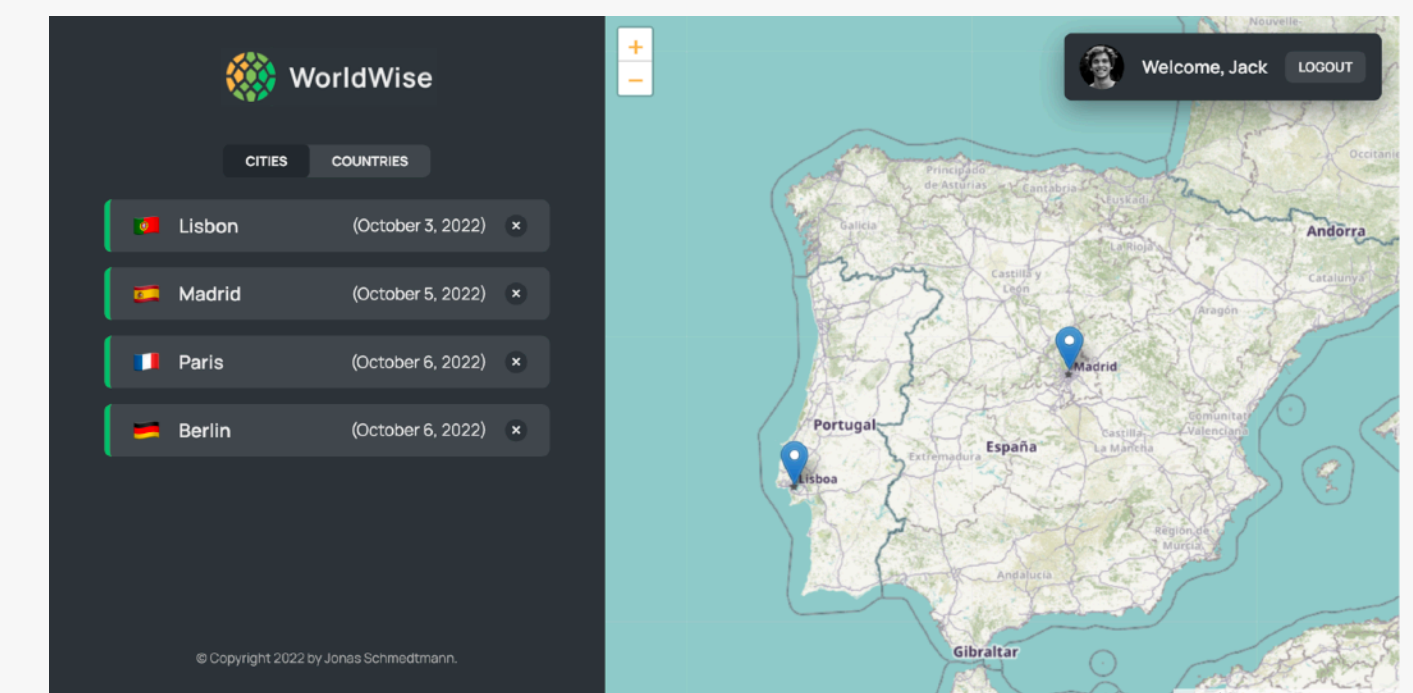
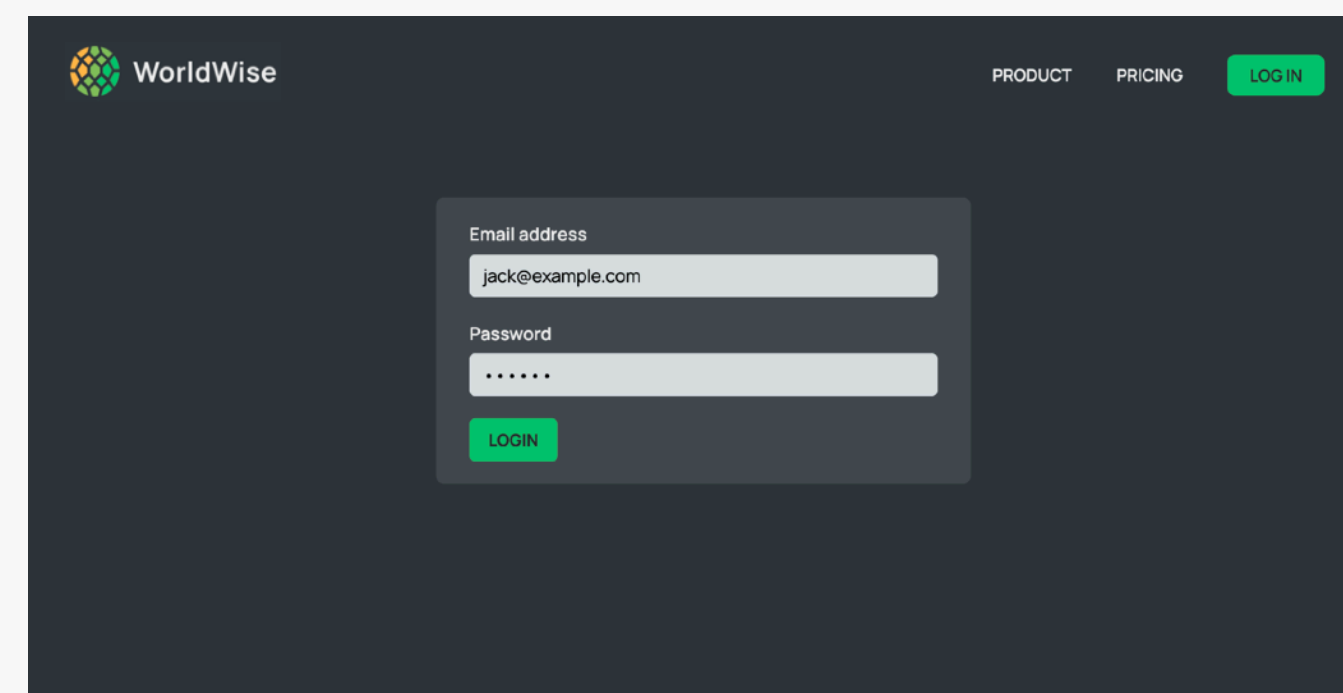
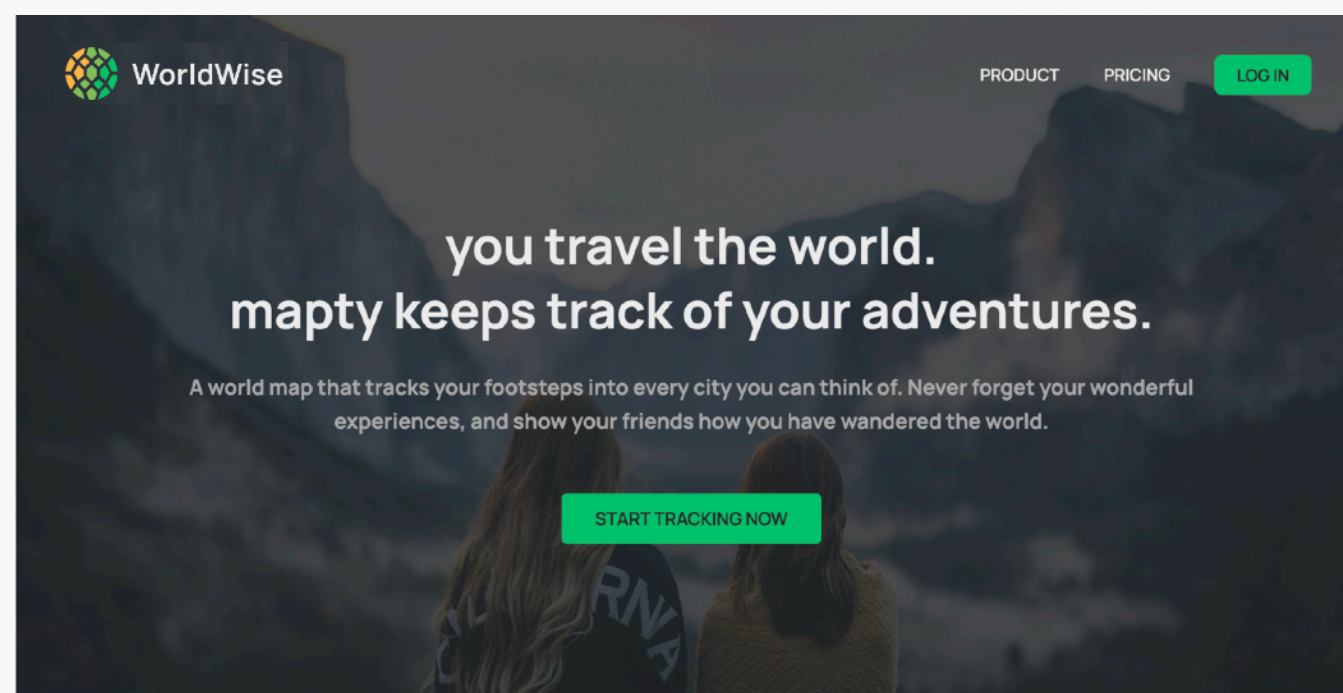


🔗 **React Router**

www.example.com/

www.example.com/login

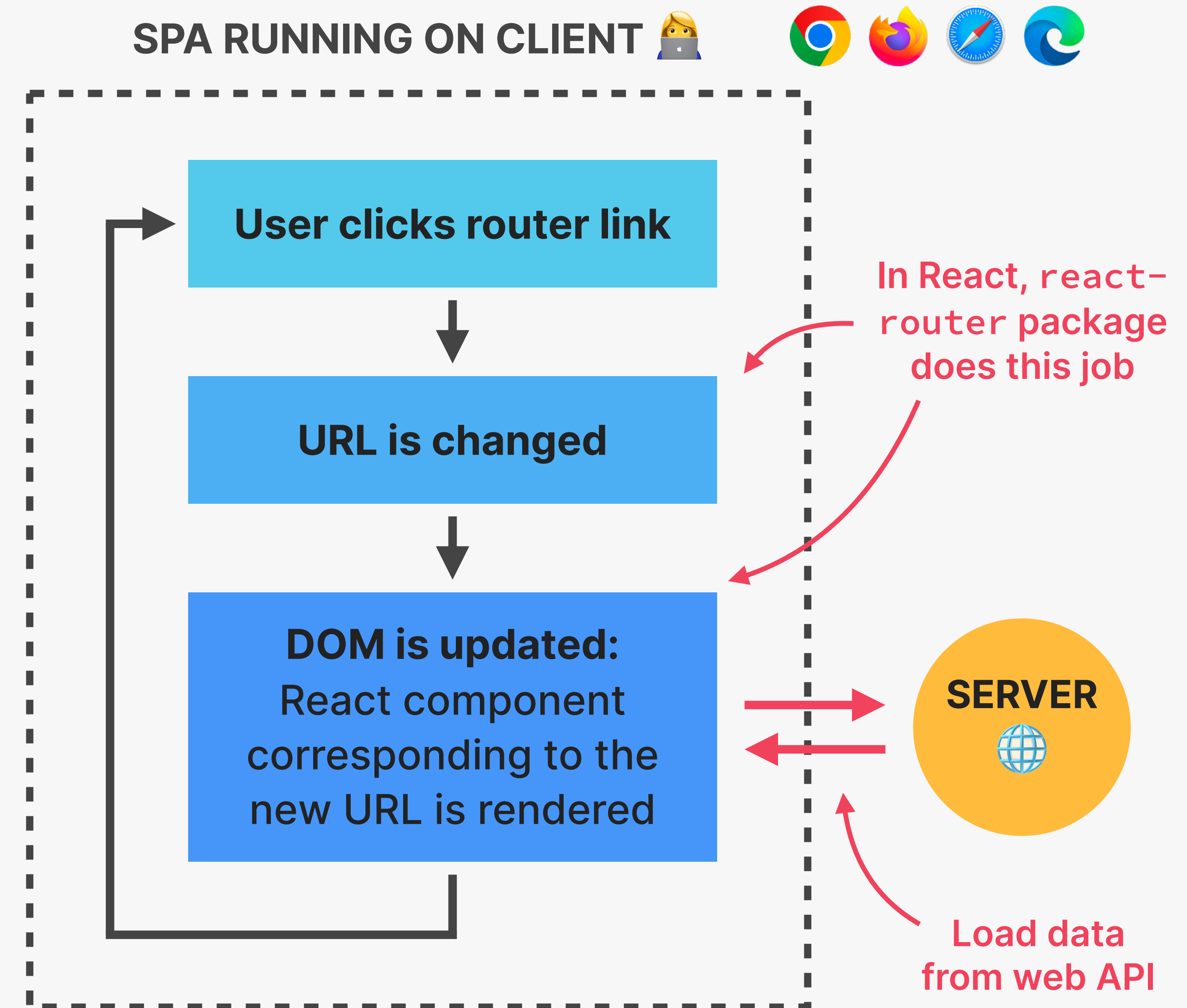
www.example.com/app



SINGLE-PAGE APPLICATIONS (SPA)

SINGLE-PAGE APPLICATION

- 👉 Application that is **executed entirely on the client** (browsers)
- 👉 **Routes**: different URLs correspond to different views (components)
- 👉 **JavaScript** (React) is used to update the page (DOM)
- 👉 *The page is never reloaded*
- 👉 Feels like a **native app**
- 👉 Additional data **might be loaded** from a web API





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REACT ROUTER: BUILDING SINGLE
PAGE APPLICATIONS (SPA)




LECTURE

STYLING OPTIONS FOR REACT
APPLICATIONS

STYLING OPTIONS IN REACT

React doesn't care about styling



STYLING OPTION	WHERE?	HOW?	SCOPE	BASED ON
----------------	--------	------	-------	----------

 Inline CSS 	JSX elements	style prop	 JSX element Local	CSS
---	--------------	------------	---	-----

 CSS or Sass file  	External file	className prop	 Entire app Global, causes problems	CSS
---	---------------	----------------	--	-----

 CSS Modules 	One external file per component	className prop	Component	CSS
--	---------------------------------	----------------	------------------	-----

 CSS-in-JS 	External file or component file	Creates new component	Component	JavaScript
--	---------------------------------	-----------------------	------------------	------------

 Utility-first CSS  tailwindcss	JSX elements	className prop	JSX element	CSS
---	--------------	----------------	--------------------	-----

 **Alternative to styling with CSS: UI libraries like MUI, Chakra UI, Mantine, etc.**   **chakra**  **Mantine**



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PAGE APPLICATIONS (SPA)

LECTURE

STORING STATE IN THE URL

THE URL FOR STATE MANAGEMENT

👉 The URL is an excellent place to store UI state and an alternative to useState in some situations!
Examples: open/closed panels, currently selected list item, list sorting order, applied list filters

- 1 Easy way to store state in a **global place**, accessible to **all components** in the app
- 2 Good way to “**pass**” data from one page into the next page
- 3 Makes it possible to **bookmark and share** the page with the exact UI state it had at the time

www.example.com/app/cities/lisbon?lat=38.728&lng=-9.141

🔗. React Router tools:

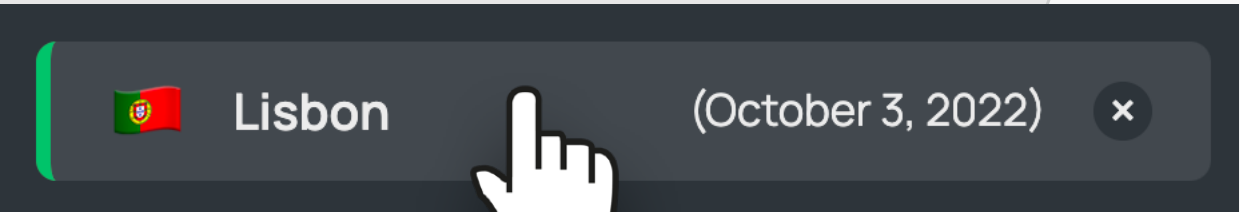
↑
path

↑
params

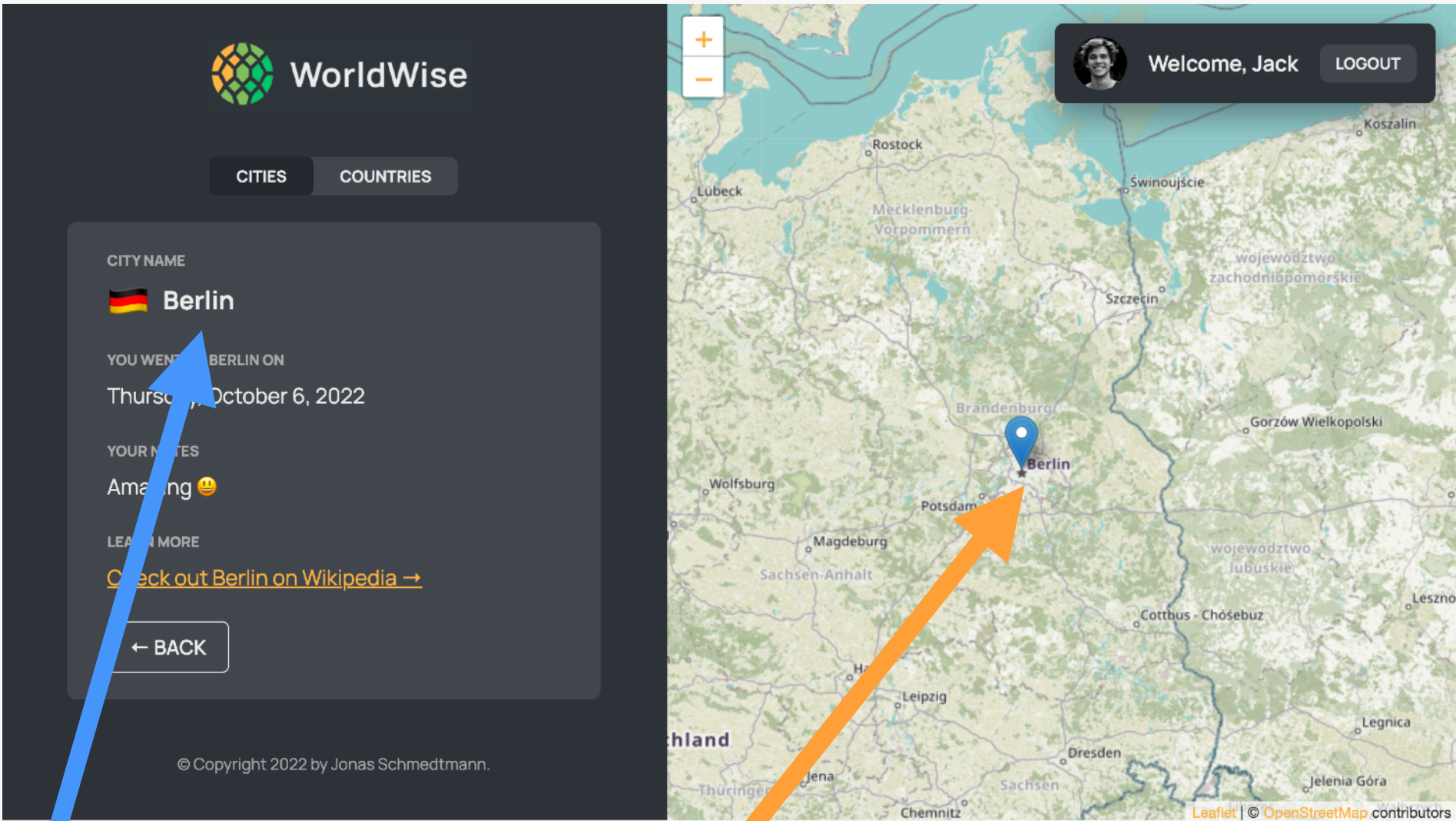
↑
query string

EXAMPLE: PARAMS AND QUERY STRING

www.example.com/app/cities/lisbon?lat=38.728&lng=-9.141



👉 City name and GPS location were retrieved from the URL instead of application state!



www.example.com/app/cities/berlin?lat=52.536&lng=13.377

ADVANCED STATE MANAGEMENT: THE CONTEXT API



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ADVANCED STATE MANAGEMENT:
THE CONTEXT API

LECTURE

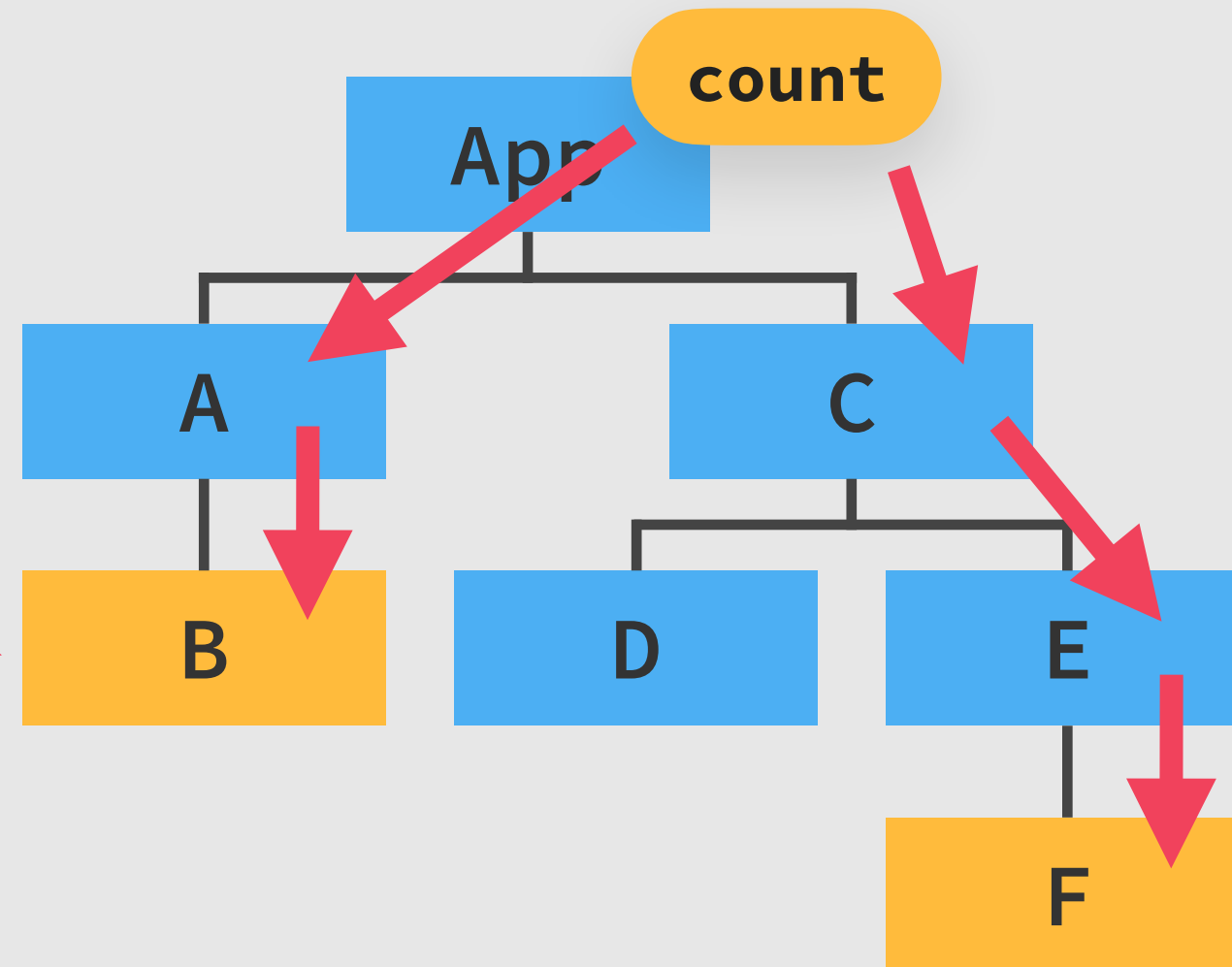
WHAT IS THE CONTEXT API?

A SOLUTION TO PROP DRILLING

👉 TASK: Passing state into multiple deeply nested child components

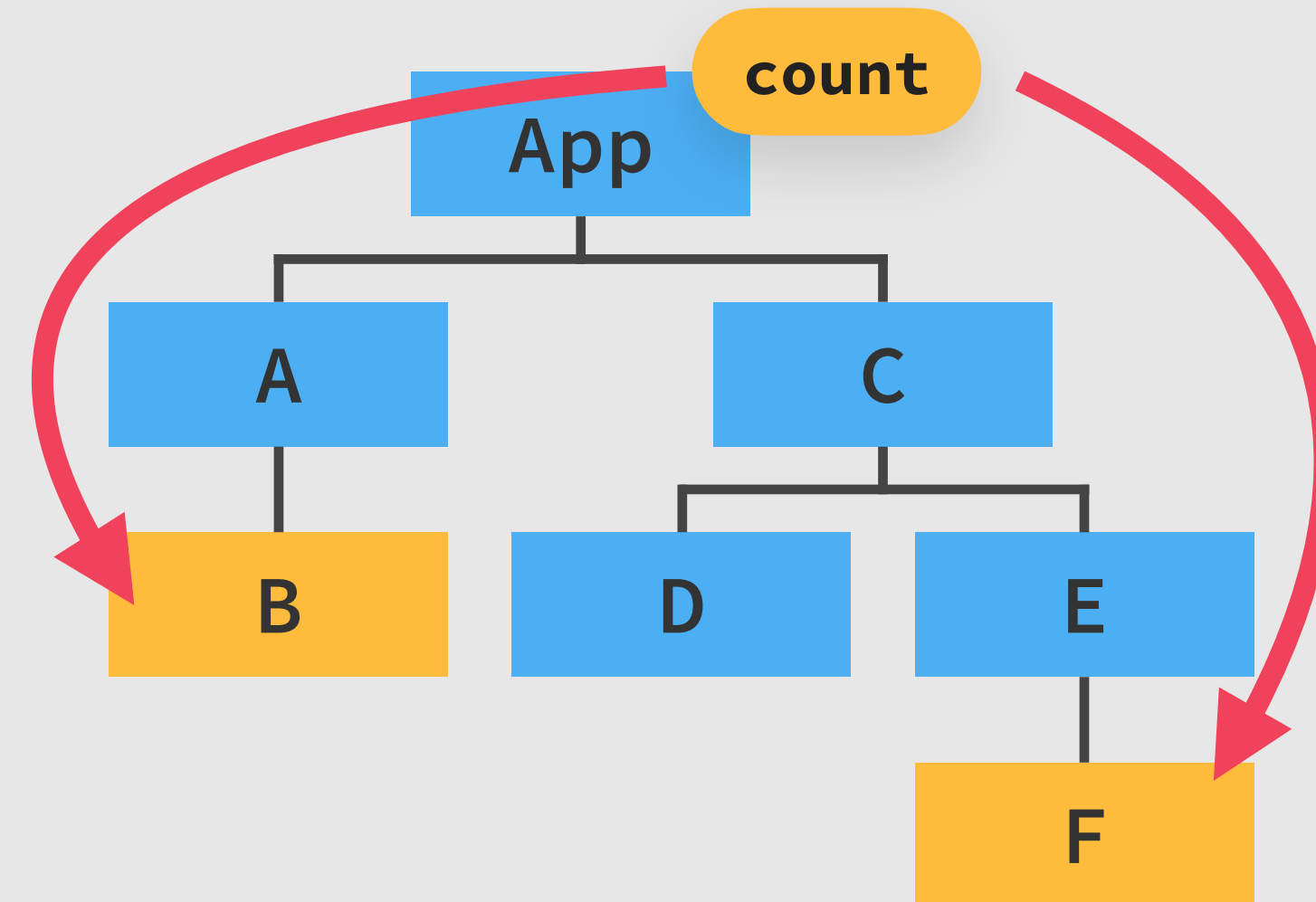
💡 SOLUTION 1: PASSING PROPS

Components
that need
count state



🚫 PROBLEM: "PROP DRILLING"

✅ SOLUTION 2: CONTEXT API



👍 READ STATE FROM EVERYWHERE

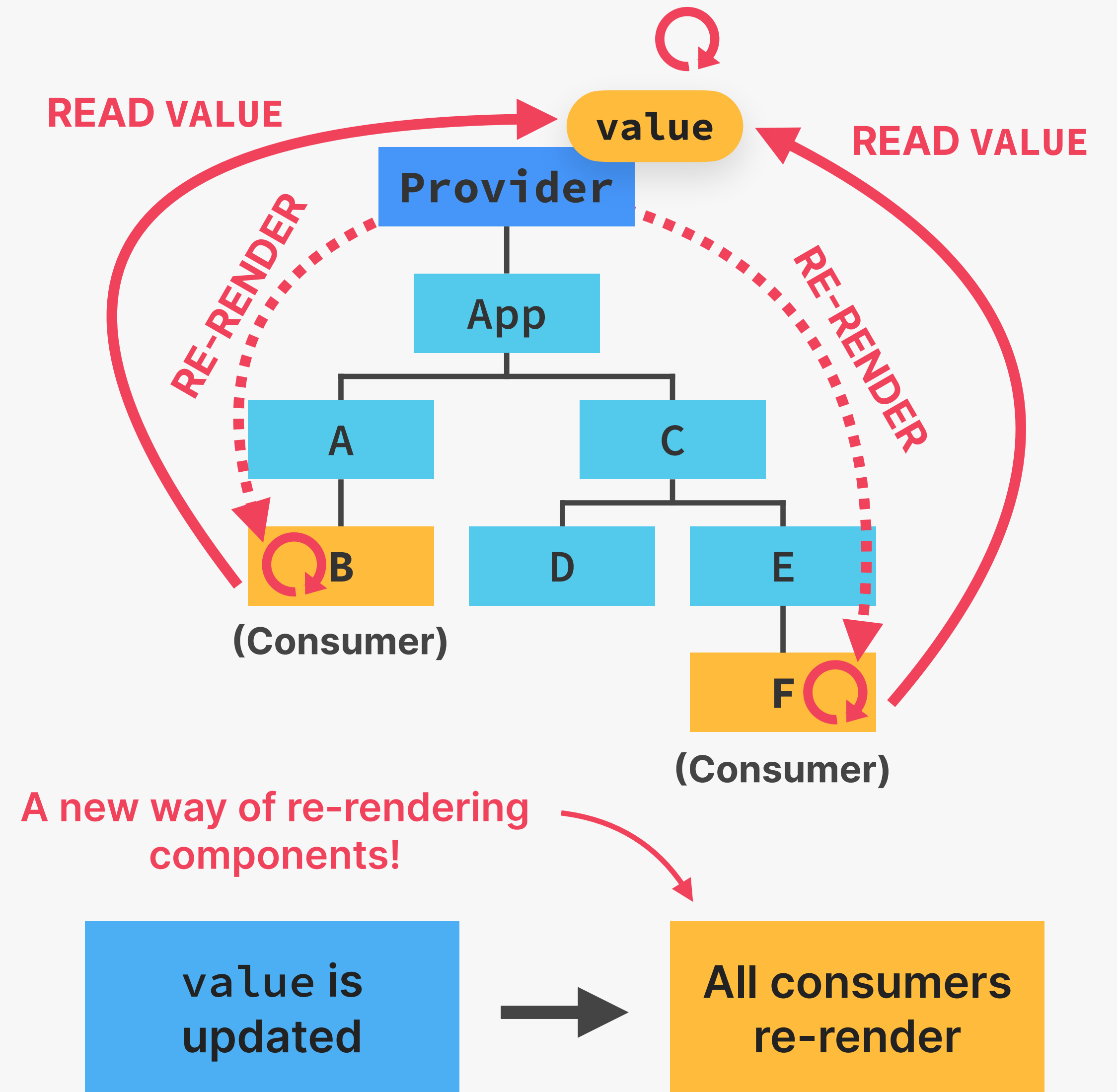
👉 Remember that a good solution to "prop drilling" is **better component composition** (see "Thinking in React" section)

WHAT IS THE CONTEXT API?

CONTEXT API

- 👉 System to pass data throughout the app **without manually passing props** down the tree
- 👉 Allows us to “**broadcast**” **global state** to the entire app

- 1** **Provider:** gives all child components access to `value`
- 2** **value:** data that we want to make available (usually state and functions)
- 3** **Consumers:** all components that read the provided context `value`





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ADVANCED STATE MANAGEMENT:
THE CONTEXT API

LECTURE

THINKING IN REACT: ADVANCED
STATE MANAGEMENT

REVIEW: WHAT IS STATE MANAGEMENT?



State management: Giving each piece of state the right home

✓ When to use state

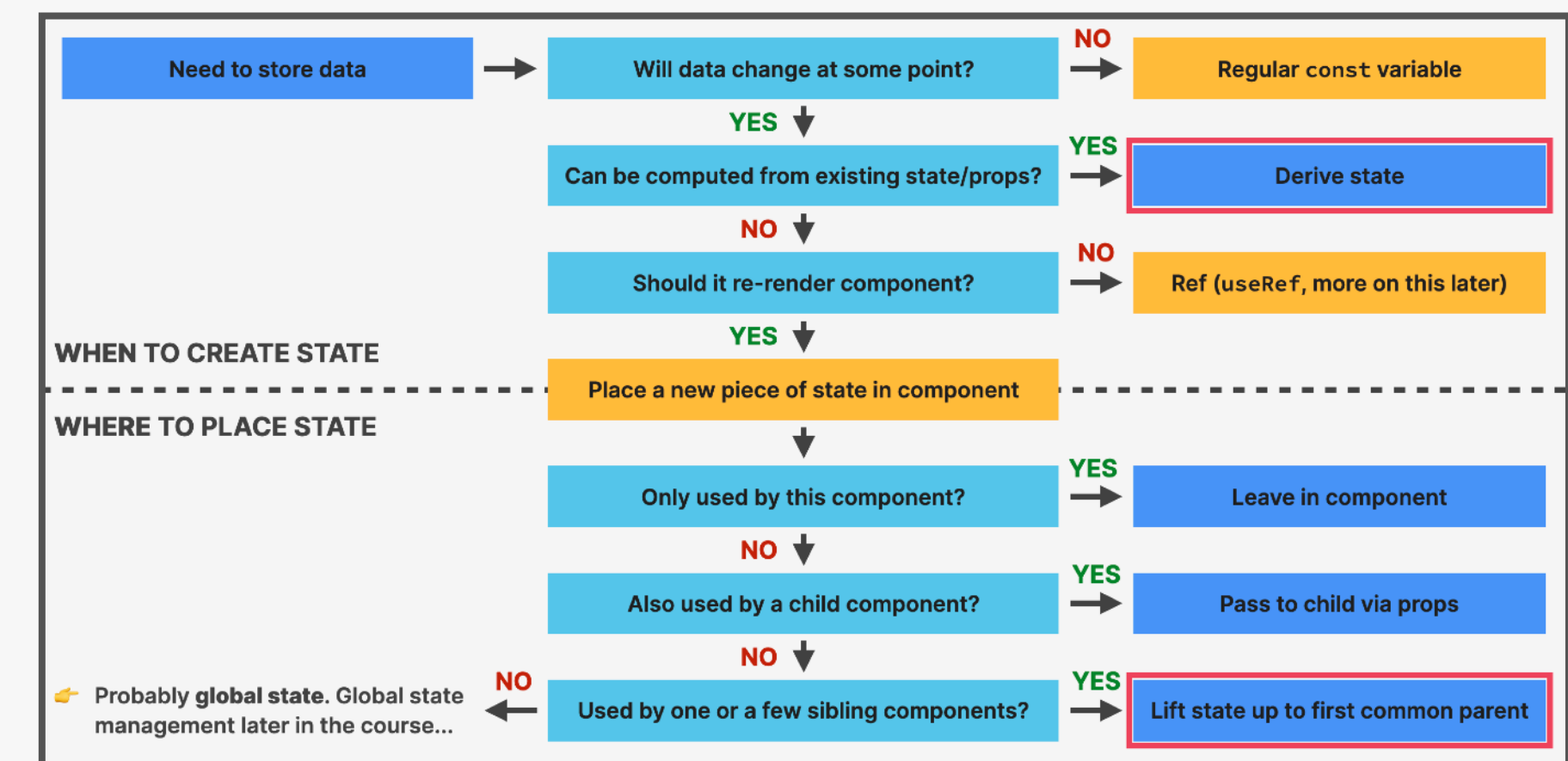
✓ Types of state (accessibility): local vs. global

👉 Types of state (domain): UI vs. remote

👉 Where to place each piece of state

👉 Tools to manage all types of state

This lecture!



From Lecture "Fundamentals of State Management". You can keep using this 👉

TYPES OF STATE

1

STATE ACCESSIBILITY

*"If this component was rendered **twice**, should a state update in one of them reflect in the other one?"*

NO



LOCAL STATE

VS.



GLOBAL STATE

- 👉 Needed only by **one or few components**
- 👉 Only accessible in **component and child components**
- 👉 Might be needed by **many components**
- 👉 Accessible to **every component** in the application

2

STATE DOMAIN



REMOTE STATE










VS.



UI STATE

- 👉 All application data loaded from a **remote server (API)**
- 👉 Usually **asynchronous**
- 👉 Needs re-fetching + updating
- 👉 **Everything else** 🤪
- 👉 Theme, list filters, form data, etc.
- 👉 Usually **synchronous** and stored in the application

STATE PLACEMENT OPTIONS

 <i>Where to place state?</i>	TOOLS 	WHEN TO USE? 
 Local component	useState, useReducer, or useRef	Local state
 Parent component	useState, useReducer, or useRef	Lifting up state
 Context	<div>Context API</div> + useState or useReducer	Global state (preferably UI state)
 3rd-party library	Redux, React Query, SWR, Zustand, etc.	Global state (remote or UI)
 URL	React Router	Global state, passing between pages
 Browser	Local storage, session storage, etc.	Storing data in user's browser

STATE MANAGEMENT TOOL OPTIONS



How to manage different types of state in practice?

1

STATE ACCESSIBILITY



LOCAL STATE



GLOBAL STATE

STATE DOMAIN

2



UI STATE



REMOTE STATE



useState



useReducer



useRef



fetch + useEffect +
useState/useReducer



Context API + useState/useReducer



Redux, Zustand, Recoil, etc.



React Router



Context API + useState/useReducer



Redux, Zustand, Recoil, etc.



React Query



SWR



RTK Query

Tools highly
specialized in
handling remote
state

Mostly in small
applications

PERFORMANCE OPTIMIZATION AND ADVANCED USEEFFECT



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PERFORMANCE OPTIMIZATION
AND ADVANCED USEEFFECT

LECTURE

PERFORMANCE OPTIMIZATION
AND WASTED RENDERS

PERFORMANCE OPTIMIZATION TOOLS

1

PREVENT WASTED RENDERS

- 👉 memo
- 👉 useMemo
- 👉 useCallback
- 👉 Passing elements as children or regular prop

2

IMPROVE APP SPEED/ RESPONSIVENESS

- 👉 useMemo
- 👉 useCallback
- 👉 useTransition

3

REDUCE BUNDLE SIZE

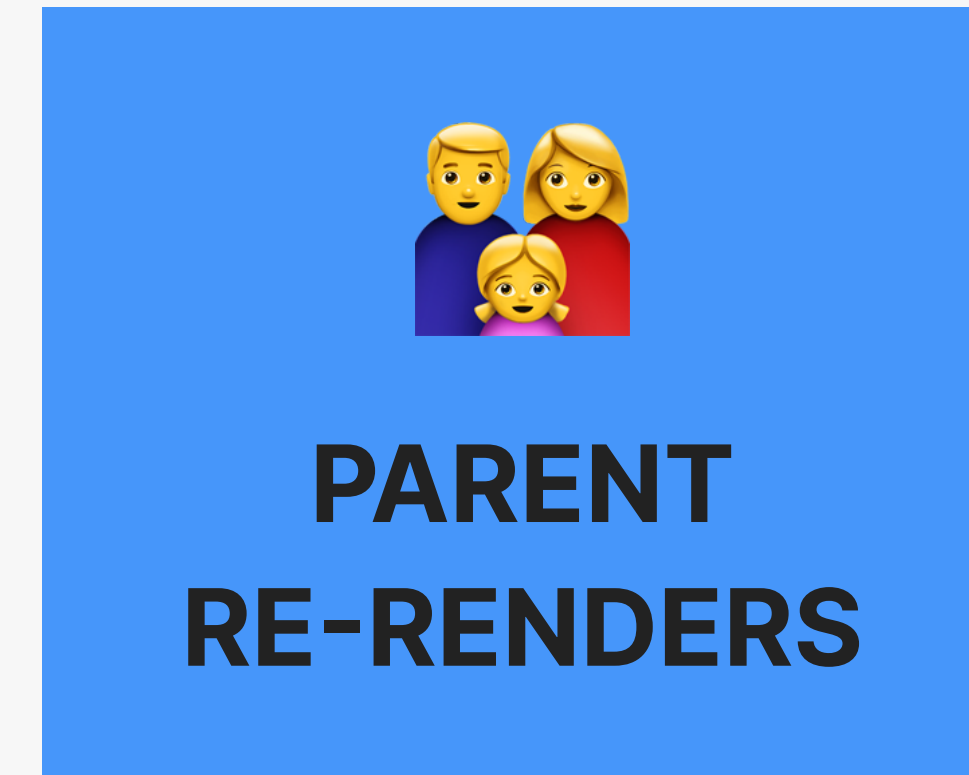
- 👉 Using fewer 3rd-party packages
- 👉 Code splitting and lazy loading



This list of tools and techniques is, by no means, exhaustive. You're already doing many optimizations by following the best practices I have been showing you 🙌

WHEN DOES A COMPONENTS INSTANCE RE-RENDER?

👉 A component instance only gets re-rendered in 3 different situations:



Creates the false impression that **changing props** re-renders a component. This is **NOT** true.



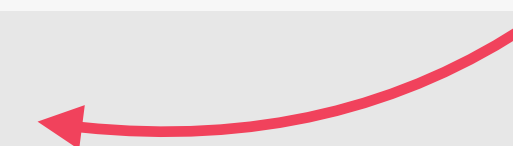
👉 Remember: a render does *not* mean that the **DOM** actually gets updated, it just means the component function gets called. But this can be an expensive operation.



👉 **Wasted render:** a render that didn't produce any change in the DOM

👉 Only a problem when they happen **too frequently** or when the **component is very slow**

Usually no problem, as React is very fast!





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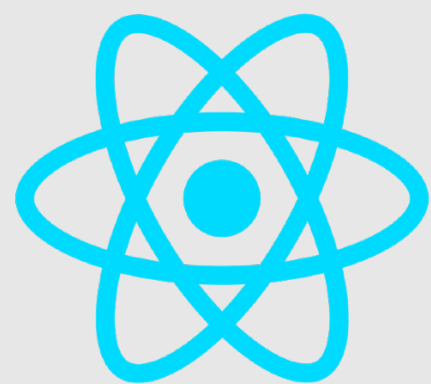
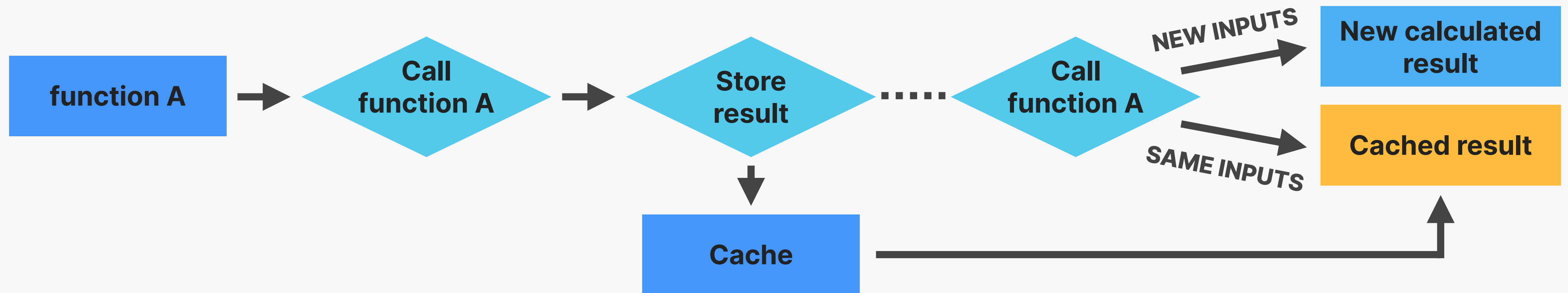
PERFORMANCE OPTIMIZATION
AND ADVANCED USEEFFECT

LECTURE

UNDERSTANDING MEMO

WHAT IS MEMOIZATION?

👉 **Memoization:** Optimization technique that executes a pure function once, and saves the result in memory. If we try to execute the function again with the **same arguments as before**, the previously saved result will be returned, **without executing the function again**.



- 👉 Memoize **components** with `memo`
- 👉 Memoize **objects** with `useMemo`
- 👉 Memoize **functions** with `useCallback`

- 1 Prevent wasted renders
- 2 Improve app speed/responsiveness

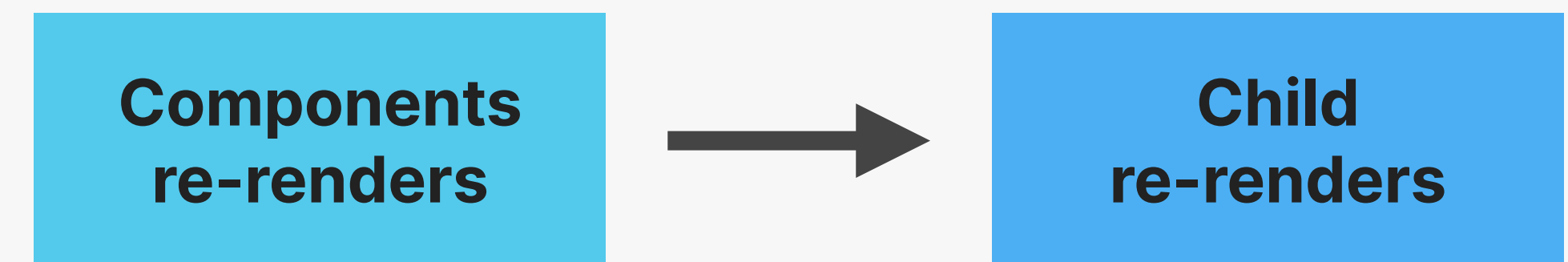
THE MEMO FUNCTION

memo

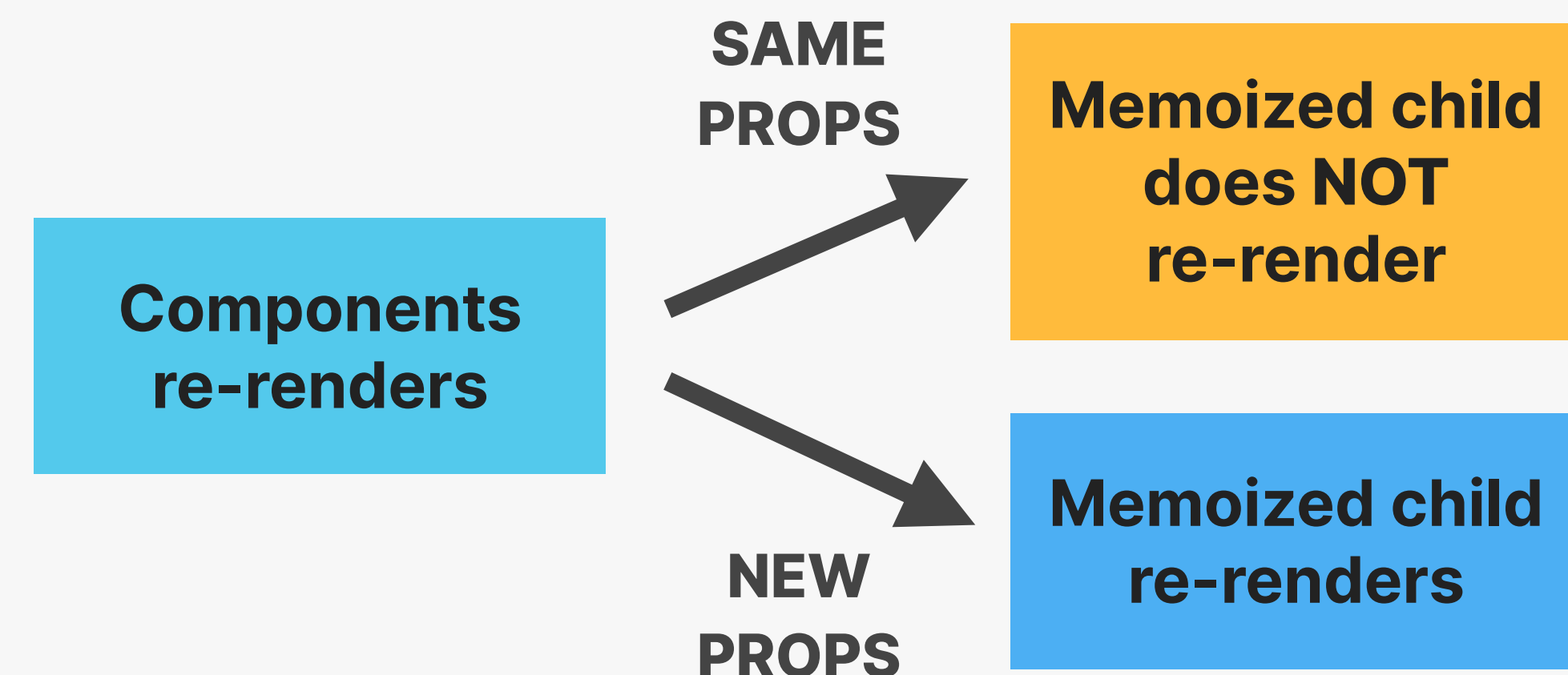
Memoized
component

- 👉 Used to create a component that will **not re-render** when its parent re-renders, as long as the **props stay the same** between renders
- 👉 **Only affects props!** A memoized component will still re-render when its **own state changes** or when a **context** that it's subscribed to changes
- 👉 Only makes sense when the component is **heavy** (slow rendering), **re-renders often**, and does so **with the same props**

🚫 REGULAR BEHAVIOR (NO MEMO)



✅ MEMOIZED CHILD WITH MEMO





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LECTURE

UNDERSTANDING USEMEMO AND
USECALLBACK

AN ISSUE WITH MEMO

In React, everything is **re-created on every render** (including objects and functions)



In JavaScript, two objects or functions that look the same, **are actually different** (`{}` **!=** `{}`)

THEREFORE



If objects or functions are passed as props, the child component will always see them as **new props on each re-render**



If props are different between re-renders, *memo will not work*

SOLUTION



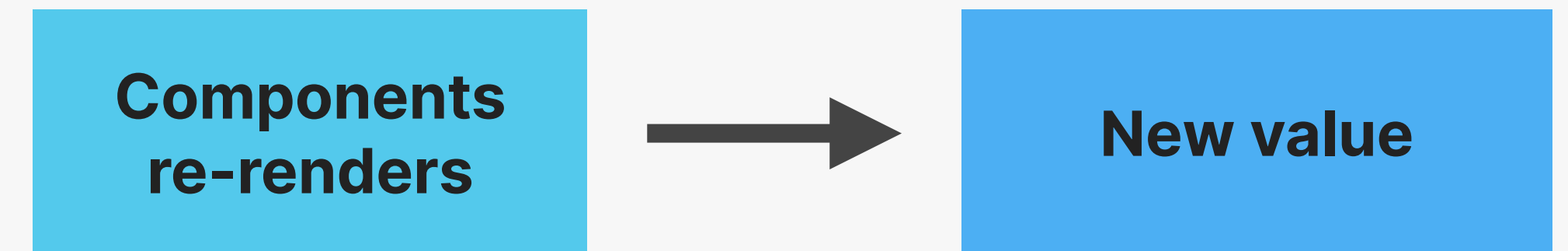
We need to memoize objects and functions, to make them stable (preserve) between re-renders (memoized `{}` **==** memoized `{}`)

TWO NEW HOOKS: USEMEMO AND USECALLBACK

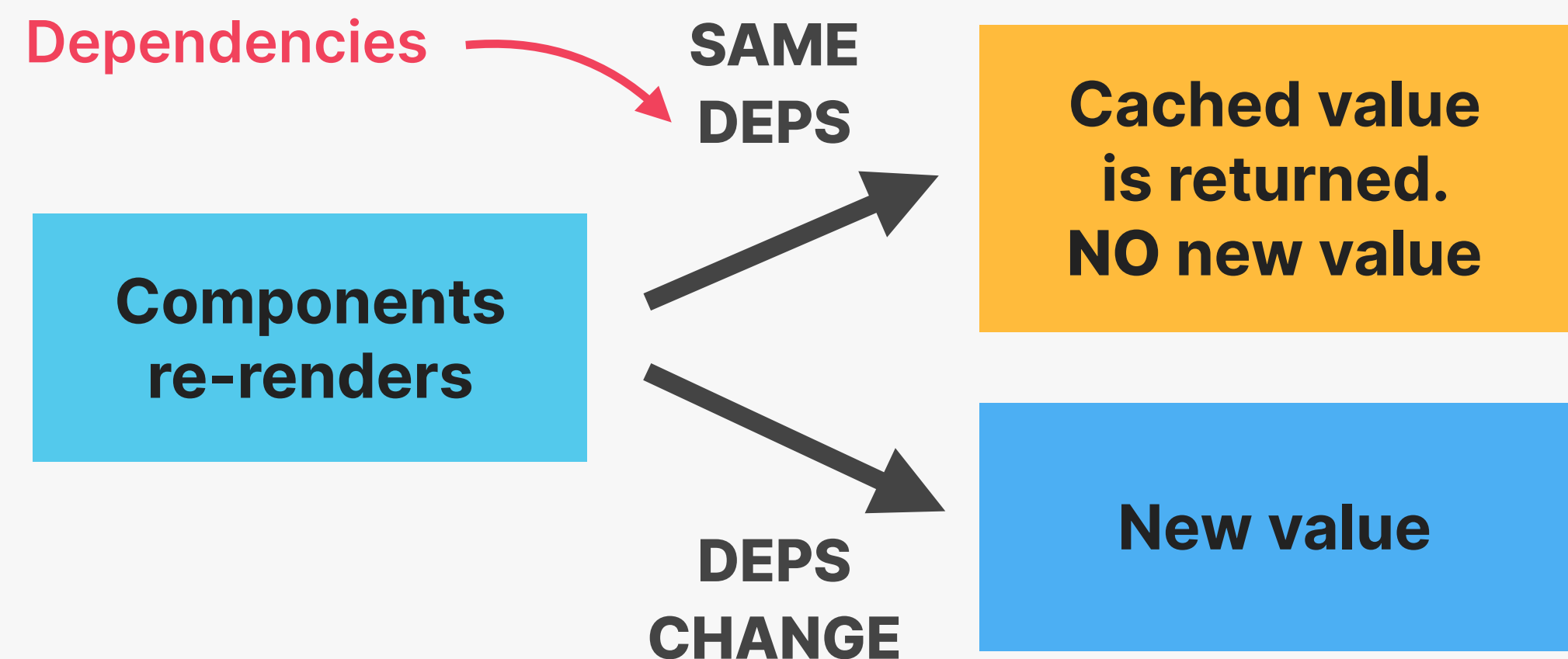
useMemo AND useCallback

- 👉 Used to memoize values (`useMemo`) and functions (`useCallback`) between renders
- 👉 Values passed into `useMemo` and `useCallback` will be stored in memory ("cached") and returned in subsequent re-renders, as long as dependencies ("*inputs*") stay the same
- 👉 `useMemo` and `useCallback` have a **dependency array** (like `useEffect`): whenever one **dependency changes**, the value will be re-created

🚫 REGULAR BEHAVIOR (NO USEMEMO)



✅ MEMOIZING A VALUE WITH USEMEMO



TWO NEW HOOKS: USEMEMO AND USECALLBACK

useMemo AND useCallback

- 👉 Used to memoize values (`useMemo`) and functions (`useCallback`) **between renders**
- 👉 Values passed into `useMemo` and `useCallback` will be stored in memory (“cached”) and **returned in subsequent re-renders, as long as dependencies (“inputs”) stay the same**
- 👉 `useMemo` and `useCallback` have a **dependency array** (like `useEffect`): whenever one **dependency changes**, the value will be **re-created**
- 👉 Only use them for one of the three **use cases!**

THREE BIG USES CASES:

- 1 Memoizing props to prevent wasted renders (together with `memo`)
- 2 Memoizing values to avoid expensive re-calculations on every render
- 3 Memoizing values that are used in dependency array of another hook

For example to
avoid infinite
`useEffect` loops



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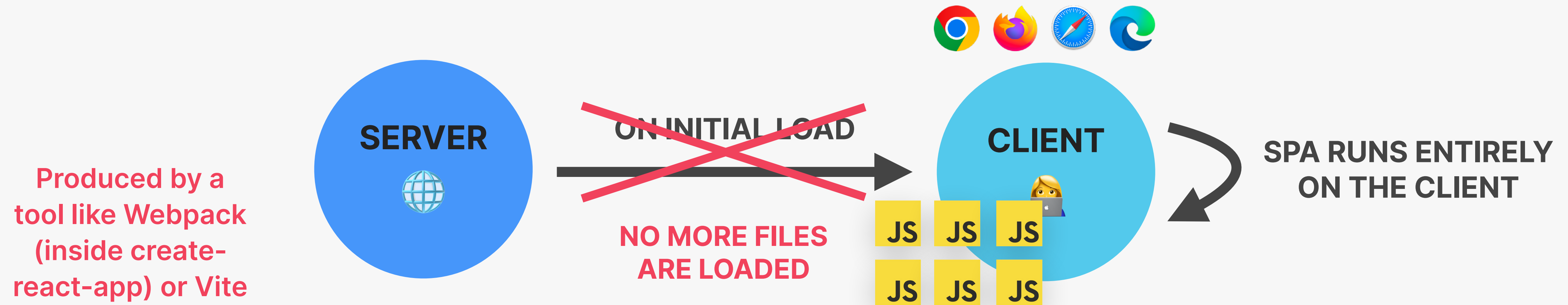
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PERFORMANCE OPTIMIZATION
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LECTURE

OPTIMIZING BUNDLE SIZE WITH
CODE SPLITTING

THE BUNDLE AND CODE SPLITTING



- 👉 **Bundle:** JavaScript file containing the **entire application code**. Downloading the bundle will load **the entire app at once**, turning it into a SPA
- 👉 **Bundle size:** Amount of JavaScript users have to download to start using the app. One of the most important things to be optimized, so that the bundle takes **less time to download**
- 👉 **Code splitting:** Splitting bundle into multiple parts that can be **downloaded over time** (“lazy loading”)



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DON'T OPTIMIZE PREMATURELY!

DON'T OPTIMIZE PREMATURELY!

DO

- ✓ Find performance bottlenecks using the Profiler and visual inspection (laggy UI)
- ✓ Fix those real performance issues
- ✓ Memoize expensive re-renders
- ✓ Memoize expensive calculations
- ✓ Optimize context if it has many consumers and changes often
- ✓ Memoize context value + child components
- ✓ Implement code splitting + lazy loading for SPA routes

DON'T!

- ⊘ Don't optimize prematurely!
- ⊘ Don't optimize anything if there is nothing to optimize...
- ⊘ Don't wrap all components in `memo()`
- ⊘ Don't wrap all values in `useMemo()`
- ⊘ Don't wrap all functions in `useCallback()`
- ⊘ Don't optimize context if it's not slow and doesn't have many consumers



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USEEFFECT RULES AND BEST
PRACTICES

USEEFFECT DEPENDENCY ARRAY RULES

DEPENDENCY ARRAY RULES

- 👉 Every **state variable**, **prop** used inside the effect **MUST** be included in the dependency array
- 👉 All “**reactive values**” must be included! That means any **function** or **variable** that reference any **other** reactive value
- 👉 Dependencies choose themselves: **NEVER** ignore the exhaustive-deps ESLint rule!
- 👉 Do **NOT** use **objects** or **arrays** as dependencies (objects are recreated on each render, and React sees new objects as **different**, `{}` **!==** `{}`)

Reactive value: state, prop, or context value, **or** any other value that *references* a reactive value

```
const [number, setNumber] = useState(5);
const [duration, setDuration] = useState(0);
const mins = Math.floor(duration);
const secs = (duration - mins) * 60;

const formatDur = function () {
  return `${mins}:${secs < 10 ? '0' : ''}${secs}`;
};

useEffect(
  function () {
    document.title =
      `${number}-exercise workout (${formatDur()})`;
  },
  [number, formatDur]
);
```

All reactive values used in effect

👋 The **same rules** apply to the dependency arrays of other hooks: `useMemo` and `useCallback`

REMOVING UNNECESSARY DEPENDENCIES



REMOVING FUNCTION DEPENDENCIES

- 👉 Move function **into the effect**
- 👉 If you need the function in multiple places, **memoize it** (`useCallback`)
- 👉 If the function doesn't reference any reactive values, move it **out of the component**



REMOVING OBJECT DEPENDENCIES

- 👉 Instead of including the entire object, include **only the properties you need** (primitive values)
- 👉 If that doesn't work, use the same strategies as for functions (**moving** or **memoizing** object)



OTHER STRATEGIES

- 👉 If you have **multiple related reactive values** as dependencies, try using a **reducer** (`useReducer`)
- 👉 You don't need to include `setState` (from `useState`) and `dispatch` (from `useReducer`) in the dependencies, as **React guarantees them to be stable** across renders

WHEN NOT TO USE AN EFFECT



Effects should be used as a **last resort**, when no other solution makes sense. React calls them an “escape hatch” to step outside of React

THREE CASES WHERE EFFECTS ARE OVERUSED:

Avoid these as a beginner

1

Responding to a user event. An event handler function should be used instead

2

Fetching data on component mount. This is fine in small apps, but in real-world app, a library like React Query should be used

3

Synchronizing state changes with one another (setting state based on another state variable). Try to use derived state and event handlers

We actually do this in the current project, but for a good reason 😅

REDUX AND MODERN REDUX TOOLKIT (WITH THUNKS)



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REDUX AND MODERN REDUX
TOOLKIT (WITH THUNKS)

LECTURE

INTRODUCTION TO REDUX

WHAT IS REDUX?

REDUX

- 👉 3rd-party library to manage **global state**
- 👉 **Standalone** library, but easy to integrate with React apps using react-redux library
- 👉 All global state is stored in one **globally accessible store**, which is easy to update using “**actions**” (like useReducer)
- 👉 It’s conceptually similar to using the Context API + useReducer
- 👉 Two “versions”: (1) Classic Redux, (2) Modern Redux Toolkit

↖️ We will learn both 😎



Global store is
updated



All consuming
components re-render



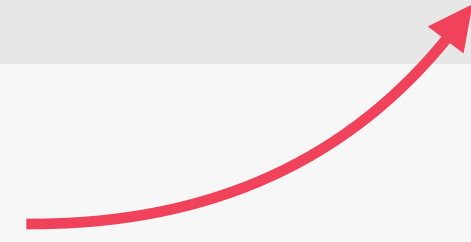
You need to have a really good understanding of the useReducer hook in order to understand Redux!

DO YOU NEED TO LEARN REDUX?



Historically, Redux was used in most React apps for all global state. Today, that has changed, because there are many alternatives. **Many apps don't need Redux anymore, unless they need a lot of global UI state.**

You might not need to learn Redux...



WHY LEARN REDUX IN THIS COURSE?

1

Redux can be hard to learn, and this course teaches it well 😅

2

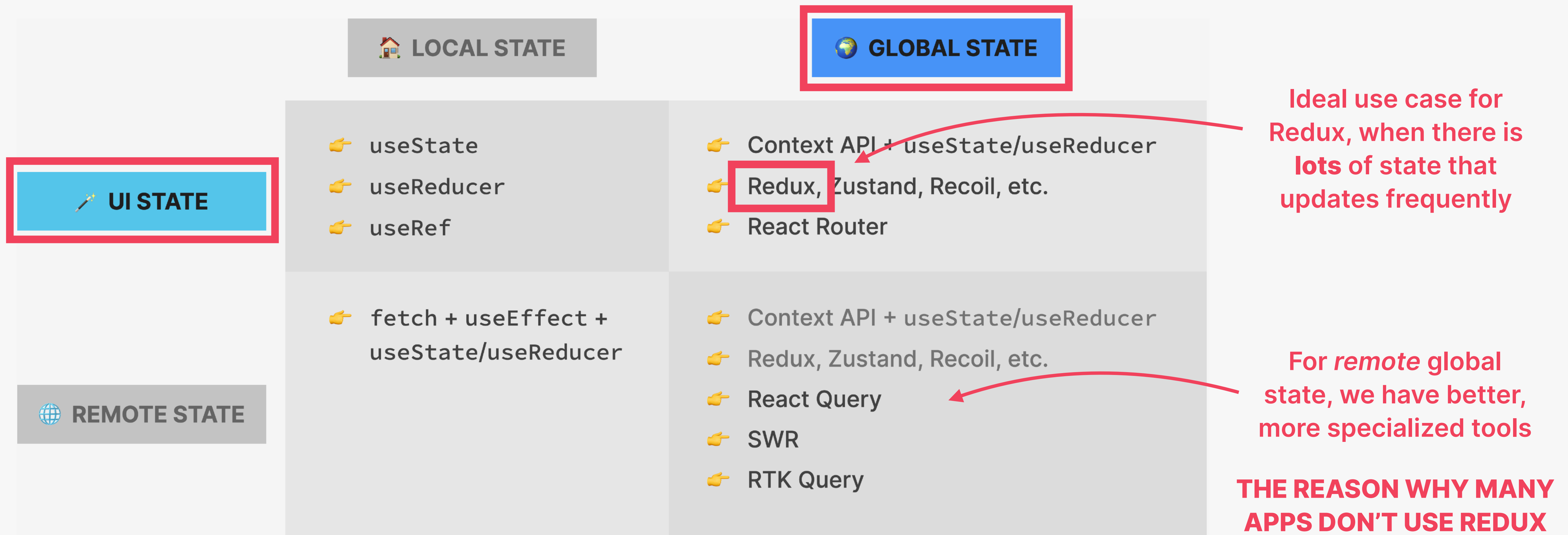
You will encounter Redux code in your job, so you should understand it

3

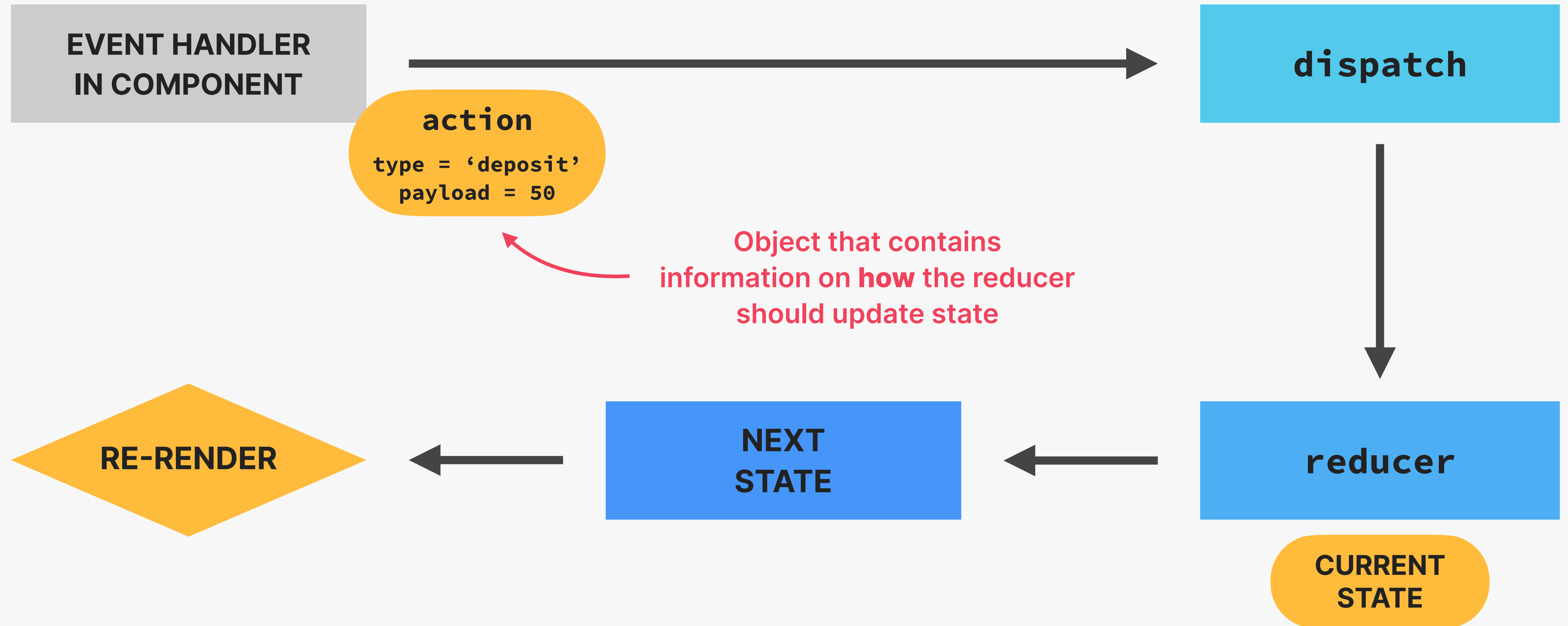
Some apps *do* require Redux (or a similar library)

REDUX USE CASES

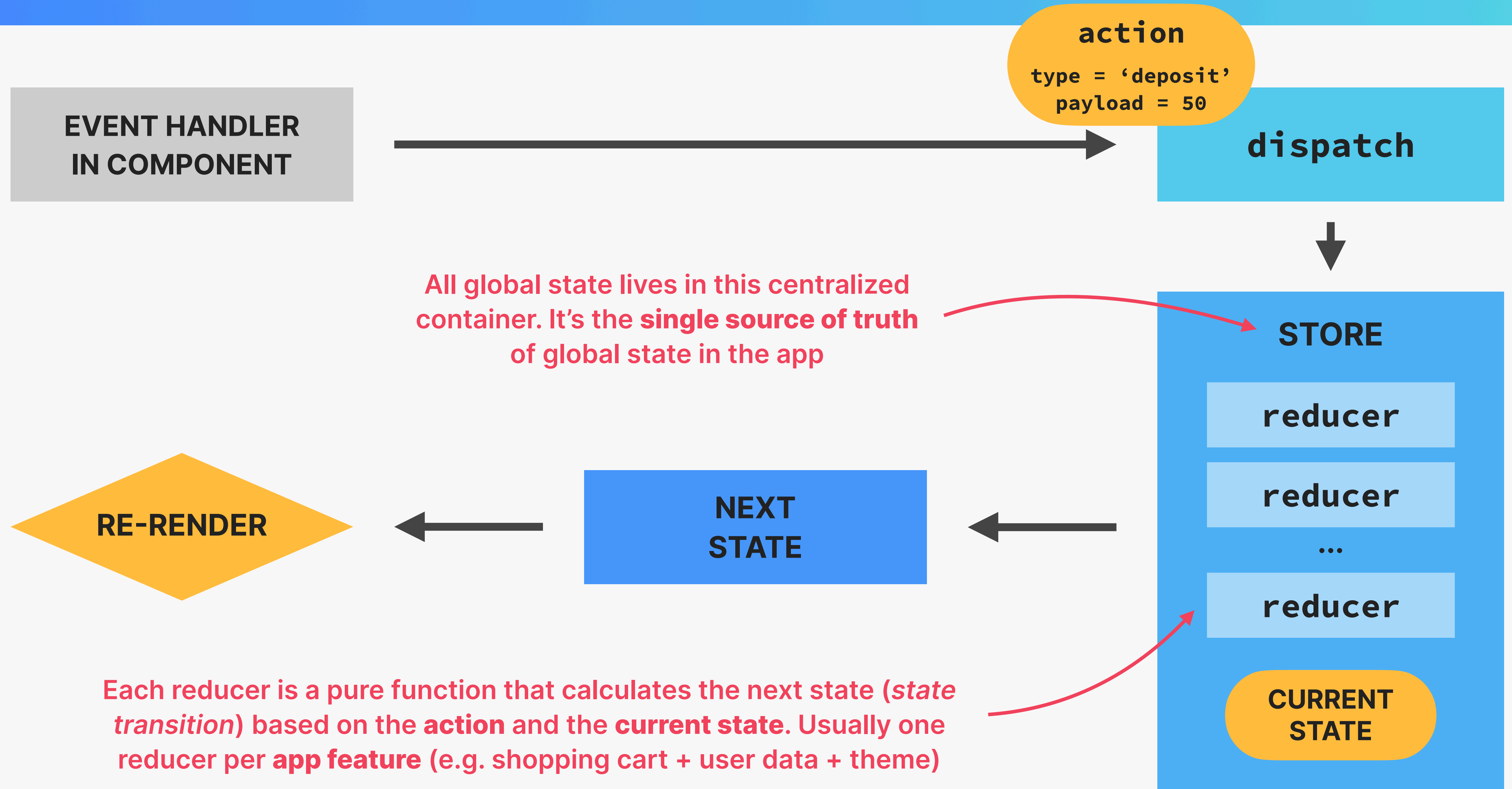
👋 Historically, Redux was used in most React apps for all global state. Today, that has changed, because there are many alternatives. **Many apps don't need Redux anymore, unless they need a lot of global UI state.**



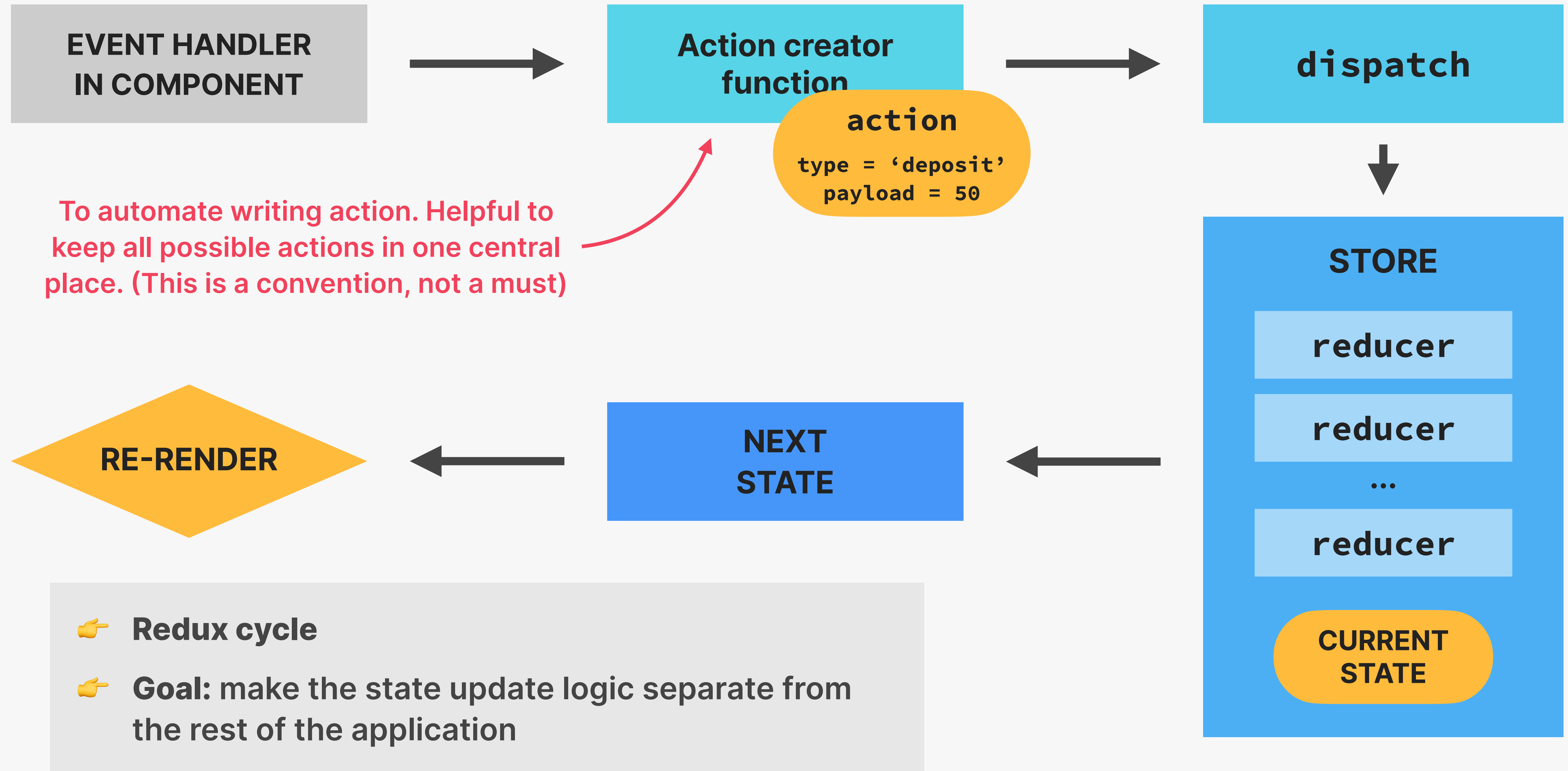
THE MECHANISM OF THE USEREDUCER HOOK



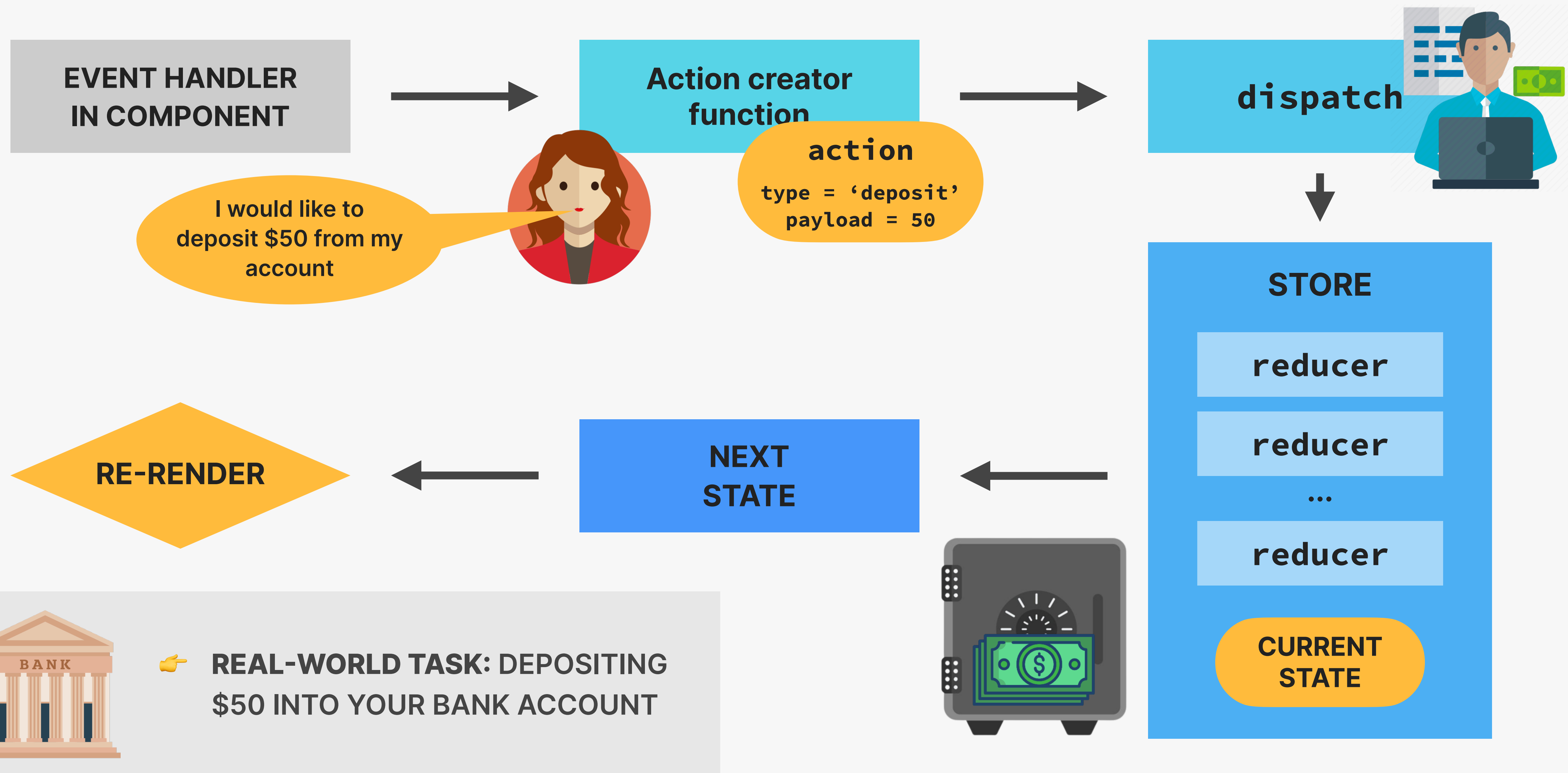
THE MECHANISM OF REDUX



THE MECHANISM OF REDUX



THE MECHANISM OF REDUX





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REDUX AND MODERN REDUX
TOOLKIT (WITH THUNKS)

LECTURE

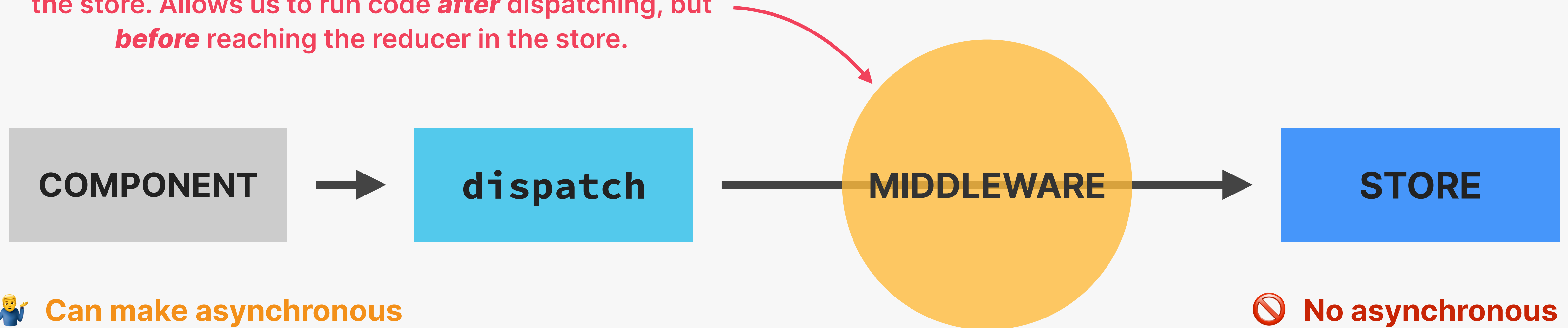
REDUX MIDDLEWARE AND
THUNKS

WHAT IS REDUX MIDDLEWARE?



Where to make an **asynchronous API call** (or any other async operation) in Redux?

A function that sits between dispatching the action and the store. Allows us to run code **after** dispatching, but **before** reaching the reducer in the store.



Can make asynchronous operations and then dispatch



Fetching data in components is not ideal



Perfect for asynchronous code



API calls, timers, logging, etc.



The place for side effects



No asynchronous operations

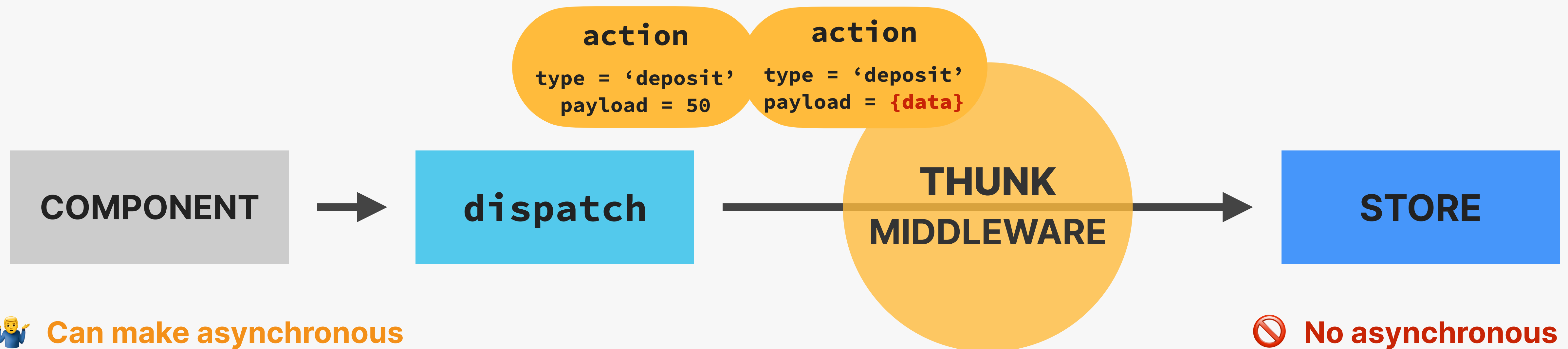


Reducers need to be pure functions

REDUX THUNKS



Where to make an **asynchronous API call** (or any other async operation) in Redux?



Can make asynchronous operations and then dispatch



Fetching data in components is not ideal



Perfect for asynchronous code



API calls, timers, logging, etc.



The place for side effects



No asynchronous operations



Reducers need to be pure functions



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REDUX AND MODERN REDUX
TOOLKIT (WITH THUNKS)

LECTURE

WHAT IS REDUX TOOLKIT (RTK)?

WHAT IS REDUX TOOLKIT?

REDUX TOOLKIT

- 👉 The **modern and preferred** way of writing Redux code
- 👉 An **opinionated** approach, forcing us to use Redux best practices
- 👉 100% compatible with “classic” Redux, allowing us to **use them together**
- 👉 Allows us to write **a lot less code** to achieve the same result (less “boilerplate”)
- 👉 Gives us 3 big things (but there are many more...):
 - 1 We can write code that “**mutates**” state inside reducers (will be converted to **immutable** logic behind the scenes by “Immer” library)
 - 2 Action creators are **automatically** created
 - 3 **Automatic** setup of thunk middleware and DevTools



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REDUX AND MODERN REDUX
TOOLKIT (WITH THUNKS)

LECTURE

REDUX VS. CONTEXT API

CONTEXT API VS. REDUX

CONTEXT API + useReducer

- 👍 Built into React
- 👍 Easy to set up a **single context**
- 👎 Additional state “slide” requires new context **set up from scratch** (“provider hell” in App.js)
- 👎 **No** mechanism for async operations
- 👎 Performance optimization is a **pain**
- 👎 Only React DevTools

REDUX

- 👎 Requires additional package (larger bundle size)
- 👎 More work to set up **initially**
- 👍 Once set up, it’s easy to create **additional state “slices”**
- 👍 Supports **middleware** for async operations
- 👍 Performance is optimized **out of the box**
- 👍 Excellent DevTools

Keep in mind that we should **not** use these solutions for **remote state**

WHEN TO USE CONTEXT API OR REDUX?

CONTEXT API + useReducer

*“Use the Context API for global state management in **small apps**”*

- 👉 When you just need to share a value that **doesn't change often** [*Color theme, preferred language, authenticated user, ...*]
- 👉 When you need to solve a simple **prop drilling** problem
- 👉 When you need to manage state in a **local sub-tree** of the app

These are not
super common
in UI state



REDUX

*“Use Redux for global state management in **large apps**”*

- 👉 When you have lots of global UI state that needs to be **updated frequently** (*because Redux is optimized for this*) [*Shopping cart, current tabs, complex filters or search, ...*]
- 👉 When you have **complex state** with nested objects and arrays (*because you can mutate state with Redux Toolkit*)

For example in the compound component pattern



There is no right answer that fits every project. It all depends on the project needs!

PART 04

—

PROFESSIONAL

REACT

DEVELOPMENT

REACT ROUTER WITH DATA LOADING (V6.4+)



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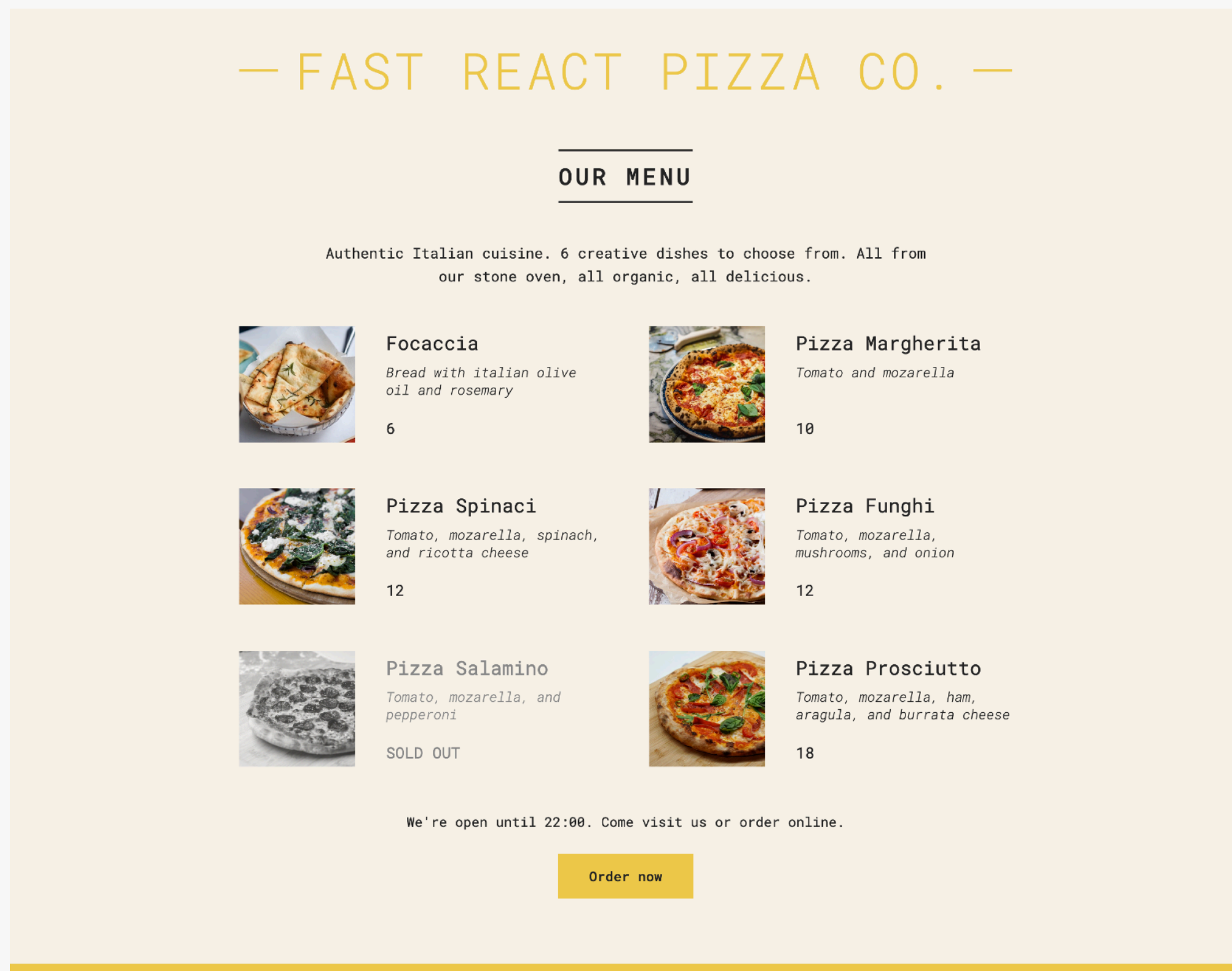
REACT ROUTER WITH DATA
LOADING (V6.4+)

LECTURE

APPLICATION PLANNING

THE PROJECT: 🍕 FAST REACT PIZZA CO.

REMEMBER OUR VERY FIRST PROJECT?



- 👉 Now the same restaurant (business) needs a simple way of allowing customers to **order pizzas and get them delivered** to their home
- 👉 We were hired to build the application front-end 🎉

HOW TO PLAN AND BUILD A REACT APPLICATION

FROM THE EARLIER “THINKING IN REACT” LECTURE:

- 1 Break the desired UI into **components**
- 2 Build a **static** version (no state yet)
- 3 Think about **state management + data flow**



- 👉 This works well for small apps with **one page and a few features**
- 👉 In **real-world apps**, we need to adapt this process

HOW TO PLAN AND BUILD A REACT APPLICATION

1 Gather application **requirements and features**

2 Divide the application into **pages**

👉 Think about the **overall** and **page-level** UI

👉 Break the desired UI into **components** ← From earlier

👉 Design and build a **static** version (no state yet) ← From earlier

3 Divide the application into **feature categories**

👉 Think about **state management + data flow** ← From earlier

4 Decide on what **libraries** to use (technology decisions)

This is just a rough overview. In the real-world, things are never this linear

PROJECT REQUIREMENTS FROM THE BUSINESS

STEP 1

- 👉 Very simple application, where users can order **one or more pizzas from a menu**
- 👉 Requires **no user accounts** and no login: users just input their names before using the app
- 👉 The pizza menu can change, so it should be **loaded from an API** ✅ DONE
- 👉 Users can add multiple pizzas to a **cart** before ordering
- 👉 Ordering requires just the **user's name, phone number, and address**
- 👉 If possible, **GPS location** should also be provided, to make delivery easier
- 👉 User's can **mark their order as "priority"** for an additional 20% of the cart price
- 👉 Orders are made by **sending a POST request** with the order data (user data + selected pizzas) to the API
- 👉 Payments are made on delivery, so **no payment processing** is necessary in the app
- 👉 Each order will get a **unique ID** that should be displayed, so the **user can later look up their order** based on the ID
- 👉 Users should be able to mark their order as "priority" order **even after it has been placed**

From these requirements, we can understand the features we need to implement

FEATURES + PAGES

STEP 2 + 3

FEATURE CATEGORIES

1 User

2 Menu

3 Cart

4 Order

NECESSARY PAGES

1 Homepage

2 Pizza menu

3 Cart

4 Placing a new order

5 Looking up an order

/

/menu

/cart

/order/new

/order/:orderID

All features can be placed into one of these. So this is what the app will essentially be about

STATE MANAGEMENT + TECHNOLOGY DECISIONS

STATE "DOMAINS" / "SLICES"

These usually map
quite nicely to the
app features

- 1 User → Global UI state (*no accounts, so stays in app*)
- 2 Menu → Global remote state (*menu is fetched from API*)
- 3 Cart → Global UI state (*no need for API, just stored in app*)
- 4 Order → Global remote state (*fetched and submitted to API*)

STEP 3 + 4

TYPES OF STATE

This is just one of many tech
stacks we could have chosen

👉 Routing

 **React Router**

The standard for React SPAs

👉 Styling

 **tailwindcss**

Trendy way of styling applications that we want to learn

👉 Remote state
management

 **React Router**

*New way of fetching data right inside React Router (v6.4+) that is worth exploring ("render-as-you-fetch" instead of "fetch-on-render"). Not really state **management**, as it doesn't persist state.*

👉 UI State
management

 **Redux**

State is fairly complex. Redux has many advantages for UI state. Also, we want to practice Redux a bit more

TAILWIND CSS CRASH COURSE: STYLING THE APP



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TAILWIND CSS CRASH COURSE:
STYLING THE APP

LECTURE

WHAT IS TAILWIND CSS?

WHAT IS TAILWIND CSS?

TAILWIND CSS

- 👉 *“A utility-first CSS framework packed with utility classes like `flex`, `text-center` and `rotate-90` that can be composed to build any design, directly in your markup (HTML or JSX)”*
- 👉 **Utility-first CSS approach:** writing tiny classes with one single purpose, and then combining them to build entire layouts
- 👉 In tailwind, **these classes are already written for us**. So we’re not gonna write any new CSS, but instead use some of tailwind’s hundreds of classes



THE GOOD AND BAD ABOUT TAILWIND

THE GOOD

These two are enough
to give tailwind a try!

- 👍 You don't need to think about class names
- 👍 No jumping between files to write markup and styles
- 👍 Immediately understand styling in any project that uses tailwind
- 👍 Tailwind is a design system: many design decisions have been taken for you, which makes UIs look better and more consistent
- 👍 Saves a lot of time, e.g. on responsive design
- 👍 Docs and VS Code integration are great

THE BAD

- 👎 Markup (HTML or JSX) looks very unreadable, with lots of class names (*you get used to it*)
- 👎 You have to learn a lot of class names (*but after a day of usage you know fundamentals*)
- 👎 You need to install and set up tailwind on each new project
- 👎 You're giving up on "vanilla CSS" 🥲

👋 Many people love to hate on tailwind for no reason. Please don't be that person! Try it before judging 🙏

SETTING UP OUR
BIGGEST PROJECT +
STYLED
COMPONENTS



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SETTING UP OUR BIGGEST
PROJECT + STYLED COMPONENTS

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APPLICATION PLANNING

THE PROJECT: THE WILD OASIS



THE WILD OASIS



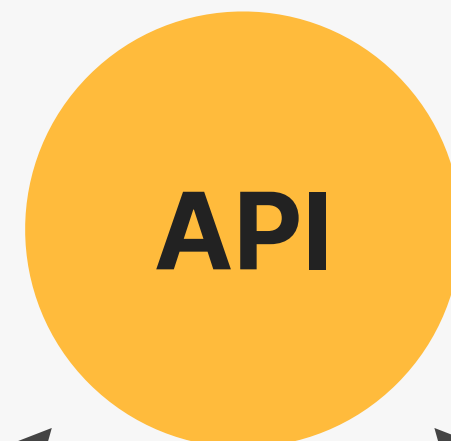
👉 “The Wild Oasis” is a small boutique **hotel** with 8 luxurious wooden cabins

👉 They need a custom-built application to manage everything about the hotel: **bookings, cabins** and **guests**

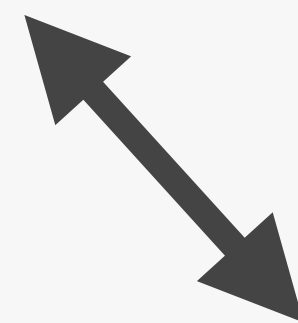
👉 This is the **internal application** used inside the hotel to **check in guests as they arrive**

👉 They have nothing right now, so they **also need the API**

👉 Later they will probably want a **customer-facing website** as well, where customers will be able to **book stays**, using the same API



**INTERNAL HOTEL
MANAGEMENT APP**



**CUSTOMER-FACING
WEBSITE TO BOOK
STAYS**

Later



REVIEW: HOW TO PLAN A REACT APPLICATION

- 1 Gather application **requirements and features**
- 2 Divide the application into **pages**
- 3 Divide the application into **feature categories**
- 4 Decide on what **libraries** to use (technology decisions)

PROJECT REQUIREMENTS FROM THE BUSINESS

STEP 1

- 👉 Users of the app are hotel employees. They need to be logged into the application to perform tasks
- 👉 New users can only be signed up inside the applications (to guarantee that only actual hotel employees can get accounts)
- 👉 Users should be able to upload an avatar, and change their name and password
- 👉 App needs a table view with all cabins, showing the cabin photo, name, capacity, price, and current discount
- 👉 Users should be able to update or delete a cabin, and to create new cabins (including uploading a photo)
- 👉 App needs a table view with all bookings, showing arrival and departure dates, status, and paid amount, as well as cabin and guest data
- 👉 The booking status can be “unconfirmed” (booked but not yet checked in), “checked in”, or “checked out”. The table should be filterable by this important status
- 👉 Other booking data includes: number of guests, number of nights, guest observations, whether they booked breakfast, breakfast price
- 👉 Users should be able to delete, check in, or check out a booking as the guest arrives (no editing necessary for now)
- 👉 Bookings may not have been paid yet on guest arrival. Therefore, on check in, users need to accept payment (outside the app), and then confirm that payment has been received (inside the app)
- 👉 On check in, the guest should have the ability to add breakfast for the entire stay, if they hadn’t already
- 👉 Guest data should contain: full name, email, national ID, nationality, and a country flag for easy identification
- 👉 The initial app screen should be a dashboard, to display important information for the last 7, 30, or 90 days:
 - 👉 A list of guests checking in and out on the current day. Users should be able to perform these tasks from here
 - 👉 Statistics on recent bookings, sales, check ins, and occupancy rate
 - 👉 A chart showing all daily hotel sales, showing both “total” sales and “extras” sales (only breakfast at the moment)
 - 👉 A chart showing statistics on stay durations, as this is an important metric for the hotel
- 👉 Users should be able to define a few application-wide settings: breakfast price, min and max nights/booking, max guests/booking
- 👉 App needs a dark mode

PROJECT REQUIREMENTS FROM THE BUSINESS

- 👉 Users of the app are hotel employees. They need to be logged into the application to perform tasks
- 👉 New users can only be signed up inside the applications (to guarantee that only actual hotel employees can get access)
- 👉 Users should be able to upload an avatar, and change their name and password

AUTHENTICATION

- 👉 App needs a table view with all cabins, showing the cabin photo, name, capacity, price, and current discount
- 👉 Users should be able to update or delete a cabin, and to create new cabins (including uploading a photo)

CABINS

- 👉 App needs a table view with all bookings, showing arrival and departure dates, status, and paid amount, as well as cabin and guest data
- 👉 The booking status can be “unconfirmed” (booked but not yet checked in), “checked in”, or “checked out”. The table should be filtered by this important status
- 👉 Other booking data includes: number of guests, number of nights, guest observations, whether they booked breakfast, breakfast price

BOOKINGS

- 👉 Users should be able to delete, check in, or check out a booking as the guest arrives (no editing necessary for now)
- 👉 Bookings may not have been paid yet on guest arrival. Therefore, on check in, users need to accept payment (outside the app) and then confirm that payment has been received (inside the app)
- 👉 On check in, the guest should have the ability to add breakfast for the entire stay, if they hadn't already

CHECK IN / OUT

- 👉 Guest data should contain: full name, email, national ID, nationality, and a country flag for easy identification

GUESTS

- 👉 The initial app screen should be a dashboard, to display important information for the last 7, 30, or 90 days:
 - 👉 A list of guests checking in and out on the current day. Users should be able to perform these tasks from here
 - 👉 Statistics on recent bookings, sales, check ins, and occupancy rate
 - 👉 A chart showing all daily hotel sales, showing both “total” sales and “extras” sales (only breakfast at the moment)
 - 👉 A chart showing statistics on stay durations, as this is an important metric for the hotel

DASHBOARD

- 👉 Users should be able to define a few application-wide settings: breakfast price, min and max nights/booking, max number of bookings per guest
- 👉 App needs a dark mode

SETTINGS

FEATURES + PAGES

STEP 2 + 3

FEATURE CATEGORIES

1 Bookings

2 Cabins

3 Guests

4 Dashboard

5 Check in and out

6 App settings

7 Authentication

👉 We will discuss state later.
Most of it will be **global**

NECESSARY PAGES

1 Dashboard

2 Bookings

3 Cabins

4 Booking check in

5 App settings

6 User sign up

7 Login

8 Account settings

/dashboard

/bookings

/cabins

/checkin/:bookingID

/settings

/users

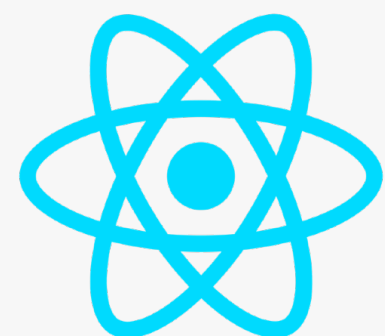
/login

/account

CLIENT-SIDE RENDERING (CSR) OR SERVER-SIDE RENDERING (SSR)?

CSR WITH PLAIN REACT

- 👉 Used to build **Single-Page Applications (SPAs)**
- 👉 All HTML is rendered on the **client**
- 👉 All JavaScript needs to be downloaded before apps start running: **bad for performance**
- 👉 **One perfect use case:** apps that are used “internally” as tools inside companies, that are entirely hidden behind a login



This is exactly what
we want to build in
this project

SSR WITH FRAMEWORK

- 👉 Used to build **Multi-Page Applications (MPAs)**
- 👉 Some HTML is rendered in the **server**
- 👉 **More performant**, as less JavaScript needs to be downloaded
- 👉 The **React team** is moving more and more in this direction

NEXT.js

Remix

TECHNOLOGY DECISIONS

STEP 4

👉 Routing

 **React Router**

The standard for React SPAs

👉 Styling

<  > styled components

Very popular way of writing component-scoped CSS, right inside JavaScript. A technology worth learning

👉 Remote state management

 **React Query**

The best way of managing remote state, with features like caching, automatic re-fetching, pre-fetching, offline support, etc. Alternatives are SWR and RTK Query, but this is the most popular

👉 UI State management

 **Context API**

There is almost no UI state needed in this app, so one simple context with `useState` will be enough. No need for Redux

👉 Form management

 **React Hook Form**

Handling bigger forms can be a lot of work, such as manual state creation and error handling. A library can simplify all this

👉 Other tools

React icons / React hot toast / Recharts / date-fns / Supabase

SUPABASE CRASH COURSE: BUILDING A BACK-END!



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SUPABASE CRASH COURSE:
BUILDING A BACK-END!

LECTURE

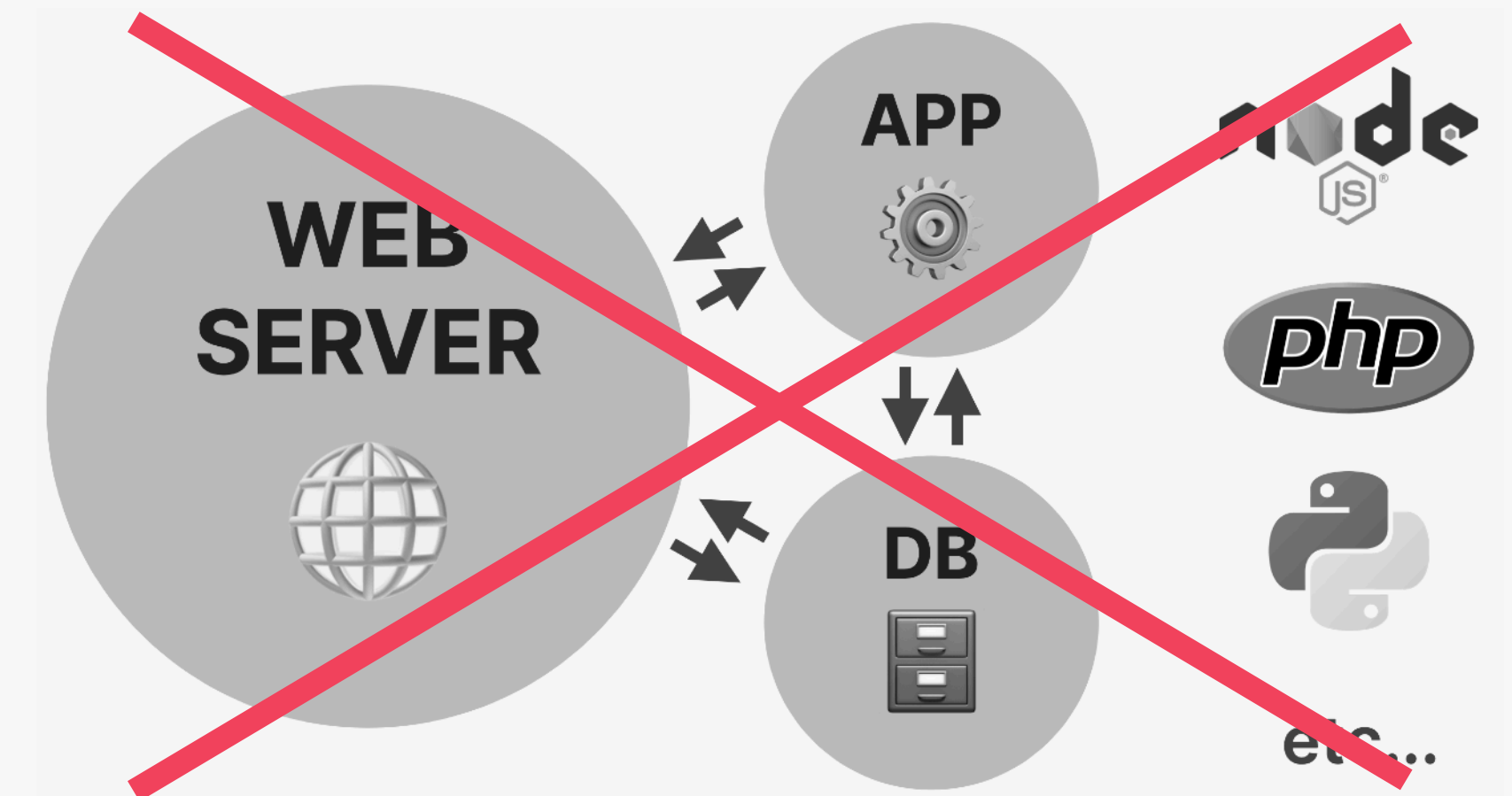
WHAT IS SUPABASE?

WHAT IS SUPABASE?

SUPABASE

- 👉 Service that allows developers to easily **create a back-end with a Postgres database**
- 👉 Automatically creates a **database** and **API** so we can easily request and receive data from the server
- 👉 **No** back-end development needed 🥳
- 👉 Perfect to get up and running **quickly!**
- 👉 Not just an API: Supabase also comes with easy-to-use **user authentication** and **file storage**

BACK-END



WITH SUPABASE, WE DON'T NEED
TO DO ANY OF THIS MANUALLY!
IT'S ALL INCLUDED





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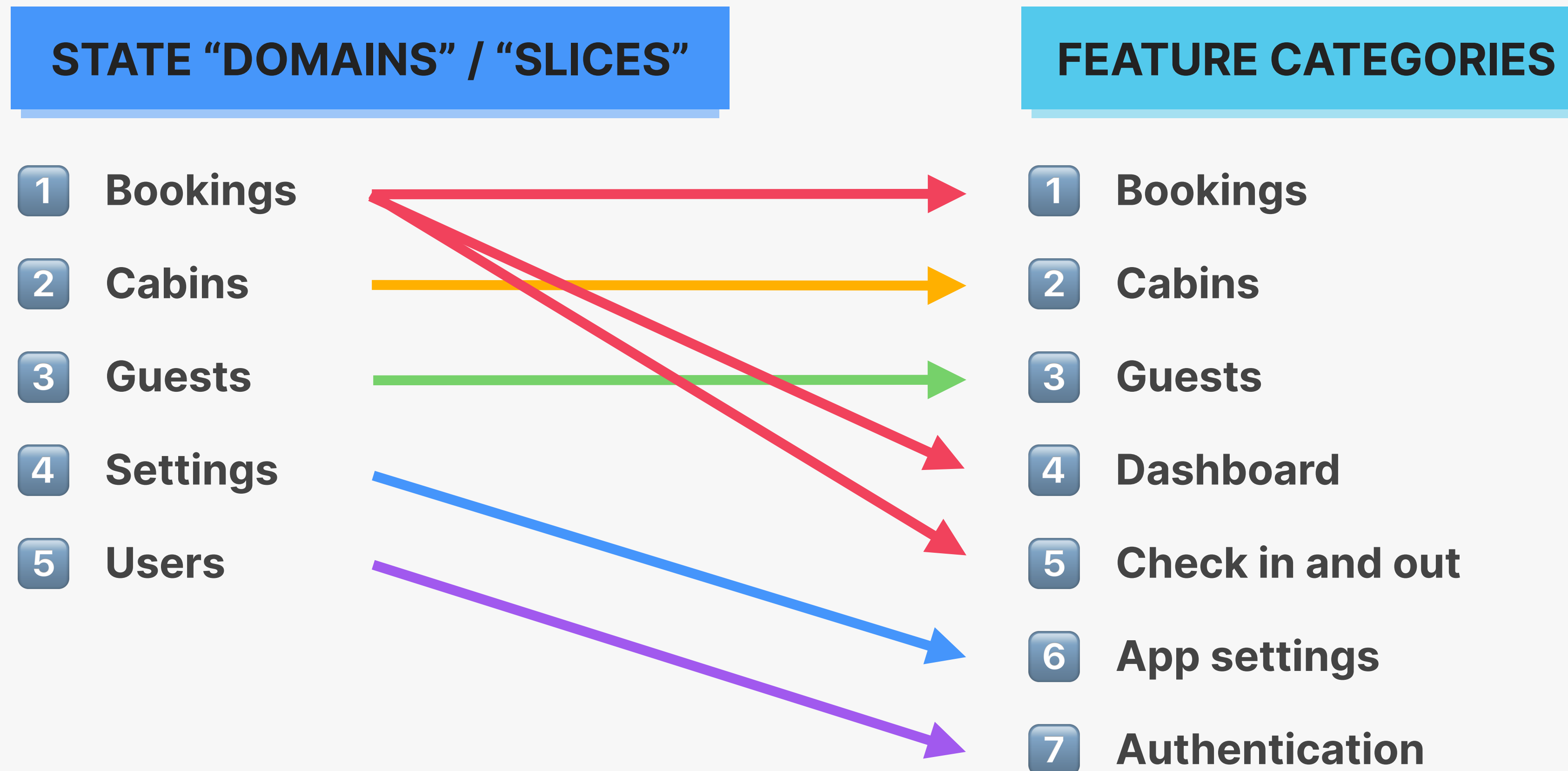
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SUPABASE CRASH COURSE:
BUILDING A BACK-END!

LECTURE

MODELING APPLICATION STATE

MODELING STATE



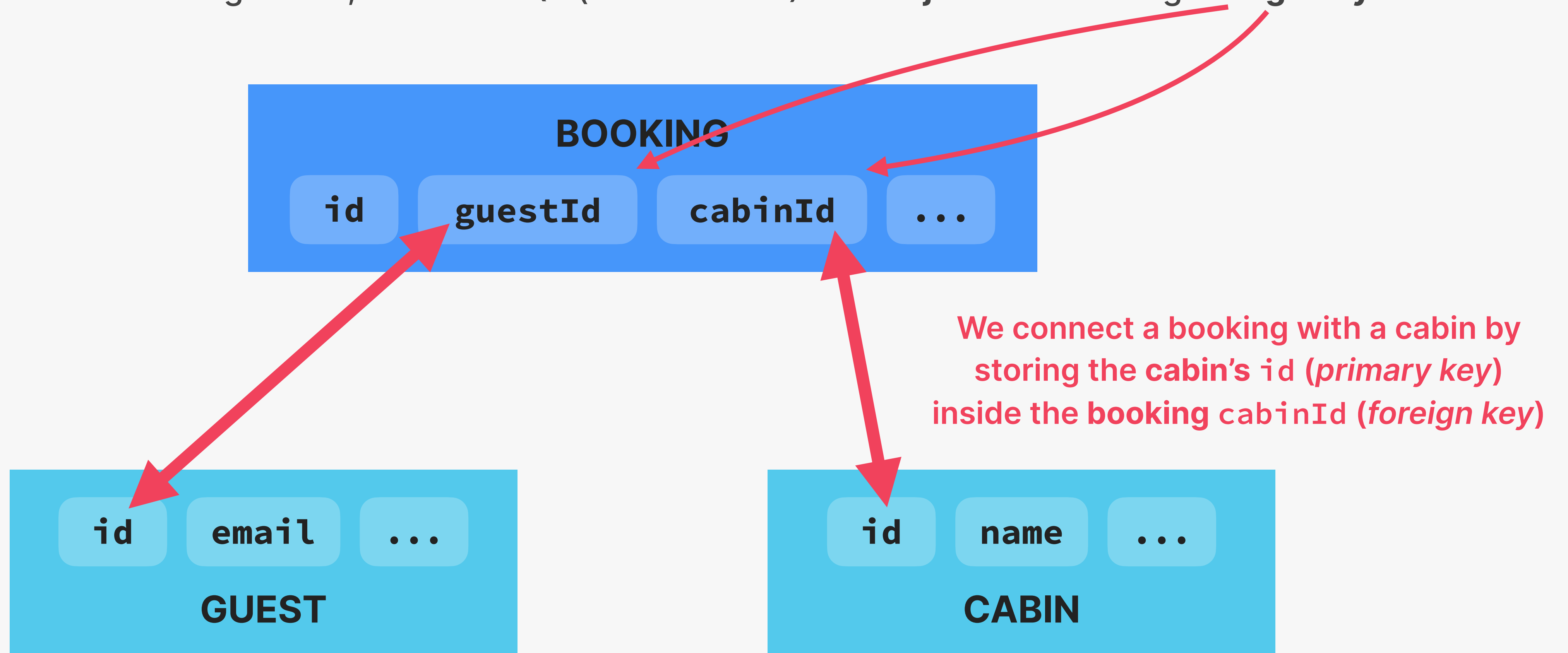
👉 All this state will be **global remote state**, stored within Supabase

👉 There will be one **table** for each state "slice" in the **database**



THE BOOKINGS TABLE

- 👉 **Bookings** are about a **guest** renting a **cabin**
- 👉 So a booking needs information about what **guest** is booking which **cabin**: we need to **connect** them
- 👉 Supabase uses a Postgres DB, which is SQL (relational DB). So we **join** tables using **foreign keys**



REACT QUERY: MANAGING REMOTE STATE



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REACT QUERY: MANAGING
REMOTE STATE

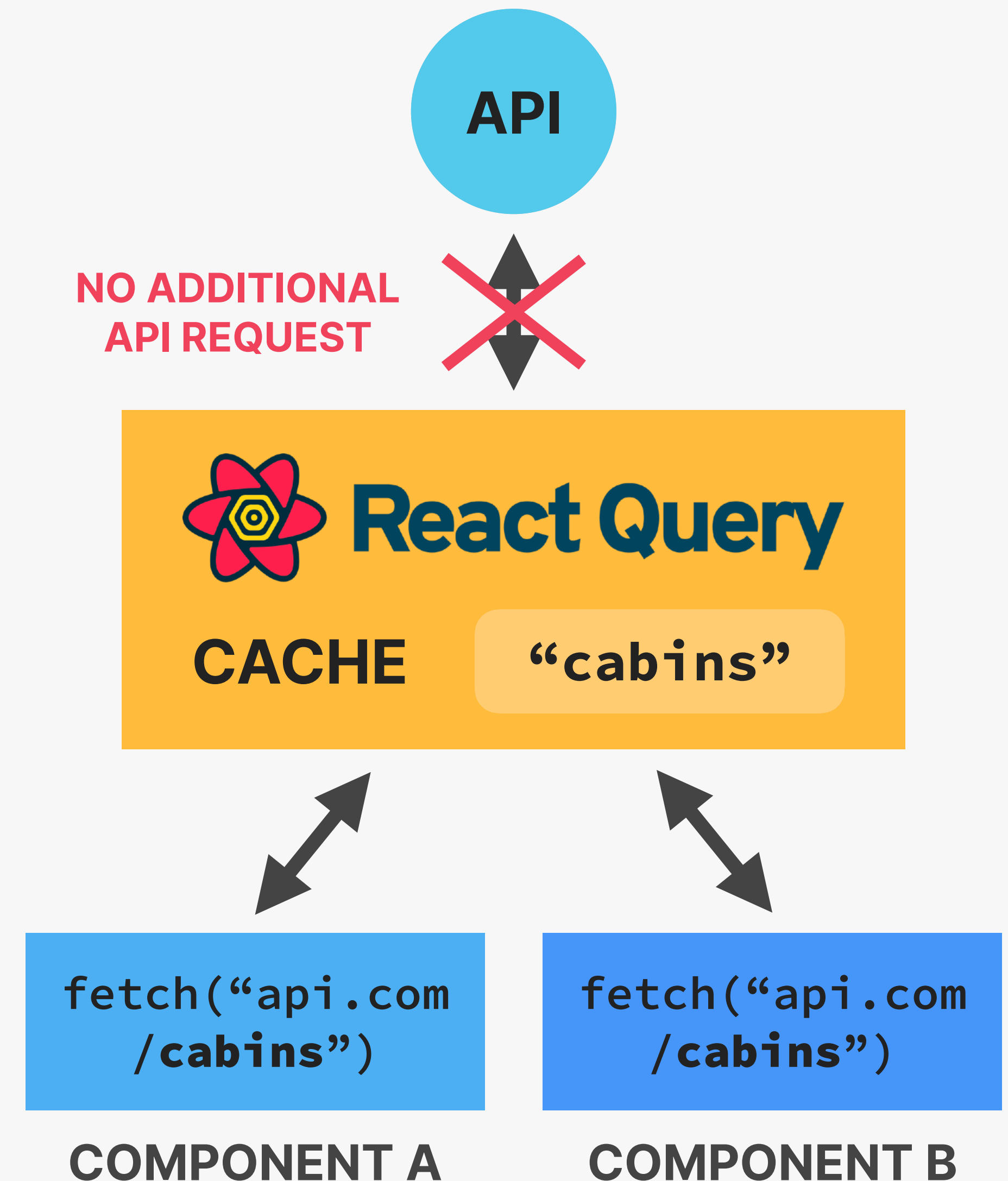
LECTURE

WHAT IS REACT QUERY?

WHAT IS REACT QUERY?

REACT QUERY

- 👉 Powerful library for managing **remote (server) state**
- 👉 Many features that allow us to write a **lot less code**, while also **making the UX a lot better**:
 - 👉 Data is stored in a cache
 - 👉 Automatic loading and error states
 - 👉 Automatic re-fetching to keep state synched
 - 👉 Pre-fetching
 - 👉 Easy remote state mutation (updating)
 - 👉 Offline support
- 👉 Needed because remote state is **fundamentally** different from regular (UI) state



ADVANCED REACT PATTERNS



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ADVANCED REACT PATTERNS

LECTURE

AN OVERVIEW OF REUSABILITY IN
REACT

HOW TO REUSE CODE IN REACT?

