CSE 331
Software Design & Implementation

Winter 2023

Section 8 – HW8 & React

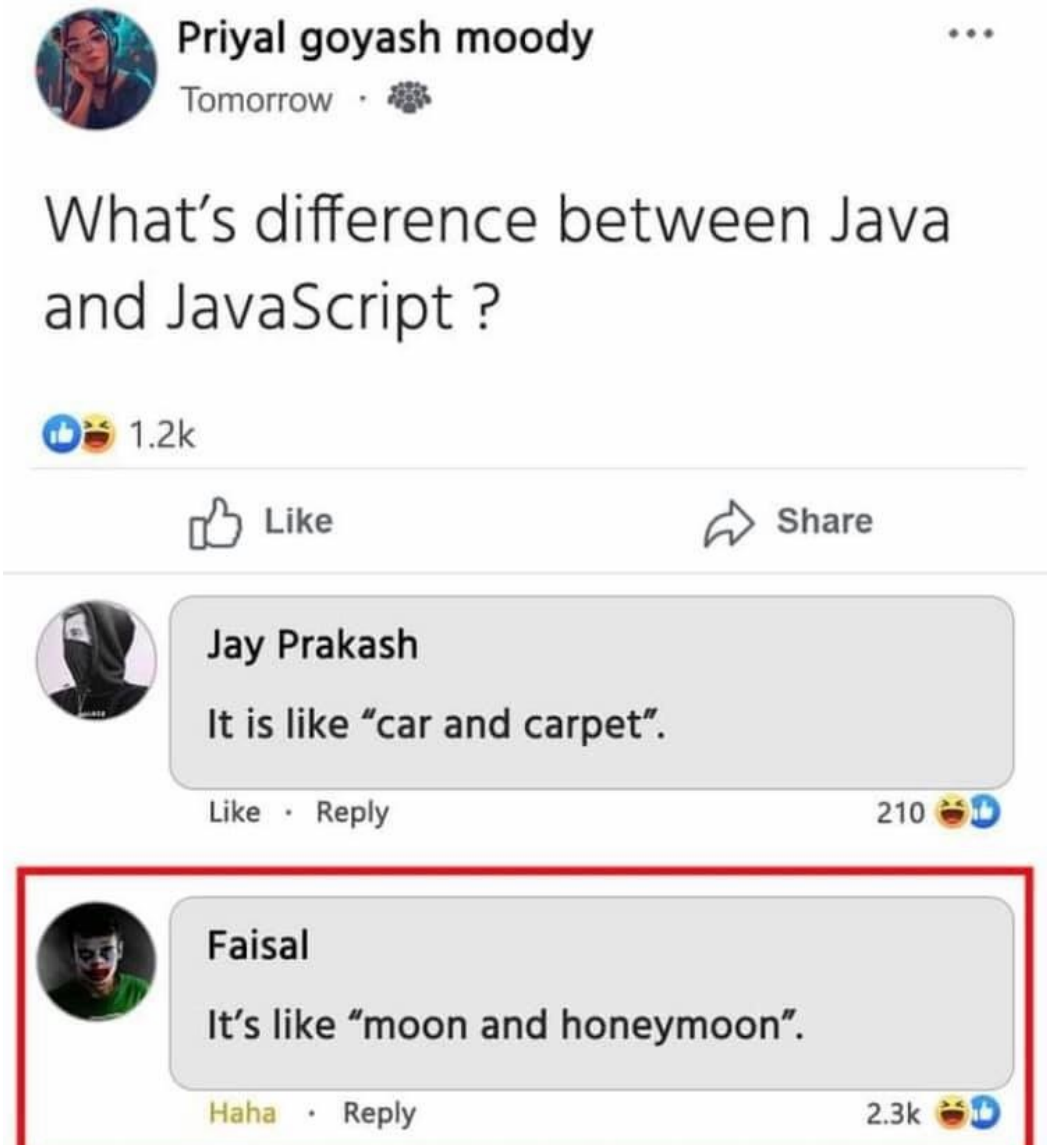
Administrivia

- HW7 due tonight!
  - Make sure to tag right!

- HW8 due next Thursday
  - No Gitlab pipeline, but you still need to tag!
  - No re-runs (no staff tests). It’s your responsibility to check that your submission runs without any compilation errors!

Agenda

- Overview of HW8 – “Draw Lines”
- React examples
- Using Leaflet for Maps in React



Priyal goyash moody

Tomorrow ·

What's difference between Java and JavaScript ?

1.2k

Like Share

Jay Prakash

It is like "car and carpet".

Like · Reply 210

Faisal

It's like "moon and honeymoon".

Haha · Reply 2.3k

Node and NPM

- Used to manage our React development environment
- Install Node.js: https://nodejs.org/en/
  - This will also install NPM
- Install the LTS version (**not** the **current** version)
  - Windows Users: Make sure you "Add to PATH" (should be automatically selected by default)
  - MacOS Users: may get a warning about the installer not coming from a "verified developer."
    To resolve this, open System Preferences and navigate to Security & Privacy > General. There, you'll be able to click "Open" to run the Node/NPM installer.

React (JavaScript library)

- React (also known as React.js or ReactJS) is an open-source front-end JavaScript library
- React code is made of entities called components, which allow you to implement different UI in different classes
  - Think of a component like a synthetic HTML tag
- Allow direct addition of HTML to the code (with some similar syntax—refer to lecture material for this)
- Modern React primarily uses functional components, but we will be using classes
  - Be careful with documentation online!

React Components

- Each component has a render method to determine what it looks like on the page
  - A component can be composed of other components
- Components form a tree:
  - `App` is the root of our tree

$$\begin{tikzcd}
 & \text{<App />} \arrow[dl, no head] \arrow[dr, no head] & \\
\text{<MyButton />} & & \text{<MyPicture />}
\end{tikzcd}$$

- Components can have **state**, which is local information used for rendering
- Components can receive information from its parent using **props**
  - Use functions passed in props as **callbacks**

Declaring Components

We declare components as classes that extend **`Component`**

```
interface PropsType { // type of props here }
interface StateType { // type of state here }

class ComponentName extends Component<PropsType, StateType>{
  constructor(props: PropsType) {
     super(props);
     this.state = { // initial state };
  }

  render() {
    // returns rendering of component
  }
}
```

Declaring Components

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interface StateType { // type of st

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```

Props are like constructor arguments from Java: values we expect to be given to the component by the creator

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}
```

Props are like constructor arguments from Java: values we expect to be given to the component by the creator

State are like fields from Java*: values that the component manages itself (and it may pass them as props to its children)

***we should restrict state to values that are used in our render method**

Declaring Components

We declare components as classes that

```
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interface StateType { // type of st

class ComponentName extends Compone
  constructor(props: PropsType) {
                                 stat
  }

  r
                                 ponent
  }
}
```

Props are like constructor arguments from Java: values we expect to be given to the component by the creator

State are like fields from Java*: values that the component manages itself (and it may pass them as props to its children)

Note: this is just a blueprint! Some components may not need constructors or can use empty types (`{ }`) for props or state

***we should restrict state to values that are used in our render method**

Using React Components

```
<ComponentName value={"Hello World"}
  onChange={() => doSomething()}/>
```

- `ComponentName` is the name of your component/class
- In this case, the **props** are `value` and `onChange`
- `onChange` takes in a function, which we call a **callback**
  - this is how we can pass information up the tree, from a child to a parent

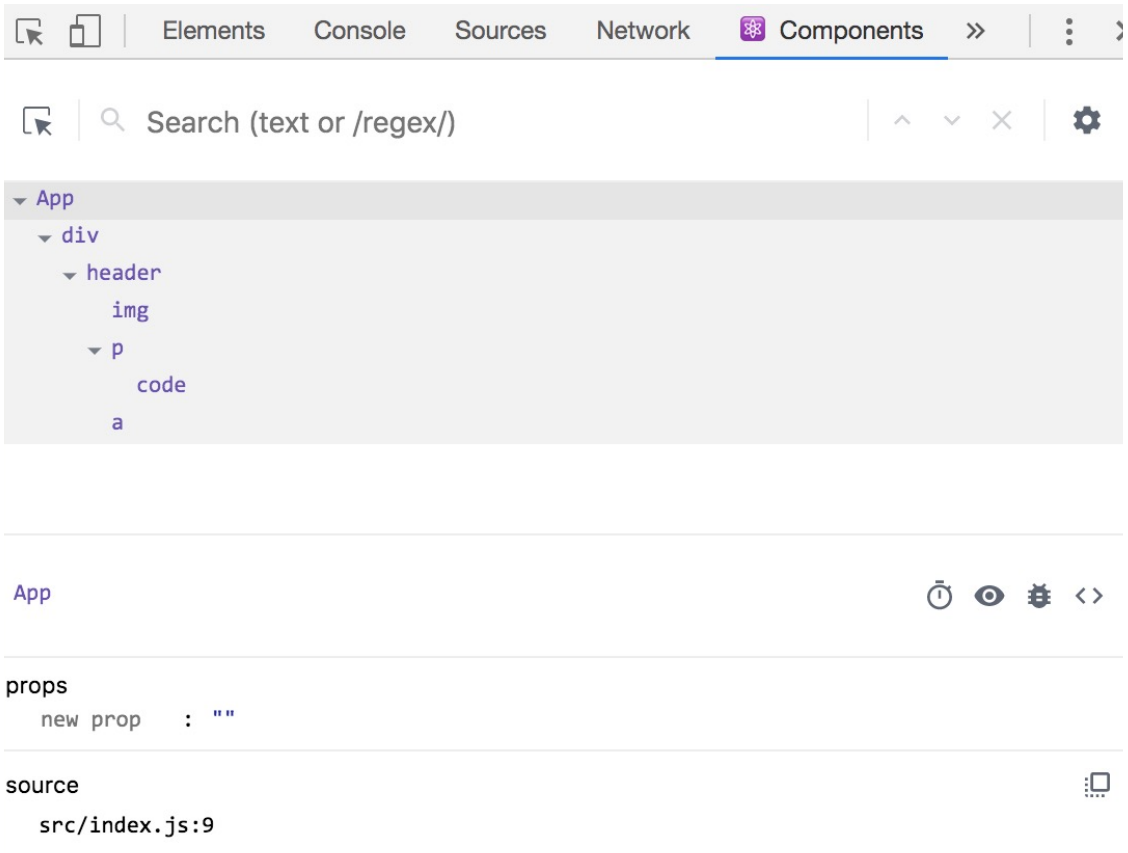
Our props type should then include both `value` and `onChange`

```
interface ComponentNameProps {
   value: string;
   onChange: () => void
}
```

React Developer Tools

- You should download the React Developer Tools!

- This is a Chrome/Edge extension that allows you to view additional details about your React app



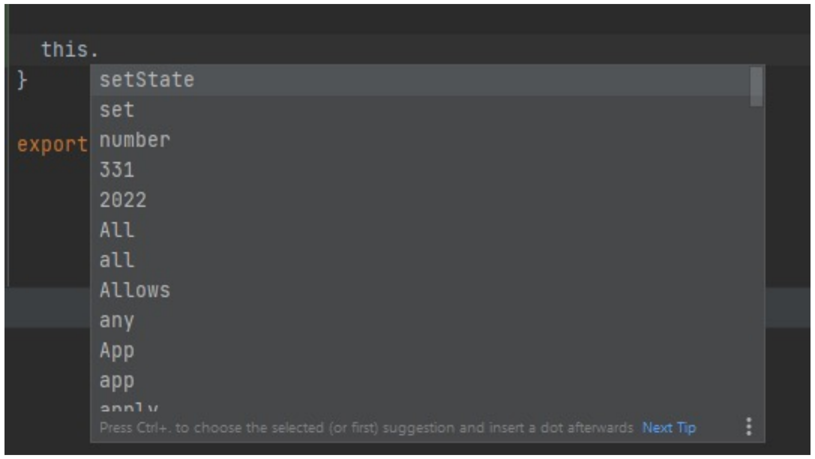
```
App
  div
    header
      img
      p
        code
      a
```

```
App

props
  new prop : ""

source
  src/index.js:9
```

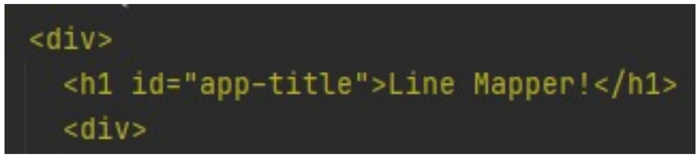
IntelliJ Ultimate Edition

Community

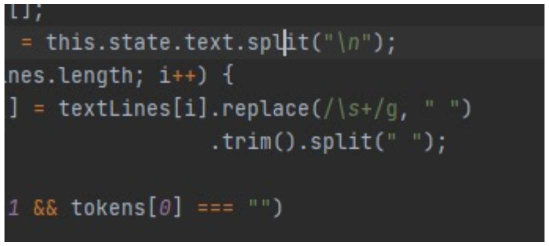
- No Javascript/Typescript support



```
this.
}     setState
      set
export number
      331
      2022
      All
      all
      Allows
      any
      App
      app
      Press Ctrl+. to choose the selected (or first) suggestion and insert a dot afterwards  Next Tip
```



```
<div>
  <h1 id="app-title">Line Mapper!</h1>
  <div>
```

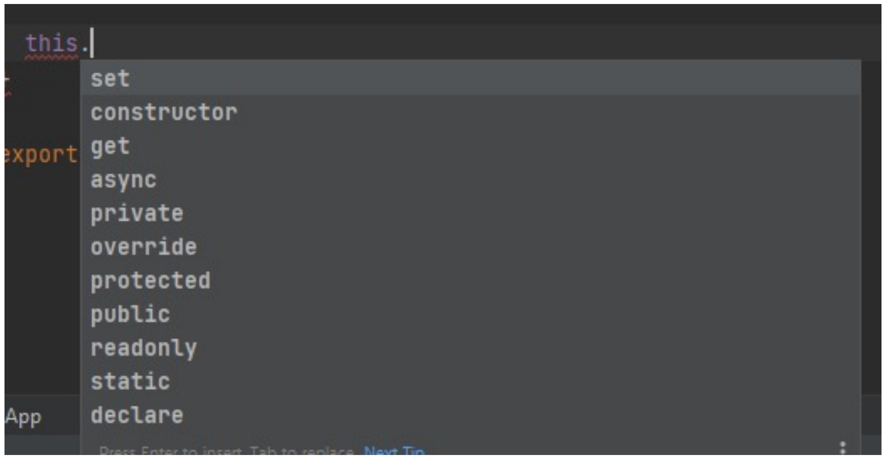


```
[];
 = this.state.text.split("\n");
nes.length; i++) {
] = textLines[i].replace(/\s+/g, " ")
                .trim().split(" ");

1 && tokens[0] === "")
```

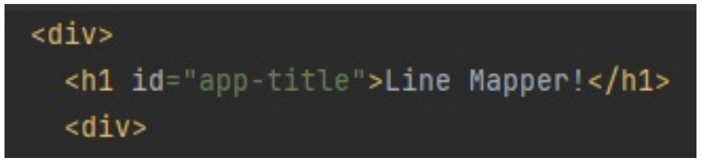
No documentation on hover!

Ultimate

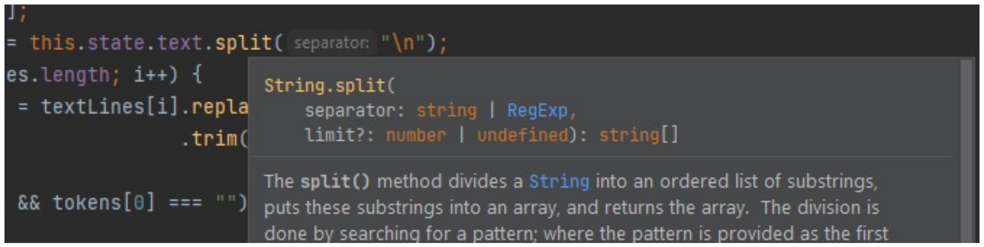
- Has Javascript/Typescript support



```
this.
      set
      constructor
xport get
      async
      private
      override
      protected
      public
      readonly
      static
App   declare
      Press Enter to insert, Tab to replace  Next Tip
```



```
<div>
  <h1 id="app-title">Line Mapper!</h1>
  <div>
```



```
];
= this.state.text.split( separator: "\n");
es.length; i++) {
 = textLines[i].repla
                .trim(
 && tokens[0] === "")
```

```
String.split(
    separator: string | RegExp,
    limit?: number | undefined): string[]
```

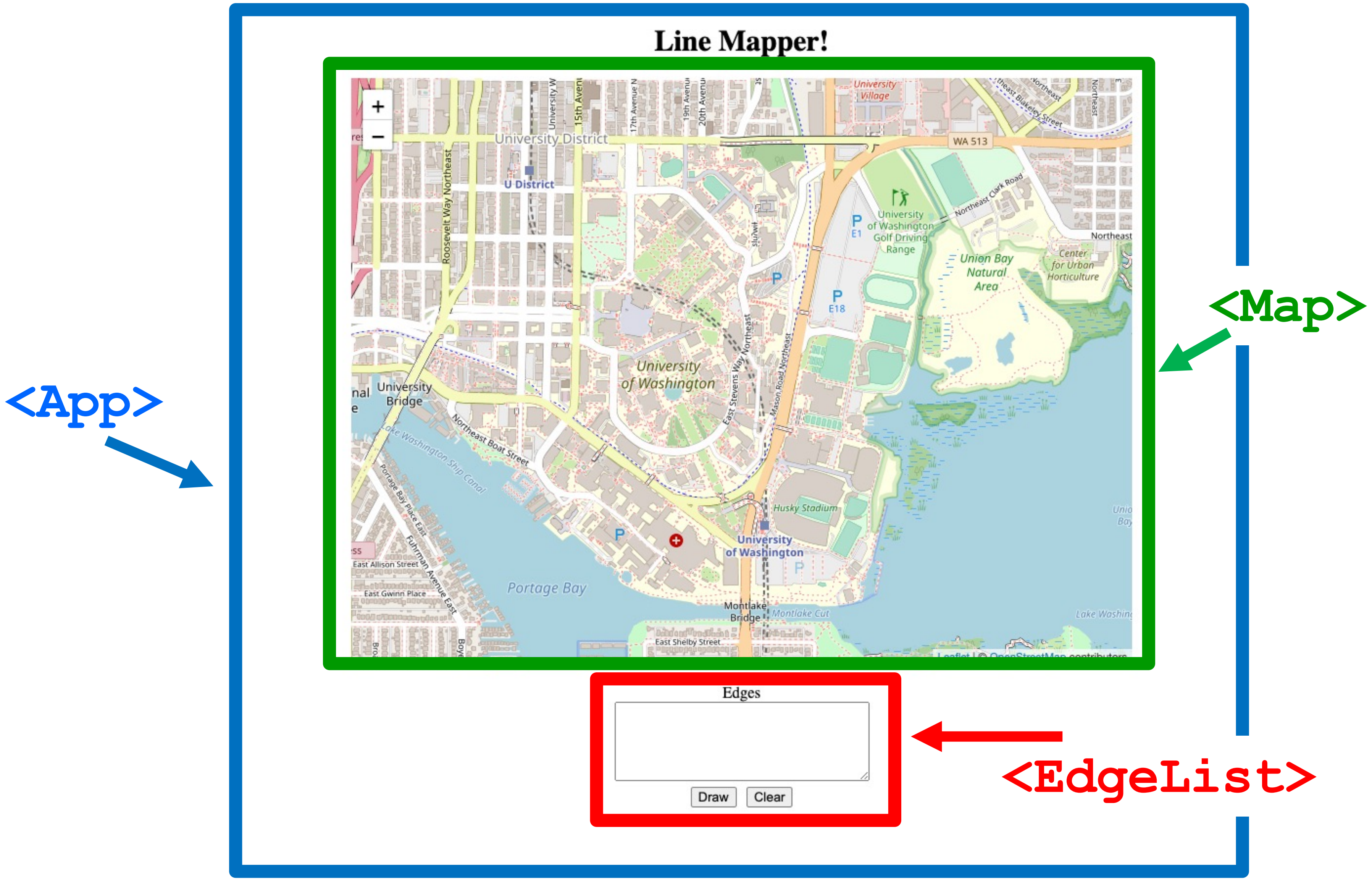
The `split()` method divides a `String` into an ordered list of substrings, puts these substrings into an array, and returns the array. The division is done by searching for a pattern; where the pattern is provided as the first

HW8

HW8 Overview

- Draw lines on a map in React
- Starter code has (most of) the pieces, but not much functionality.
  - Lots of hard-coded values, placeholders (`console.log` instead of doing stuff), etc..
- Your job: "wire all the pieces together"
  - Accept user input
  - Process/parse the data
  - Error check – users do weird stuff, make sure you can't crash
  - Move data between components as necessary
  - Add the actual functionality in response to user input.
- Structure:
  - Top-level <App> component, with two child components.

HW8 Component Structure



Running a React App

`npm`: Similar to gradle, but we need to install manually the first time.

In the terminal, change directory until you're in the same place as the "**package.json**" file for the project you want to run.

To Install (first time): **`npm install --no-audit`**

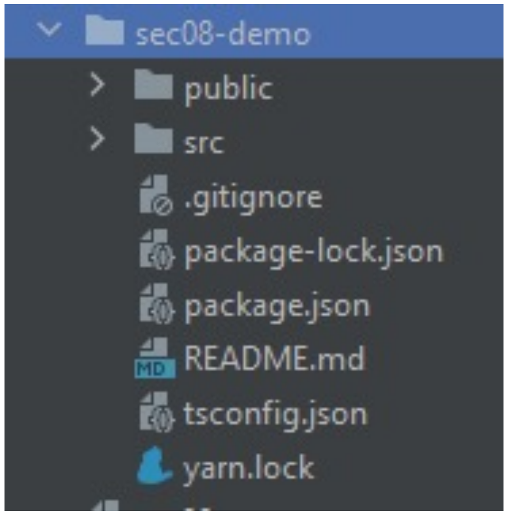
To Run (every time): **`npm start`**

Once started, you can edit and save files and the page will automatically reload – no need to restart. Use Control-C to shut down when you're done developing.

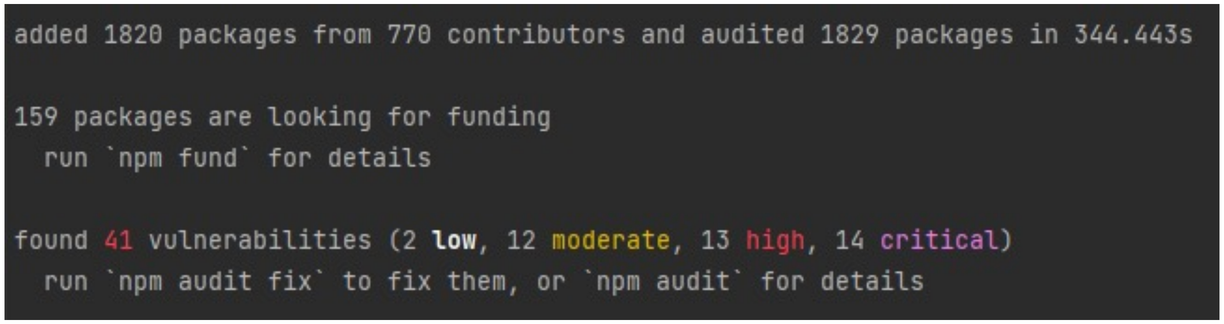
Section Demo

Running The Section Demo

- Download and unzip the section demo.
- IntelliJ: File > Open…



- From the IntelliJ terminal:
  - **`npm install --no-audit`**

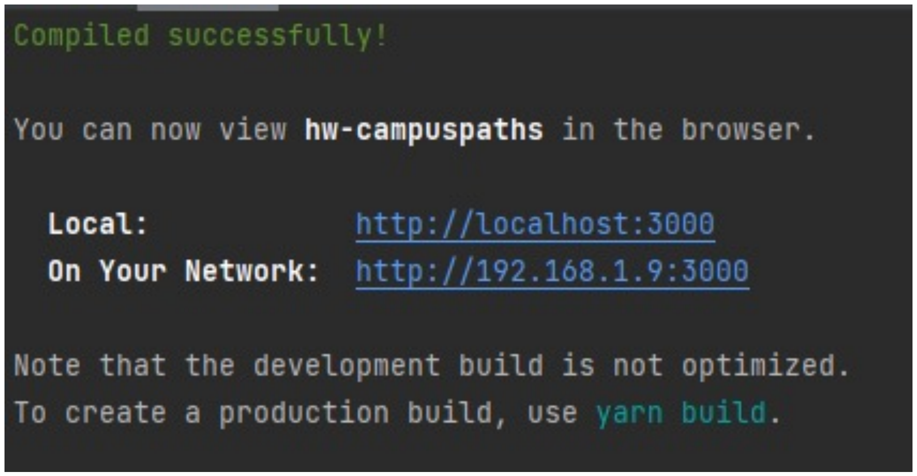


```
added 1820 packages from 770 contributors and audited 1829 packages in 344.443s

159 packages are looking for funding
  run `npm fund` for details

found 41 vulnerabilities (2 low, 12 moderate, 13 high, 14 critical)
  run `npm audit fix` to fix them, or `npm audit` for details
```

- Success!
  (These warnings are **normal**).

Running The Section Demo

- After installation finishes, run **`npm start`**
- A browser window should open up automatically



```
Compiled successfully!

You can now view hw-campuspaths in the browser.

  Local:            http://localhost:3000
  On Your Network:  http://192.168.1.9:3000

Note that the development build is not optimized.
To create a production build, use yarn build.
```

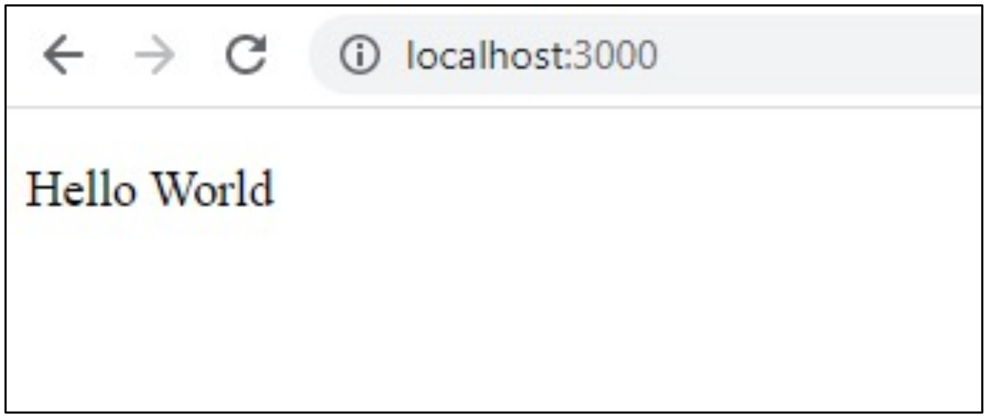
- Doesn't work?
  - Did you install the correct version (LTS)?

Example 1:

React Boilerplate

- This is a React component with minimum parts needed to display a Hello World message.

```
render() {
    return (
        <p>Hello World</p>
    );
}
```



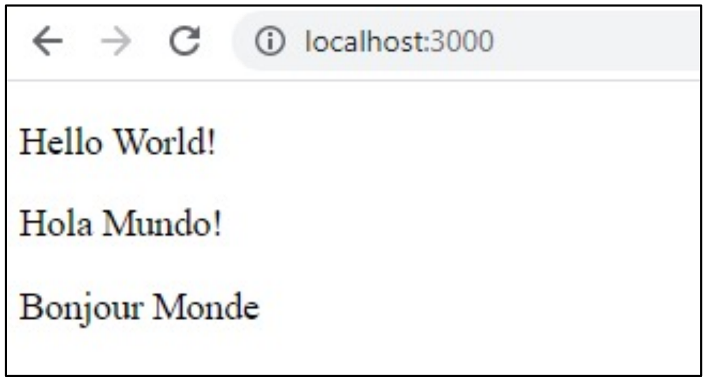
Hello World

Example 2:

Rendering an Array of Elements

- This shows you how to render an **array** of JSX Elements
- Recall:
  `let myParagraph: JSX.Element = <p>Hello World</p>;`

```
render() {
    let arr: JSX.Element[] = [<p>Hello World!</p>,
                               <p>Hola Mundo!</p>,
                               <p>Bonjour Monde</p>];

    return (
        <div>
            {arr}
        </div>
    );
}
```



Hello World!

Hola Mundo!

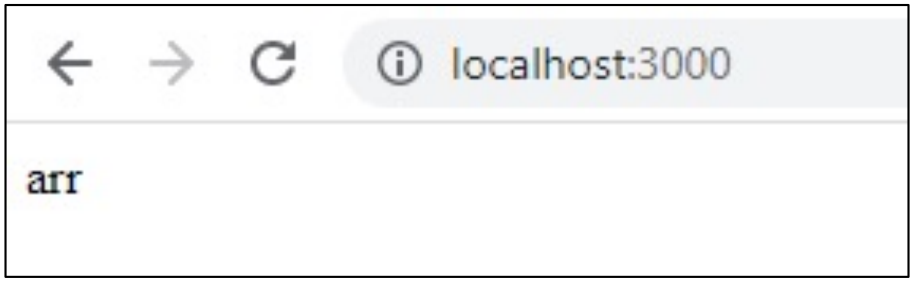
Bonjour Monde

Example 2:

Rendering an Array of Elements

- What happens if you don’t put curly-braces around **`arr`**?
  - It gets interpreted as plain text!

```
render() {
    let arr: JSX.Element[] = [<p>Hello World!</p>,
                              <p>Hola Mundo!</p>,
                              <p>Bonjour Monde</p>];

    return (
        <div>
            arr
        </div>
    );
}
```



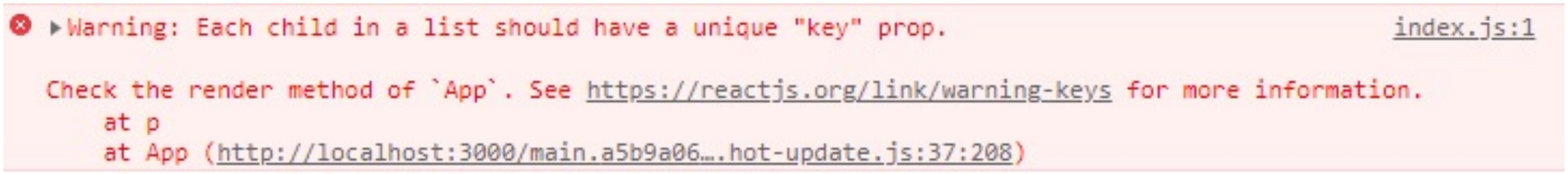
arr

- Curly braces { } are special syntax in JSX, **used to evaluate a JavaScript expression during compilation**.

Example 2:

Rendering an Array of Elements

- When rendering any **array** of JSX elements, each element needs a unique "key" **prop**. Keys can be anything as long as they are **unique**.



```
▸Warning: Each child in a list should have a unique "key" prop.                    index.js:1

Check the render method of `App`. See https://reactjs.org/link/warning-keys for more information.
    at p
    at App (http://localhost:3000/main.a5b9a06….hot-update.js:37:208)
```

```
render() {
    let arr: JSX.Element[] = [<p key={1}>Hello World!</p>,
                              <p key={2}>Hola Mundo!</p>,
                              <p key={3}>Bonjour Monde</p>];
    return (
        <div>
            {arr}
        </div>
    );
}
```

Example 3:

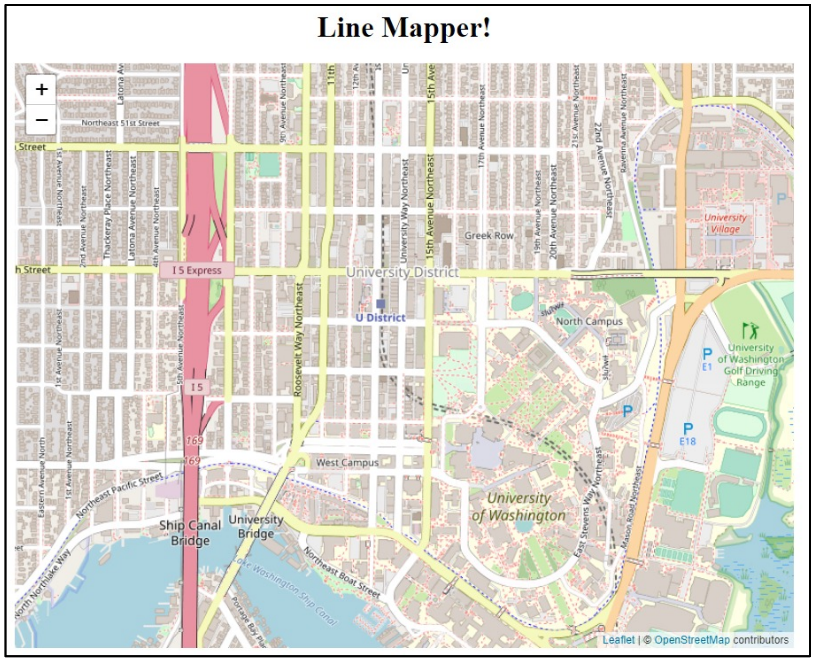
Drawing on a Map

- We will use the React Leaflet plugin to display an interactive map of the campus using React.
- **`<Map>`** tag: creates an instance of the map component. This component is also provided with your HW8 starter code.
- We're using **`<Map>`** in HW8 and HW9 to draw lines/paths on top of images (like a map of campus!)
- **`<MapContainer>`** – Creates a container for the map with properties such as the default position and zoom level.
- **`<MapLine>`** – Represents an edge on the map.
  - Takes the source and destination coordinates as well as the color of each edge.
  - Map should be in the format provided in HW7.

Example 3:

Drawing on a Map

```
render() {
  return (
    <div>
      <h1 id="app-title">Line Mapper!</h1>
      <div>
        <Map edgeList={[]} />
      </div>
    </div>
  )
}
```


Line Mapper!

We pass in an empty array into **Map** as the **edgeList** prop

Example 3:

Drawing on a Map

- Why did we need to pass in the **`edgeList`** **prop** into the **`Map`** element? **`<Map edgeList={[]} />`**

`Map.tsx:`

```
interface MapProps {
  edgeList: ColoredEdge[]; // edges to be drawn
}

class Map extends Component<MapProps, {}> {
```

All **`Map`** elements **must** have the **props** defined in the interface passed in on the left.

Example 4:

State

- We are initializing the information about our lines in our constructor.
  - Initialize **state** with **`this.state = {…}`**

- We are storing our lines and the color of our lines in our **state**.

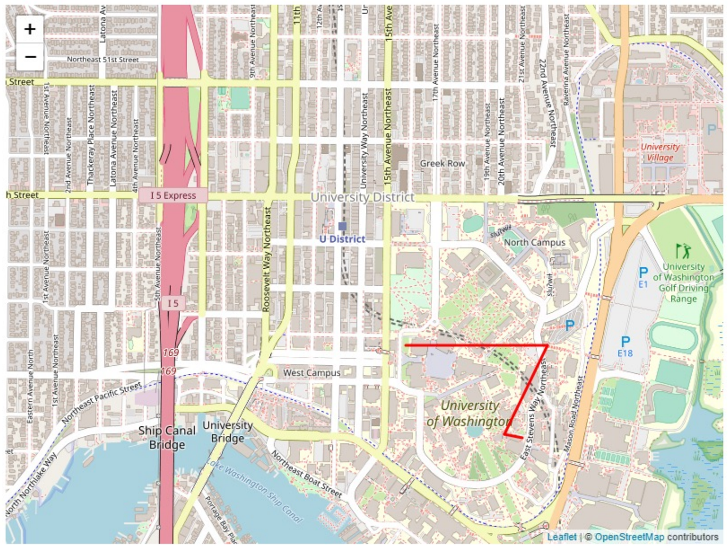
- **`App`**'s **state** in this example is **never** getting updated after initialization.

Example 4:

State

```
constructor(props: any) {
  super(props);
  // initialize tempLines
  // and color_
  this.state = {
    color: color_,
    lines: tempLines
  };
}

render() {
   return (
     ...
       <Map edgeList={this.state.lines} />
     ...
   )
}
```

Line Mapper!



We created lines in **App**'s constructor, passed them through **this.state** into **Map** as the **edgeList** **prop**

Example 4:

State

```
interface AppState {
    lines: ColoredEdge[];
    color: string
}

class App extends Component<{}, AppState> {
```

App's `state` object **must** follow the interface passed in on the right.

```
this.state = {};
```

Compiler Error: Type '{}' is missing the following properties from type 'Readonly ': lines, color

Aside: Interfaces

Interfaces define what properties an object is required to have.

- Conceptually: the “shape” of an object

```
interface HasLabel {           interface Empty {
  label: string;                 // nothing
}                              }

let obj1: HasLabel = { label: "label1" };
let obj2: Empty = { label: "label2" };

console.log(obj1.label);
console.log(obj2.label);
```

Compiler Error: Property 'label' does not exist on type 'Empty'.

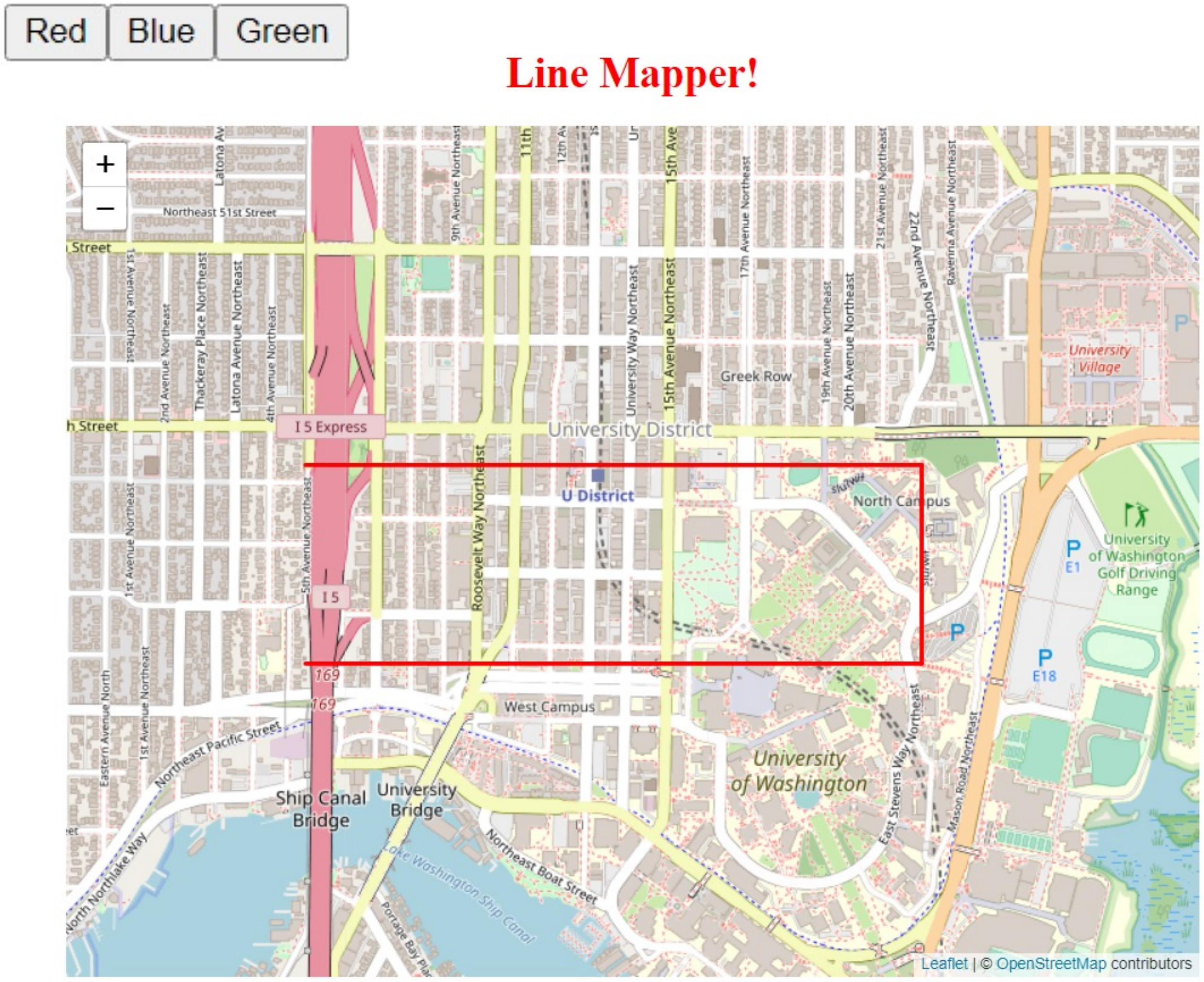
Example 5:

Changing State

- **`App`** still stores a current color and a list of edges
- We have 3 buttons to update the color to **red**, **blue**, or **green**.
- Button's **`onClick`** event listener calls **`setState`** in **`App`** to change the color and trigger a **`re-render`** when the button is clicked.
  - Initialize state using **`this.state = {...}`**
  - Use **`this.setState`** to update the state after initialization
    - Otherwise, React might not notice the state update and not update the UI!

Example 5:

Changing State



Line Mapper!

Example 5:

Changing State

```
<button onClick={this.onGreenClick}>Green</button>

onGreenClick = () => {
    const tempLines = this.state.lines;
    for (let i in tempLines){
        tempLines[i].color = "green";
    }
    let newState = {
        color: "green",
        lines: tempLines
    };
    this.setState(newState);
};
```

When the button is clicked, we grab the **old state**, **modify it**, and then **replace** the **old state** with our **new state**!

Example 5:

Changing State

React's re-renderer watches for `state` updates. When it detects a `state` update, a re-render is **queued**. It does not happen instantly, as React might group multiple `state` updates in one re-render.

```
this.setState(someNewState)
```

👀 Queue a re-render!

```
render() {
  return(
    ...
    <div>
      <Map edgeList={this.state.lines} />
    </div>
    ...
  )
}
```

Updated `state` is passed in!

Aside: Passing Functions Around

```
render() {
  let text: string = "Hello!";
  return (
    <p>{text}</p>
  )
}
```

Notice how these two are *pretty much* equivalent!

```
render() {
  return (
    <p>Hello!</p>
  )
}
```

Aside: Passing Functions Around

```
onGreenClick = () => {
    // function body
};

render() {
  return (
    <button onClick={this.onGreenClick}>Green</button>
  )
}
```

Similarly, these two are also *pretty much* equivalent!

```
<button onClick={() => {
    // function body
  };
}>Green</button>
```

The version on top is significantly cleaner. Please use that one!

Example 6:

Children and Props

- We have a new component that puts a title above the Map, called **`ColorTitle`**
  - **`ColorTitleProps`** includes a color that it will display

- We must include **`ColorTitle`** in **`App`**'s render method

- Current color is passed to child component in **`props`**

Example 6:

Children and Props

We pass in `this.state.color` as the `color` **prop** of our `ColorTitle` element.

App.tsx:

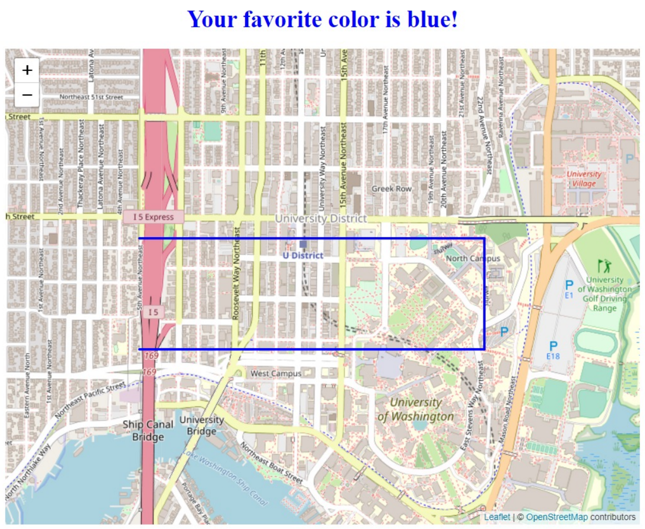
```
render() {
  return (
    <div>
      ...
      <ColorTitle color={this.state.color} />
      ...
    </div>
  );
}
```

Example 6:

Children and Props

The **ColorTitle** element takes the **color prop** and displays it!

```
render() {
  return (
    <h1 id="app-title"
        style={{color: this.props.color}}>
      Your favorite color is {this.props.color}!
    </h1>
  );
}
```



Your favorite color is blue!

Example 7:

Callbacks

- We factor out the three buttons into **`ButtonGroup`**
- **`ButtonGroup`** uses a **callback** function to notify **`App`** that a new color has been chosen
  - Remember: **`ButtonGroup`** is a child of **`App`**
- **Callback** function is passed in via **`props`** also

Example 7:

Callbacks

In our **App** component:

```
update_color = (color_: string) => {
  // create newState by getting the old state and modifying
  // it using the color_ parameter, then replacing the old
  // state with our new state!
  this.setState(newState);
}
```

We pass this **update_color** function as a **prop** into our **ButtonGroup** element. This function updates **App**’s **state**.

```
<ButtonGroup onColorChange={this.update_color} />
```

Example 7:

Callbacks

In the **ButtonGroup** component:

We pass **information** from **ButtonGroup** to **App** when we call the **callback** function

```
onGreenClick = () => {
  this.props.onColorChange("green");
};

...

render() {
  return (
    <div>
      <button onClick={this.onGreenClick}>Green</button>
      ...
    </div>
  );
}
```

When **ButtonGroup**'s button is clicked, it calls **onGreenClick**, which calls the **callback** function that we passed in as a **prop**!

Example 7:

Callbacks

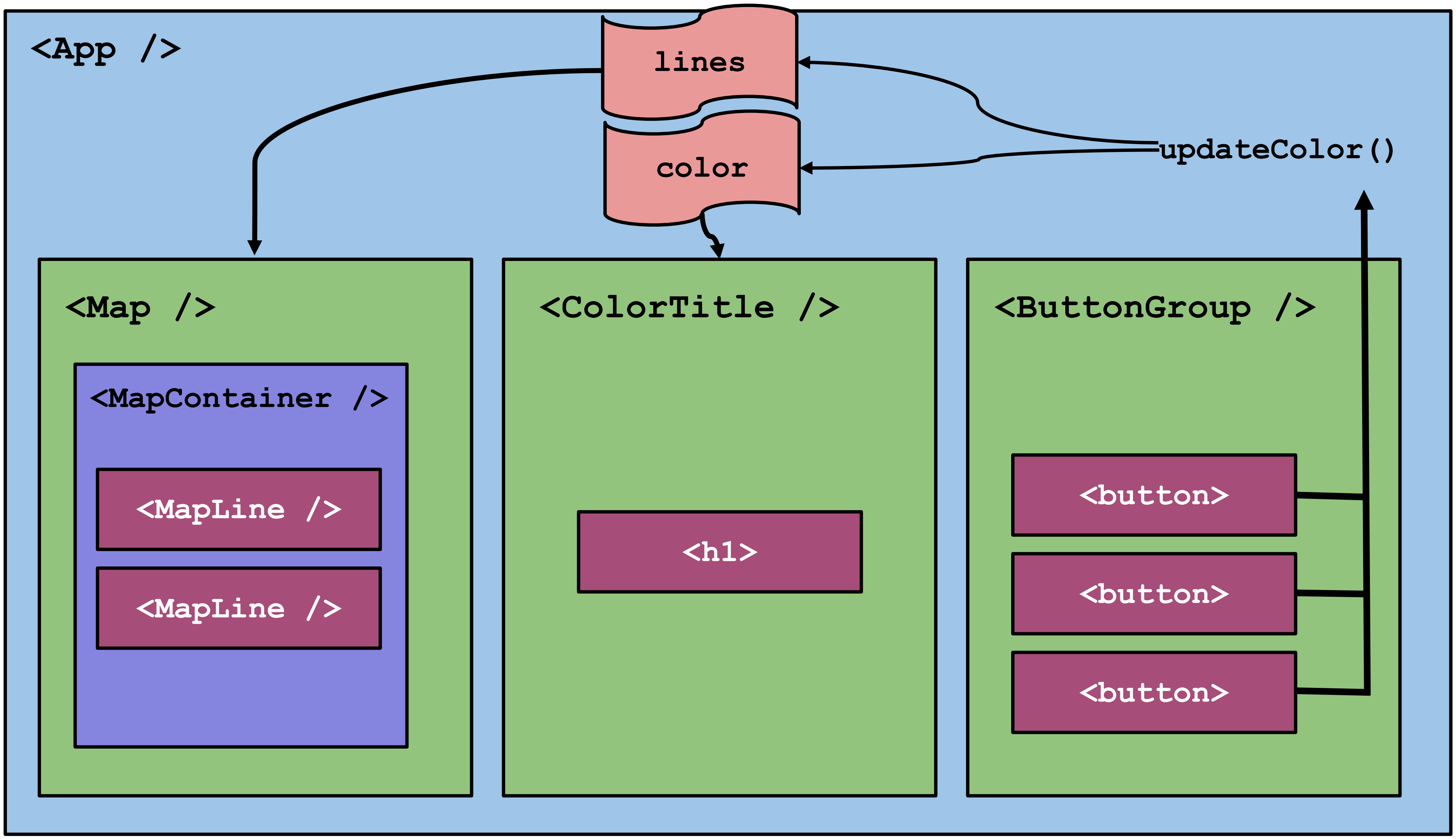
`update_color` updates **`App`**'s **state** using the information received through the **`color_`** parameter (`"green"`).

Queue a re-render!

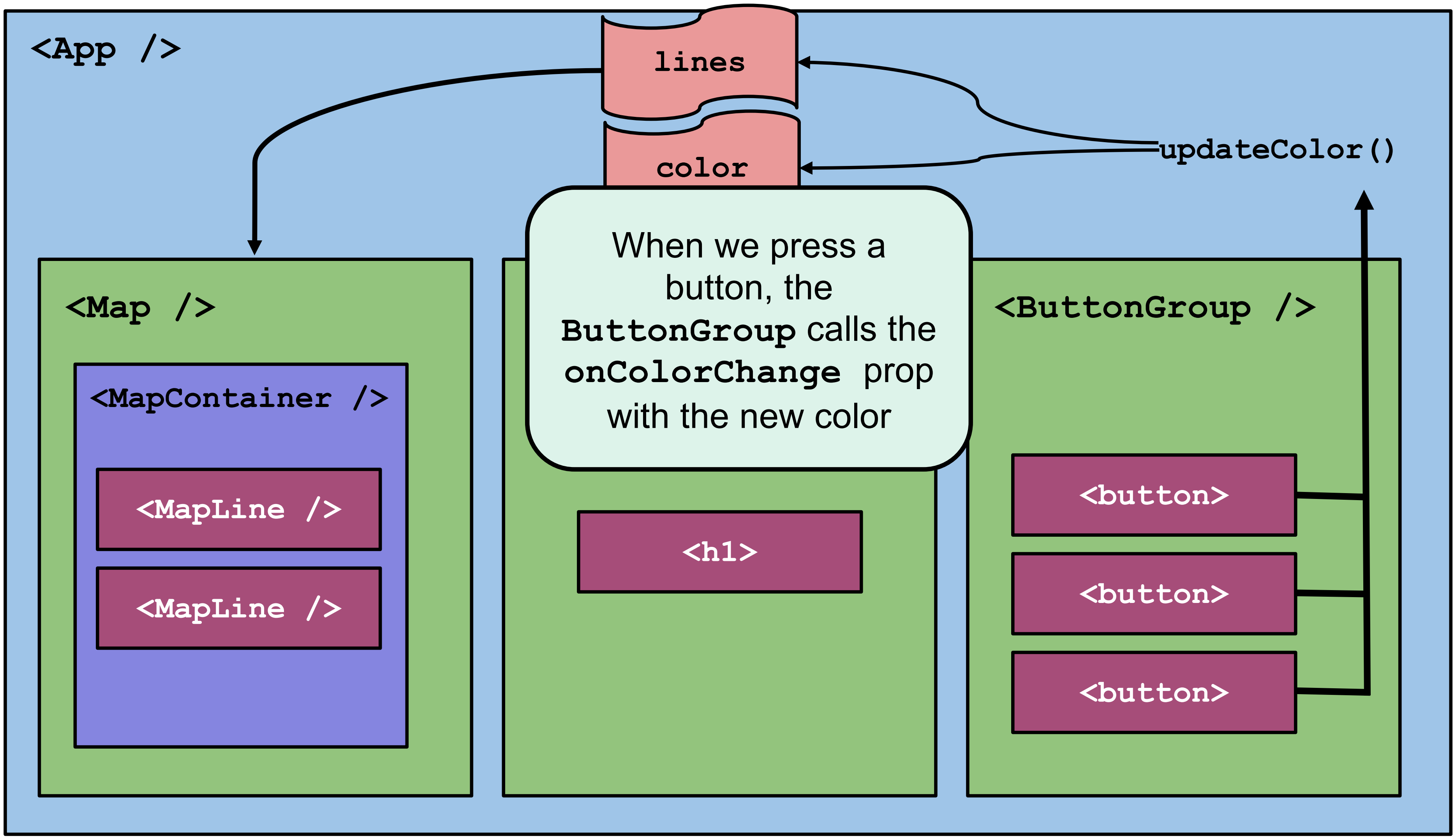
```
render() {
  return (
    <div>
      <ButtonGroup onColorChange={this.update_color} />
      <br />
      <ColorTitle color={this.state.color} />
      <div>
        <Map edgeList={this.state.lines} />
      </div>
    </div>
  );
}
```

When **`ButtonGroup`**'s button is clicked, it calls `onGreenClick`, which calls the **callback** function that we passed in as a **prop**, which updates **`App`**'s **state**, and re-renders the **`ColorTitle`** and **`Map`** elements using **`App`**'s **updated state** as **props**!

The *Flow*

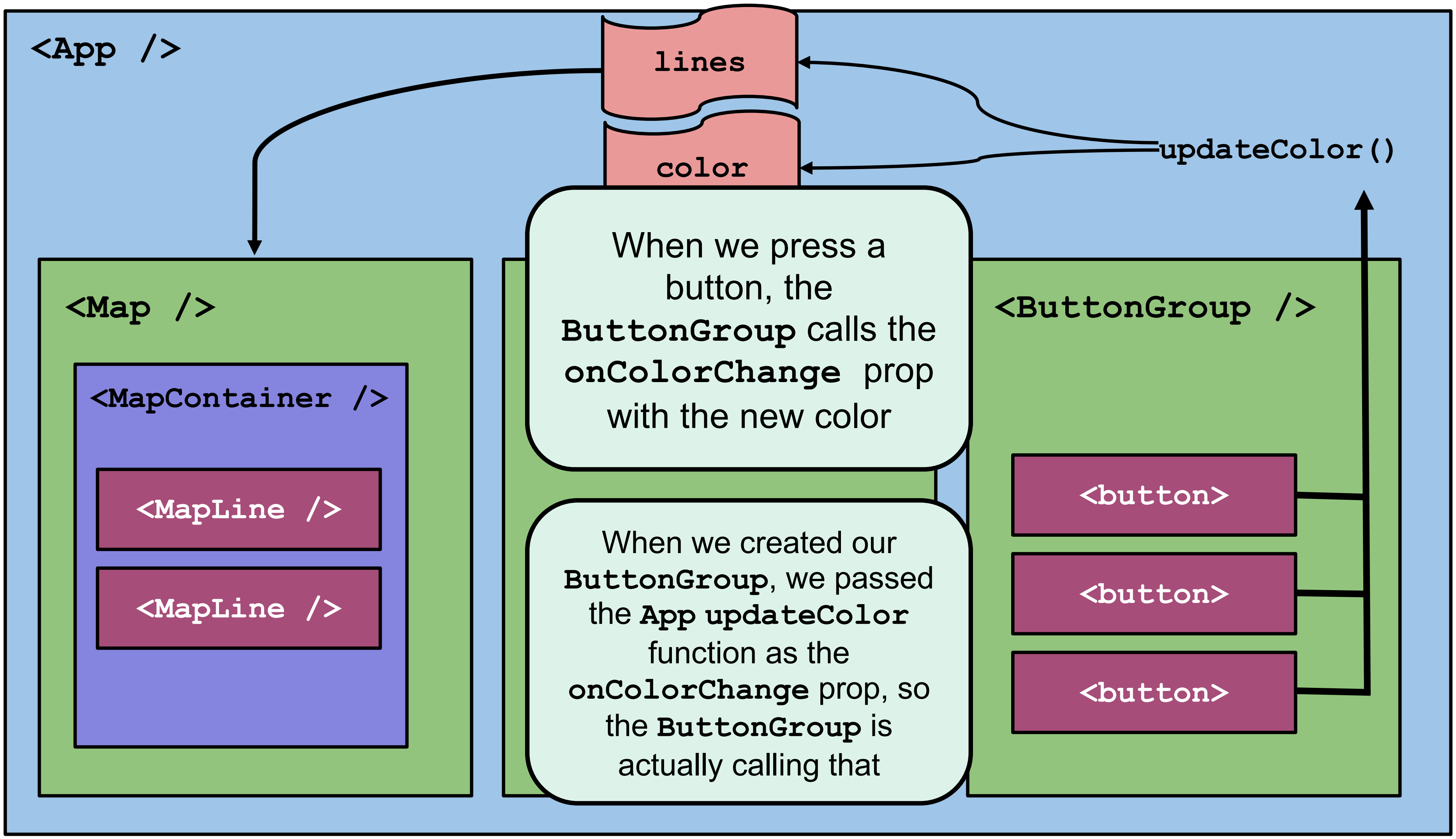


The *Flow*



When we press a button, the **`ButtonGroup`** calls the **`onColorChange`** prop with the new color

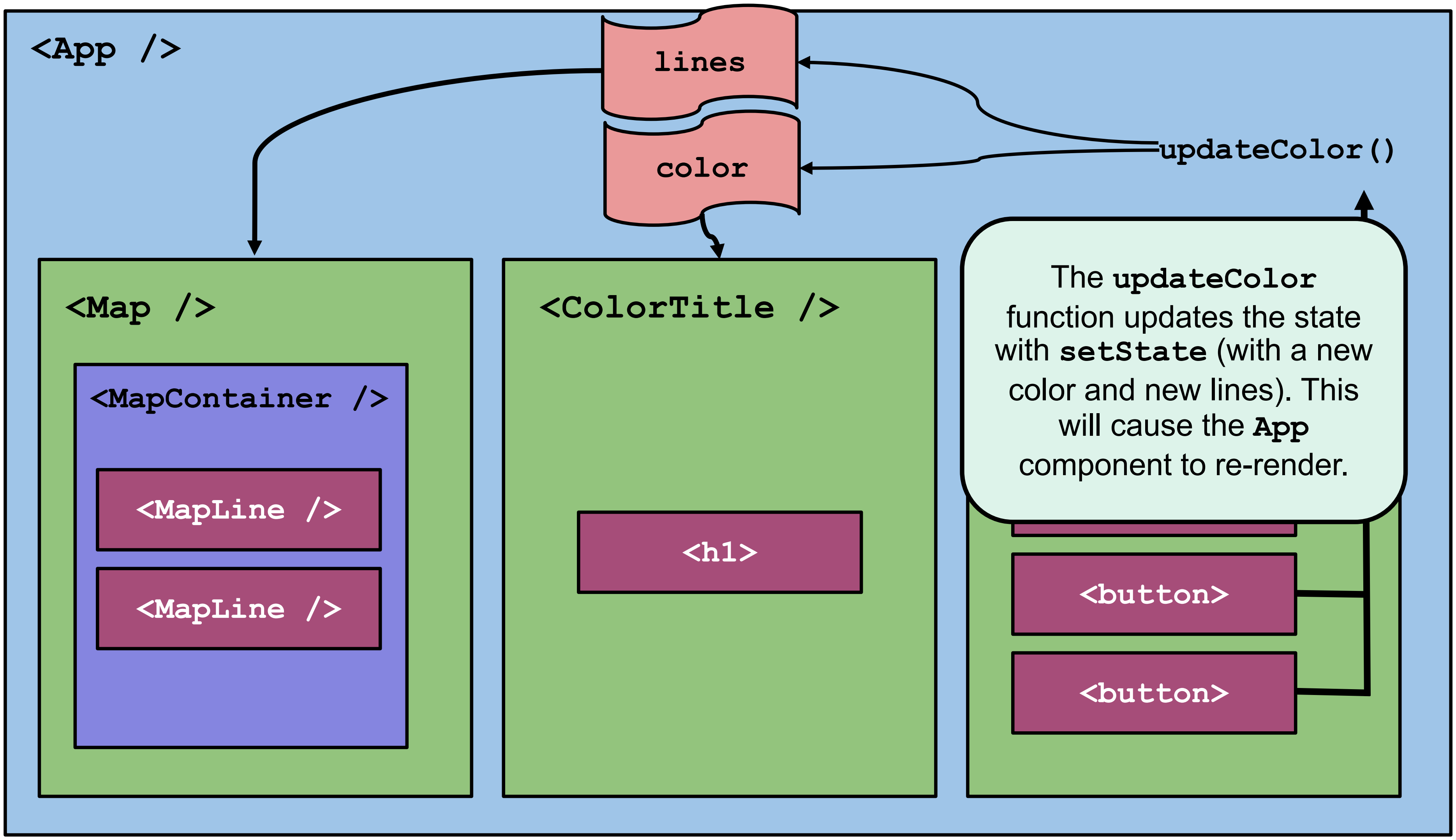
The *Flow*



When we press a button, the **`ButtonGroup`** calls the **`onColorChange`** prop with the new color

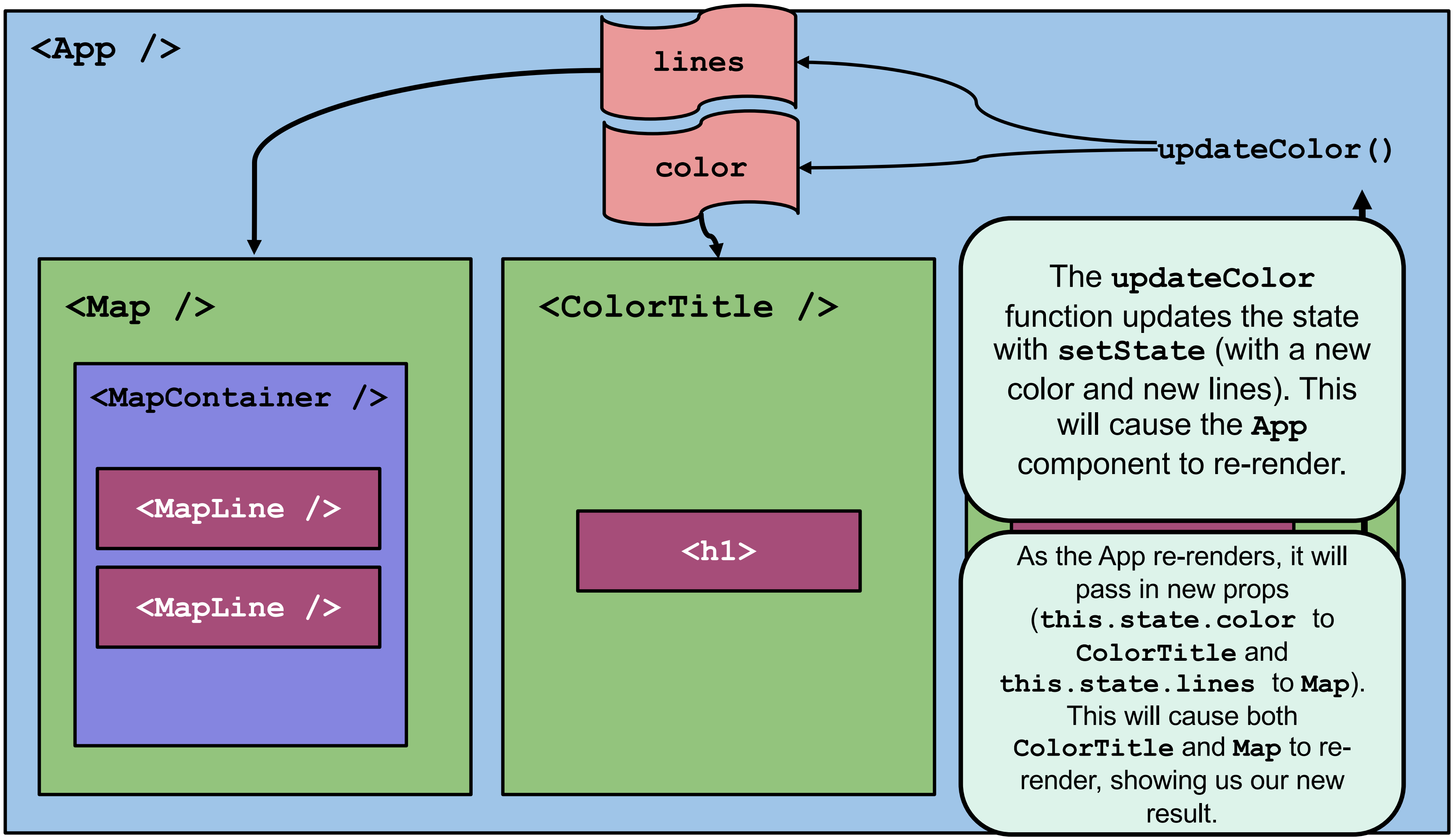
When we created our **`ButtonGroup`**, we passed the **`App updateColor`** function as the **`onColorChange`** prop, so the **`ButtonGroup`** is actually calling that

The *Flow*



The **updateColor** function updates the state with **setState** (with a new color and new lines). This will cause the **App** component to re-render.

The *Flow*

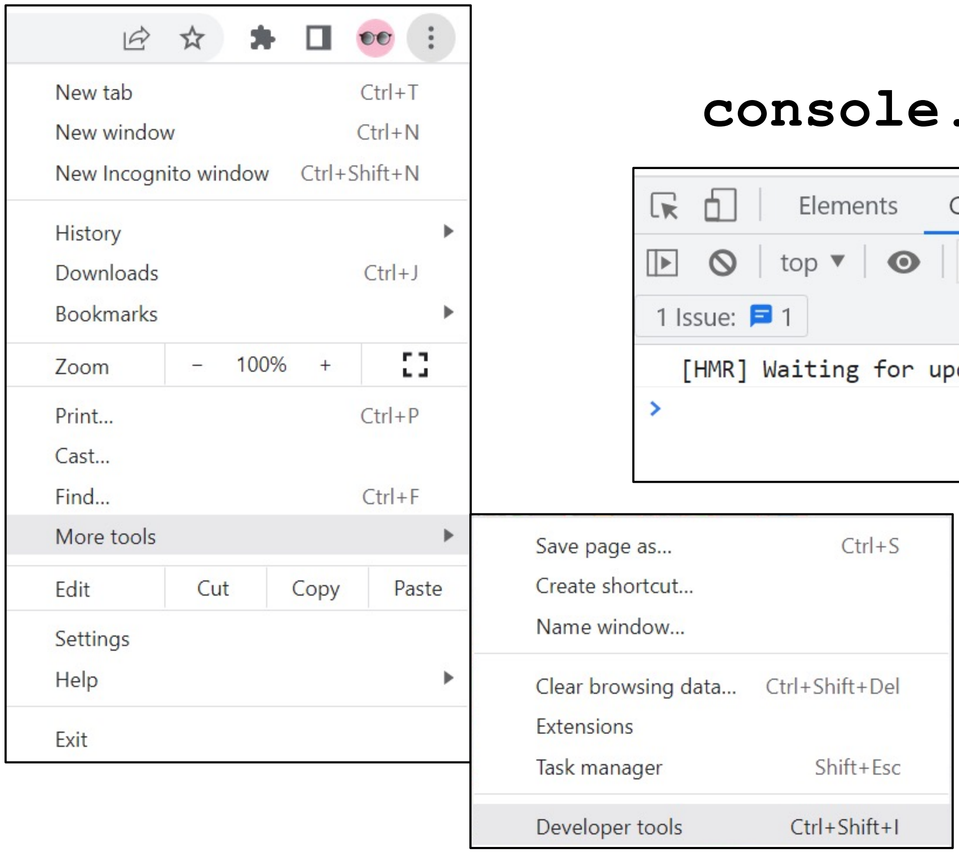


The **updateColor** function updates the state with **setState** (with a new color and new lines). This will cause the **App** component to re-render.

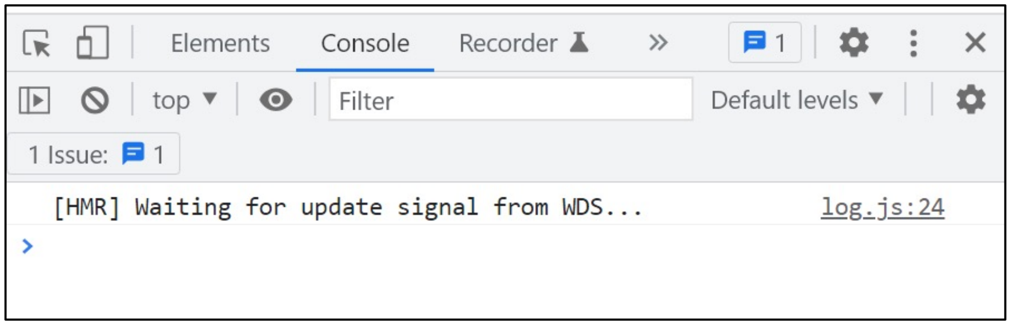
As the App re-renders, it will pass in new props (**this.state.color** to **ColorTitle** and **this.state.lines** to **Map**). This will cause both **ColorTitle** and **Map** to re-render, showing us our new result.

Aside: `console.log` output

- Kebab menu > More tools > Developer tools



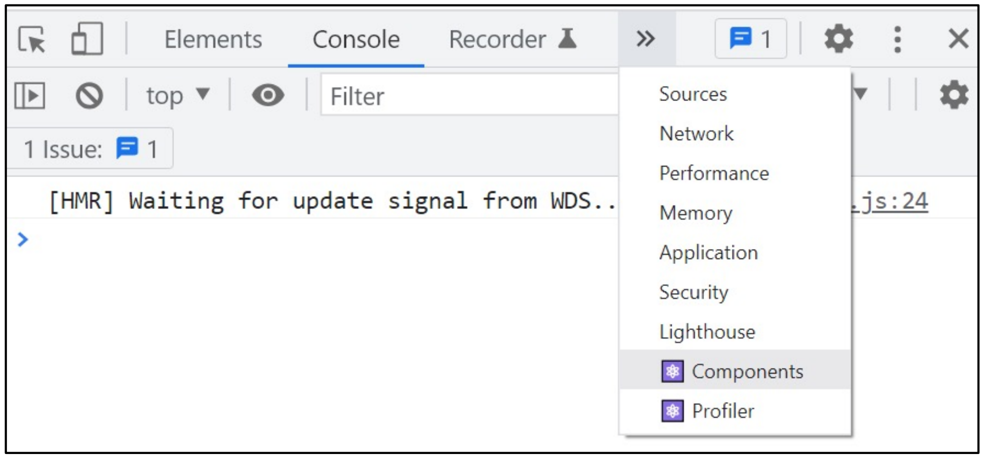
`console.log` will get output here



```
[HMR] Waiting for update signal from WDS...                    log.js:24
```

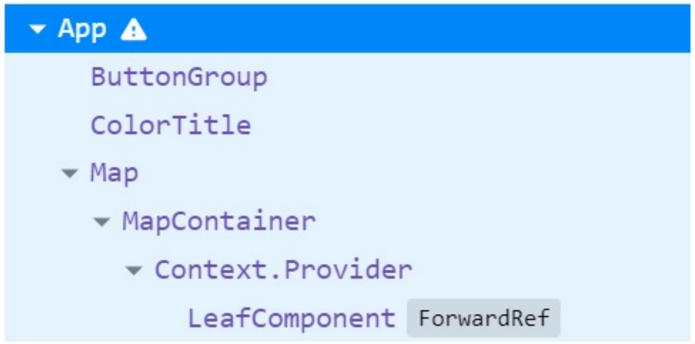
Using React Developer Tools

- ⚛️ Components Tab

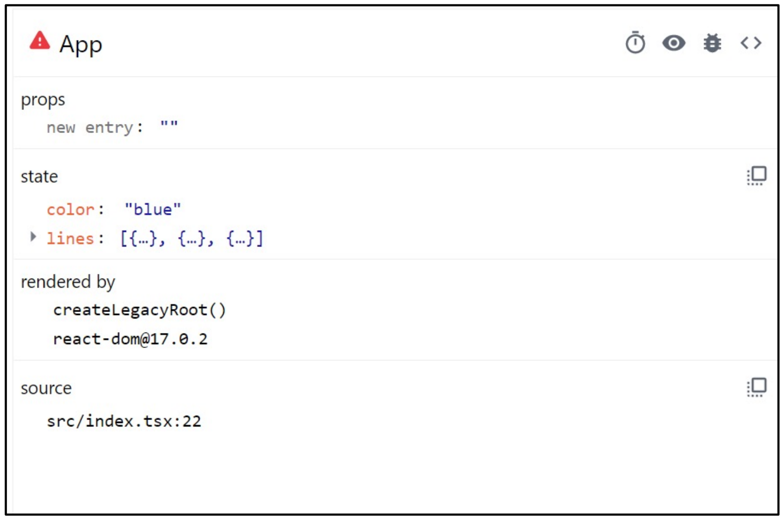


```
[HMR] Waiting for update signal from WDS..   .js:24
```

- See the component structure!



```
▾ App ⚠
    ButtonGroup
    ColorTitle
  ▾ Map
    ▾ MapContainer
      ▾ Context.Provider
          LeafComponent ForwardRef
```



```
⚠ App
props
  new entry: ""
state
  color: "blue"
▸ lines: [{…}, {…}, {…}]
rendered by
  createLegacyRoot()
  react-dom@17.0.2
source
  src/index.tsx:22
```

- Verify the **props** and **state**!

Summary

- Components are reusable blocks of code that allow **modular design** and **proper cohesion**.
- Components contain other components and HTML tags to determine how they appear on a webpage.
  - React is responsible for managing the underlying webpage.
- Data owned/controlled by a component is stored in that component's **state**.
- Data flows *down* from parent to child through **props**.
- Data flows *up* from child to parent through **callbacks** from the child into the parent's code.
- React notifies components of changes to their data, and re-renders happen accordingly.