

<WA1/>
<AW1/>
2021

Introduction to React

JS Frameworks to the rescue

Fulvio Corno
Luigi De Russis
Enrico Masala



Goal

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



React

A JavaScript library for building user interfaces

<https://reactjs.org/>

Why a Framework?

- 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

Learning the main concepts

The screenshot shows the React documentation page for 'Hello World'. The main heading is 'Hello World'. Below it, a code block shows the following code:

```
ReactDOM.render(  
  <h1>Hello, world!</h1>,  
  document.getElementById('root')  
)
```

 The page includes a sidebar with navigation links for 'INSTALLATION', 'MAIN CONCEPTS', 'ADVANCED GUIDES', 'API REFERENCE', 'HOOKS', 'TESTING', 'CONCURRENT MODE (EXPERIMENTAL)', 'CONTRIBUTING', and 'FAQ'. The 'MAIN CONCEPTS' section is expanded, showing a list of 12 topics, with '1. Hello World' selected.

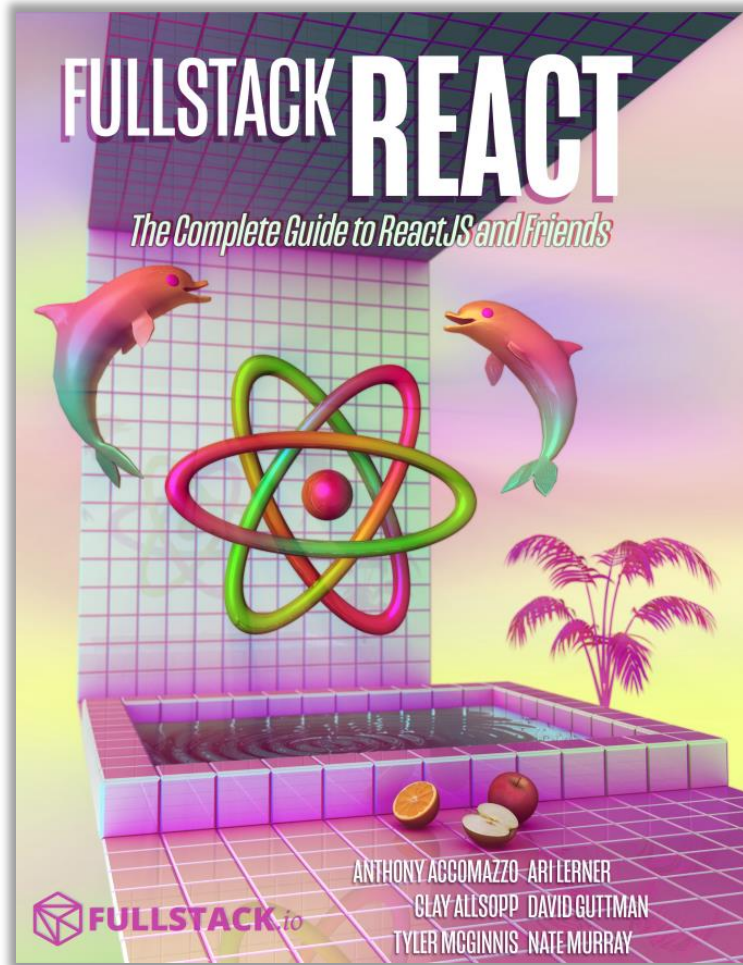
<https://reactjs.org/docs/hello-world.html>

Learn by doing tutorial

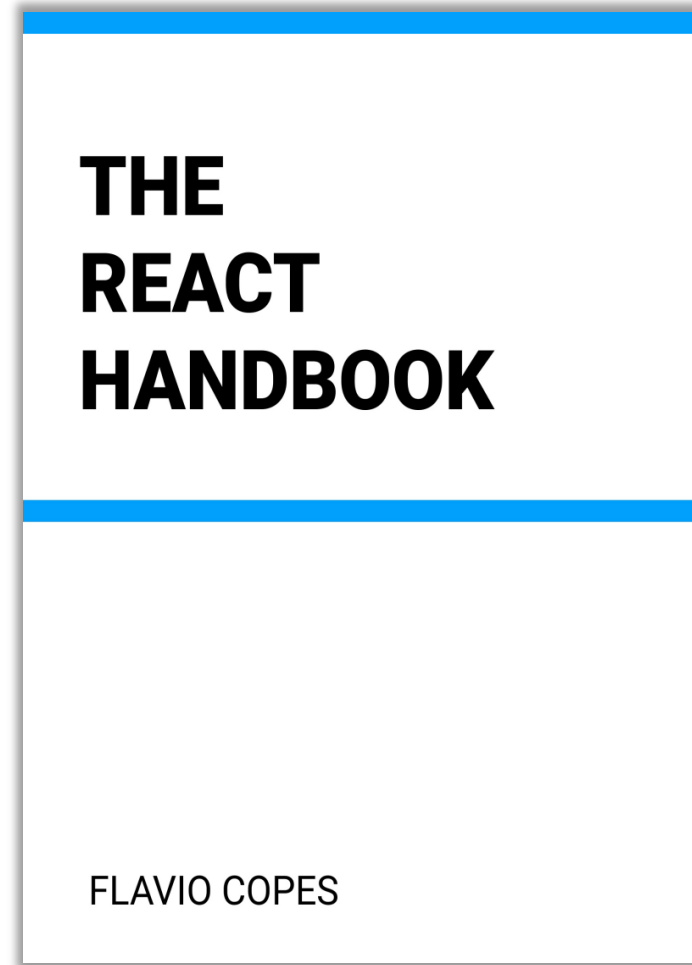
The screenshot shows the React documentation page for 'Tutorial: Intro to React'. The main heading is 'Tutorial: Intro to React'. Below it, a text block states: 'This tutorial doesn't assume any existing React knowledge.' The page includes a sidebar with navigation links for 'TUTORIAL', 'Before We Start the Tutorial', 'Completing the Game', 'Adding Time Travel', and 'Wrapping Up'. The 'TUTORIAL' section is expanded, showing a list of 12 topics, with '1. Hello World' selected.

<https://reactjs.org/tutorial/tutorial.html>

Main Resources

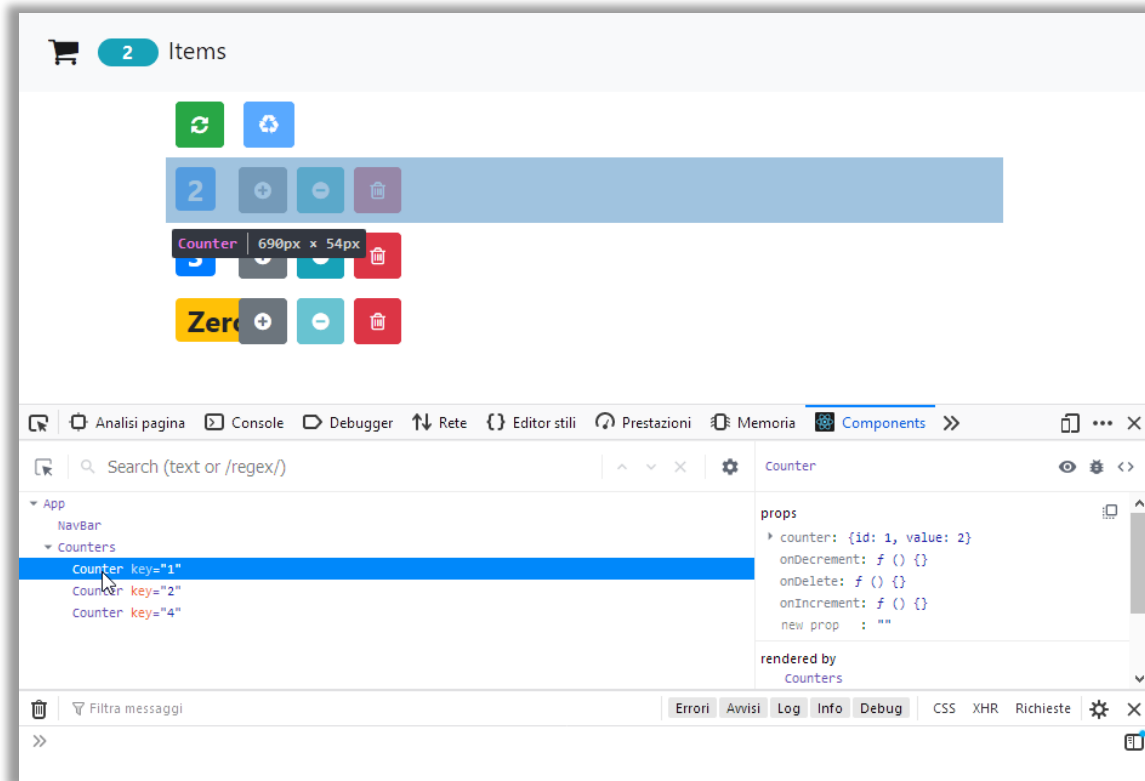


<https://www.newline.co/fullstack-react/>



<https://flaviocopes.com/page/react-handbook/>

Browser Development Tools



2/



chrome web store



React Developer Tools

Offered by: Facebook

★★★★★ 1,255 | Developer Tools | 2,000,000+ users

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



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 is Declarative

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

React Key Concepts

- Functional design approach
- Components
- Re-render everything on every change
- Virtual DOM
- Synthetic Events
- Controls the *state* of the application

React is Functional

- UI Fragment = $f(\text{state}, \text{props})$
- Many components don't need to manage state
- UI Fragment = $f(\text{props})$
 - Idempotent
 - Immutable
- Jargon note: props = properties

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

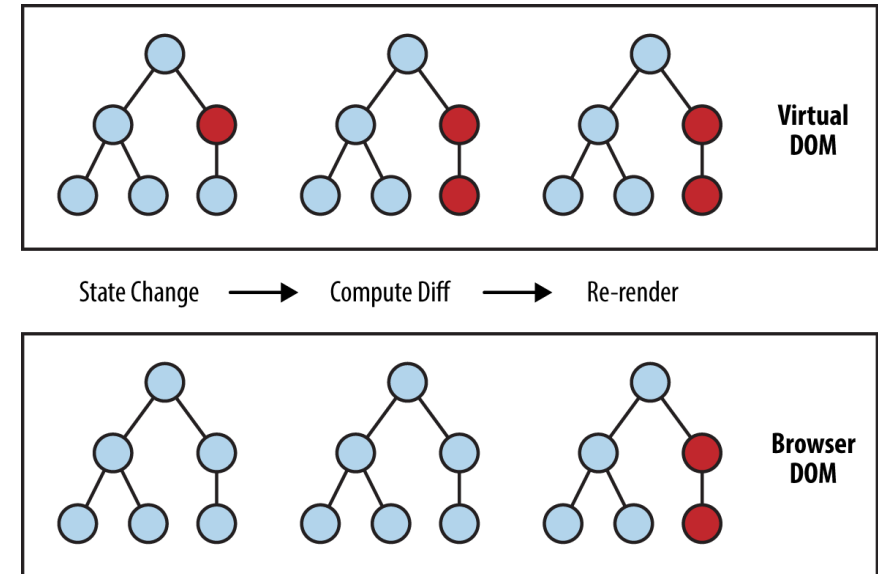
- The application is made of Components
- The entire application is re-rendered
 - Every time a state is changed
 - Every time a property is changed
- Each Component will re-build itself from scratch
 - With minor variations, or
 - Radically different
- Performance?

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>

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

How React Code Looks Like

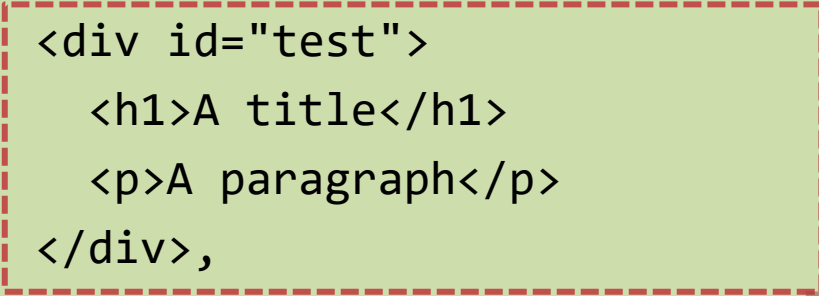
```
ReactDOM.render(  
  <h1>Hello, world!</h1> ,  
  document.getElementById( 'root' )  
);
```

Render element into container

React element

DOM container node

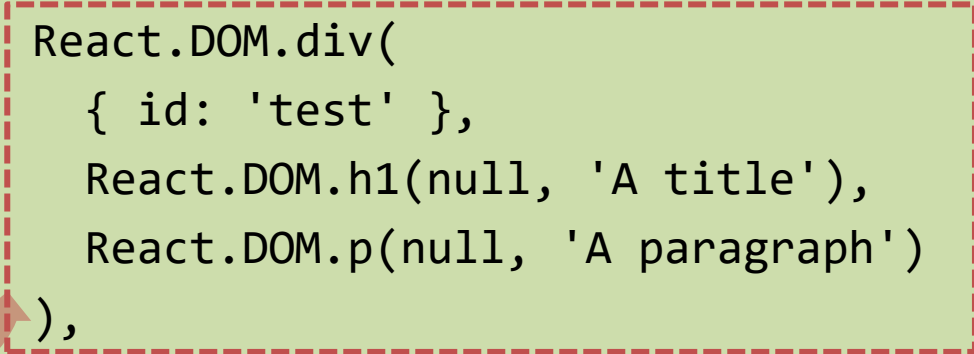
JSX Syntax

```
ReactDOM.render(  
    
  <div id="test">  
    <h1>A title</h1>  
    <p>A paragraph</p>  
  </div>,  
  document.getElementById('myapp')  
);
```

JSX Syntax

Equivalent

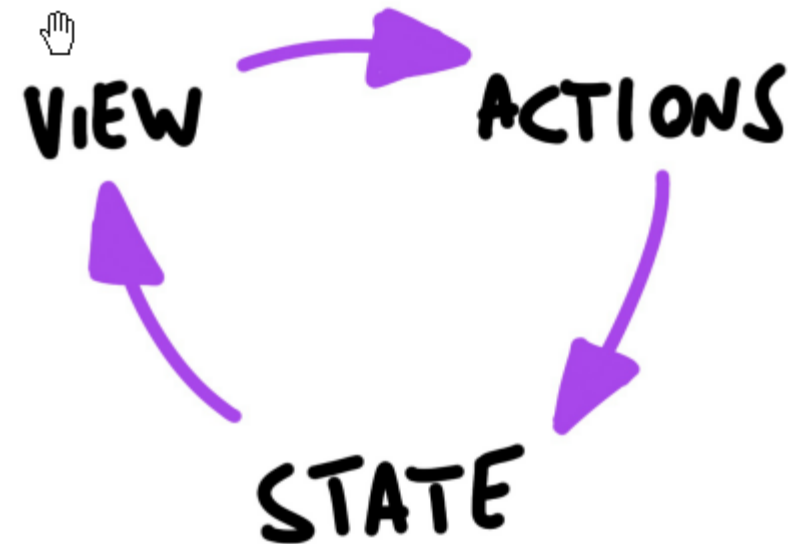
Transpiling
(Babel)

```
ReactDOM.render(  
    
  React.DOM.div(  
    { id: 'test' },  
    React.DOM.h1(null, 'A title'),  
    React.DOM.p(null, 'A paragraph')  
  ),  
  document.getElementById('myapp')  
);
```

JS calls to `React.createElement`

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

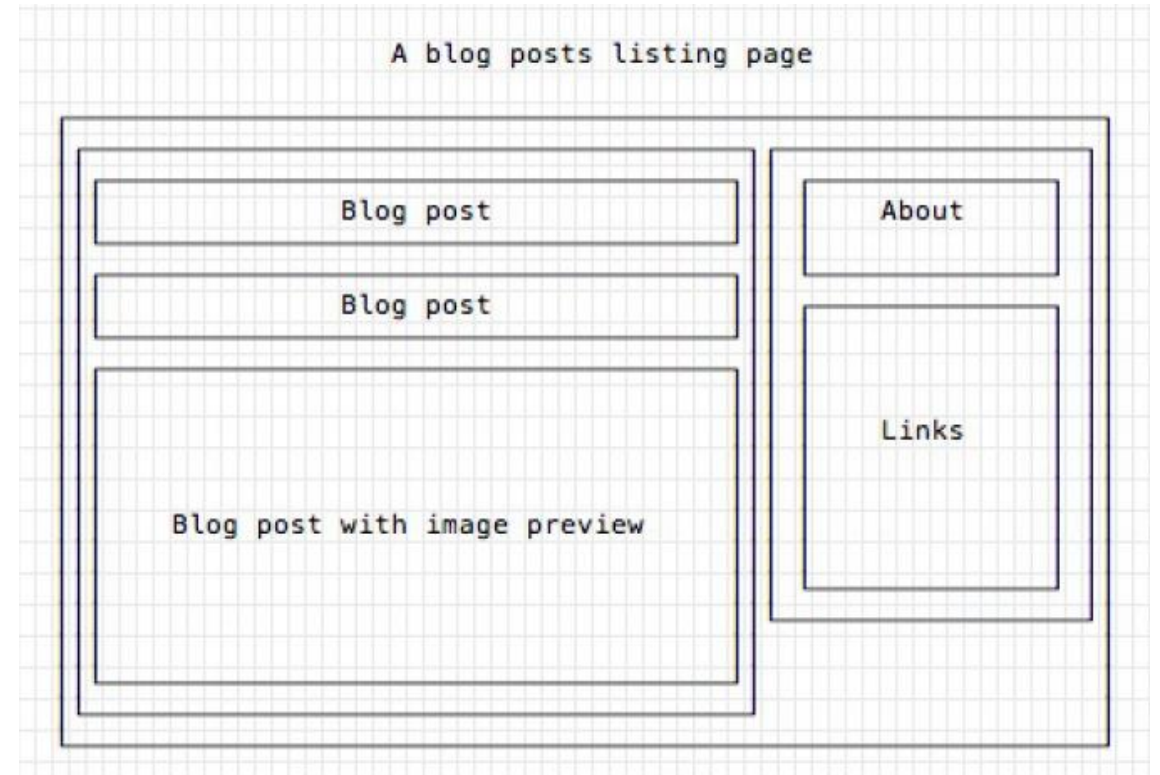


Corollary

- 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.

Components

- Everything on a page is a Component
 - Even simple HTML tags (React.DOM.element)
- Components may be **nested**
- ReactDOM.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>  
  )  
}
```

As a class, with a render() method

```
import React, { Component } from 'react'  
  
class BlogPostExcerpt extends Component {  
  render() {  
    return (  
      <div>  
        <h1>Title</h1>  
        <p>Description</p>  
      </div>  
    )  
  }  
}
```

Types of Components

Presentational Components

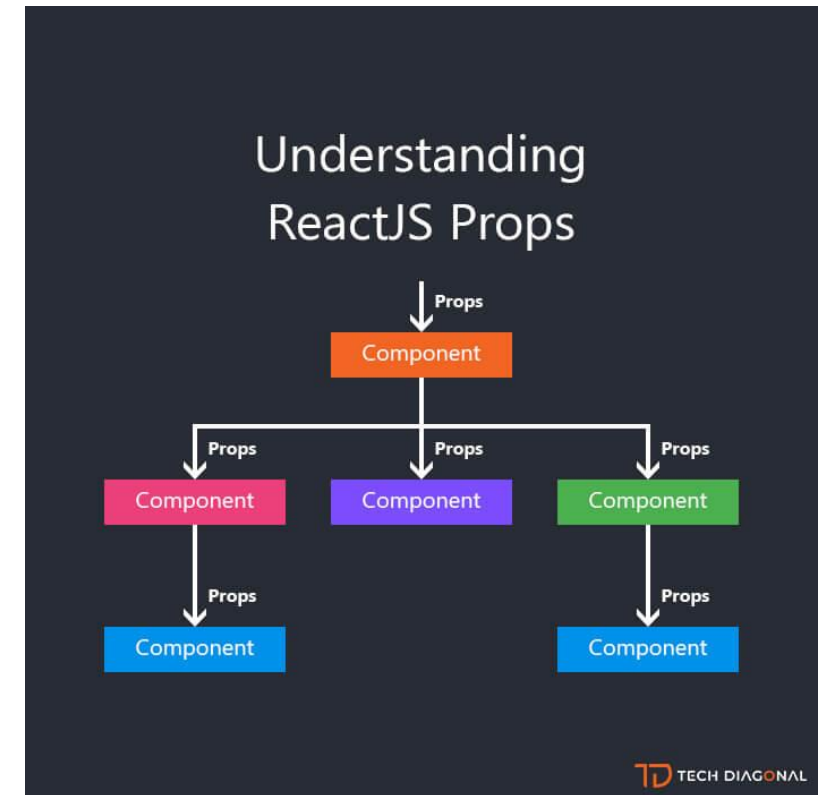
- Generate DOM nodes to be displayed
- Do not manage application state
- Might have some internal state, uniquely for presentation purposes

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

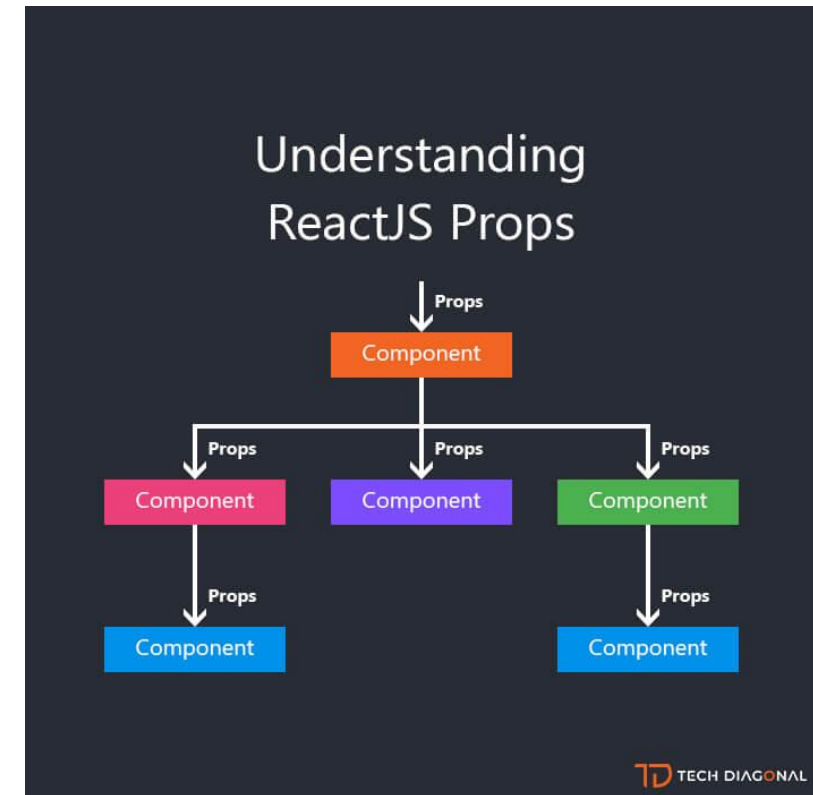
- **Props** (properties) are passed to a component by its parent
 - **Values** (strings, objects, ...) to configure how the component displays or behaves
 - Top-to-bottom data flow
 - **Functions** (callbacks) to access the parent's methods
 - Bottom-to-top action requests



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/

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

1. `npx create-react-app my-app`
2. ⌚ ... *270 Megabytes later* ... ⌚
3. `cd my-app`
4. `npm start`
5. Visit `http://localhost:3000`

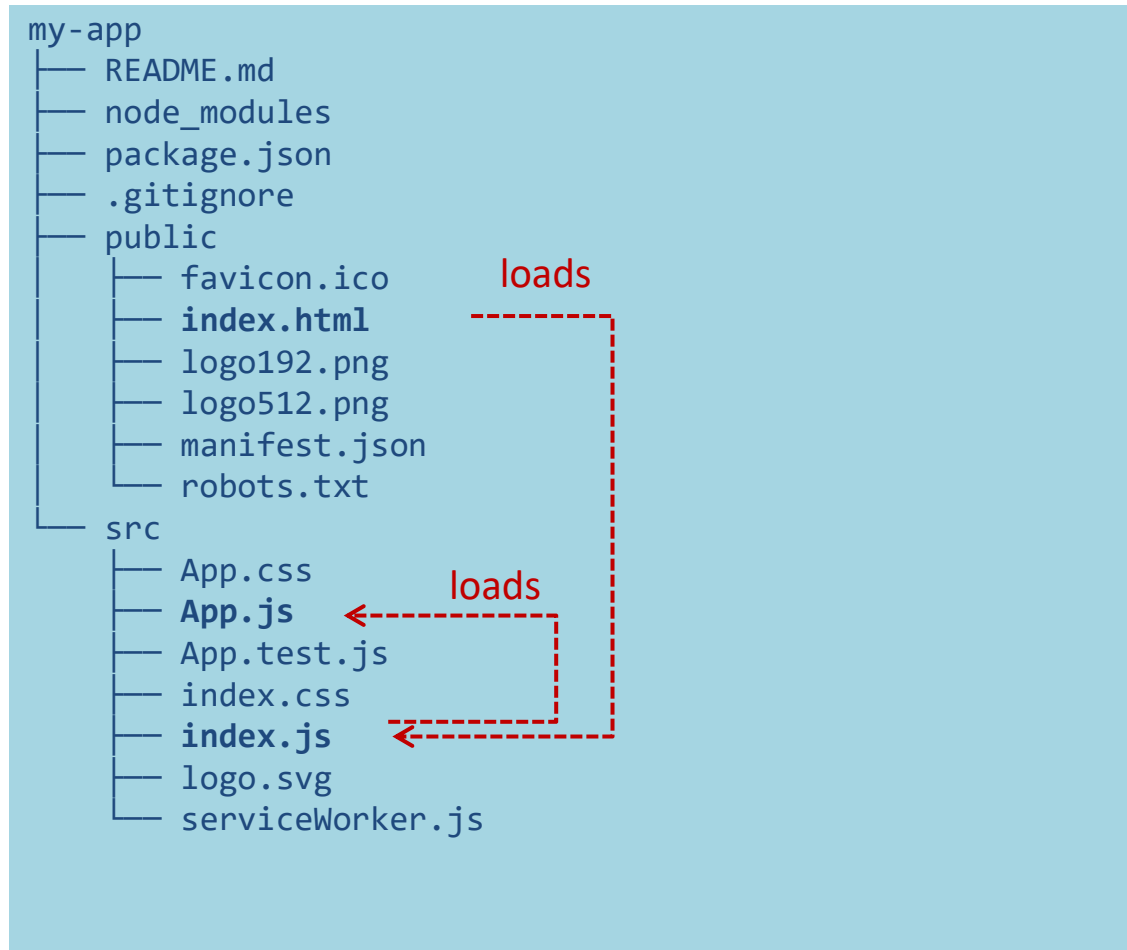


`npx` downloads the npm module and runs it immediately.

It will save the downloaded package in a local cache, but outside the current project.

<https://create-react-app.dev/>

Folder Structure



- `public` is the web server root
 - Static files go here
- `public/index.html` is the page template
 - Published at <http://localhost:3000>
 - Automatically reloads when app changes
 - No need to modify, normally
- `src` contains all scripts
- `src/index.js` is the JavaScript entry point
 - Contains the `ReactDOM.render` call to mount the App in the `#root` element
 - Do not touch, normally
- `src/App.js` is the file containing your application
 - **Develop here!**
 - Feel free to `import` other components

Example: Hello world

App.js

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

function App() {
  return (
    <p>
      Premi qui: <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.js

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

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

export default App;
```

Button.js

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

export default Button;
```

Example: Dynamic State

Button.js

```
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;
```



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.js

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

import MyButton from './Button.js';

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

export default App;
```




Example: adding Bootstrap

Button.js

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

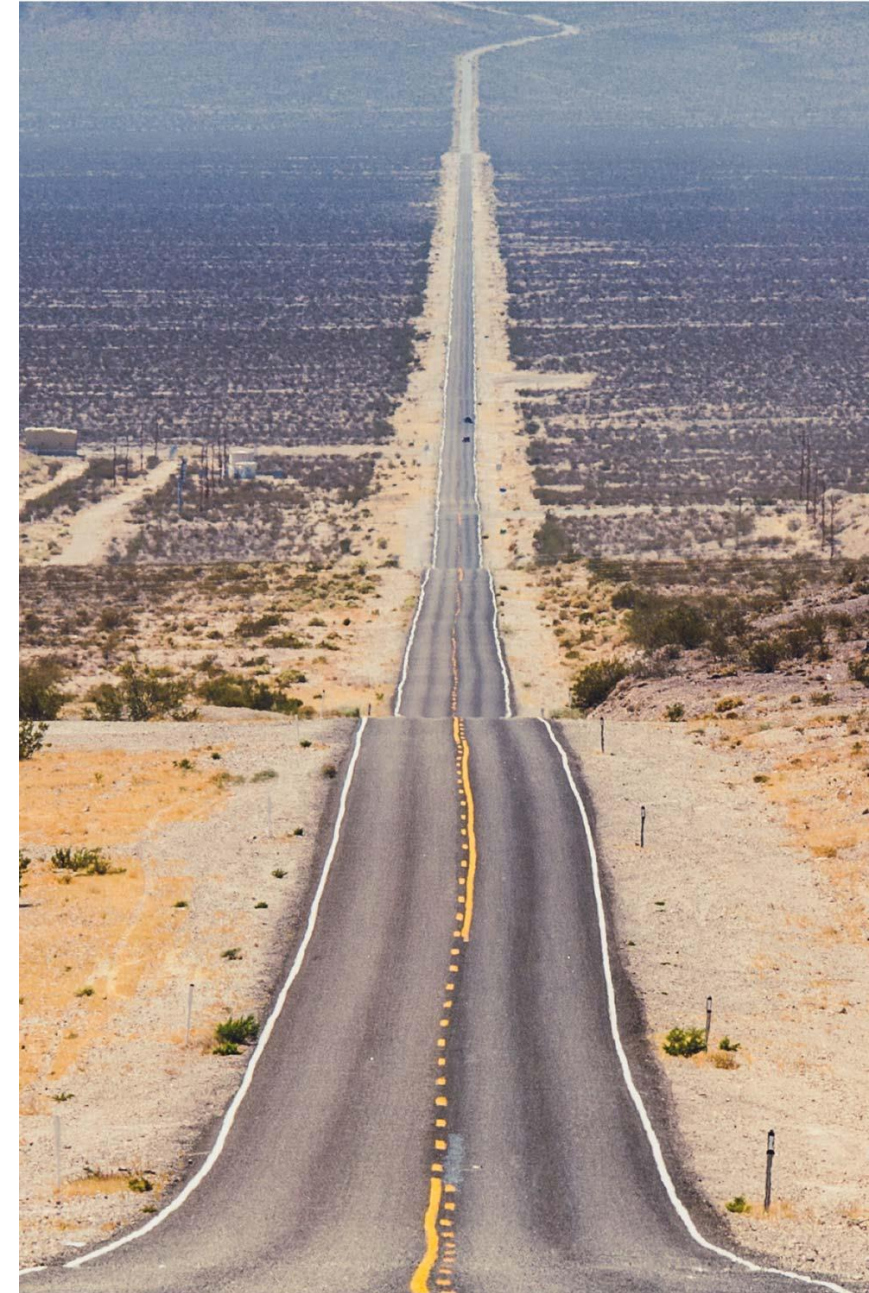
function MyButton(props) {
  let [buttonLang, setButtonLang] = useState(props.lang) ;

  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
- ...





License

- These slides are distributed under a Creative Commons license “**Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0)**”
- **You are free to:**
 - **Share** — copy and redistribute the material in any medium or format
 - **Adapt** — remix, transform, and build upon the material
 - The licensor cannot revoke these freedoms as long as you follow the license terms.
- **Under the following terms:**
 - **Attribution** — You must give [appropriate credit](#), provide a link to the license, and [indicate if changes were made](#). You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
 - **NonCommercial** — You may not use the material for [commercial purposes](#).
 - **ShareAlike** — If you remix, transform, or build upon the material, you must distribute your contributions under the [same license](#) as the original.
 - **No additional restrictions** — You may not apply legal terms or [technological measures](#) that legally restrict others from doing anything the license permits.
- <https://creativecommons.org/licenses/by-nc-sa/4.0/>

