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2023

Introduction to React

JS Frameworks to the rescue

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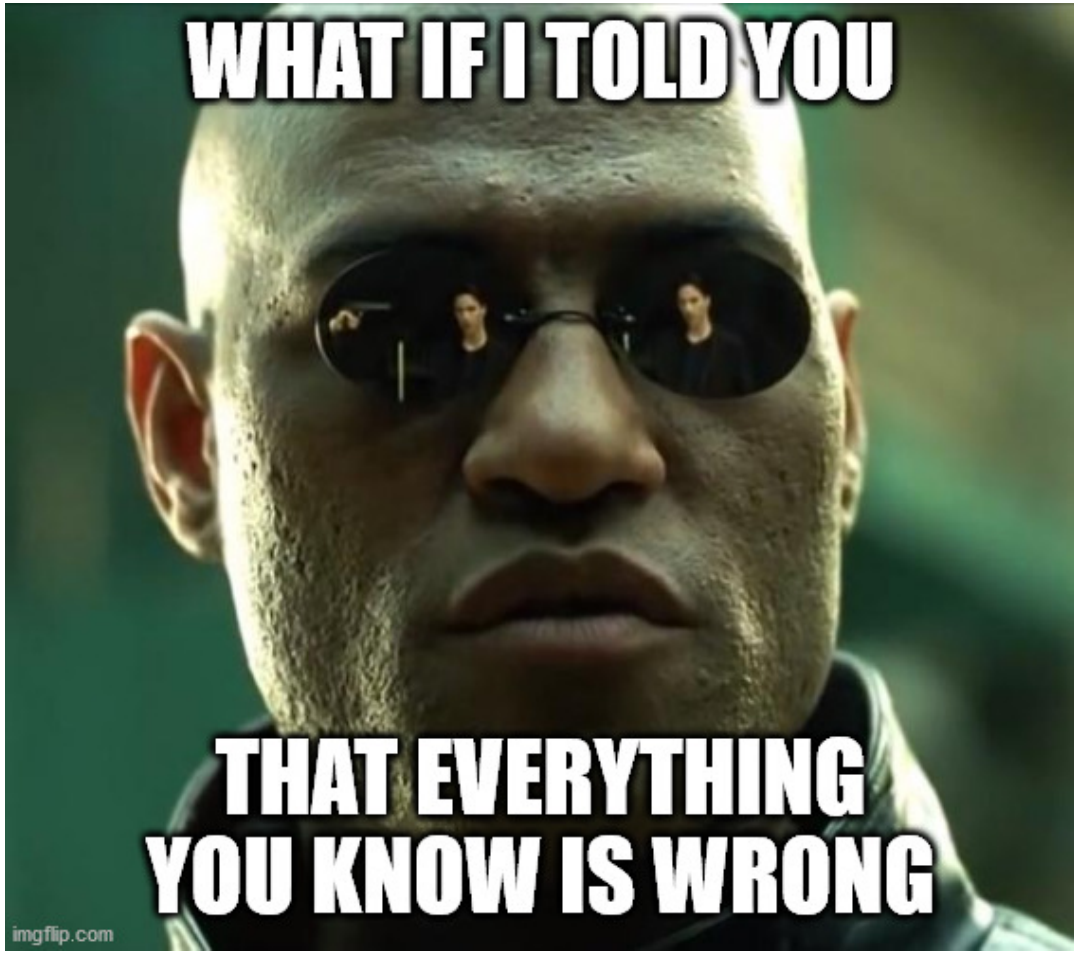


Goal

Version 18.2.0
Released on June 14, 2022

- Learn one of the most popular front-end libraries
  - Basic principles
  - Application architecture
  - Programming techniques
- Leverage the knowledge of JS concepts

React

The library for web and native user interfaces

https://react.dev/
https://github.com/facebook/react

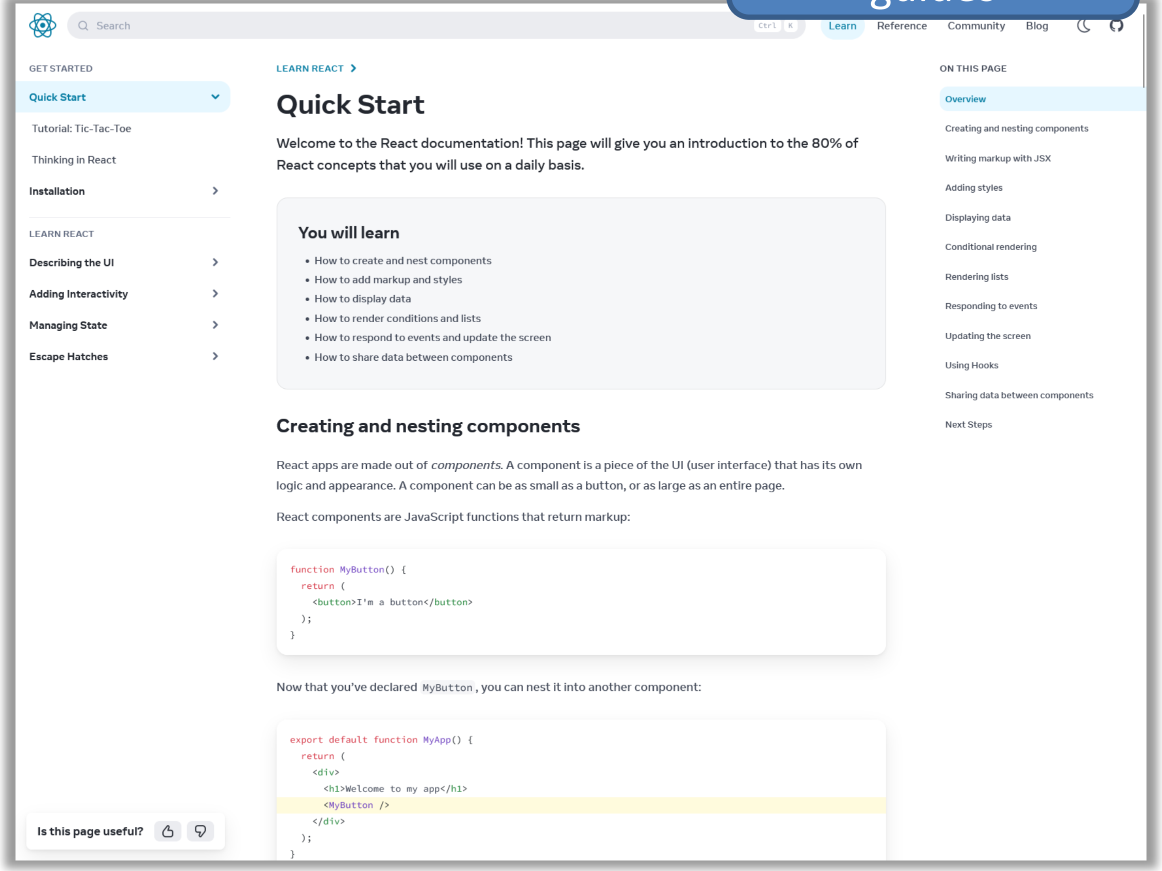
Why a Library?

- Simplify the browser environment
  - Uniform DOM methods
  - More explicit hierarchy
  - **Higher-level** components than HTML elements
  - **Automatic** processing of events and updates

- Simplify the development methods
  - Predefined programming **patterns** and application architecture
  - Lots of compatible plugins and extensions
  - Explicit and rigid **state** management

Main Resources

Tutorials and guides



LEARN REACT >

Quick Start

Welcome to the React documentation! This page will give you an introduction to the 80% of React concepts that you will use on a daily basis.

You will learn

- How to create and nest components
- How to add markup and styles
- How to display data
- How to render conditions and lists
- How to respond to events and update the screen
- How to share data between components

Creating and nesting components

React apps are made out of *components*. A component is a piece of the UI (user interface) that has its own logic and appearance. A component can be as small as a button, or as large as an entire page.

React components are JavaScript functions that return markup:

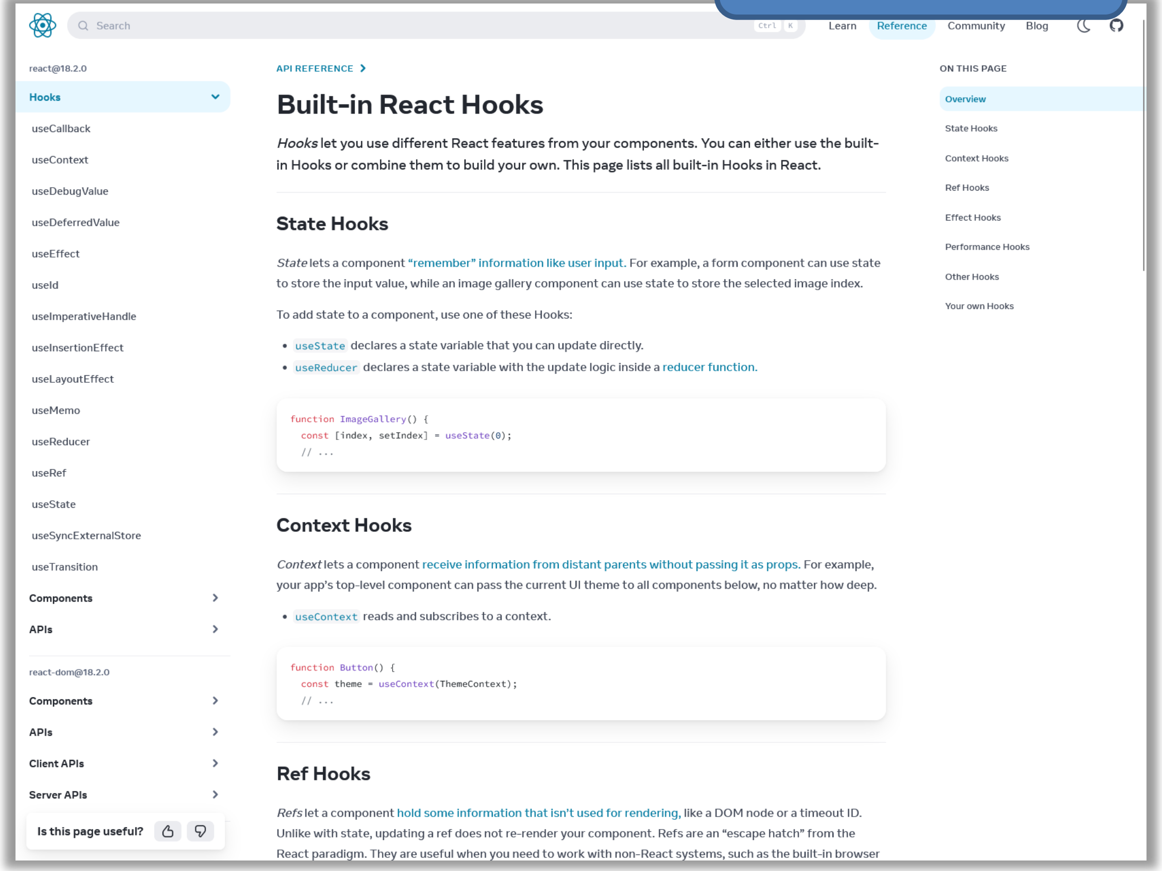
```
function MyButton() {
  return (
    <button>I'm a button</button>
  );
}
```

Now that you've declared `MyButton`, you can nest it into another component:

```
export default function MyApp() {
  return (
    <div>
      <h1>Welcome to my app</h1>
      <MyButton />
    </div>
  );
}
```

https://react.dev/learn

API Reference



API REFERENCE >

Built-in React Hooks

Hooks let you use different React features from your components. You can either use the built-in Hooks or combine them to build your own. This page lists all built-in Hooks in React.

State Hooks

State lets a component "remember" information like user input. For example, a form component can use state to store the input value, while an image gallery component can use state to store the selected image index.

To add state to a component, use one of these Hooks:

- `useState` declares a state variable that you can update directly.
- `useReducer` declares a state variable with the update logic inside a reducer function.

```
function ImageGallery() {
  const [index, setIndex] = useState(0);
  // ...
```

Context Hooks

Context lets a component receive information from distant parents without passing it as props. For example, your app's top-level component can pass the current UI theme to all components below, no matter how deep.

- `useContext` reads and subscribes to a context.

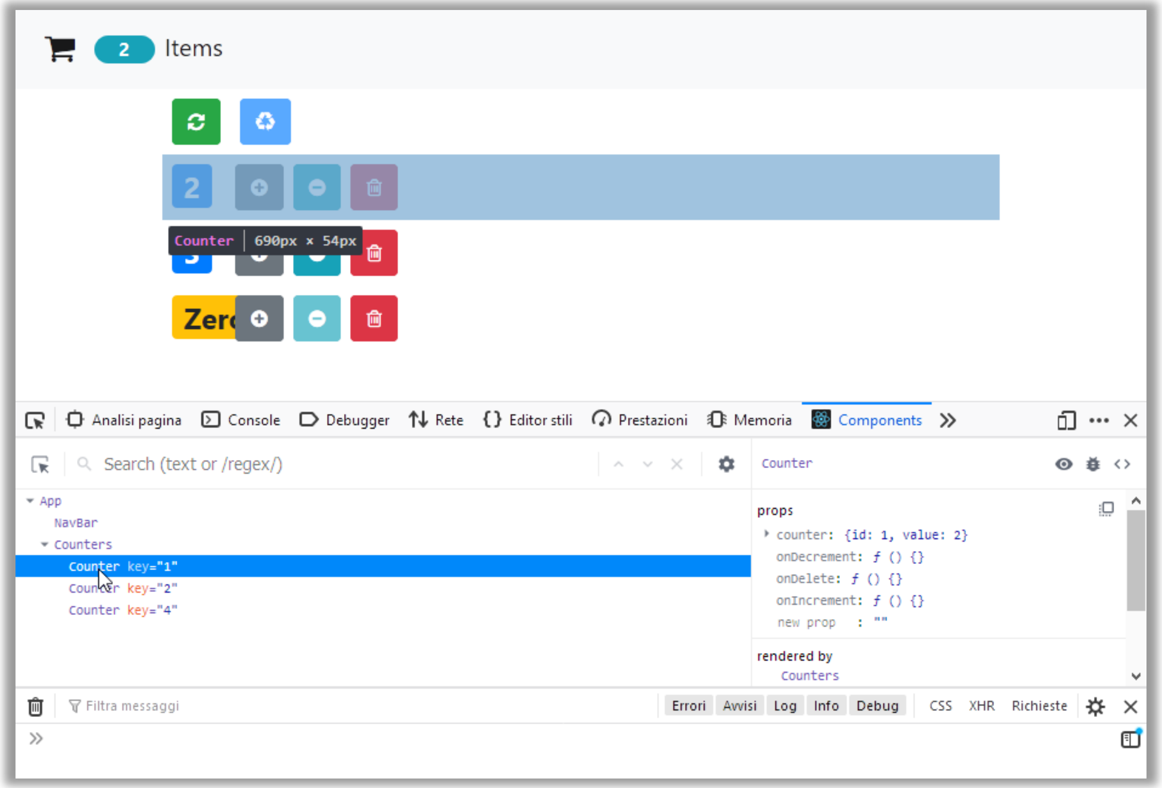
```
function Button() {
  const theme = useContext(ThemeContext);
  // ...
```

Ref Hooks

Refs let a component hold some information that isn't used for rendering, like a DOM node or a timeout ID. Unlike with state, updating a ref does not re-render your component. Refs are an "escape hatch" from the React paradigm. They are useful when you need to work with non-React systems, such as the built-in browser

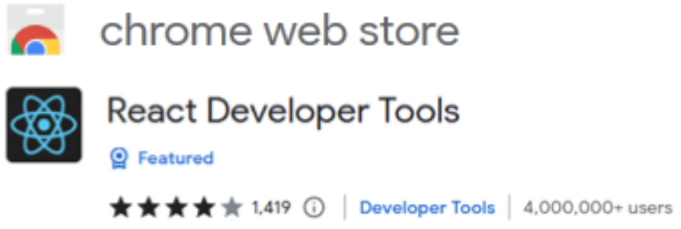
https://react.dev/reference/react

Browser Development Tools



```
▾ App
    NavBar
  ▾ Counters
      Counter key="1"
      Counter key="2"
      Counter key="4"
```

```
Counter

props
 ▸ counter: {id: 1, value: 2}
   onDecrement: ƒ () {}
   onDelete: ƒ () {}
   onIncrement: ƒ () {}
   new prop   : ""

rendered by
   Counters
```



chrome web store

React Developer Tools

Featured

★★★★★ 1,419 | Developer Tools | 4,000,000+ users

https://chrome.google.com/webstore/detail/react-developer-tools/fmkadmapgofadopljbjfkapdkoienihi?hl=en

Firefox Browser ADD-ONS

React Developer Tools

by React

https://addons.mozilla.org/en-US/firefox/addon/react-devtools/

The React Handbook, Flavio Copes
https://flaviocopes.com/page/react-handbook/

A first high-level run about the main design concepts in React

DESIGN PRINCIPLES

React Key Concepts

- Declarative approach
  - Never explicitly manipulate the DOM
  - Never explicitly define the order of operations
  - Just define how each component is going to render itself

- Functional design approach
  - Components as functions
  - Re-render everything on every change (Virtual DOM)
  - Explicit management of the *state* of the application

React is Functional

- UI Fragment = f(`state`, `props`)

- Many components don’t need to manage state
- UI Fragment = f(`props`)
  - Idempotent
  - Immutable

- Jargon note: `props` = *properties*

http://slides.com/johnlynch/reactjs

Immutability

- Reacts exploits **Immutability** of objects, for ease of programming and efficiency of processing
- Component ‘`props`’ are immutable (read-only by the component)
- Component ‘`state`’ is not directly mutable (can be changed only through special calls)
- Functions are ‘pure’ (have no side-effects besides computing the return value)
  - Idempotency (re-rendering the same component always yields the same result)
  - Predictability

Re-Rendering

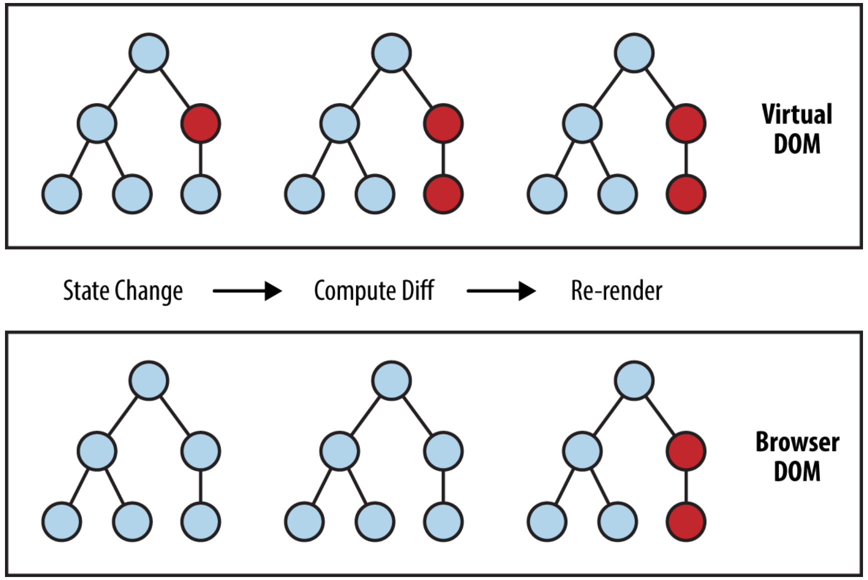
- The application is made of Components
- The entire application is re-rendered:
  - Every time a state is changed
  - Every time a property is changed
- Each Component will re-build itself from scratch
  - With minor variations, or
  - Radically different
- Performance?

Re-Rendering Performance

- Modifications to the DOM are expensive (re-computing layout and updating GUI)
- React implements a **Virtual DOM** layer
  - Internal in-memory data structure, optimized and very fast to update
  - Corrects some DOM anomalies and asymmetries
  - Manages its own set of “synthetic” events
  - After components re-render, React computes the difference between the “old” DOM and the new modified Virtual DOM
  - Only modifications and differences are selectively applied to the browser’s DOM, in batch

Update Cycle

- Build new Virtual DOM tree
- Diff with old one
- Compute minimal set of changes
- Put them in a queue
- Batch render all changes to browser



https://www.oreilly.com/library/view/learning-react-native/9781491929049/ch02.html

http://slides.com/johnlynch/reactjs

Synthetic Events

- React implements its own event system
- A single native event handler at root of each component
- Normalizes events across browsers
- Decouples events from DOM

http://slides.com/johnlynch/reactjs

How React Code is integrated in the DOM

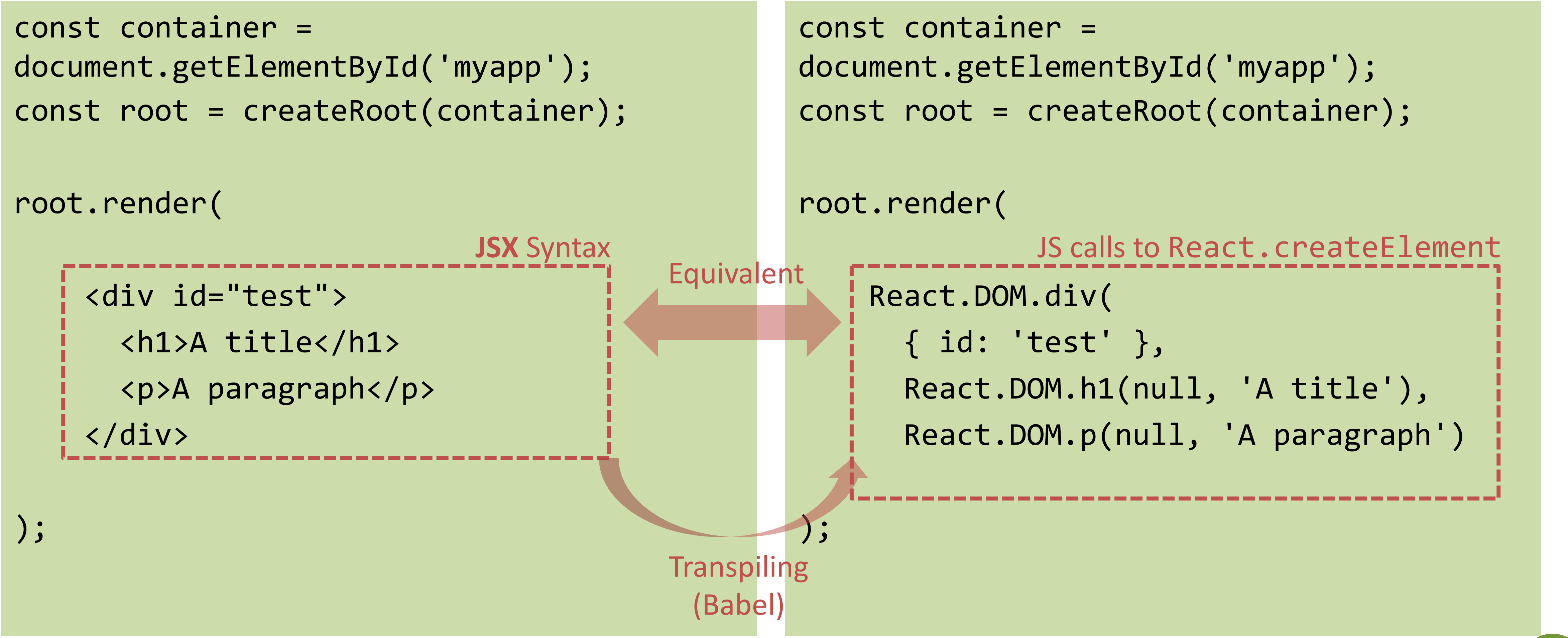
```
const container =
  document.getElementById('root');

const root = createRoot(container);

root.render(<h1>Hello, world!</h1>);
```

DOM **container** node

React **element**

Render **element** into **container**

JSX Syntax



```
const container =
document.getElementById('myapp');
const root = createRoot(container);

root.render(
```

JSX Syntax

```
    <div id="test">
      <h1>A title</h1>
      <p>A paragraph</p>
    </div>

);
```

Equivalent

Transpiling
(Babel)

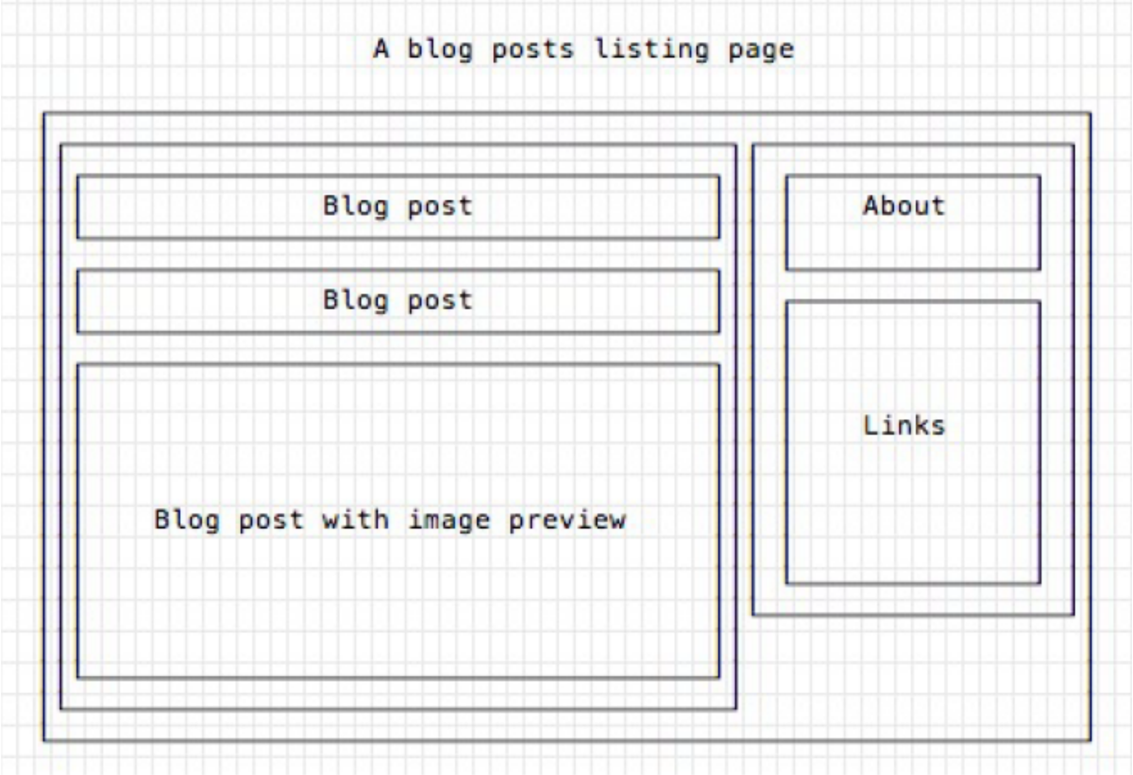
```
const container =
document.getElementById('myapp');
const root = createRoot(container);

root.render(
```

JS calls to React.createElement

```
    React.DOM.div(
      { id: 'test' },
      React.DOM.h1(null, 'A title'),
      React.DOM.p(null, 'A paragraph')

);
```

Components

- Everything on a page is a Component
  - Even simple HTML tags (React.DOM.element)
- Components may be **nested**
- ReactDOM.createRoot().render() builds a component and attaches it to a DOM container



Defining Custom Components

As a function, returning DOM elements

```
const BlogPostExcerpt = () => {
  return (
    <div>
      <h1>Title</h1>
      <p>Description</p>
    </div>
  )
}
```

The function may receive some props

```
const BlogPostContent = (props) => {
  return (
    <div>
        <p>{props.content}</p>
    </div>
  )
}
```

Types of Components

Presentational Components

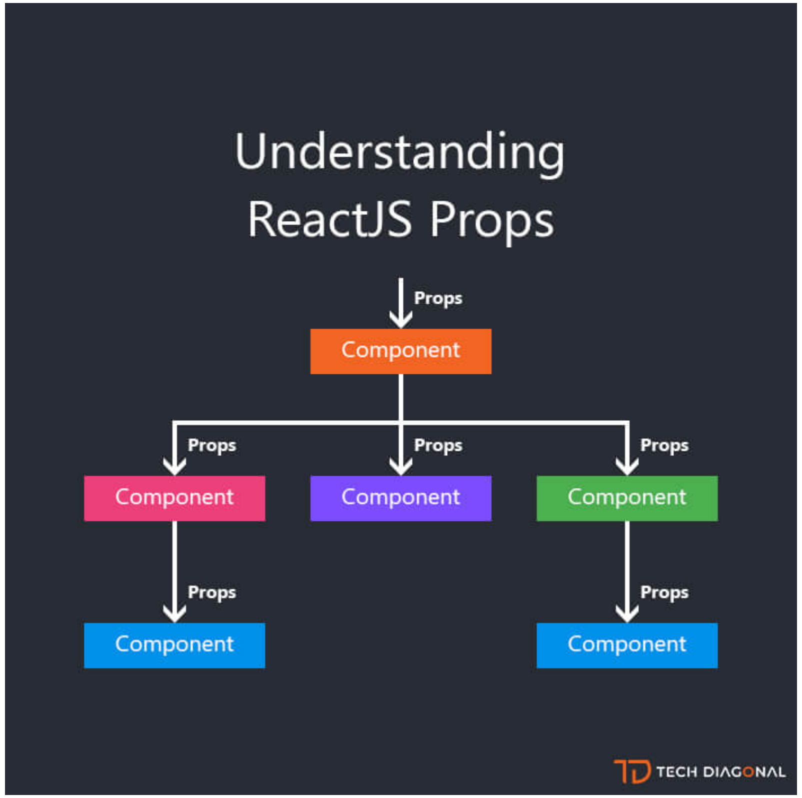
- Generate DOM nodes to be displayed
- Do not manage application state
- Might have some internal state, uniquely for **presentation** purposes

Container Components

- Manage the **state** for a group of children
- May interact with the back-end
- Create (presentational) children to display the information

Props and State

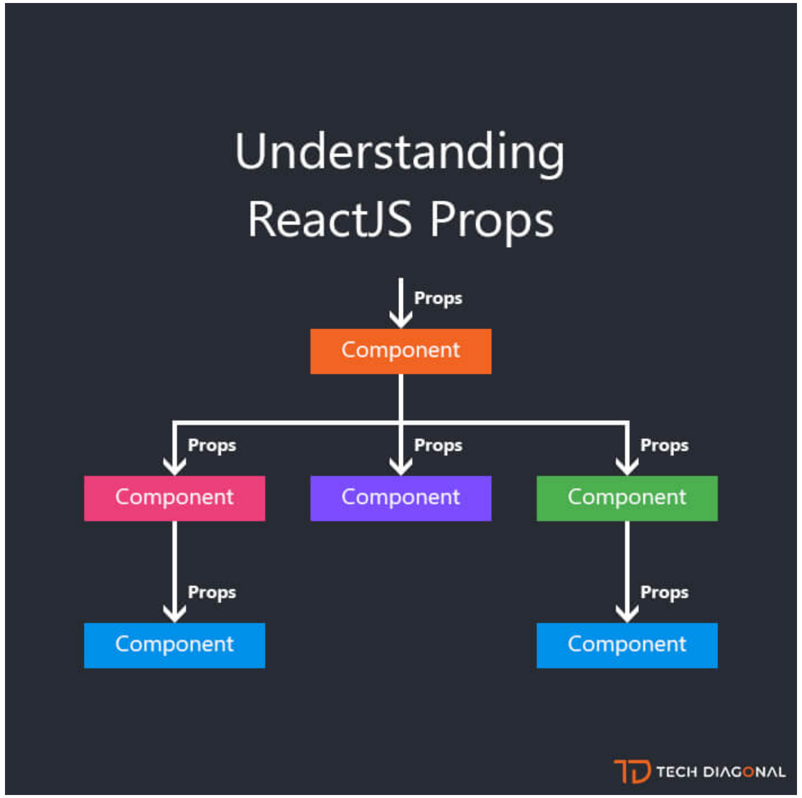
- **Props** (properties) are passed to a component by its parent
  - – Values (strings, objects, …) to configure how the component displays or behaves
    - Top-to-bottom data flow
  - – Functions (callbacks) to access the parent’s methods
    - Bottom-to-top action requests



https://www.techdiagonal.com/reactjs_courses/beginner/understanding-reactjs-props/

Props and State

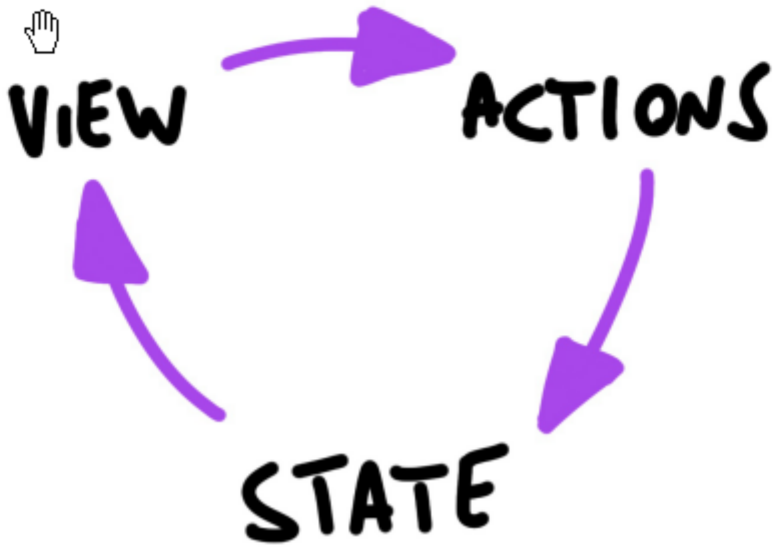
- **State** is a set of variables local to the component
  - Initialized with default value or by props' values
  - Can be mutated only by calling specific methods
    - Asynchronous
    - Will initiate re-rendering of the Virtual DOM
  - Current state value can be passed to children (as props)



https://www.techdiagonal.com/reactjs_courses/beginner/understanding-reactjs-props/

Unidirectional Data Flow

- State is passed to the view and to child components
- Actions are triggered by the view
- Actions can update the state
- The state change is passed to the view and to child component



Corollary

- A **state** is always **owned by one Component**
  - Any data that's affected by this state can only affect Components below it: its children.
- Changing state on a Component will never affect its parent, or its siblings, or any other Component in the application
  - Just its children
- For this reason, state is often **moved up** in the Component tree, so that it can be **shared** between components that need to access it.

Installing, configuring and running the Hello World

FIRST REACT APPLICATION

Basic requirements

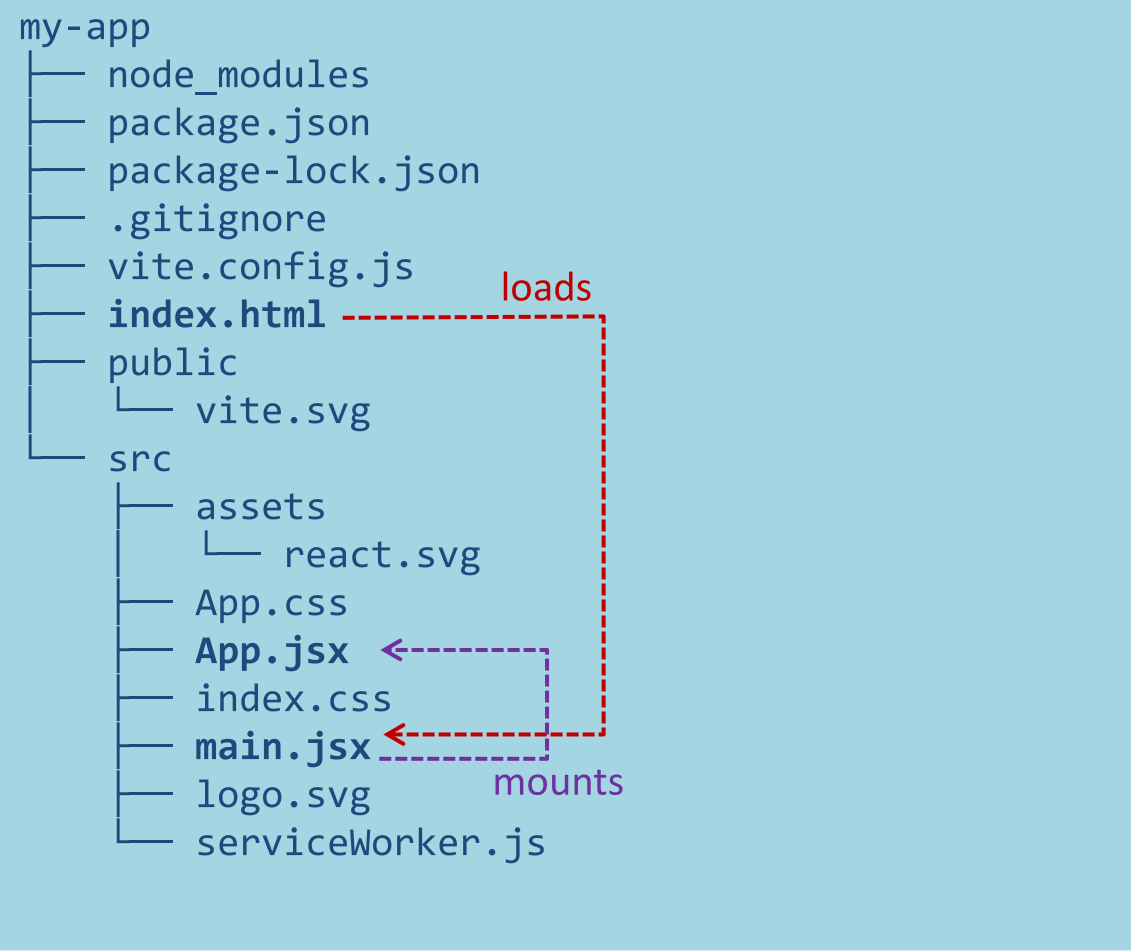
- Import the React library
  - Import several needed libraries
- We want to use **JSX**
  - Babel required
- We need to run on a web server
  - To be able to use modules
    - `import` in JS code
    - `<script type='module'>` in HTML code
  - Avoid problems with CORS
- Implement polyfills for browser compatibility
- Ease app development (edit-save-reload cycle)
- …

Starting With All The Needed Infrastructure

https://vitejs.dev/

1. `npm create vite@latest my-app`
2. From the menu, choose React, then JavaScript
3. `cd` *`my-app`*
4. `npm install`
5. *… 65 Megabytes later …*
6. `npm run dev`
7. Visit http://localhost:5173

Folder Structure



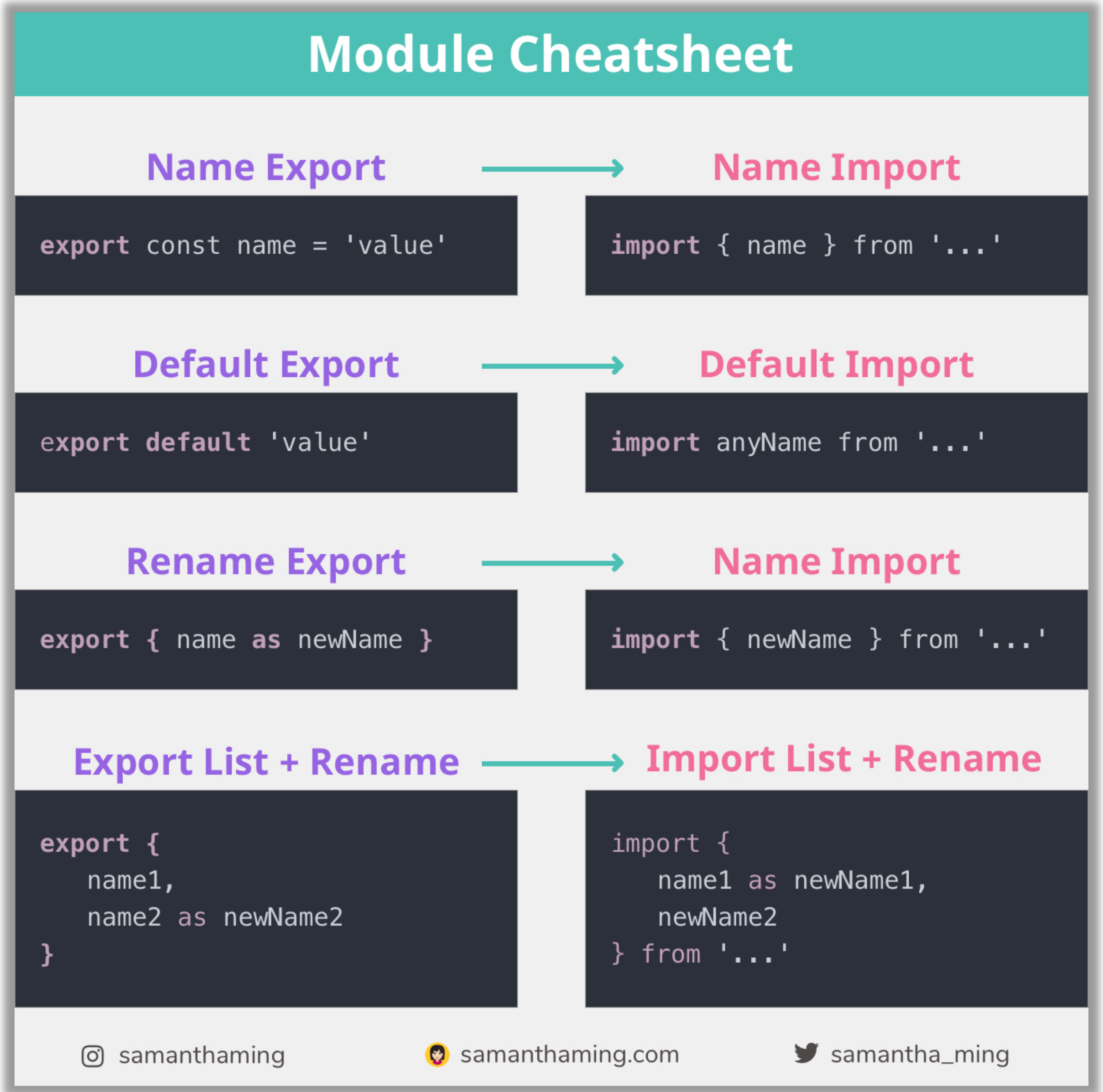
```
my-app
├── node_modules
├── package.json
├── package-lock.json
├── .gitignore
├── vite.config.js
├── index.html
├── public
│   └── vite.svg
└── src
    ├── assets
    │   └── react.svg
    ├── App.css
    ├── App.jsx
    ├── index.css
    ├── main.jsx
    ├── logo.svg
    └── serviceWorker.js
```

- `public` is the web server root
  - Static files go here
- `index.html` is the page template
  - Published at http://localhost:xxxx
  - Automatically reloads when app changes
  - No need to modify, normally
  - Contains an element with id="root"
- `src` contains all scripts
- `src/main.jsx` is the JavaScript entry point
  - Contains the `createRoot` call to mount the App in the #root element
  - Do not touch, normally
- `src/App.jsx` is the file containing your application
  - **Develop here!**
  - Feel free to `import` other components

Importing/Exporting

- The browser uses “ES6 Modules”
  - ECMA Standard
- Uses `import/export` keywords
  - Different than the `require` function used in Node.js

- *More details in a future lesson*



Module Cheatsheet

Name Export ⟶ **Name Import**

```
export const name = 'value'
```

```
import { name } from '...'
```

Default Export ⟶ **Default Import**

```
export default 'value'
```

```
import anyName from '...'
```

Rename Export ⟶ **Name Import**

```
export { name as newName }
```

```
import { newName } from '...'
```

Export List + Rename ⟶ **Import List + Rename**

```
export {
   name1,
   name2 as newName2
}
```

```
import {
   name1 as newName1,
   newName2
} from '...'
```

samanthaming samanthaming.com samantha_ming

https://www.samanthaming.com/tidbits/79-module-cheatsheet/

Example: Hello world

App.jsx

```
function Button(props) {
  if (props.lang === 'it')
    return <button>Ciao!</button>;
  else
    return <button>Hello!</button>;
}

function App() {
  return (
    <p>
      Press here: <Button lang='it' />
    </p>
  );
}

export default App;
```

- App must return the JSX of the whole application
- We may use "custom components"
  - Simply defined as JS functions
  - Receive 'props'
    - The `lang` JSX attribute becomes a property `props.lang`

Example: Components in a Separate File

App.jsx

```
import Button from './Button.jsx';

function App() {
  return (
    <p>
      Premi qui: <Button lang='it' />
    </p>
  );
}

export default App;
```

Button.jsx

```
function Button(props) {
    if (props.lang === 'it')
        return <button>Ciao!</button>;
    else
        return <button>Hello!</button>;
  }

export default Button;
```

Example: Dynamic State

Button.jsx

```
import { useState } from "react";

function Button(props) {
    let [buttonLang, setButtonLang] = useState(props.lang) ;

    if (buttonLang === 'it')
        return <button onClick={()=>setButtonLang('en')}>Ciao!</button>;
    else
        return <button onClick={()=>setButtonLang('it')}>Hello!</button>;
}

export default Button;
```

https://react-bootstrap.github.io/

Example: adding Bootstrap

- Bootstrap CSS may be loaded "manually" from index.html

or, better…

- The `react-bootstrap` library delivers many React Components that mimic the various Bootstrap classes
  - `npm install react-bootstrap`
  - `npm install bootstrap`

App.jsx

```
import 'bootstrap/dist/css/bootstrap.min.css';
import { Col, Container, Row } from 'react-
bootstrap';

import MyButton from './Button.jsx';

function App() {
  return (
    <Container>
      <Row>
        <Col>
          Premi qui: <MyButton lang='it' />
        </Col>
      </Row>
    </Container>
  );
}

export default App;
```

Example: adding Bootstrap

https://react-bootstrap.github.io/

Button.jsx

```
import { useState } from "react";
import { Button } from "react-bootstrap";

function MyButton(props) {
    let [buttonLang, setButtonLang] = useState(props.lang) ;

    if (buttonLang === 'it')
        return <Button variant='primary' onClick={()=>setButtonLang('en')}>Ciao!</Button>
    else
        return <Button variant='primary' onClick={()=>setButtonLang('it')}>Hello!</Button>
}

export default MyButton;
```

What’s next?

- Components and props
- JSX
- State and Hooks
- Events
- Forms
- Lifecycle
- Router
- …

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