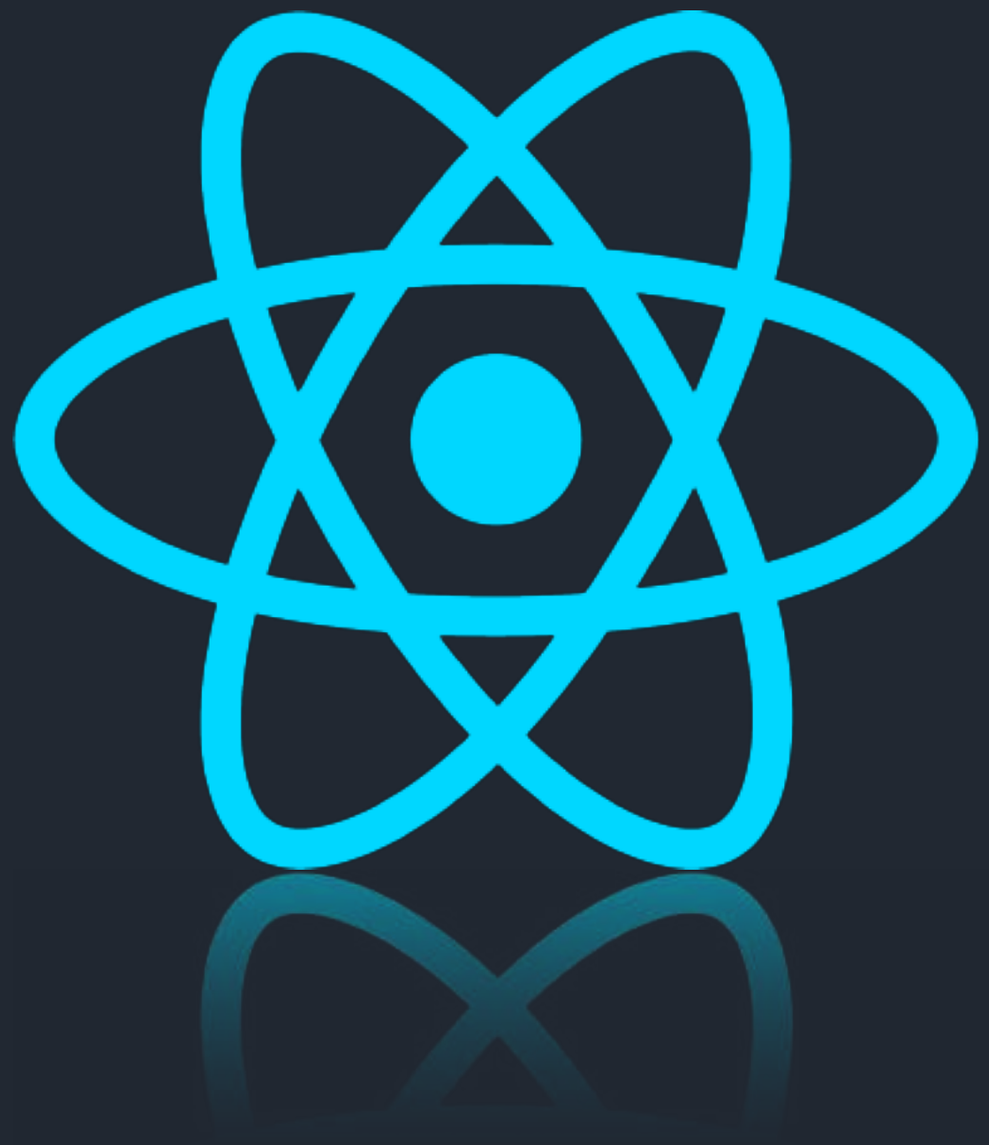


Front-End Development with React

Mail: jonas.bandi@ivorycode.com

Twitter: @jbandi

ABOUT ME

Jonas Bandi
jonas.bandi@ivorycode.com
Twitter: @jbandi

- Freelancer, in den letzten 12 Jahren vor allem in Projekten im Spannungsfeld zwischen modernen Webentwicklung und traditionellen Geschäftsanwendungen.
- Dozent an der Berner Fachhochschule seit 2007
- In-House Kurse & Beratungen zu Web-Technologien im Enterprise: UBS, Postfinance, Mobiliar, AXA, BIT, SBB, Elca, Adnovum, BSI ...

Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

letsboot.ch
swiss dev training

digicomp

JavaScript / Angular / React / Vue / Vaadin
Schulung / Beratung / Coaching / Reviews

jonas.bandi@ivorycode.com

About you ...

AGENDA

DAY 1

Intro

Getting started quickly with `create-vite`

JSX,React Components and Hooks

Component Architecture & Data Flow

Routing

DAY 2

Side Track: Async JavaScript & Ajax

Backend Access

In-Depth Topics:

More Hooks & Custom Hooks

State Management Concepts

Ecosystem Picks:
Tanstack-Query
nuqs

Performance Topics

Fullstack React

"SIDE-TRACK"

Modern JavaScript Development Tooling

Modern JavaScript (es2015 - es2024)

TypeScript

Material

Git Repository:
`https://github.com/ivorycode/react-galliker-2025`

Initial Clone:
```
git clone https://github.com/ivorycode/react-galliker-2025
```

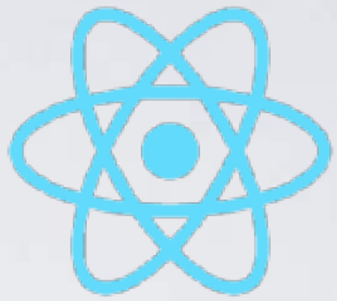
Update:
```
git pull
```

```
git reset --hard
git clean -dfx
git pull
```

(discard all local changes)

Slides & Exercises: `<checkout>/00-CourseMaterial`

React



React is a JavaScript library for building user interfaces.

Created by Facebook in 2013.

Current Version: 19 (released in December 2024)

Core Principles:

The DOM is created programmatically.

JSX enables declarative DOM programming.

A virtual DOM abstracts the real DOM.

One-way data flow instead of two-way data binding.

https://react.dev/
https://github.com/facebook/react/
https://react.dev/blog/2024/12/05/react-19

https://react.dev/versions

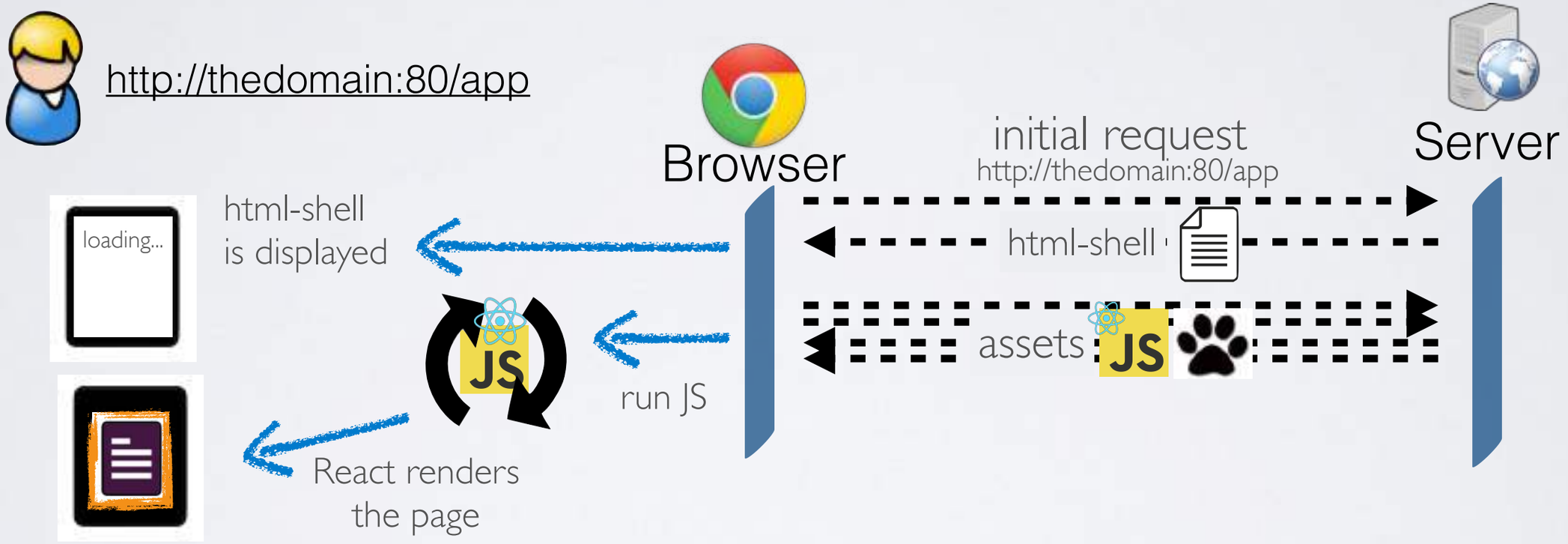
Single Page Applications

"Rich Clients running in the Browser"

EXERCISE

Exercise - Three Apps

Traditional SPA:
Client Side Rendering



Components are rendered on the client.

The Browser DOM

The "UI Engine" of SPAs

Document

"initial UI"

Page load

html parser

produce

DOM

```
<body>
  <div>
    <h1>...</h1>
    <div>
      <input/>
      <button> </button>
    </div>
  </div>
</body>
```

"live UI"

manipulate

JavaScript Engine


```
const list = document.getElementById('book-list')
const newListItem = document.createElement('li');
list.appendChild(newListItem);
```

What does React provide?

- A mechanism to create dynamic UIs (DOM manipulations)
  - declarative DOM programming instead of imperative manipulations
- "Componentization" of the UI
  - Provide Structure for the UI
  - Enable reuse of components
  - Manage state in components
- Constructs to create a "data-flow" through the component tree

Everything is a Component

React is not a Framework

- React is "only" a view library (however recently the scope is growing)

  Next.js, ReactRouter v7 (formerly Remix), RedwoodJS and TanStack Start are popular Frameworks based on React.

- React is often combined with other libraries/frameworks to build a complete stack for building a frontend-application
  - Routing
  - Data-Fetching (http, websocket ...)
  - i18n
  - Styling …
  - State-Management

Evolution of React

2013 — React (Virtual Dom)

2015 — React Native components are based on ES2015 classes

2016 — splitting React and ReactDOM
React 0.14
Create React App
NEXT.JS
React 15

2019 — React 16.8: Hooks ("Function Components for everything")

2022 — Vite 2.0
React 18
Next.js App Router with RSCs

2024 — React 19
"official" release of RSCs

2025 — React Compiler

Cory House @housecor · Oct 30

React in 2014:
✅Make SPAs.
✅Use create-react-app.

React in 2022:
✅Make SPAs, native mobile, static, MPAs, and hybrid apps.
✅Use Vite, Next, Remix, Astro, etc.
✅HTTP via react-query, swr, Apollo, etc.
✅Routes via React Router, Remix, Next, Tanstack Router, etc…

38 119 1,131

Cory House @housecor · Oct 30

React 2014: Simple, but limited.

React 2022: Powerful and remarkably flexible, but intimidating and fragmented. A massive number of compelling options to consider. The hardest part is keeping up with the churn and choosing between multiple compelling options.

https://twitter.com/housecor/status/1586704800988684288

History: Fundamental Change in 2019

https://twitter.com/ryanflorence/status/1130286263926284289

React 16.8 (February 2019) introduced "Hooks": a way to use state and other React features without writing a class.

This resulted in major changes in the React ecosystem.

https://playfulprogramming.com/posts/react-history-through-code

React Hooks

introduced with React 16.8 in 2019.

https://react.dev/reference/react/hooks

Class Component:

```
class Counter1 extends React.Component {

  state = {
    count: 0
  };

  increase = () => {
    this.setState({count: this.state.count + 1})
  };

  render() {
    return (
      <div>
        <h1>Count {this.state.count}</h1>
        <button onClick={this.increase}>
           Increase
         </button>
      </div>
    );
  }
}
```

method derived from base class

using ES2015 classes
using JSX
using proposed class fields

the "old" way

Function Component with Hook:

```
function Counter2() {

  const [count, setCount] = useState(0);

  function increase() {
    setCount(count + 1);
  }

  return (
    <div>
      <h1>Count {count}</h1>
      <button onClick={increase}>Increase</button>
    </div>
  );
}
```

Hook

using JavaScript functions
using JSX

the "new" way

Note : functional components and class components can be mixed in the same application.

Motivation: https://legacy.reactjs.org/docs/hooks-intro.html

Why Hooks (2019)?

https://reactjs.org/docs/hooks-intro.html#motivation

"Hooks solve a wide variety of seemingly unconnected problems of class components."

Hooks reduce complexity in components and enable better patterns for decoupling application logic and ui-logic.

Hooks enable better structure, better reuse and better composition of application logic.

Hooks are often an elegant replacement for previous reusability patterns like "higher order components" and "render props"

Hooks are not undisputed:

- https://stevenkitterman.com/posts/the-catch-with-react-hooks/
- https://blog.logrocket.com/frustrations-with-react-hooks/
- https://dillonshook.com/a-critique-of-react-hooks/
- https://medium.com/swlh/the-ugly-side-of-hooks-584f0f8136b6
- https://medium.com/better-programming/why-react-hooks-are-the-wrong-abstraction-8a44437747c1
- https://danielrotter.at/2022/01/16/some-reasons-for-disliking-react-hooks.html

"Why React Hooks":
https://www.youtube.com/watch?v=eX_L39UvZes

Why Hooks (2025)?

Because the React ecosystem has embraced Hooks.

(and React without it's ecosystem is like a car without seats, wheels, windows, pedals ...)

All modern React libraries expose their APIs via Hooks:

- ReactRouter / TanStack Router
- Jotai, Zustand, LegendState, Valtio ...
- TanStackQuery, SWR
- react-i18next
- ...

Starting a Client-Side React Project with Vite

Vite Next Generation Frontend Tooling

https://vitejs.dev/

generating project files

```
npx create-vite@latest my-react-project --template react-swc-ts
```

```
cd my-react-project
npm install
npm run dev
```

installing dependencies

running the app in development mode

optional using TypeScript & SWC

Vite is one of the recommended ways to "build a React app from scratch":
https://react.dev/learn/build-a-react-app-from-scratch

Alternative Syntax: `npm create vite@latest my-react-project -- --template react-swc-ts`

Full-Stack React

(aka. Meta Frameworks)

The official React documentation is recommending to use a "production-grade framework".

https://react.dev/learn/creating-a-react-app#full-stack-frameworks

NEXT.JS

https://nextjs.org/

```
npx create-next-app@latest
```

React Router v7

Remix "Framework Mode"

https://reactrouter.com/

```
npx create-react-router@latest my-app
```

The common goal of those meta-frameworks is to simplify the project setup of frontend applications.
They include concepts for server-side-rendering, routing, data-fetching, mutations ...
But they come with their own conceptual overhead and learning curve!
These frameworks typically require running JavaScript on the server (like Node.js).

RedwoodJS
RedwoodSDK

https://redwoodjs.com/
https://docs.rwsdk.com/

TanStack Start

https://tanstack.com/start/

MODERN.JS

https://modernjs.dev/

Waku

https://waku.gg/

Remix was merged into React Router v7: https://remix.run/blog/react-router-v7

Alternatives for Client-Side React Project Setup

PARCEL

The zero configuration build tool.

https://parceljs.org/

Rsbuild

The Rspack Powered Build Tool.

https://rsbuild.dev/

create-tsrouter-app

Aiming to be the CRA replacement.
Still very early. But might be a good option if you want to use TanStack Router.

https://github.com/TanStack/create-tsrouter-app/tree/main/cli/create-tsrouter-app

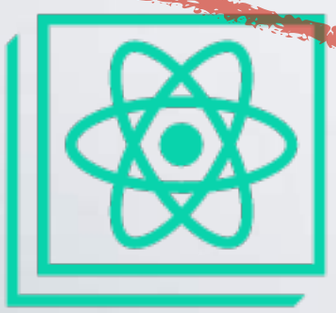
```
npx create-tsrouter-app@latest my-app --template typescript
```

```
npx create-tsrouter-app@latest my-app --template file-router
```

https://nx.dev/

Nx is a scaffolding an build tool for modern frontend projects with the focus on monorepos and modern tooling.

https://nx.dev/getting-started/react-standalone-tutorial



~~Create-React-App (CRA)~~

~~CRA was the de-facto starter for a React SPA for a long time. But it is not recommended any more.~~

~~https://create-react-app.dev/~~

https://react.dev/blog/2025/02/14/sunsetting-create-react-app

EXERCISES

Exercise 1 - Create a React Project from Scratch

Understanding a React Project

serves a dev build (in memory)

```
npm run dev
npm run build
npm run preview
```

creates a prod build (on disk)

serves prod build (from previous step)

Project Configuration:

- package.json
- node_modules
  package-lock.json
- tsconfig.json

Bootstrapping:

- index.html
- src/main.tsx

App Component:

- /src/App.tsx
- /src/App.css

prod build with source maps:

```
export default defineConfig({
  plugins: [react()],
  build: {sourcemap: true }
});
```

vite.config.js

https://vitejs.dev/config/build-options.html

React Project Build

modern JavaScript
TypeScript
JSX

Write Code

esbuild

SWC

TypeScript

Compile

esbuild or SWC compile TS to JS.
The TypeScript compiler is used for type-checking.

dev build

prod build

rollup.js

Bundle

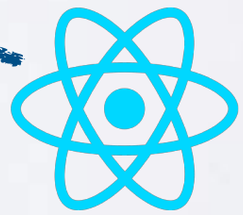
Create coarse-grained & optimized bundles from many files and 3rd-party libraries.

many single JS modules

pure JS

Run in Browser

- few optimized JavaScript bundles
- JavaScript transpiled to browser target.



Libs

https://vitejs.dev/
https://esbuild.github.io/
https://swc.rs/
https://github.com/vitejs/vite-plugin-react-swc
https://rollupjs.org/

Debugging

- Debugging in Browser Developer Tools (Sources -> Ctrl-P)
- IDE Integration is easily possible with Jetbrains IDEs or VS Code

React Developer Tools:
a browser extension to
inspect React components

Available for Chrome and Firefox

JSX

XML-like extension for JavaScript

JSX

https://facebook.github.io/jsx/

```
const heading = <h1>Hello World</h1>;
const button = <button disabled>Click!</button>;
const div = <div> {heading} {button} </div>;
ReactDOM.createRoot(document.getElementById('root')!).render(div);
```

JSX is a XML-like syntax extension for JavaScript which defines a concise and familiar syntax for defining tree structures with attributes.

With JSX we can declare HTML structures in JavaScript.

JSX is *not* an embedded HTML template. It gets compiled to imperative JavaScript statements which use the React API to manipulate the DOM.

JSX can also be used in other libraries: Preact, Solid.js, Qwik, Stencil, Vue.js, Inferno, Brisa …
JSX in Java: https://complate.org/

JSX

JSX syntax is just syntactic sugar for the *JSX factory* function.

(`_jsx, _jsxDEV, React.createElement …`)

```
function render() {
  return <div color="red">Hello World</div>;
}
```


```
function render() {
  return _jsx("div", {
    color: "red",
    children: "Hello World"
  });
}
```

React 17+

```
function render() {
  return React.createElement(
    "div",
    { color: "red" },
    "Hello World"
  );
}
```

React 16

Many tools can compile JSX to JavaScript: TypeScript, Babel, esbuild, SWC …

- try it in the Babel REPL: https://babeljs.io/repl/
- try it in the TypeScript Playground: https://www.typescriptlang.org/play

https://facebook.github.io/react/docs/jsx-in-depth.html
https://reactjs.org/blog/2020/09/22/introducing-the-new-jsx-transform.html

HTML in JavaScript?

- React enhances JavaScript in order to declare the UI ("If you want to read React: you have to learn JavaScript")
  - Leverage the power of JavaScript
  - It makes sense to keep the component and the template in the same file, since they are tightly coupled
  - build-time syntax checking and error messages
  - "Separation of concerns" is still possible
- Comparison: Angular & Vue enhance HTML with a their own template language
  ("If you want to read Angular: you have to learn a long list of Angular specific syntax")

https://medium.com/javascript-scene/jsx-looks-like-an-abomination-1c1ec351a918#.xwa2wfc2y
https://medium.com/@housecor/react-s-jsx-the-other-side-of-the-coin-2ace7ab62b98
https://medium.freecodecamp.com/angular-2-versus-react-there-will-be-blood-66595faafd51

Dan Abramov
@dan_abramov

Following

Separating concerns by files is as effective as separating school friendships by desks. Concerns are “separated” when there is no coupling: changing A wouldn’t break B. Increasing the distance without addressing the coupling only makes it easier to add bugs.

9:37 PM - 16 Jun 2018

540 Retweets **1,817** Likes

40 540 1.8K

https://twitter.com/dan_abramov/status/1008131488481730561

JSX: Collections

In JavaScript you can transform arrays with **`map`**:

```
const a = [1,2,3];
const b = a.map(e => e * e); // b = [1,4,9]
```

In JSX expressions you can produce dynamic "embedded" JSX:

```
<ul>
   {
      myArray.map(
         (e, index) => <li>Item {index} {e}</li>
      );
   }
</ul>
```

Rendering a React Application

React itself does not render components, rendering is separated into the **`react-dom`** package:

```
const root = ReactDOM.createRoot(
  document.getElementById('root') as HTMLElement
);
root.render(
  <React.StrictMode>
    <App />
  </React.StrictMode>
);
```

React Native provides other renderers for iOS & Android.
Server-Side Rendering of React renders components into HTML-Text.
React for Windows an macOS provide renderers for their platform.

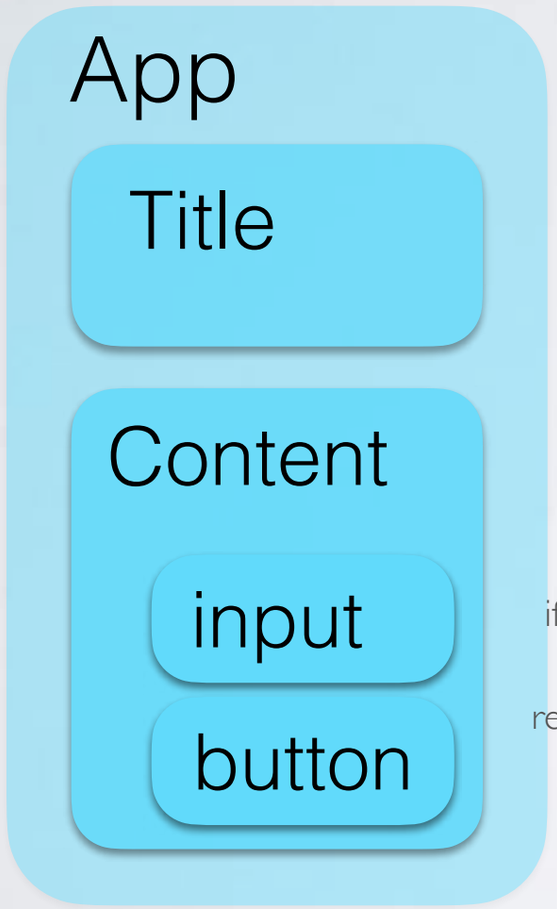
The Virtual DOM

Components

Virtual DOM

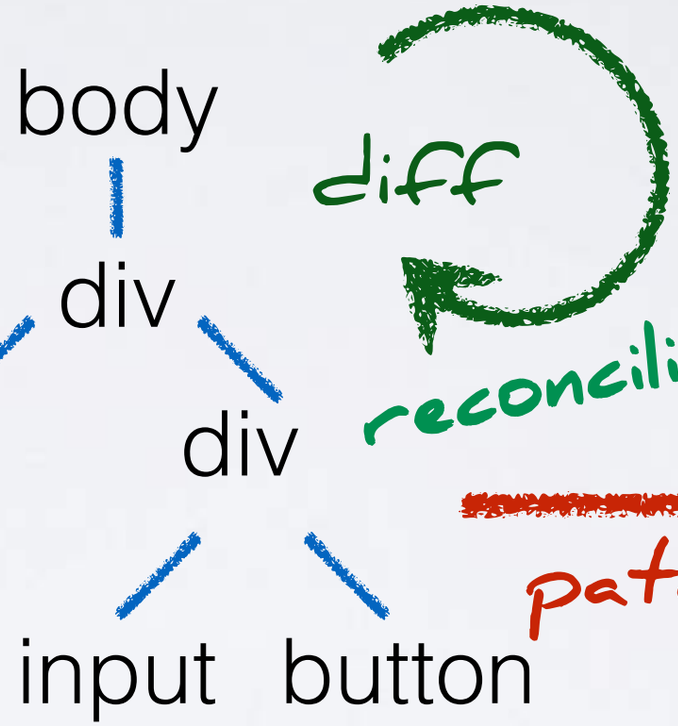
In-Memory, implemented in JavaScript

Browser DOM



render

if the state changes components are rendered completely including all their children



diff

reconciliation

patch

```
<body>
  <div>
    <h1></h1>
    <div>
      <input/>
      <button>
          </button>
    </div>
  </div>
</body>
```

"React Client Rendering Runtime"

The Virtual DOM also enables server-side rendering and rendering to iOS/Android UIs.

Compilation in React

ES2015+
TypeScript
JSX

compilation (build-time)

BABEL

TypeScript

esbuild
https://esbuild.github.io/
(written in Go)

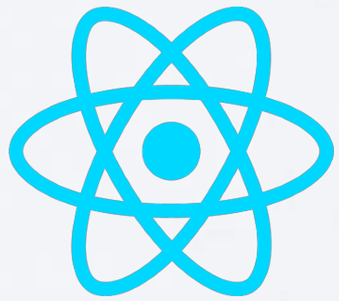
SWC
https://swc.rs/
(written in Rust)

JS

Plain
JavaScript

JavaScript
data structures

React Runtime
Virtual DOM



run-time

Browser DOM

Components

React Components

React components can be implemented as functions or as classes.

```
import React from 'react';

export function Greeter() {
  return <h1>Hello World!</h1>;
}
```

```
import React from 'react';

export class Greeter extends React.Component {
    render() {
        return <h1>Hello World!</h1>;
    }
}
```

Note: The name of a React component (class or function) has to start with an capital letter (this is the distinction to a html element in JSX).

Example usage:

```
import {Greeter} from './Greeter';
...
<div>
  <Greeter>
</div>
```

Since the introduction of *Hooks* in React 16.8) function components offer the same functionality as class components (i.e. state and life-cycle).
Functional components are the de-facto standard in modern React development.

Function Components

Components are written as plain JavaScript functions.


```
function AppComponent(props) {
    return (
        <div>
            <h1>{props.title}</h1>
            <p>{props.message}</p>
        </div>
    );
}
```

The function is called each time the UI is rendered (i.e. with every "data-change")

React expects that the body of your component behaves like a *pure function*:
If the "inputs" (props, state, and context) are the same, it should return exactly the same JSX.
https://react.dev/learn/keeping-components-pure

A Visual Guide To React Mental Models:
https://obedparla.com/code/a-visual-guide-to-react-mental-models/

The Essence of Components

🎨 Rendering & Event Handling ⚡

🧩 State

♻️ Lifecycle

🎨 Rendering &

⚡ Event Handling

Component Rendering

Rendering is the process of turning JavaScript data structures into DOM structures.

```
function Greeter() {
    const name = 'Tyler';
    return (
        <div>
            Hello {name}!
        </div>
    );
}
```

component

Browser DOM

```
<div>
    Hello Tyler!
</div>
```

A component must return *only a single* element as render output.
A component can return `null` or `undefined` (since React 18) as render output.
From the perspective of TypeScript, the return value must be `React.ReactNode`.

Rendering should be "pure" and not have any side effects!

https://beta.reactjs.org/learn/your-first-component

https://beta.reactjs.org/learn/keeping-components-pure

Component Composition

Components can render child components.

App component

```
function App(){
  ...
     return (
        <div>
           <Greeter/>
        </div>
     );
  }
```

Browser DOM

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

UI

(DOM ...)

Greeter component

```
function Greeter() {
    return (
       <h1> Hello World! </h1>
    );
}
```

Conditional Rendering

using variables:

```
function App(){
    const showGreeter = true;

    ...

    let greeter;
    if (showGreeter) {
        greeter = <Greeter/>
    }

    return (
      <div>
        <h1>Welcome</h1>
        { greeter }
      </div>
    );
}
```

inline expressions:

```
return (
  <div>
    <h1>Welcome</h1>
    { showGreeter && <Greeter/> }
  </div>
);
```

```
return (
  <div>
    { showGreeter ?
        <Greeter/> : <h1>Welcome</h1> }
  </div>
);
```

https://react.dev/learn/conditional-rendering

Rendering Lists

Using JavaScript expressions that produce arrays of JSX elements.

```
const numbers = [1,2,3,4,5,6,7];
...
return (
  <ul>
    { numbers.map((n) => <li key={n}>{n}</li> }
  </ul>
);
```

Each element in the array must be assigned a unique **key** property.

The mapping function must return *a single top-level* JSX element.

```
const todoObjects = ...
...
return (
  <div>
    { todoObjects.map((n) => {
        const fullName = p.firstName + p.lastName;
        return (
          <div key={p.id}>
            <p>{fullName}</p>
            <p>{p.dateOfBirth}</p>
          </div>
        )}
      }
  </div>
);
```

https://react.dev/learn/rendering-lists

https://medium.com/@robinpokorny/index-as-a-key-is-an-anti-pattern-e0349aece318

React Fragment

A React Fragment is an element that can hold other elements but is not rendered into the browser DOM.

With a Fragment you can return multiple elements from React constructs that allow to return only a single element (i.e. render output of a component, collection mapping function ...)

explicit Fragment rendering

```
...
   return (
      <React.Fragment>
         <ChildA/>
         <div>Hello</div>
         <ChildB/>
      </React.Fragment>
  );
...
```

shortcut syntax supported by Babel & TypeScript

```
...
   return (
      <>
         <ChildA/>
         <div>Hello</div>
         <ChildB/>
      </>
  );
...
```

https://react.dev/reference/react/Fragment

Event Handling

DOM events are exposed on React elements as properties.
You pass a callback function to the propery.

```
function ClickComponent(){

    function handleClick(event: React.MouseEvent<HTMLButtonElement>) {
        alert('Event: ' + event.type);
    }

    return (
       <button onClick={handleClick}>
           Click me!
       </button>
    );
}
export default ClickComponent;
```

function

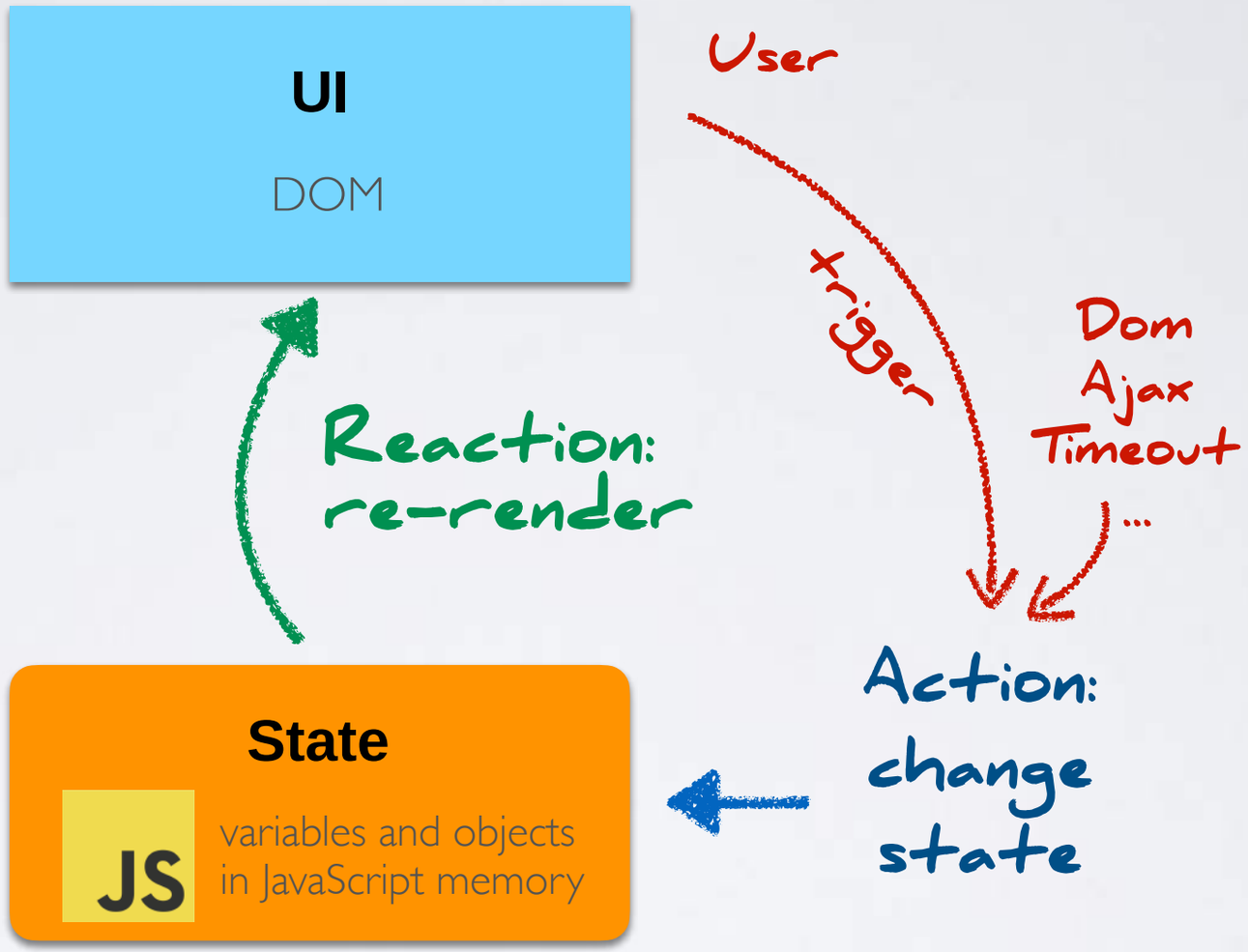
Note: React events are named in camelCase

React provides a *synthetic event system*: event handlers are registered with React and not on DOM elements. React listens to all DOM events on the document and calls the appropriate handlers.

https://facebook.github.io/react/docs/handling-events.html

State

State is Managed in JavaScript



Reactivity: React reacts on state changes and updates the UI.

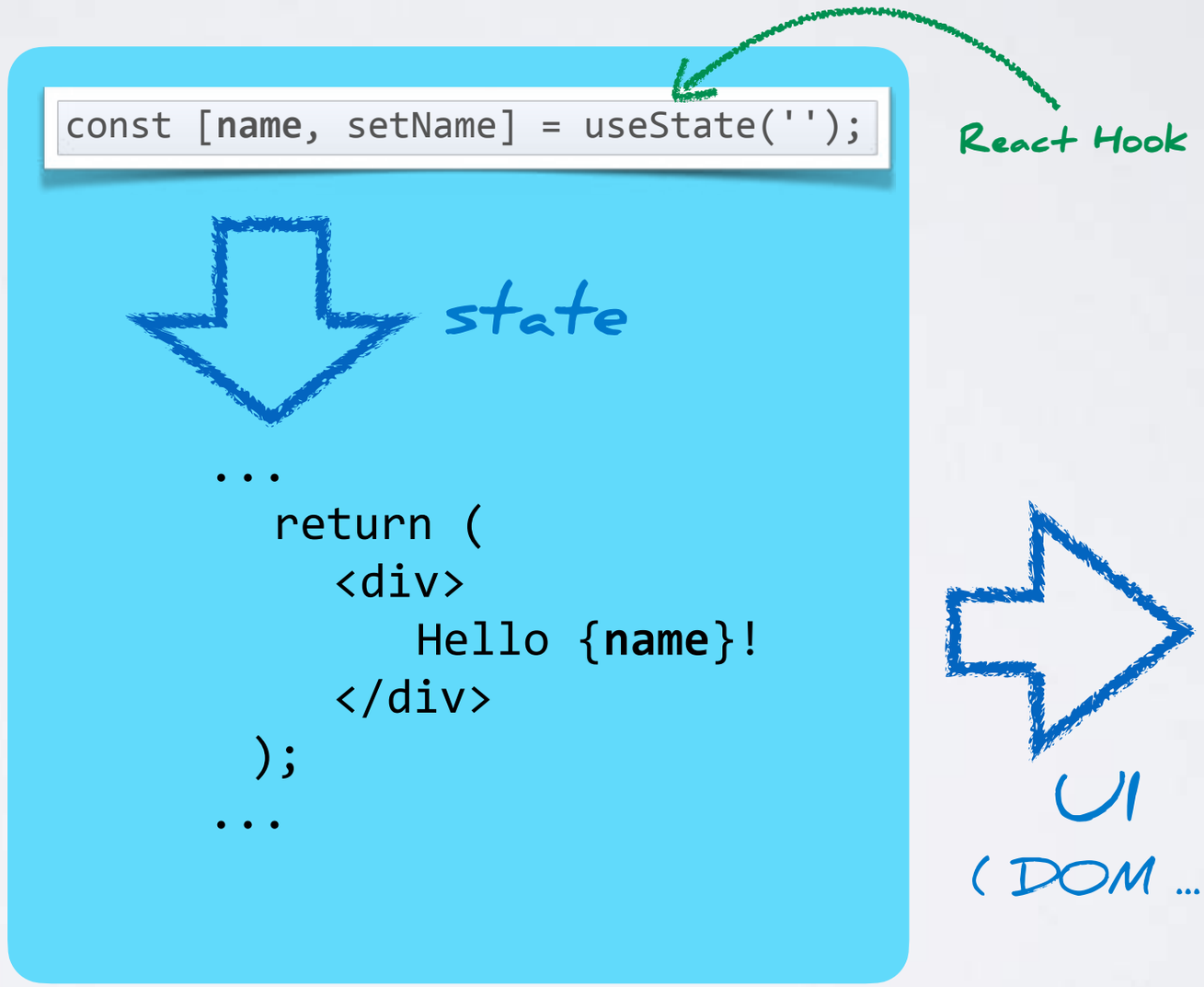
State in a Component Tree

https://react.dev/learn/thinking-in-react

Stateful Components

A component can hold state.
The state is changed by the component.

When the state changes, the component and its children are re-rendered.



https://reactjs.org/docs/components-and-props.html

State in Function Components

```
function Greeter() {

   const [name, setName] = useState('');

   return (
     <div>
       <input value={name} onChange={(event) => setName(event.target.value)}/>
       <div>{name}</div>
     </div>
   );

}
```

Note: The example above uses *array destructuring* of ES2015

`useState(initialValue)` is a Hook.

When it is called the first time it instructs React to manage a "slice" of state.

Each time it is called, it returns the current state and a function to update the state.

Calling the update function:
- sets the complete state (no shallow merge)
- triggers a re-rendering of the component

Note: there are other Hooks to manage state:
`useRef`, `useReducer`, `useContext` ...

https://reactjs.org/docs/hooks-reference.html#usestate
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/Destructuring_assignment

Functional State Updates: `useState`

State updates may be asynchronous!

The update function of the `useState` Hook also accepts a function:

```
const [state, setState] = useState(initialState);
setState((currentState) => newState);
```

```
function MyComponent(){

  const [count, setCount] = useState(0);

  function increment(){
    setCount(count + 1);
    console.log('count after set', count);
    setCount(count + 1);
  }

  return (
      <div>
        <div>Count: {count}</div>
        <button onClick={increment}>Increase</button>
      </div>
    );
}
```

wrong!

count is not incremented yet!

correct!

```
function increment(){
  setCount((count) => count + 1);
  setCount((count) => count + 1);
}
```

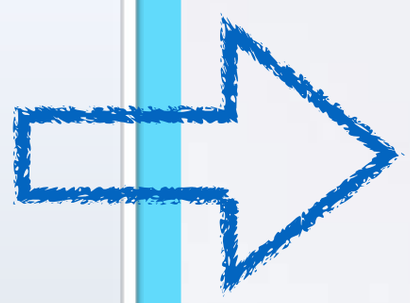
the updated count will be passed!

https://react.dev/reference/react/useState#updating-state-based-on-the-previous-state

Passing Data to Components

A component can receive **`props`**.

```
type GreeterProps = { message: string; };

function Greeter(props: GreeterProps) {
  ...
  return (
    <div>
      Hello {props.message}!
    </div>
  );
};
```



It is a good practice to *destructure* props in the component signature:

```
function Greeter({message}: GreeterProps) {
  <div> Hello {message} </div>
```

`props` is data owned by some other component and should not be changed (it should be treated as immutable data)

In TypeScript it could be declared as `ReadOnly<GreeterProps>`

https://react.dev/learn/passing-props-to-a-component

Passing Props

```
function App() {

    const today = new Date();

    return (
      <div>
        <Info message={'Current date ' + today}>
      </div>
    );
}
```

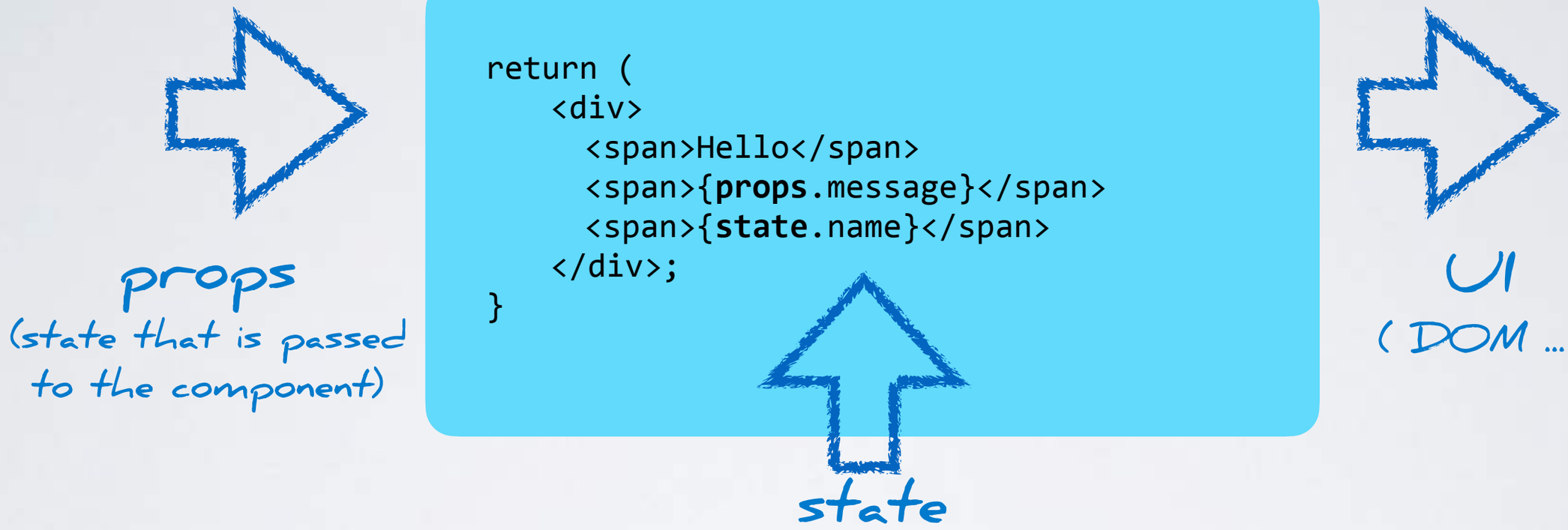
props: {message: 'Current date Tue Nov 15 2022'}

```
type InfoProps = {message: string};
function Info({message}: InfoProps) {

    return (
      <div>Message: {message}</div>
    );

}
```

Every function component receives a **`props`** argument. It is an object that holds all the props that are passed to the component instance.

Rendering Updates

A component transforms JavaScript state into the DOM structure.



- When state changes, the whole component is re-rendered into the virtual dom.
- When a component is rendered all it's children are also rendered.
- Since `props` are state of a parent components, a component typically re-renders when `props` change
- `Rect.memo` is a mechanism to prevent re-rendering a component if its `props` did not change.

https://www.joshwcomeau.com/react/why-react-re-renders/

https://blog.isquaredsoftware.com/2020/05/blogged-answers-a-mostly-complete-guide-to-react-rendering-behavior/

Custom Events

React components can expose events via **`props`**.

The parent component passes an event handler (callback function) to the child component. The child component then can trigger the handler of the parent component.

```
function Parent() {

  function handler(){ ... }

  return (
    <Child onInnerClick={handler} />
  );
};
```

prop

function

Because `handler` is declared inside `Parent`,
it has access to the props and state of `Parent`!
(via the JavaScript Closure)

```
type ChildProps = {
  onInnerClick: () => void;
};

function Child({onInnerClick}) {
    ...
    return (
      <button onClick={onInnerClick}>
          Click Me 1
      </button>;
  }
};
```

prop destructuring

function

https://react.dev/learn/responding-to-events#passing-event-handlers-as-props

Lifecycle

Component Lifecycle

React renders your components.
Your code does not call function components or instantiate class components. React does this.

The component "lifecycle" is managed by React:

- A component is "*mounted*" when it is rendered to the DOM for the first time
- A component can be *updated* while it is present in the DOM
- A component is "*unmounted*" when it is removed from the DOM

Typically application logic is coupled to the lifecycle of components (i.e. loading data, starting timers, manual DOM changes ...).
This logic is often called "*side efffects*" since it has an effect outside of the component tree.

In future React versions components may "mount" and "unmount" more than once!

Lifecycle: `useEffect`

A component has a "lifecycle": created, updated, deleted.
But Functions do not have a "lifecycle"! `useEffect` provides an API to "tap" into the component lifecycle.

The `useEffect` Hook is used to trigger side effects coupled to the component lifecycle.

Components re-rendered on any change and therefore also for each "lifecycle-stage".

The `useEffect` Hook can be used for several scenarios:
- to trigger logic *after each rendering*.
- to trigger logic *after a rendering* when the certain props or parts of the state did change.
- to trigger logic (only) *after the first rendering*.

The `useEffect` Hook can optionally define *cleanup logic*, which is executed by React.

The mental model of `useEffect` is closer to implementing "synchronization" than to responding to lifecycle events.

React 18 *Strict Mode* executes the effects twice in development mode!
https://reactjs.org/blog/2022/03/08/react-18-upgrade-guide.html#updates-to-strict-mode

In future React versions components may "mount" and "unmount" more than once!

https://react.dev/reference/react/useEffect
https://react.dev/learn/you-might-not-need-an-effect
https://overreacted.io/a-complete-guide-to-useeffect/

Note: There is also `useLayoutEfffect`:
https://react.dev/reference/react/useLayoutEffect
https://kentcdodds.com/blog/useeffect-vs-uselayouteffect

Lifecycle: `useEffect`

```
useEffect(() => {
  performSideEffect();
  return () => { cleanup(); }
  }, [dep1, dep2]);
```

the actual effect

optional cleanup

optional dependencies: effect is only re-executed if dependencies changed. Should typically contain all the variables used in the effect function.

Executing a function after each render:

```
import React, { useState, useEffect } from 'react';

function Example() {
  const [count, setCount] = useState(0);

  useEffect(() => {
    console.log(document.getElementById('message').innerText);
  });

  return (
    <div>
      <p id="message">You clicked {count} times</p>
      <button onClick={() => setCount(count + 1)}>
        Click me
      </button>
    </div>
  );
}

export default Example;
```

access delayed until after render

(note: accessing the document directly is an antipaatern in React)

Executing a function after first render, cleaning up when component is removed:

```
import React, { useState, useEffect } from 'react';

function Example() {
  const [count, setCount] = useState(0);

  useEffect(() => {
    console.log('Mounted!');

    return () => { console.log('Unmounted'); }
  }, []);

  return (
    <div>
      <p id="message">You clicked {count} times</p>
      <button onClick={() => setCount(count + 1)}>
        Click me
      </button>
    </div>
  );
}

export default Example;
```

executed when removed

only executed on first render

You Might Not Need an Effect

https://react.dev/learn/you-might-not-need-an-effect

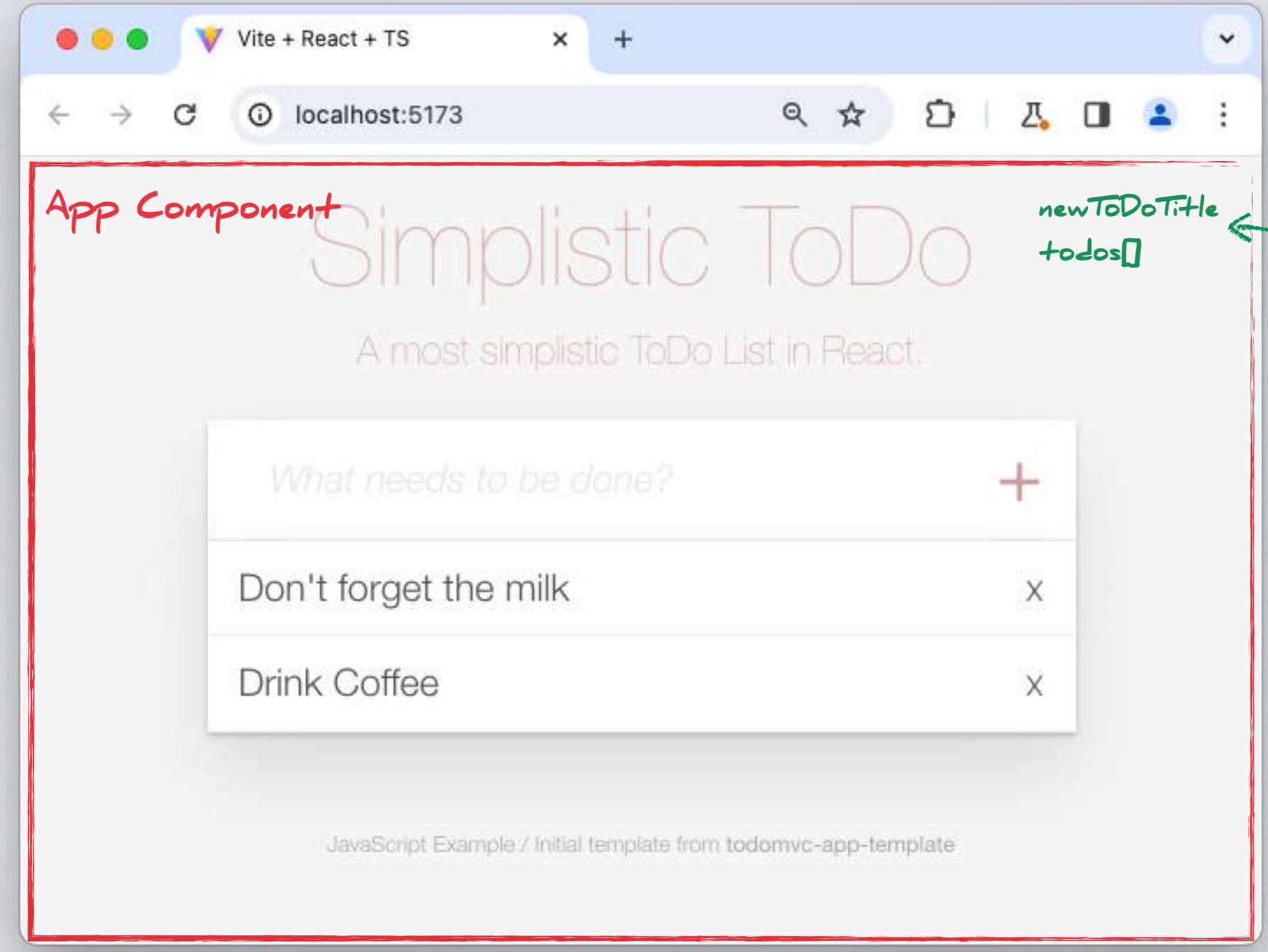
Effects are an escape hatch from the React paradigm. [...]
If there is no external system involved (for example, if you want to update a component's state when some props or state change), you shouldn't need an Effect.
Removing unnecessary Effects will make your code easier to follow, faster to run, and less error-prone.

If you need an effect, think about "hiding" it in a custom hook.
The fewer raw useEffect calls you have in your components, the easier you will find to maintain your application.

EXERCISES

Exercise 3 - Simple ToDo App

Simple ToDo App



Form: Controlled Components

```
function Form() {
  const [firstName, setFirstName] = useState('');
  const [lastName, setLastName] = useState('');

  function submitForm() {
    console.log('Form Values', firstName, lastName);
  }

  return (
      <div className="card">
        <form action={submitForm}>
          <label htmlFor="firstName">Firstname:</label>
          <input value={firstName} onChange={(e) => setFirstName(e.target.value)}
                type="text" id="firstName" name="firstName" />
          <br />
          <label htmlFor="lastName">Lastname:</label>
          <input value={lastName} onChange={(e) => setLastName(e.target.value)}
            type="text" id="lastName" name="lastName" />
          <br/>
          <button type="submit">Submit</button>
        </form>
        <p>
          Hello {firstName} {lastName}
        </p>
      </div>
  );
}
```

This is the basic mechanism provided by React.

There are many alternative techniques:

- uncontrolled components using ref or action.
- custom hook with an object in state.
- useActionState for async state changes
- 3rd party form libraries

Form Submisson in React 19

React 19 introduces *Actions:*
https://vercel.com/blog/whats-new-in-react-19#actions

An action can be used to handle form submission:

```
function FormComponent() {

  function submitForm(formData) {
    const firstName = formData.get("firstName");
    console.log('Form Values', firstName);
  }

  return (
      <div className="card">
        <form action={submitForm}>
          <label htmlFor="firstName">Firstname:</label>
          <input type="text" id="firstName" name="firstName" />
          <button type="submit">Submit</button>
        </form>
        <p>
          Hello {firstName}!
        </p>
      </div>
  );
}
```

Caution: Pitfall!

Form Submisson in React before v19

```
function FormComponent() {
  const [firstName, setFirstName] = useState('');

  function submitForm(e: FormEvent) {
    e.preventDefault();
    console.log('Form Values', firstName);
  }

  return (
      <div className="card">
        <form onSubmit={submitForm}>
          <label htmlFor="firstName">Firstname:</label>
          <input value={firstName} onChange={(e) => setFirstName(e.target.value)}
                 type="text" id="firstName" name="firstName" />
          <button type="submit">Submit</button>
        </form>
        <p>
          Hello {firstName}!
        </p>
      </div>
  );
}
```

Preventing the default behavior of the browser with this form submission!

If a form is submitted, the browser will trigger a request to the backend (GET or POST):
https://developer.mozilla.org/en-US/docs/Learn/Forms/Sending_and_retrieving_form_data

React does not "magically" prevent this default behavior. We have to prevent the default behavior in the event handler.

Immutability

Immutability

React propagates a programming model based on immutable data structures: props & state should be treated as immutable.

- props are owned by a parent and should only be changed by this parent ("unidirectional data-flow")
- state changes are more explicit and easier to track if state is immutable
- React can better optimize re-rendering based on shallow comparison of objects.

```
const [todos, setTodos] = useState([]);
...
let newTodos = [...this.state.todos, newToDo];
setTodos({todos: newTodos});
```

the **`useState`** Hook only re-renders if we pass a new value to the setter function

Why immutability is important?
https://reactjs.org/tutorial/tutorial.html#why-immutability-is-important
https://reactkungfu.com/2015/08/pros-and-cons-of-using-immutability-with-react-js/

Why is react doing this? https://gist.github.com/sebmarkbage/a5ef436427437a98408672108df01919

Why does React care about purity? https://beta.reactjs.org/learn/keeping-components-pure

Immutable Update Patterns

Whenever your object would be mutated, don't do it.
Instead, create a changed copy of it.

array changes

```
const arr1 = ['first', 'second', 'third'];
const arr2 = [...arr1, 'fourth']; // adding
const arr3 = arr2.filter(e => e !== 'second'); //removing
const arr4 = [...array.slice(0, 2), 'between', ...array.slice(2)]; //inserting
```

object changes

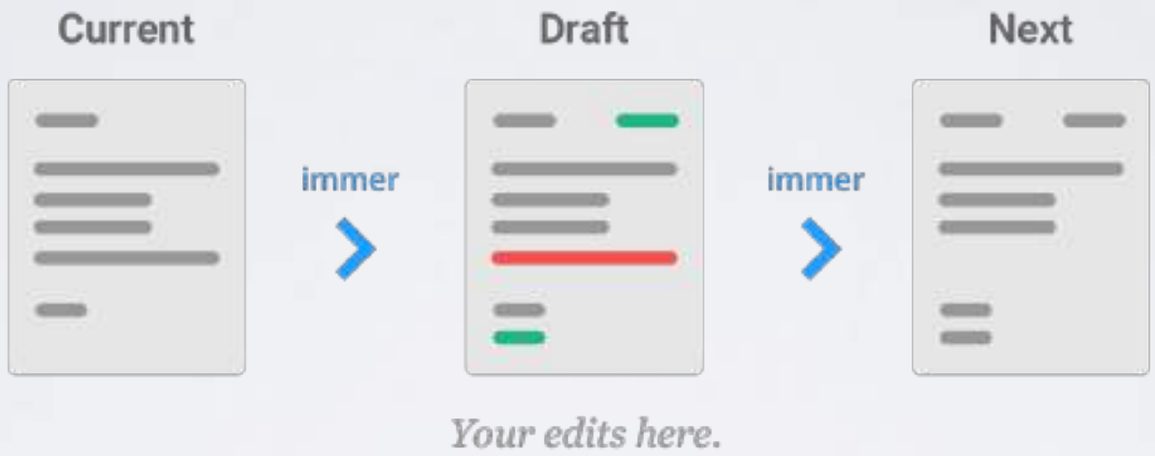
```
const person = {firstName: 'Tyler', lastName: 'Durden', age: 42,
                                address: {street: 'papermill', number: 2}};
const changedPerson = {...person, age: 43};
const personWithChangedAddress = {...person, address: {...person.address, number: 3}};
```

```
const arr = [{id: 1, title: 'eat', completed: true},
   {id: 2, title: 'learn', completed: false},
   {id: 3, title: 'sleep', completed: false}];
const changed = arr.map(e => e.id !== 2 ? e : {...e, completed: true})
```

https://redux.js.org/recipes/structuring-reducers/immutable-update-patterns

Immer.js

Immer is a tiny package that allows you to work with immutable state in a more convenient way. It is based on the copy-on-write mechanism.




```
import produce from "immer"

const baseState = [
    { todo: "Learn typescript", done: true },
    { todo: "Try immer", done: false}
]

const nextState = produce(baseState, draftState => {
    draftState.push({todo: "Tweet about it"})
    draftState[1].done = true
})
```

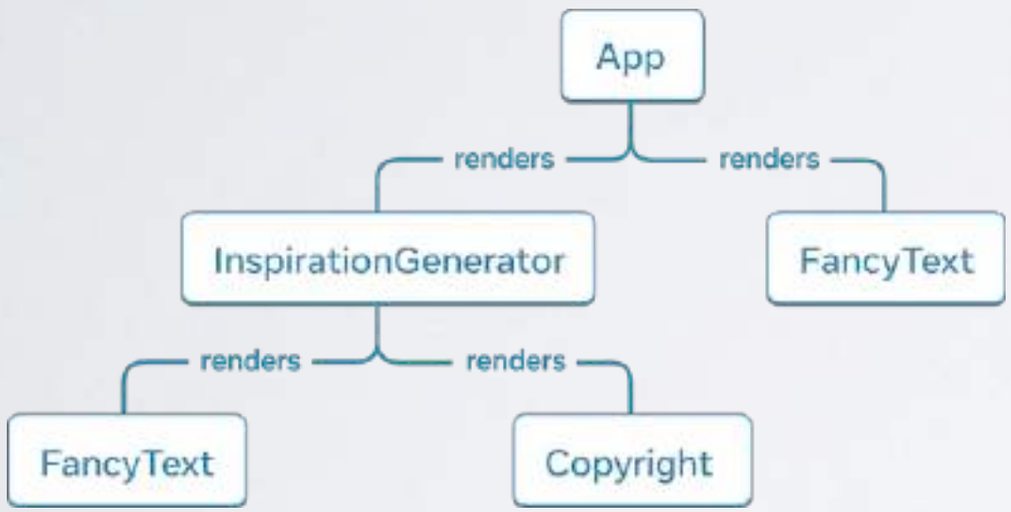
Integration with React Hooks: https://github.com/immerjs/use-immer
Immer is included in Redux Toolkit.

https://immerjs.github.io/immer/

Data Flow

Data Flow Mechanisms

The UI is a tree of components:



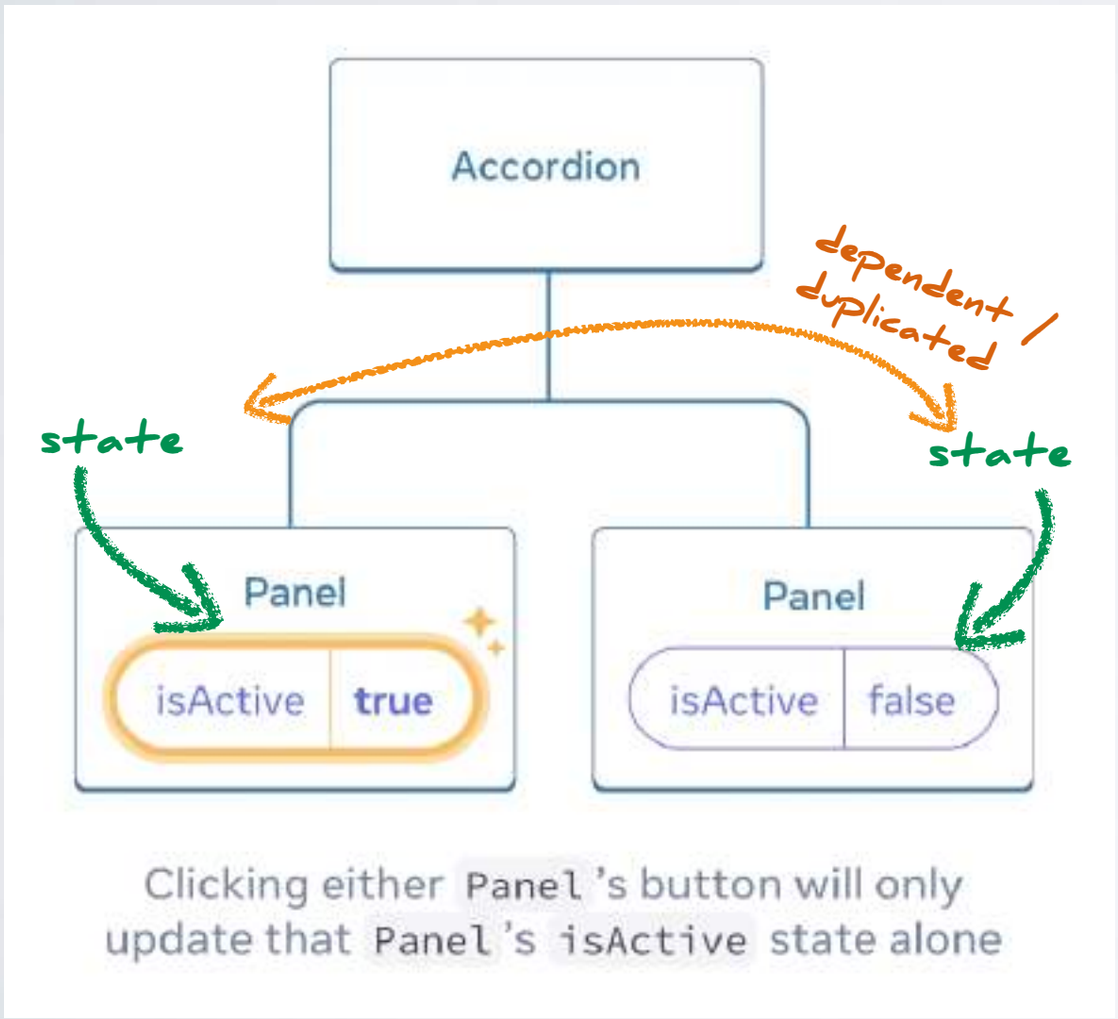
https://react.dev/learn/understanding-your-ui-as-a-tree

Data and event handlers are passed to child components via props.

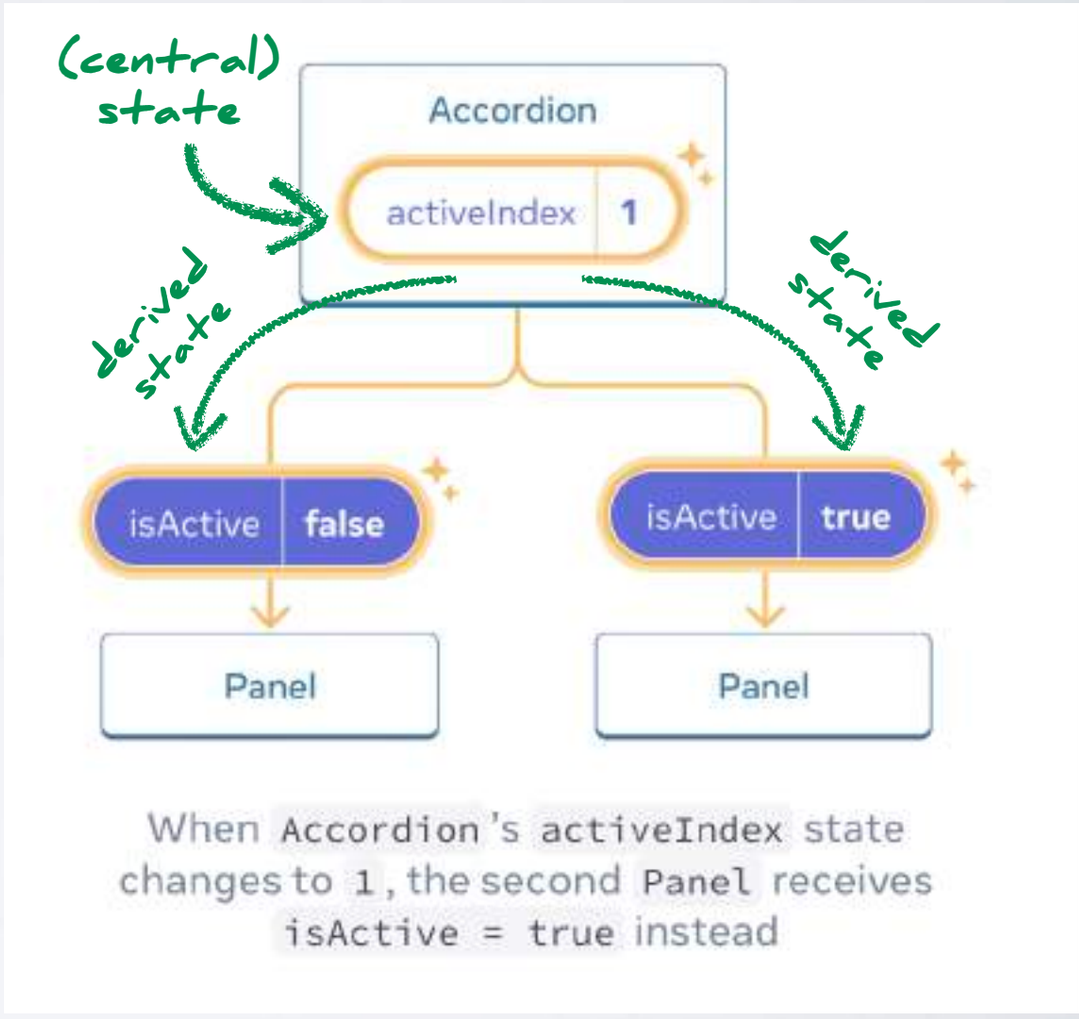
```
type ChildProps = {
  data: string;
  onEvent: () => void;
};

function Child({data, onEvent}) {
    ...
    return (
      <div>
        <h1>{data}</h1>
        <button onClick={onEvent}>
           Click Me 1
        </button>;
      </div>
  }
};
```

Thinking in React: Lifting State Up

State should be modeled as a single source of truth.
Duplicated state should be avoided! Sometimes duplication can be avoided by *deriving* dependent state from existing state.



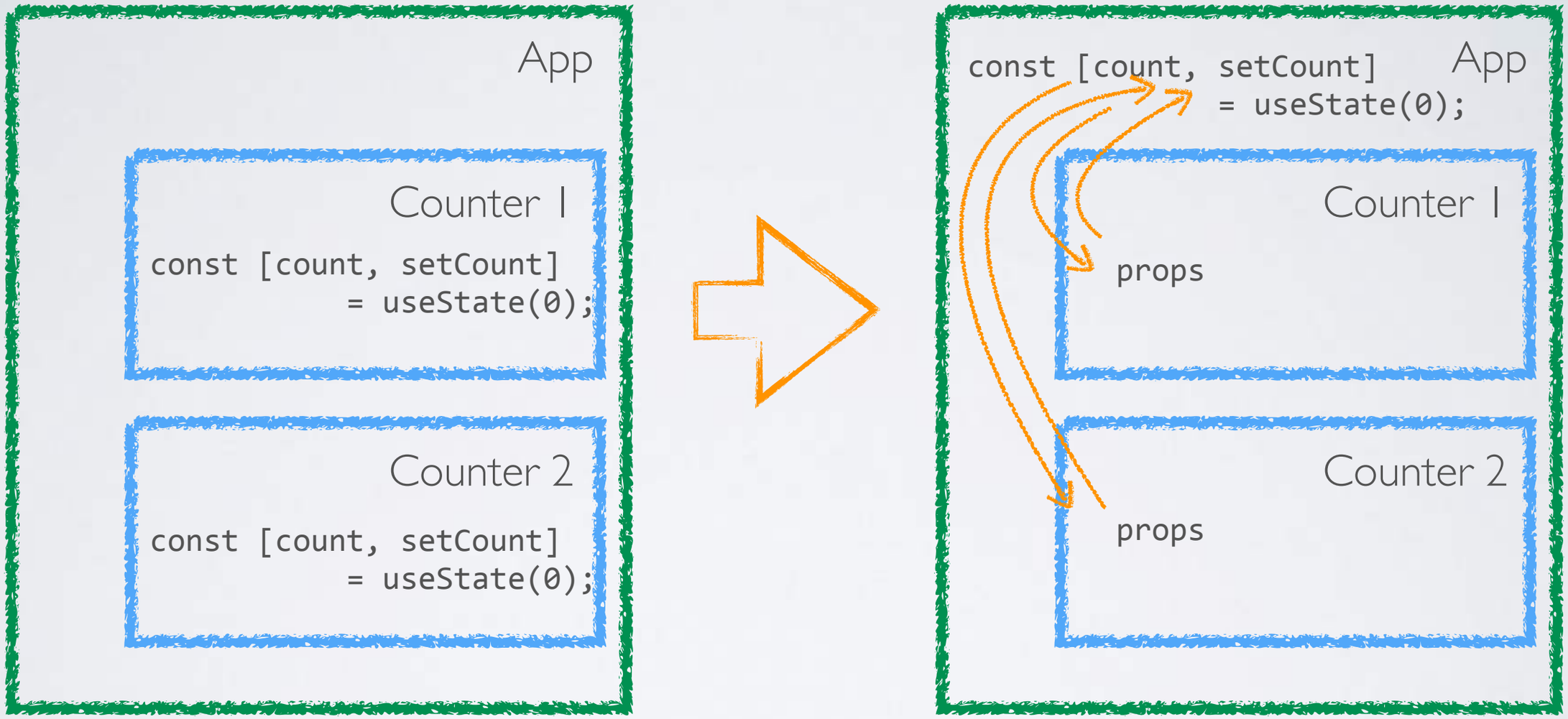
Clicking either `Panel`'s button will only update that `Panel`'s `isActive` state alone



When `Accordion`'s `activeIndex` state changes to `1`, the second `Panel` receives `isActive = true` instead

https://react.dev/learn/sharing-state-between-components
https://react.dev/learn/thinking-in-react

Lifting State up

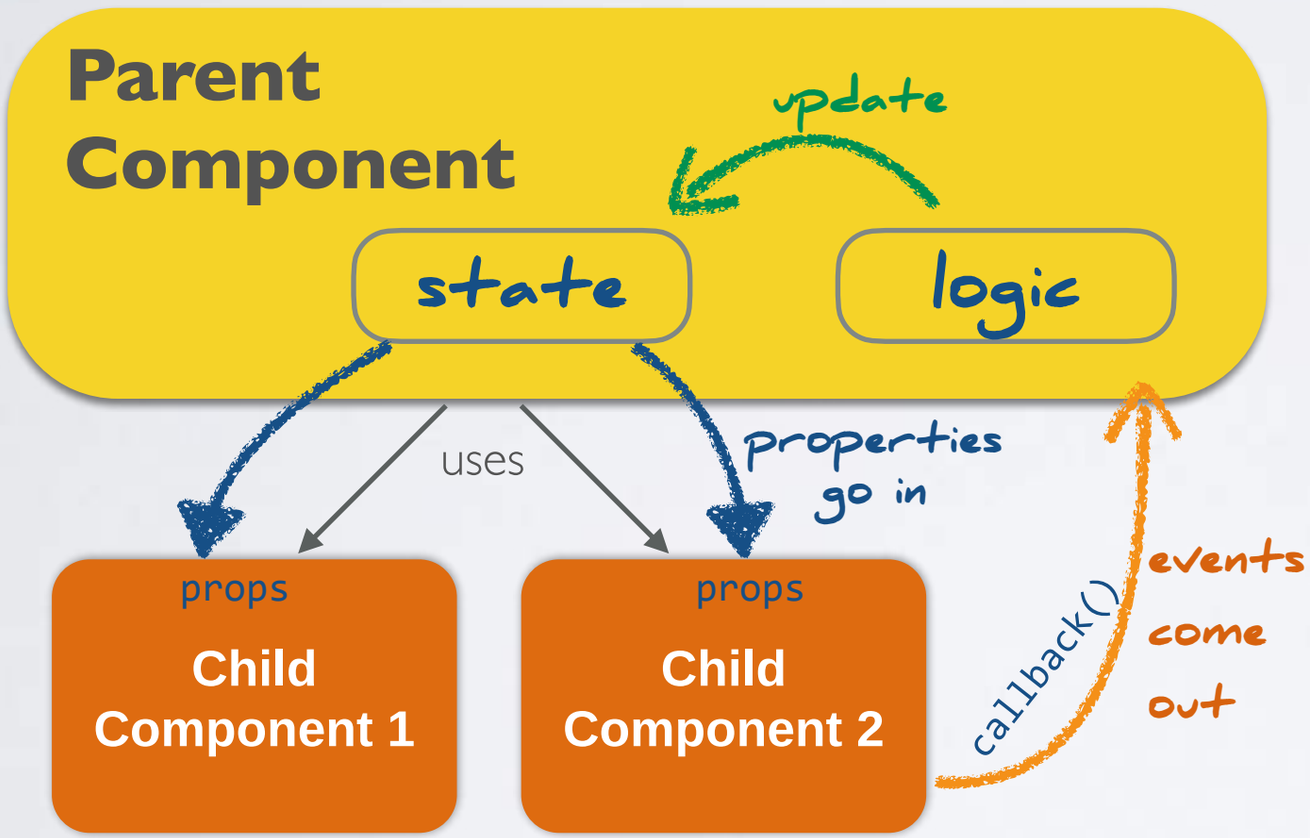


https://react.dev/learn/sharing-state-between-components

Unidirectional Data-Flow

State should be explicitly owned by one component.
State should *never be duplicated* in multiple components.

(sometimes it is tricky to detect the *minimal state* from which other state properties can be *derived*)



- A parent component passes state to children as properties. Children are re-rendered when these properties change.
- Children should not edit state of their parent
- Children "notify" parents (events, callbacks …)

React formalises **unidirectional data-flow** via `props`:
passing data and callbacks to child components

Data flows Down / Events flow Up

Passing props from parent to child:

```
function Parent() {

  let message = 'Test';
  function handler(){
     console.log('Child clicked!');
  }

  return (
    <Child
        message={message}
        onInnerClick={handler}>
    </Child>
  );
};
```

Using props and emitting events:

```
interface ChildProps {
    message: string,
    onInnerClick: () => void
}
function Child({message, onInnerClick}: ChildProps){
    return (
      <div>
        <div>{message}</div>
        <button
          onClick={onInnerClick}>
          Click Me
        </button>;
      </div>
  }
};
```

This programming model is very similar to the native DOM elements:

```
<input value={firstName} onChange={handleChange} />
```

Container vs. Presentation Components

"Separtion of Concerns"

Application should be decomposed in container- and presentation components:

Container	**Presentation**
Little to no markup	Mostly markup
Pass data and actions down	Receive data & actions via props
typically stateful / manage state	mostly stateless
	better reusability

aka: Smart- vs. Dumb Components

https://medium.com/@dan_abramov/smart-and-dumb-components-7ca2f9a7c7d0

Separation of Concerns

Separation of concerns is not equal to separation of file types!

Keep things together that change together.

You can split a component into a controller and a view:

```
import {View} from './View';

export function Controller {
  ... // state & behavior
  return (
    <View data={...}
          onEvent={...} />
  );
}
```

Controller.js

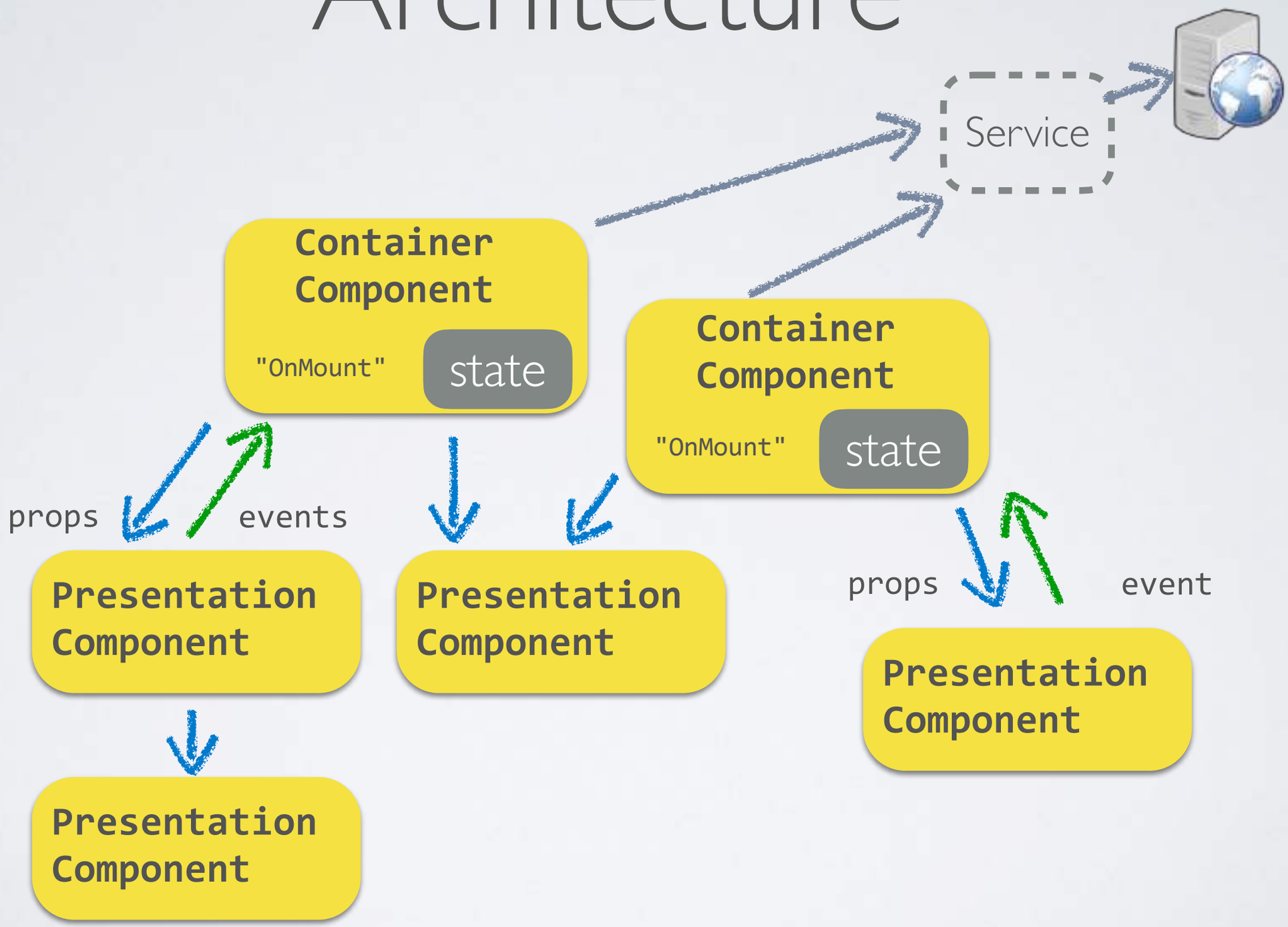
```
export function View({data, onEvent}){
  return (
    <div>
      {data.message}
      <button onClick={()=>onEvent()}>
        Go!
      </button>
    </div>
  );
}
```

View.js

https://codesandbox.io/s/NxqMqyxlD

https://medium.com/styled-components/component-folder-pattern-ee42df37ec68

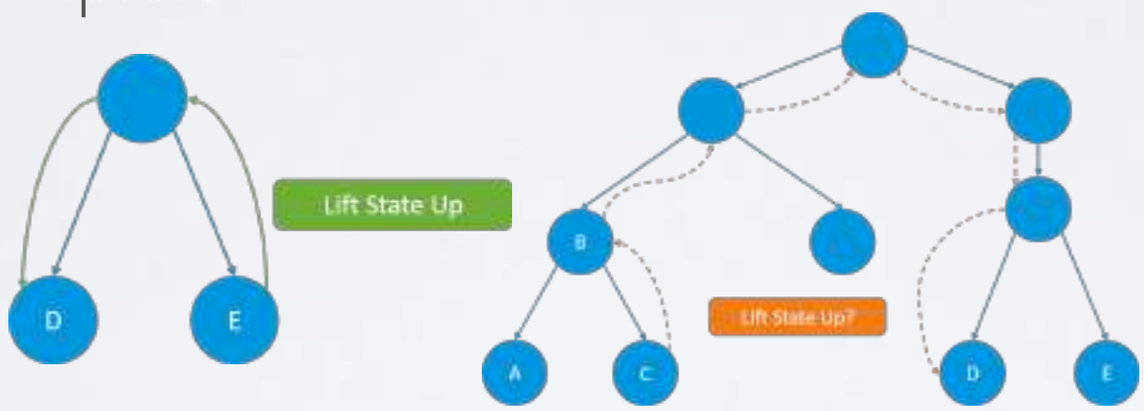
Data Flow & Component Architecture



React Data Flow Critique

In React the data flow is heavily coupled to the component structure and the re-rendering of the component tree.

The idea behind "lifting" state up is, that the component tree matches the data-flow tree. This is an abstraction that might become a problem for more complicated applications.
At a certain point, "lifting state up" will hurt the “Composability and Reusablity” principles.



"Fine-grained reactivity" is not possible in React. Changes only propagate if a component-tree is re-rendered.
Some 3rd party solutions propose to "lift state out" instead of "lifting state up".

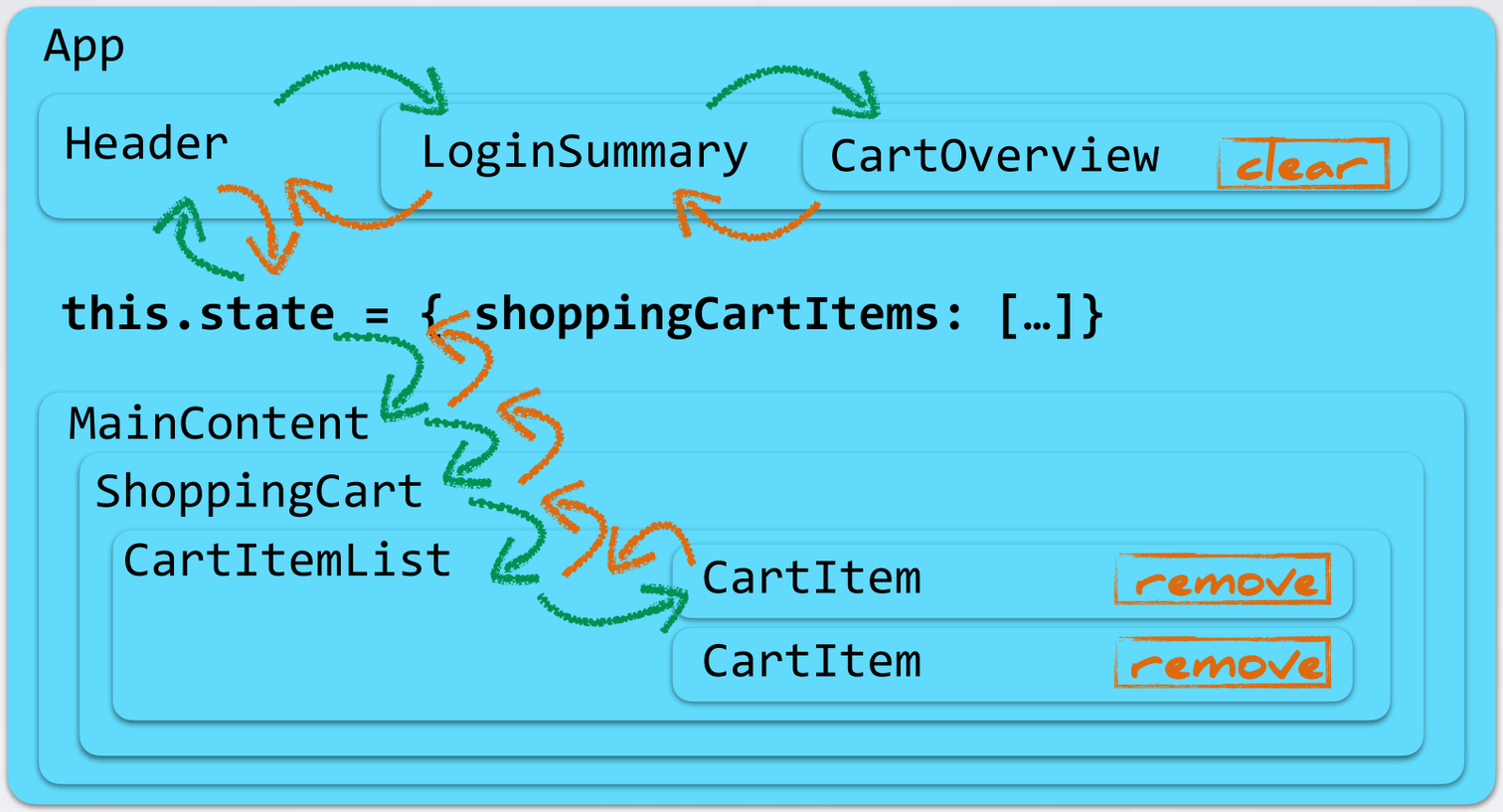
Vue, Solid.js, Qwik, Svelte and modern Angular offer fine grained reactivity with signals.

https://podrocket.logrocket.com/usewat-david-khourshid
https://medium.com/@nimelrian/thinking-in-react-a-paradox-statement-33c19e2eb9e2
https://react.dev/reference/react/useSyncExternalStore

Prop Drilling

From the component architecture follows the pattern of "*lifting state up*": if several components need to reflect the same changing data, then the shared state should be liftet up to their closest common ancestor.

https://react.dev/learn/sharing-state-between-components



"Prop Drilling" is the process you have to go through to pass data and events through the component tree.

Prop drilling can be a *good thing*: it makes the data-flow very explicit!
Prop drilling can be a *bad thing*: passing data from its holder to a consumer via serveral intermediates is tedious and makes changing the component tree more difficult.

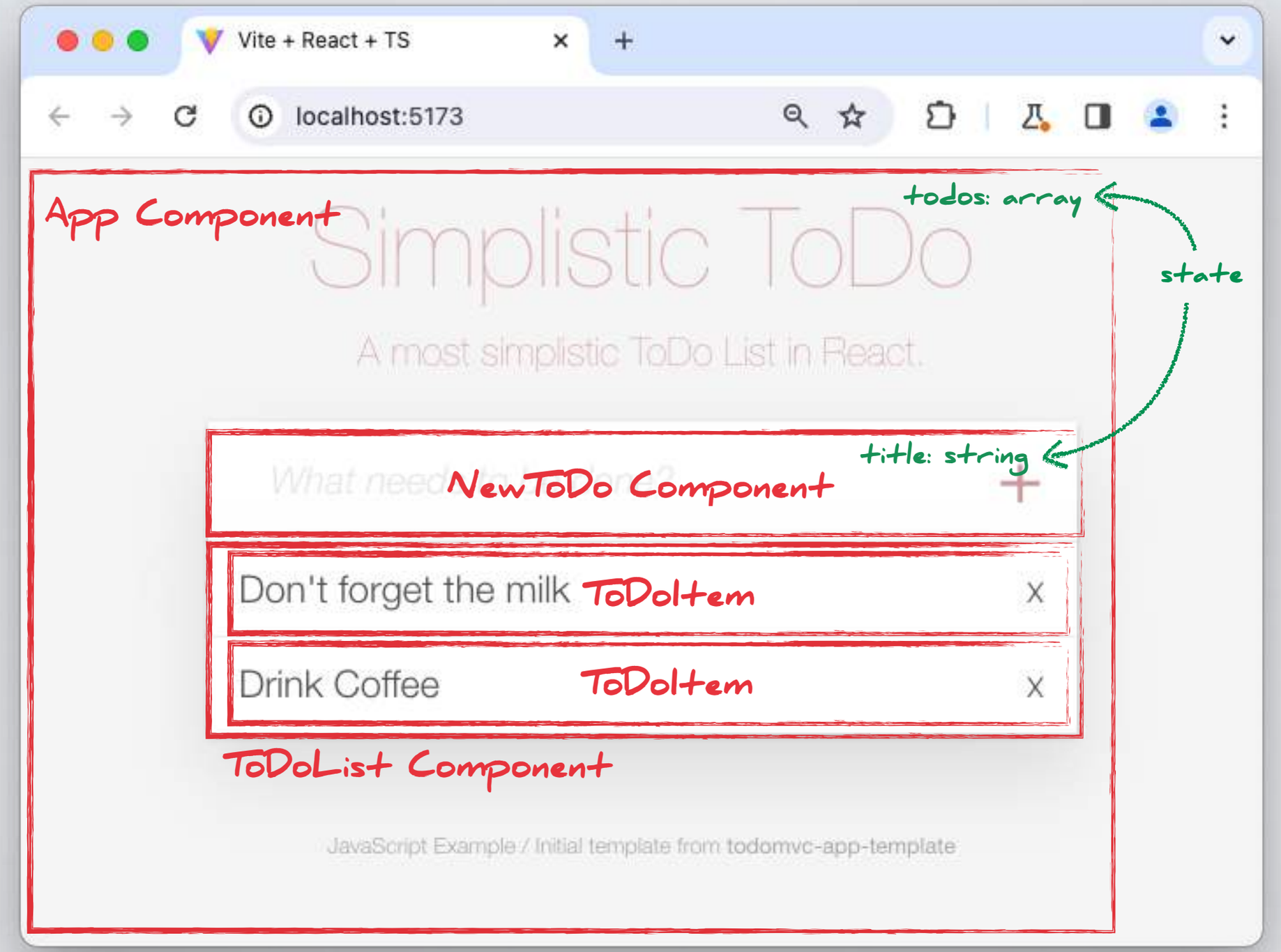
https://blog.kentcdodds.com/prop-drilling-bb62e02cb691
https://react.dev/learn/passing-data-deeply-with-context

EXERCISES

Exercise 4 - ToDo App Component Architecture

The Component Tree

Designing the component tree and the corresponding structure of state.



Client Side Routing

Getting Started:

TanStack Router

https://tanstack.com/router/

```
npx create-tsrouter-app@latest my-app --template typescript
```

CLI options: https://github.com/TanStack/create-tsrouter-app/tree/main/cli/create-tsrouter-app

Documentation:
https://tanstack.com/router/latest/docs/framework/react/overview

http://localhost:3000/

<head>
</head>

<body>
  ...
  <RouterProvider
  router={router}/>
  ...
</body>

SPA Shell

/path1

<ToDoScreen/>

/path2

<DoneScreen/>

```
const routeTree = rootRoute
          .addChildren([toDoRoute]);

const router = createRouter({ routeTree })
```

```
const rootRoute = createRootRoute({
  component: () => <Outlet />
})
```

```
const toDoRoute = createRoute({
  getParentRoute: () => rootRoute,
  path: '/',
  component: ToDoScreen,
})
```

Routing Libraries in the React Ecosystem

With client-side routing the browser URL and the rendered UI can can change without making a request to the server.

React Router has been almost a "de-facto" standard for a long time.
https://reactrouter.com/

Routing libraries used to be simple and with a single concern. In recent years routing libraries evolved into powerful, but complicated "frameworks".

React Router 7 can still be used as a library, but it is also a "production grade framework".
https://reactrouter.com/start/modes

https://www.youtube.com/watch?v=BKi4YwLaMBI

Router Alternatives

REACT Router

https://reactrouter.com/

NEXT.JS

Next.js has its own file-based router

https://nextjs.org/docs/app/building-your-application/routing

TanStack Router

https://tanstack.com/router/

Wouter: tiny router that relies on hooks

https://github.com/molefrog/wouter

Chicane: A safe router for React and TypeScript

https://swan-io.github.io/chicane/

Alternative Projects (but no recent activity 😔):

- Remix: has been merged into ReactRouter v7: https://remix.run/blog/merging-remix-and-react-router
- hookrouter: https://github.com/Paratron/hookrouter
- Type Route: https://www.type-route.org/
- navi: https://frontarm.com/navi/en/
- router 5: https://router5.js.org/
- ReachRouter was merged with React Router 6 https://reach.tech/router/

TanStack Router

https://tanstack.com/router/

Reasons to choose TanStack Router:

- it is focusing on client-side scenarios.
- it is built from ground-up with type-safety
- it is well documented
- it has powerful features

https://tanstack.com/router/latest/docs/framework/react/comparison

https://tkdodo.eu/blog/the-beauty-of-tan-stack-router

TanStack Router

https://tanstack.com/router/

TanStack Router offers *code-based* routing and *file-based* routing.
File-based routing is the recommended setup:
https://tanstack.com/router/latest/docs/framework/react/decisions-on-dx

File based routing uses a build plugin that generates code at development time.

Project Scaffolding:

```
npx create-tsrouter-app@latest my-app --template file-router
```

CLI options: https://github.com/TanStack/create-tsrouter-app/tree/main/cli/create-tsrouter-app

Manual Installation:

```
npm install @tanstack/react-router @tanstack/react-router-devtools
npm install -D @tanstack/router-plugin
```

Documentation:
https://tanstack.com/router/latest/docs/framework/react/overview

TanStack Router

https://tanstack.com/router/

API:

```
import {
   createRouter,
   createRoute,
   createRootRoute,
   Outlet,
   RouterProvider,
   Link,
   useLocation,
   useParams
   useNavigate
} from '@tanstack/react-router'
```

factory functions

components

hooks

... and more.

Documentation:
https://tanstack.com/router/latest/docs/framework/react/overview

TanStack Router

https://tanstack.com/router/

Many features beyond routing:

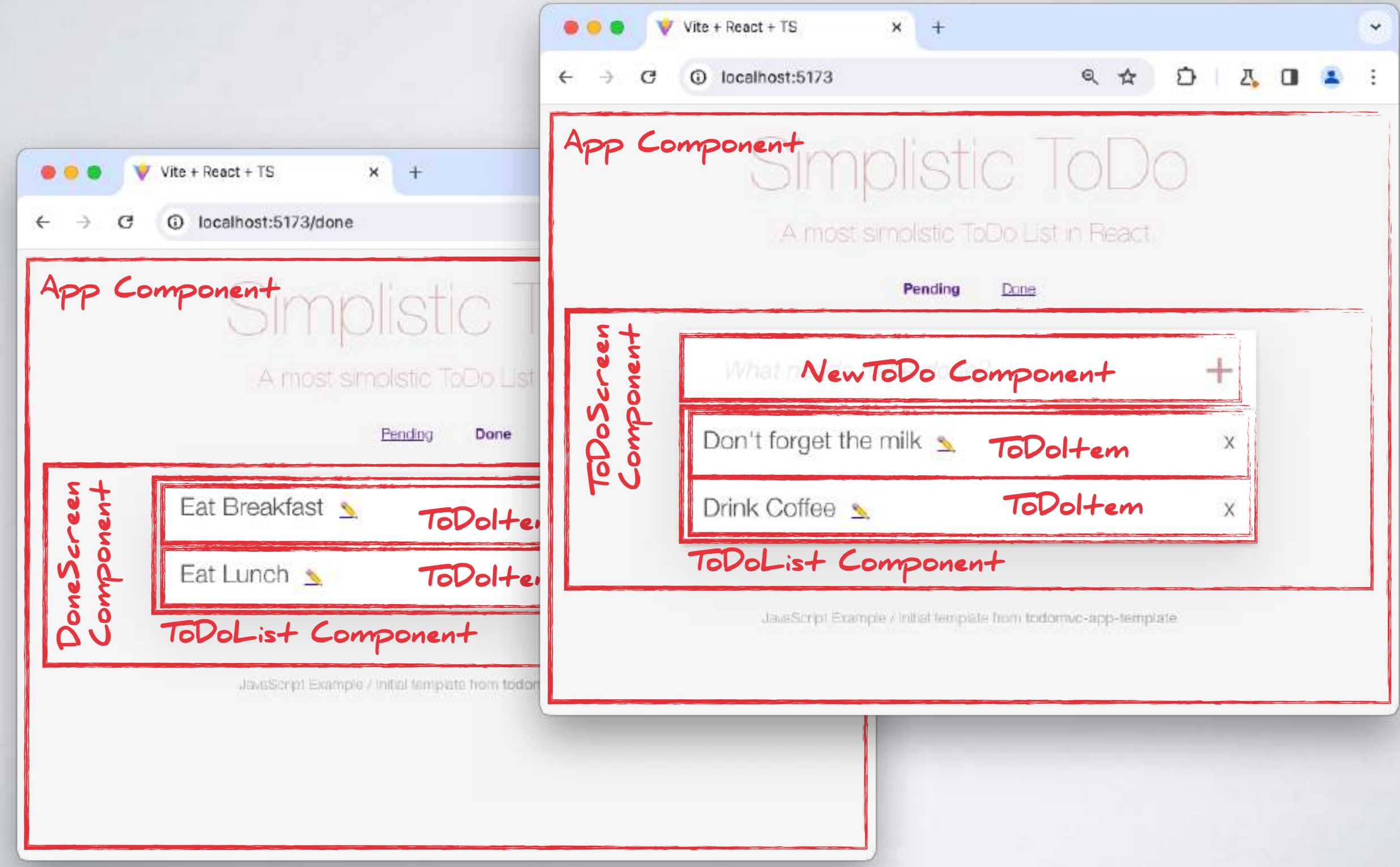
- data fetching
- url based state management
- query param validation
- dependency injection with router contet

Documentation:
https://tanstack.com/router/latest/docs/framework/react/overview

EXERCISES

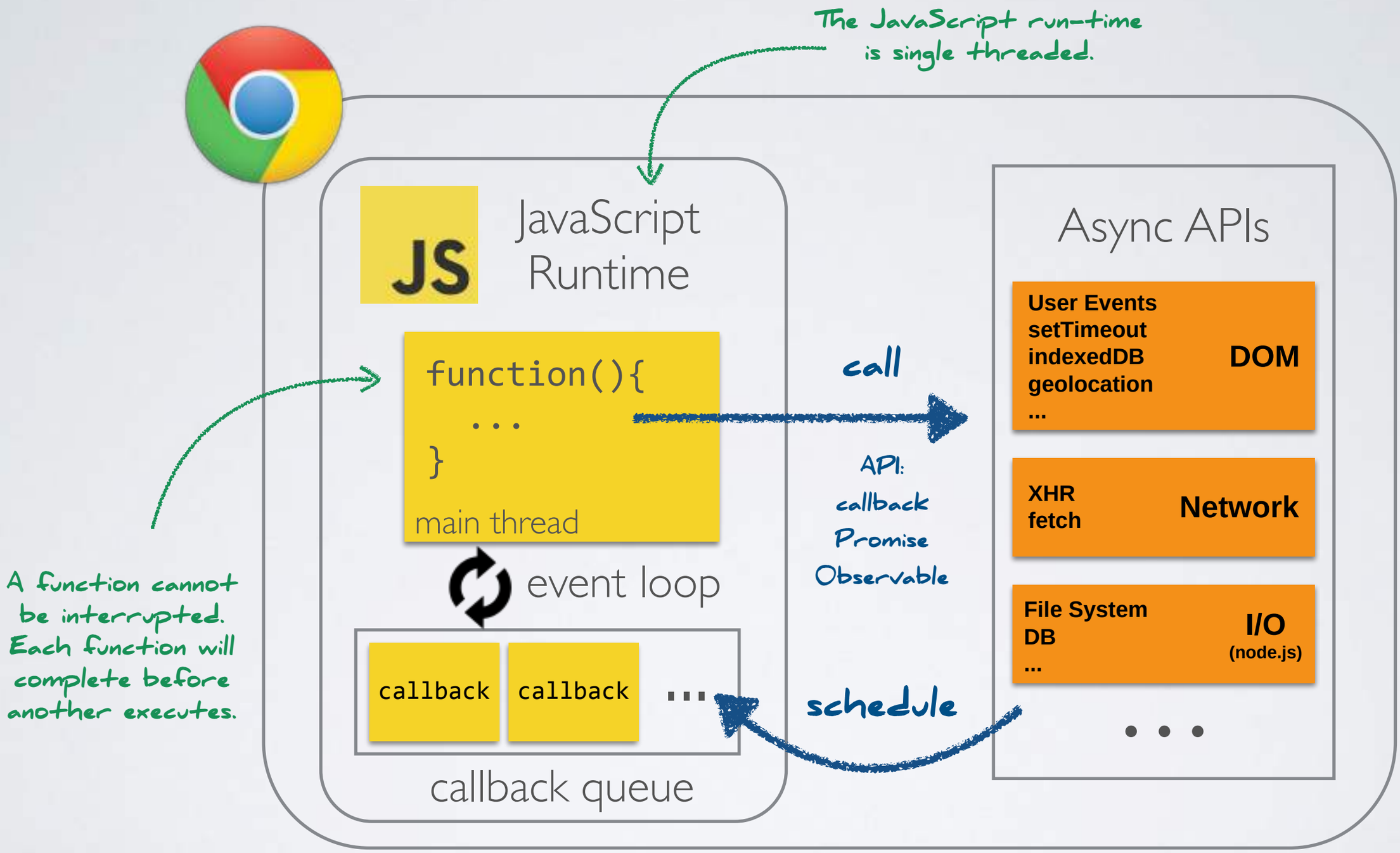
Exercise 5 - ToDo App Routing

Routing


Vite + React + TS
localhost:5173
App Component
Simplistic ToDo
A most simplistic ToDo List in React
Pending
Done
ToDoScreen Component
NewToDo Component
Don't forget the milk
ToDoItem
Drink Coffee
ToDoItem
ToDoList Component
JavaScript Example / Initial template from todomvc-app-template
Vite + React + TS
localhost:5173/done
App Component
Simplistic T
A most simplistic ToDo List
Pending
Done
DoneScreen Component
Eat Breakfast
ToDoIte
Eat Lunch
ToDoIte
ToDoList Component
JavaScript Example / Initial template from todom

Side-Track: Async JavaScript

Concurrency in JavaScript: Event Loop



https://www.tedinski.com/2018/10/16/concurrency-vs-parallelism.html
What the heck is the event loop anyway? - https://www.youtube.com/watch?v=8aGhZQkoFbQ
Interactive Visualization: http://latentflip.com/loupe/
Jake Archibald: In The Loop: https://www.youtube.com/watch?v=cCOL7MC4Pl0
https://jakearchibald.com/2015/tasks-microtasks-queues-and-schedules/

Note: there is also the differentiation between macro- and micro tasks on the event loop: https://javascript.info/event-loop

Side-Track: Async JavaScript

There are different models/APIs for concurrency in JavaScript.

Callbacks → "Pyramid of Doom"

Promises → Promise chains → async/await

Promises → Promise combinations

Promises → cancellation

async generators

Observables → RxJS

RxJS → Future: native Observables

XMLHttpRequest

The underlying technology for AJAX.

```
const req = new XMLHttpRequest();
req.addEventListener("load", done);
req.addEventListener("error", failed);
req.addEventListener("readystatechange", stateChanged);
req.open("GET", "https://jsonplaceholder.typicode.com/albums");
req.setRequestHeader("Content-Type", "application/json");
req.send(JSON.stringify({title: 'Learn the Fetch API', completed: false}));

function stateChanged() {
    if (this.readyState === 4) {
        if (this.status === 201) {
            console.log('success state', this.responseText)
        }
    } else {
        console.log('error state', this.statusText);
    }
}

function done() {
    console.log('DONE', this.responseText);
}

function failed() {
    console.log('ERROR', this.statusText);
}
```

The API is low-level, complicated and verbose.

https://developer.mozilla.org/en/docs/Web/API/XMLHttpRequest/Using_XMLHttpRequest

AJAX with Callbacks

using jQuery

```
$.get('http://localhost:3001/comments', (data) => {
    console.log(data);
});
```

```
$.post('http://localhost:3001/comments',
       {text: 'test - ' + new Date()},
       () => {
          console.log('POST!');
});
```

`fetch`: a modern AJAX API

`fetch` is a new API available in modern browsers that is more elegant than `XMLHttpRequest`.

```
fetch('https://swapi.info/api/people/1')
    .then(response => response.json())
    .then(data => console.log('SUCCESS', data))
    .catch(error => console.log('ERROR:', error));
```

`fetch` is available in all modern browsers.

`fetch` is built on Promises.

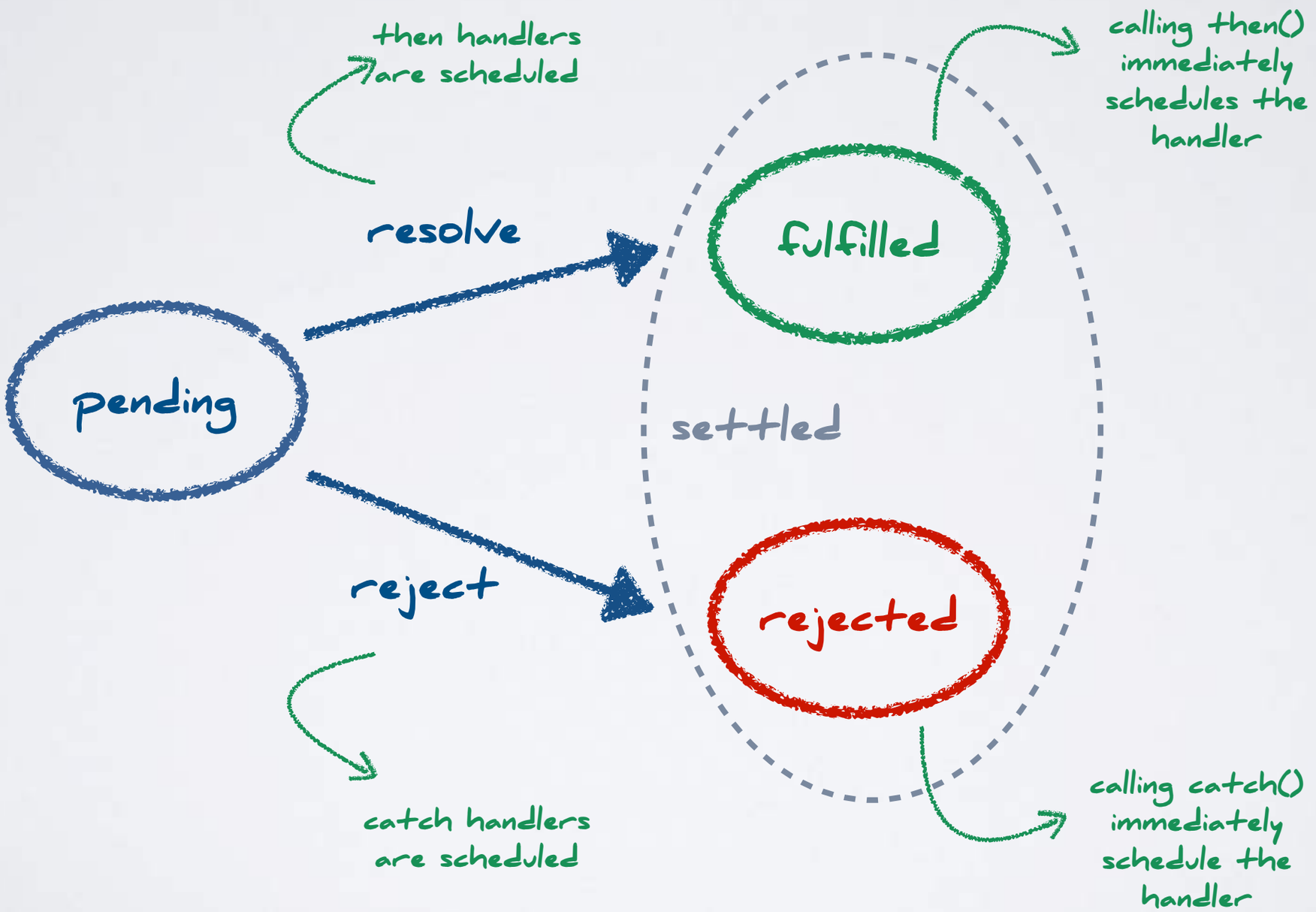
alternative API using `Request`:

```
const request = new Request('https://swapi.info/api/people/1');
fetch(request)
    .then(response => response.json())
    .then(data => console.log('SUCCESS', data))
```

Browser support:
http://caniuse.com/#search=fetch

https://developer.mozilla.org/en-US/docs/Web/API/Window/fetch
https://developer.mozilla.org/en-US/docs/Web/API/Fetch_API/Using_Fetch

Promises represent a Statemachine



Advantages of Promises: Chaining Async Operations

Callback-Hell:
(aka Pyramid of Doom)

```
api(function(result){
    api2(function(result2){
        api3(function(result3){
            // do work
        });
    });
});
```

Promise Chaining:

If a "then-callback" returns another promise, the next "then" waits until it is settled.

```
api().then(function(result){
    return api2();
}).then(function(result2){
    return api3();
}).then(function(result3){
    // do work
}).catch(function(error) {
    //handle any error
});
```

```
api().then(api2)
    .then(api3)
    .then(/* do work */);
```

Promise Chaining

```
doSomething().then(function () {
  return doSomethingElse();
}).then(finalHandler);
```

```
doSomething().then(function () {
  doSomethingElse();
}).then(finalHandler);
```

```
doSomething()
  .then(doSomethingElse())
  .then(finalHandler);
```

```
doSomething()
  .then(doSomethingElse)
  .then(finalHandler);
```

https://pouchdb.com/2015/05/18/we-have-a-problem-with-promises.html

Evolution of ECMAScript Promises

ECMAScript 2015:

Construction:
- `new Promise((resolve, reject) => {})`
- `Promise.resolve(), Promise.reject()`

Handling/Flow:
- `Promise.prototype.then()`
- `Promise.prototype.catch()`

Combinators:
- `Promise.all()`
- `Promise.race()`

DOM API: Abort Controller (2017) -> can be used to cancel a Promise API

ECMAScript 2018: `Promise.prototype.finally()`

ECMAScript 2020: `Promise.allSettled()`

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Promise/allSettled

ECMAScript 2021: `Promise.any()`

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Promise/any

async / await

async/await provides convenient language support
on top of any Promise based API.

```
try {
   const response = await axios.get(API_URL);
   console.log(response);
} catch (error) {
   console.log(error)
}
```

```
const response = await axios.post(API_URL, payload);
console.log(response);
```

```
const response = await axios.delete(`${API_URL}/${id}`);
console.log(response);
```

Note: **`await`** can only be used inside an **`async`** function

(or on top level of modules, see https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Operators/await#top_level_await)

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/async_function

Backend Access

Promise-based Backend Access: `fetch` vs. `ky` / `axios` ...

`fetch` is a modern built-in browser API:

```
const res = await fetch('https://swapi.co/api/people/1/');
if (!res.ok) {
  throw new Error('Network response was not ok');
} else {
  const data = await res.json();
  console.log('SUCCESS', data);
}
```

non-2XX status is NOT an error!

`fetch` is available in all modern browsers (http://caniuse.com/#search=fetch).

For many projects, it makes sense to use a http library with more features:

- `ky`: https://github.com/sindresorhus/ky (modern, based on fetch)
- `up-fetch`: https://github.com/L-Blondy/up-fetch
- `axios`: https://github.com/axios/axios (legacy, based on XHR)

```
import ky from 'ky';
const response = await ky.get('http://www.example-api.com');
const data = await response.json<ResponseType>();
```

Features of http libraries: automatic json data transformation, status handling, http interceptors, response timeout, easily cancellable ...

Backend Access: **ky**

ky is a promise based HTTP client library for the browser and Node.js

```
npm i ky
```

```
import ky from 'ky';
```

```
try {
   const response = await ky.get(API_URL);
   const data = await ky.json<GetResponseType>()
   console.log(response);
} catch (error) {
   console.log(error)
}
```

```
const response = await ky.post(API_URL, {json: payload});
...
```

```
const response = await ky.put(`${API_URL}/${id}`, {json: payload});
...
```

```
const response = await ky.delete(`${API_URL}/${id}`);
...
```

https://github.com/sindresorhus/ky

Consider combining with Tanstack Query: https://tanstack.com/query/

Pragmatic Data Fetching with `useEffect`

There is no dedicated mechanism for data fetching in client-side React. It is a common practice to use `useEffect` for data fetching.

```
function MyComponent() {
  const [data, setData] = useState(undefined);

  useEffect(() => {
    async function loadData(){
      const data = await fetch(...);
      setData(data);
    }
    loadData();
  });

  return <div>{data.toString()}</div>
}
```

effect function can't be async!

missing error handling!

potential race condition if the effect is outdated!

Tanstack Query is a widely used declarative data fetching library: https://tanstack.com/query/

React Server Components provide a mechanism for data fetching in full-stack React: https://nextjs.org/docs/app/building-your-application/data-fetching/patterns

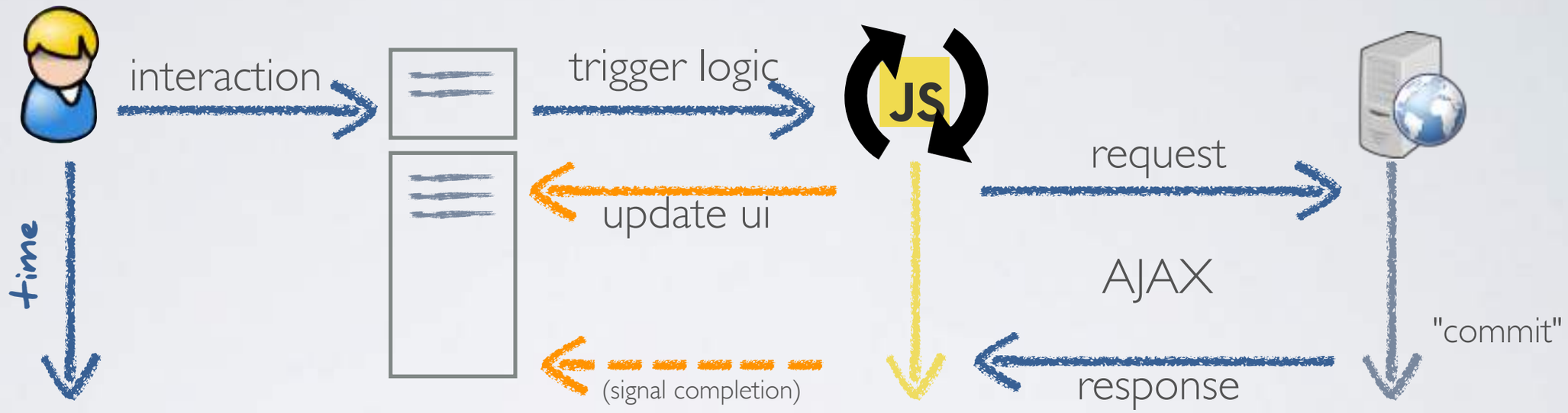
Support for promises in React client components might provide other patterns in the future: https://react.dev/reference/react/use

EXERCISES

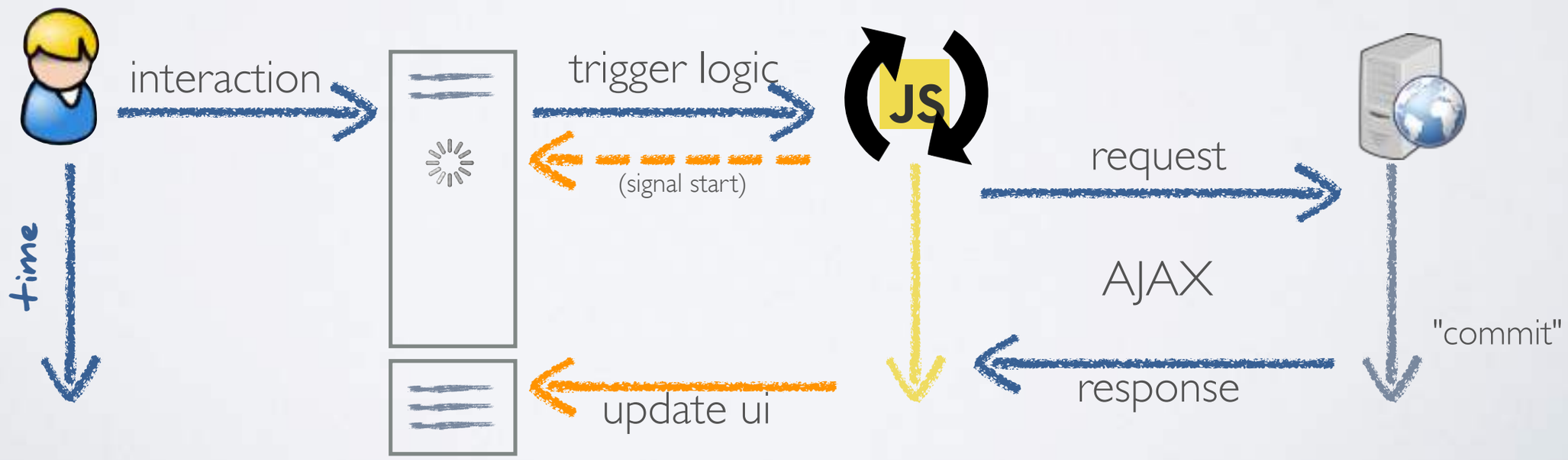
Exercise 8 - BackendAccess

Mutations: Optimistic vs. Pessimistic UI

Optimistic UI:



Pessimistic UI:



https://www.smashingmagazine.com/2016/11/true-lies-of-optimistic-user-interfaces/

Mutating Data

Pessimistic UI  Optimistic UI

```
await triggerMutation(change);
const newState = await refetchState();
setState(newState)
```

```
const mutationResponse = await triggerMutation(change);
const newState = merge(state, mutationResponse);
setState(newState)
```

```
const newState = merge(state, change);
setState(newState)
const mutationResponse = await triggerMutation(change);
const updatedState = merge(state, mutationResponse);
setState(updatedState)
```

Proper Data Fetching with **useEffect**

https://react.dev/learn/synchronizing-with-effects#fetching-data

```
useEffect(() => {
  let ignore = false;

  async function startFetching() {
     try {
        const json = await fetchTodos(userId);
        if (!ignore) {
           setTodos(json);
        }
     } catch (e: any) {
        setError('An error occured: ' + e.getMessage());
     }
  }

  startFetching();

  return () => {
    ignore = true;
  };
}, [userId]);
```

effect function can't be async!

avoiding race conditions by ignoring "outdated" fetches

error handling

cleanup function:
-ignoere the result
-alternative: abort the fetch

potential for further improvement:
-caching / dedupiung
-loading state

Proper data fetching verbose and complicated:

- consider using a library
- encapsulate the logic into custom hooks

https://react.dev/learn/synchronizing-with-effects#what-are-good-alternatives-to-data-fetching-in-effects

Custom Hooks for Data Fetching

```jsx
function useUsers(){

  const [data, setData] = useState(initialValue);
  const [error, setError] = useState(null);
  const [loading, setLoading] = useState(true);

  useEffect(() => {
      let cancelled = false;
     (async () => {
       try {
         const res = await fetch('https://jsonplaceholder.typicode.com/users');
         const resJson = await res.json();
         if (!cancelled) setData(resJson);
       } catch (err) {
         if (!cancelled) setError(err);
       } finally {
         if (!cancelled) setLoading(false);
       }
     })();
      return () => { cancelled = true }
    }

  return {loading, data, error};
}
```

custom Hook

```jsx
function AppComponent() {
  const {loading, data, error} = useUsers();

  if (loading) return <Spinner/>;
  if (error) return <>...</>;
  ...
  return <>...</>
}
```

Consider using **`axios-hooks`**, **`use-http`** or *TanStack Query* or *SWR* instead of implementing the low-level fetch.

https://github.com/simoneb/axios-hooks
https://github.com/ava/use-http
https://swr.vercel.app/
https://tanstack.com/query

Data Fetching Libraries

If you are using "plain" axios or fetch, then you have to care about cancellation, loading & error state, caching, deduplication, refetching ...

Consider a data-fetching library:

- TanStack Query https://tanstack.com/query/
- SWR https://github.com/vercel/swr
- RTK Query (only if already using Redux): https://redux-toolkit.js.org/rtk-query/overview

Consider data loading and mutation via the router:

- ReactRouter: https://reactrouter.com/en/main/start/overview#data-loading
- TanStack Router https://tanstack.com/router/latest/docs/framework/react/guide/data-loading

... or a more-lightweigth hook

- use-http: https://use-http.com
- axios-hooks: https://github.com/simoneb/axios-hooks