**ReactJS Notes**

**What is React**

* a JavaScript library for building user interfaces
* client-side (runs on the user browser)
* the page doesn’t need to refresh as it does not need to request a new html page, making it super fast
* reduces code needed
* uses components which has dedicated, but small task
* we use react mainly for single page applications. Sometimes when we click a new tab, it looks like we requested a new html page, but we just changed what is visible
* there is html code in js code, which browser cannot understand which is why there is a ‘build’ process which makes the code readable from the browser, so the code we write is not exactly the same as the code the browser reads. Babel helps to convert JSX to plain JS.

**Installing React**

* You can use npx or npm
* npx is an npm package runner which gets installed when we install node. This is why we are able to directly run create-react-app.
* npm installs the create-react-app package globally and then use the package to generate the projects.
* Graphical user interface, text, application

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* Using npx is likely preferred since we don’t have to install create-react-app package globally
* Installing using npx:
  + You’ll need to have Node >= 14.0.0 and npm >= 5.6 on your machine.
  + check nodejs is installed by typing node -v into the cmd. If you don’t have it, go to <https://nodejs.org/en/> and download the latest version
  + open cmd and cd into a folder where you want the react app to be (such as desktop)
  + run in cmd: npx create-react-app INSERT\_APP\_NAME
  + once it says happy hacking, you are done
  + run in cmd: cd INSERT\_APP\_NAME
  + run in cmd: npm start (as long as you keep this up, the website will update depending on code changes)
  + this should open a tab on your browser at <http://localhost:3000/>
  + A picture containing logo

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  + npm start starts our development server which live reloads itself anytime we save changes to files
  + npm run build takes our application and builds/optimizes/compiles it so it is much quicker. We only want to do this when we are deploying our application to a production server.

**Connecting to Github**

* create a repo on github.com
* git init
* git remote add origin <https://github.com/ChenGrant/REPO_NAME.git> which connects the local files to github
* git add .
* git commit -m ‘first commit’
* git push -u origin master
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* Now our repo on github.com looks like the following:
* A screenshot of a computer

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* Now if we make a branch, go to the branch, and add/delete/change some files as shown below, we get the following git message
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* We can also merge with the master branch
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* Now, our repo on github.com looks like the following:
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**Folder Structure**

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* package.json contains the dependencies and scripts for the project
* For example, we can see that we are using react version 17.0.2
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* The node\_modules folder is where all the dependencies are installed. This folder is generated when we run the create-react-app command or when we run npm install.
* The public folder contains only 1 important file, the index.html file (Manifest.json is important too, but it is too advanced of a topic for now). Index.html will be the only html file we have in our application since we are building single page applications. Normally, we don’t add any code to this file (maybe in the head tag sometimes, but definitely not the body tag since we want react to take care of the body). In runtime, react takes over the div with id = root in index.html to display all the components.
* The src folder is the folder we will work with most in development. Here, we can create a folder called components to keep track of all our components. We also have the index.js file

**Setting Up Files**

* open the react app in a code editor
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* In the src folder, delete: app.test.js, logo.svg, reportWebVitals.js, setupTests.js, and App.css
* You should be left with the following: Graphical user interface, application

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* In src, go to index.js and make it look like the following
* Text

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* In src, go to index.css and remove all of it
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* In src, go to app.js and make it the following
* Graphical user interface, application

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* VS Code React Extensions
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* Snippets: <https://marketplace.visualstudio.com/items?itemName=burkeholland.simple-react-snippets>

**JSX**

* JSX (JavaScript XML) is a syntax extension to JavaScript which is combines HTML syntax with JS syntax.
* JSX is not understood by browsers. Thus, tools like Babel which is a JS compiler/transpiler converts JSX to browser readable JS Code. This conversion is done behind the scenes.
* JSX isn’t mandatory in React, but JSX makes the code a lot cleaner.
* Ex: 
* JSX is also really safe since we can put text that is user generated inside HTML elements. In normal JS, not only does creating an element/adding it to the DOM take many lines, but the user could also inject some scripts if we used .innnerHTML.
* Any code in between {} is treated as JS code.

**import React from ‘react’**

* This allows us to use Hooks and other exports that React provides
* Before, we had to import React from ‘react’ for components because the JSX is converted into regular Javascript that use react's React.createElement method.
* Ex:
  + 
  + So behind the scenes, the above line is turned into the below line.
  + 
* React has introduced a new JSX transform with the release of React 17 which automatically transforms JSX without using React.createElement (as mentioned above). Thus, no longer need to import React for simple functional components.

**Index.js**

* Index.js is the entry point of our react application and will be the first code that will be executed in our browser.
* The ReactDOM object is imported from the ‘react-dom’ library. With this ReactDOM object, we call a render method which allows us to render our own html element (the <App/> element) in the element with an id of root.
* 
* Notice if you inspect the page (use inspect and not Ctrl+U), and open the div with id root, we see code added there even though we didn’t add it directly on the index.html page.
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**Elements**

* Elements are the smallest building blocks of React apps which describe what you want to see on the screen
* 
* Elements are what components are made of.
* Unlike browser DOM elements, React elements are plain objects, and are cheap to create. React DOM takes care of updating the DOM to match the React elements.
* React elements are immutable so you cannot change it’s children or attributes. The only way to update the UI is to create a new element.

**Components**

* A component represents a part of the UI. All the components come together to make up the entire application.
* For example, we could have one component for the header, one for the sidenav, one for the footer, etc.
* We can also have a component that contains other components. An example of such is App.js since it contains many other components.
* In terms of code, a component is a JavaScript class or function that returns JSX (or we can return null).
* When creating a React component, the component's name MUST start with an upper case letter.
* React Components can only return 1 JSX element. If we want to return many JSX elements (not-nested), we can wrap the JSX elements in an empty element <> </> which is called a JSX fragment.
* We can also perform logic/console.log like we would inside a normal JS function. We have to put that before the return since the return only returns JSX.
* Components should be in their own files and are reusable bits of code. We could also have components placed in .JSX extensions instead of .js extensions but we don’t need to know that for now.
* In react, we have to component types, a stateless functional components and a stateful class component. Differences include: syntax, props, state, lifecycle methods
* Functional Components
  + Functional components are JS functions that can take in optional parameters and returns JSX.
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  + We can use normal JavaScript notation such as arrow functions (snippet shortcut: rafce)
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  + Text

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* Class Components
  + Class components are regular JS ES6 classes that extend the component class from the react library (meaning we also have to import React from “react”).
  + By creating an inheritance to React.Component, the component has access to React.Component's functions.
  + They must contain a render method that returns JSX.
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* While the examples above show you how to create components, you have to connect them with the rest of the application by importing them into the files you need them in.
* Ex:
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* Notice that we used the Component1 component inside the App component by using <Component1/> which is self closing. We could also write < Component1></ Component1>, but since there is not content between it, we can self close it.
* Generally, it is preferred to use functional components whenever possible because of their predictability and conciseness. Since, they are purely presentational, their output is always the same given the same props.

**Comments**

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**Props**

* Props is an immutable JS object used to pass down arguments/data from a parent to its child component.
* To pass in arguments, we add key\_name = value to the component tag.
* To access the arguments, it depends on if we are using a functional component or class component.
* For functional components, we can add a parameter called props (we can name it whatever we want) and we access the value using {props.key\_name}.
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* For class components, we can access the value using {this.props.key\_name}.
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* Ex:
  + Suppose we have the following component:
  + Text

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  + We pass in props to the component tag
  + Text

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  + It displays the following
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  + NOTE: we can also pass in objects as props, it’s just that in the component we can’t just say props.key\_name which will return an error, we have to say props.key\_name.propertyName
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  + Text

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  + => Output: 
  + We will learn how to display arrays better later on
* Props Children
  + Sometimes, we don’t know what the key name for props will be, but we still want to render/change/use those props.
  + Props Children allows us to solve this problem.
  + Every component receives the props.children prop by default and props.children holds the content that is passed between the opening and closing of a component tag.
  + We can pass in elements/components in-between the opening and closing tags for a component.
  + We can access the content in between the opening and closing tag for a component through props.children
  + Functional components
    - Text

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    - Here, we are passing Hello <div>Ayooo</div> to the Greet Component as the value for props.children
    - Text

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    - Here, we are accessing Hello <div>Ayooo</div> that we passed to the Greet Component via props.children and rendering them. (we also got props.my\_param since we knew the key name beforehand)
    - Output: Text

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  + Class Components
    - Text

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    - Here, we are passing Hello <div>Ayooo</div> to the Greet Component as the value for props.children
    - Text

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    - Here, we are accessing Hello <div>Ayooo</div> that we passed to the Greet Component via this.props.children and rendering them. (we also got this.props.my\_param since we knew the key name beforehand)
    - Text

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* Read-Only
  + Whether you declare a component as a function or a class, it must never modify its own props. Props are Read-only, you will get an error if you try to change their value.
  + All React components must act like pure functions with respect to their props. Such functions are called “pure” because they do not attempt to change their inputs, and always return the same result for the same inputs.
  + Ex: Pure Function
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  + Ex: Impure Function
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  + If props.my\_param is immutable, we can simply use =
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    - => Graphical user interface, text, application

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    - Note if we did props.my\_param++ as shown below, we get an error
    - A screenshot of a computer screen

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  + If props.my\_param is mutable, we have to be careful.
    - If we directly changed props.my\_param as shown in the following, we would not get an error
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    - Text

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    - Thus, we need to new an array with a different memory address.
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    - Text

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    - =>Graphical user interface, text

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    - Notice we used the spread operator to copy the array into a new array with a different memory address. Not that we cant say let copy = props.my\_param since copy makes a reference to a memory address, doesn’t take on the value stored in the memory address

**Hooks (general)**

* We can only use hooks inside functional components, we cannot use them in class components
* Every time your component renders (your function runs), the hooks must execute in the same order. So if you have 4 useState hooks in your component, they must always run in the same order. If you have a useState inside an if statement, it will cause an error even if it is if(true). You cannot put hooks inside if-statements, loops, functions, etc. They must be in the top level of the component.

**useState (functional components)**

* useState is a hook that we can import that allows you to have state variables in functional components
* we can think of state as a variable value at a certain time, whether a button is showing or not, etc
* 
* To use useState, we call useState() which is a function that takes in an initial value and returns an array.
* That initial value is the initial of whatever state we are managing. (Ex: inital number of points in a game might be 0)
* UseState returns an array with 2 values, the first being the state, the second is a function that will allow us to update our state.
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* Notice we set the initial value of count to be 4 using useState which is why 4 appears in the div

Changing State

* When we update our state to something new, the component rerenders.
* If we want to change the value of count, we need to use setCount.
* If the new value of count depends on the previous value of count, there is a wrong and right way to do it.
* Incorrect way of incrementing the value of count by 2 is shown in add2\_wrong.
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* This is because when we do setCount(count + 1), the value of count is the value when we rendered our function. So let’s say we render our function and our count is 4. Then we click Add2 Wrong. We will do setCount(count + 1) the first time so the new value count is now the value of count when we last rendered plus 1. So the new value of count is now 4 + 1 = 5. However, this new value of count = 5 is not rendered yet since the add2\_wrong function is done executing. So the value of count when we last rendered is still 4. Thus when we get to setCount(count + 1) the second time, the new value of count is the value of count when we last rendered plus 1. Although we changed the new value of count to be 5, the value of count when we last rendered was 4. So the new value of count is now 4 + 1 = 5. Thus, the new value of count is 5 and since add2\_wrong is done executing, the new count value of 5 is rendered. Notice that writing setCount(count – 1) two times is useless since the second time we do setCount(count – 1), it overrides whatever we did for setCount the first time.
* The right way of incrementing the value of count by 2 is shown in add2\_correct.
* Graphical user interface, text

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* We should use the version of useCount that takes in a function. This function takes in the previous value of count and returns the new value of count. Notice this function argument is correct since the parameter is the previous value of count, not the value of count when we last rendered the component.
* If we update the state, but not to something new, the component does not rerender.
* Text

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* In this component, we have a function, add2, that logs “hi” to the console and updates the value of count to 4. Notice that the initial value of count is 4. Notice that the Greet component logs “rerender” whenever it rerenders. Notice that we never actually display the value of count via JSX.
* When we first render the component, the console prints “rerender” since we have to render the component. The value of count is now 4.
* When we click the button, the add2 function is called so “hi” is printed to the console. We then set the value of count to be 4. But since the value of count was already 4, the component does not rerender so “rerender” is not printed.

Initial State Value

* useState takes the initial value of the state variable as an argument.
* The initial value will be assigned only on the initial render. In subsequent renders (due to a change of state in the component or a parent component), the argument of the useState Hook will be ignored and the current value will be retrieved.
* Ex: If we say , the value of count will be 4 on the first render. If the component ever rerenders, the value of count is not reassigned to 4 since the value of 4 will be ignored.
* Ex: If we say Text

  Description automatically generated, the value of count will be 4 on the first render. As well, only on the first render, the number 3 will be logged to the console. If the component ever rerenders, the value of count is not reassigned to 4 since the value of 4 will be ignored. As well, the number 3 will not be logged to the console again.
* In the previous example, we passed in a function as a callback. However, if it’s a function execution with brackets, that function will be executed every time, but the return value will be ignored.
* Ex: If we say Text

  Description automatically generated with low confidence, the value of count will be 4 on the first render. As well, the number 3 will be logged to the console. If the component ever rerenders, the value of count is not reassigned to 4 since the value of 4 will be ignored. However, the number 3 will be logged to the console again each time the component rerenders. Thus if we did useState(some\_complex\_math\_function()), we could really slow down our program.

Merging State

* If our state is an object, updating a property of the state replaces/overrides the state object to only have that 1 updated property instead.
* Ex:
  + Text

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  + On render, the output is the following:
  + Text

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  + When we click the add2 button, we update the state. Before, the value of state was {count: 4, theme: "blue"}. After add22 runs, the value of state is now {count: 5} and not {count: 5, theme: "blue"}.
  + Thus, the output is the following:
  + 
  + Notice since the state does not have a theme property anymore, blue is no longer displayed.
* If we want to update our state object while keeping the other properties, we need to create a new object with all the desired properties and values.
  + Ex:
  + Text

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  + On render, the output is the following:
  + A picture containing diagram

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  + When we update the state. Before, the value of state was {count: 4, theme: "blue"}. After add22 runs, the value of state is now {count: 5, theme: "blue"} since we returned an object using the spread operator (check back to JS notes if u forget). Also recall that the spread operator copies the values stored at the memory address, not a reference to actual memory address.
  + Thus, the output is the following:
  + Text

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  + Notice since state object has all the old properties since we passed in a new object.
* The reason automatic merging does not happen and instead the object is overridden is because we should have multiple state hooks.
* Thus, instead of having , we should have .
* We can update the value of both count and theme in a function by calling both setCoutn and setTheme.
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* Note: we can’t do  since the value of prevCount will be returned and then prevCount will be incremented by 1.
* Ex:
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**State (Class Components)**

* Before hooks were introduced the only way to modify state was with class components and this.state
* In class components, the initial state is defined in a constructor as an object which contains all the state for the component.
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* The state object is initialized in the constructor
* Graphical user interface, application

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* The state object can contain as many properties as you like:
* Graphical user interface, text, application, chat or text message

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* Refer to the state object anywhere in the component by using the this.state.propertyname syntax:
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* To change a value in the state object, use the this.setState() method. When a value in the state object changes, the component will re-render, meaning that the output will change according to the new value(s). Recall that in a functional component, if our state is an object, updating a property of the state replaces/overrides the state object to only have that 1 updated property instead. However, with class components, if our state is an object, updating a property of the state keeps all the properties from before and updates the properties that were changed.
* Suppose we have:
* Text

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* Then we run the following function
* Text

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* The previous state was Graphical user interface, table

  Description automatically generated with medium confidence. The new state is now Table

  Description automatically generated with low confidence. Notice we still have the properties brand and year.
* If the new value of a some state depends on the previous value of state, (such as increment count by 2), we do the following:
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* Note the following will actually only increment count by 1 since the value of this.state.count was the value of count when the component was last rendered.
* Text

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useState vs State in Class Components

* In function components, if we update the state, but not to something new, the component does not rerender.
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* In the above example, the state of count = 4 and then we click the Add2 button, we change the state of count to 4. Since the state of count is still 4, the component does not rerender. Note that even though the add2 function has a side effect of logging “hi” which will be logged every time the button is clicked, the component does not rerender.
* In class components, if we update the state, but not to something new, the component still rerenders.
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* In the above example, the state of count = 1 and then we click the change button, we change the state of count to 1. Even though the state of count is still 1, the component does rerender.

**React DOM/ Virtual DOM/ Re-Rendering**

* Diagram

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* The actual DOM is really slow. Accessing/rerendering items is really slow.
* Since the React DOM is written in JS and JS is really fast, React DOM is really fast. As well, React changes only what needs to be changed which makes rerendering is a lot faster.
* React components automatically re-render whenever there is a change in their state, props, or their parent component re-renders.
* So how is React able to update the DOM so quickly?
* Behind the scenes, React creates an exact copy of the whole real DOM called the React DOM/Virtual DOM.
* When there is an update, the entire virtual DOM gets copied and then the copy is updated. The updated virtual Dom gets compared to what it looked like before it updated and React figures out which objects have changed.
* The changed objects, and the changed objects only, get updated on the read DOM.
* Changes on the real DOM cause the screen to change.
* Causes for Component Re-rendering
  + Update in State
    - Note that a change in state rerenders the component even if the state variable is not displayed.
  + Update in prop
  + Re-rendering of the parent component
    - A parent component rerendering causes both the parent and its child components to rerender. The parent component is rerendered first, then the child components.
    - Note that a child component rerendering only causes the child component to rerender, and not the parent component to rerender.

**useEffect**

* useEffect is a hook that we can import that allows us to have side effects when something happens
* since useEffect is a hook, it is only available inside functional components
* 
* To use useEffect, we call useEffect() which is a function that takes in two parameters. The first parameter is a function. The second parameter is an array called the dependencies array. After any values within the dependencies array (the second parameter) changes, the function (the first parameter) is executed. If the dependencies array includes a state variable that changes, the order of events will be: the state variable will change, followed by a rerender, followed by useEffect function (the first parameter) executing.
* Note: the function is always executed once right after the component is rendered for the first time regardless of the parameters in the array.
* Ex:
  + Text

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  + When we render the component for the first time, we get  displayed on the webpage. Right after the component renders, “resource type changed” is logged into the console.
  + Whenever we click a button, we change the state. If the first button we click is posts, we change the state resourceType = “posts” to have a new value of “posts”. Since it is the same value, the component does not render again. But more importantly, since the value of resourceType is still the same (remains unchanged), the function in useEffect is not executed. Thus “resource type changed” is not logged to the console.
  + When we click the users or comments button, we change the state resourceType = “posts” to have a new value of “users” or “button” depending on which button we clicked. Since value of resourceType changed, the component rerenders. But more importantly, since the value of resourceType changed, the function in useEffect is executed. Thus “resource type changed” is logged to the console.
* If the second parameter is not included, the function is executed every time the component rerenders
* If the second parameter is the empty array [], the function is executed right after the component is rendered for the first time and is never executed again since the empty array never changes.
* Ex:
  + Text

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  + Webpage: => 
  + Console: Graphical user interface, application

    Description automatically generatedyo is printed. Then there is a delay. Then 11351, “hi”, 4, 11351 are immediately printed.
  + The component renders and displays 4 on the webpage since that is the initial value of the items state variable.
  + After this component renders for the first time, the function inside is called.
  + “yo” is immediately printed.
  + Response takes a while to fetch since it is a large file. Moreover, all the following lines of code, whether they use information related to response or not must all wait for response to finish fetching before they are executed. (the following lines are pushed into microtask q)
  + We then turn the data into JSON.
  + We then log 11351 which is the length of the data.
  + We then set the value of the items state variable to now be 11351.
  + We then log “hi”
  + We then log 4. Note that even though we updated the items state variable, 4 was the value of the items state variable when it was last rendered. Thus 4 is displayed.
  + We then create a variable called updatedItemsValue which we use to store the current value of items, no the last rendered value.
  + We then log that updatedItemsValue which is 11351
  + Since we changed the state, the webpage is rerendered so that it longer displays 4 for items, but 11351 instead.
  + Note that the component is rendered twice, once when we first render the component. Right after we render for the first time, we run the function inside the useEffect which change the state, causing a second render.
* Ex:
  + Text

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  + Output:
  + Graphical user interface, application, table

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  + This code generates an infinite loop.
  + We first render the component, its initial state is 0.
  + Right after the component renders, we run the function inside useEffect, update the state to 1, then return from the function.
  + Since the state was changed, two things happen. First, the component is rerendered so the webpage now displays 1 instead of 0. Second, state is one of the dependencies of the useEffect. Since state changed, the function inside useEffect is executed. This leads to an infinite loop.
  + In fact, if we modified the example above to not include the second parameter, the effect would be the same. This is because the function would be executed every time the component rerenders. Executing the function causes a change in state, which causes the component to be rerendered, which causes the function to be executed again.
* Cleaning up side effects
* We can add a return inside the useEffect function. This return itself will also be a function that I will call a cleanup function.
* In general, the cleanup function be called right before the functional parameter to useEffect is executed.
* However, when the component renders for the very first time, the cleanup function is not called.
* Also, the cleanup function will be executed whenever the component gets removed as long as the useEffect function gets called at least once. Since the useEffect function always gets called at least once (right after the component renders for the first time), the cleanup function will always be executed whenever the component gets removed.
* We can put code inside the cleanup function that might cleanup any side effects from the previous execution of the useEffect parameter function, hence the name cleanup.
* Text

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* In the above code, after we render the component for the first time, we run the function within the useEffect, but not the cleanup function. Thus, we log “resource change” and then we render the component.
* Note that useEffect changes whenever the component rerenders. In the above code, the component rerenders if the state changes.
* Thus, if we click the users button, we change the value of the resourceType state variable from “posts” to “users”. This change in state causes the component to rerender. Before the component rerenders, useEffect triggers.
* When useEffect is triggered, the return function is executed first so “return from resource change” is logged to the console. Then, the parameter function is executed so “resource change” is logged to the console. Then the component rerenders.
* An example of where this cleanup function might be useful is when we are adding eventListeners.
  + Consider the following code:
  + Text

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  + Right after this component renders for the first time, the function within useEffect is executed.
  + The function inside useEffect adds a ‘resize’ eventListener to the window which updates the value of the windowWidth state variable to be whatever the new window inner width is. Not that when the state changes (because the window gets resized), the component is rerendered.
  + However, there is a problem. If we ever remove the App component, there will still be an eventListener for window. This can slow down our application.
  + To resolve this issue, we can add a cleanup function.
  + Text

    Description automatically generated

Component Lifecycle Methods

* When we create components, it goes through many stages of it as shown below.
* Graphical user interface, text, application, email

  Description automatically generated
* React provides us with methods called lifecycle methods that allow to what components should do at different stages of their lifecycle.
* Life cycle methods ONLY exist in the class components, but useEffect Hook can make this kind of method exist in Functional Components. The useEffect Hook sorta acts as componentDidMount, componentDidUpdate, and componentWillUnmount combined.
* Graphical user interface, text, application, email

  Description automatically generated
* Mounting Lifecycle Methods
  + These methods are called when an instance of a component is being created and inserted into the DOM.
  + React has four built-in methods that get called, in the following order, when mounting a component:
  + constructor(props)
    - The constructor(props) method is called before anything else, when the component is initiated, and it is the natural place to set up the initial state , other initial values.
    - We should not do anything that may cause side effects. Ex: do not many any HTTP requests
    - We must call super(props) inside the constructor which will initiate the parent's constructor method and allows the component to inherit methods from its parent (React.Component).
    - Only after we have done super(props) do we have access to this.props.
    - The constructor is the only place we should initialize the state by overwriting this.state fields. In other scenarios, we have to use this.setState.
    - Ex:
      * Text

        Description automatically generated with low confidence
  + static getDerivedStateFromProps(props, state) //RARELY USED
    - This method is called right before rendering the element(s) in the DOM.
    - This method should be used to update the state of a component in response to a change in props.
    - It takes state as an argument, and returns an object that represents the new state of the component.
    - Since this method is static, it does not have access to the ‘this’ keyword. Thus, we cannot call this.setState in this method.
    - We should not cause any side effects in this method such as fetching data.
    - Note we could also return null to make no updates
    - Ex:
      * Graphical user interface, text, application

        Description automatically generated
      * The example below starts with the favorite color being "red", but the getDerivedStateFromProps() method updates the favorite color based on the favcol attribute
  + render()
    - The render() method is required, and is the method that actually outputs the JSX to the DOM.
    - The render method should be a pure method.
    - We should not change the state/interact with the DOM/fetch
    - The lifecycle methods of the children components are executed right after the parent render method.
    - Ex:
      * Graphical user interface

        Description automatically generated with medium confidence
  + componentDidMount()
    - This method is only called once. It is called right after the component and all of its children components have rendered to the DOM.
    - This is where you run statements that requires that the component is already placed in the DOM.
    - This method is where we should cause side effects such as interact with the DOM and fetch data.
    - Ex:
      * Text, letter

        Description automatically generated
  + Consider this following example
    - A picture containing text

      Description automatically generated
    - Text

      Description automatically generated
    - The console will print:
    - Graphical user interface, text, application, email

      Description automatically generated
    - The webpage will be:
    - 
    - Recall the order of mounting lifecycle methods from above.
    - When we create an instance of the App component, the constructor is invoked first. Thus, we set the state to have a field favoriteColor with a value of ‘constructor\_color’. Then we print out ‘Lifecycle A constructor’
    - The getDerivedStateFromProps method is invoked second so we print ‘Lifecycle A getDerivedStateFromProps’. Since we said return {favoriteColor: props.color}, the state now becomes { favoriteColor: "props\_color" }
    - The render method is invoked third so we print ‘Lifecycle A render’. Then we render the JSX onto the webpage and since state is currently { favoriteColor: " props\_color" }, the h1 tag ‘My favorite color is props\_color’ is rendered to the screen.
    - Then the componentDidMount is invoked fourth so we print ‘Lifecycle A componentDidMount’
  + Consider the following example
    - Text

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    - Text

      Description automatically generated
    - App and App2 are the same except App2 is a child component of App. As well, App prints ‘Lifecycle A something’ while App2 prints ‘Lifecycle B something’
    - Webpage:
    - Text

      Description automatically generated with medium confidence
    - Color\_b is printed first instead of color\_a because in component A, we rendered rendered App2 first then App’s h1 tag. If we swapped the order, then color\_a would be first. This order has nothing to do with the order of lifecycle methods between parent and class components.
    - Console:
    - Graphical user interface, text, application

      Description automatically generated
    - Recall that componentDidMount() is called right after the component and all of its children components have rendered to the DOM. Thus, before App’s componentDidMount() is called, all of App2 must be rendered to the DOM. That is why ‘Lifecycle A componentDidMount’ appears last in the console.
* Updating Lifecycle Methods
  + These method are called when a component is being rerendered because of changes to either props or state
  + React has five built-in methods that get called, in the following order, when mounting a component:
  + Static getDerivedStateFromProps(props, state)
    - This method is called every time a component is re-rendered.
    - This method should be used when the state depends on the props of the component.
    - We should not cause any side effects
    - This method is invoked in both the mounting and updating phases.
    - Ex:
      * A picture containing text

        Description automatically generated
  + shouldComponentUpdate()//RARELY USED
    - Within this lifecycle method, you can return a boolean  —  true or false — and control whether the component gets rerendered or not respectively (e.g., upon a change in state or props).
    - By default, this function returns true which means all class components will rerender whenever the props/state changes. This method can prevent this default behaviour by returning false.
    - In this method, we can compare the existing state and prop values with the nextProps and nextState values and return true or false to let react know if we should rerender.
    - This method is for performance optimization and should not cause any side effects
    - Ex:
      * A picture containing text

        Description automatically generated
  + Render()
    - If the shouldComponentUpdate method returns true, render causes the component to rerender. If the shouldComponentUpdate method returns false, render is not called.
    - Ex:
      * Graphical user interface, text, application

        Description automatically generated
  + getSnapshotBeforeUpdate(prevProps, prevState) //RARELY USED
    - This method lets you have access to the props and state before the update, meaning that even after the update, you can check what the values were before the update.
    - This method is called right before the changes from the virtual DOM are to be reflected in the DOM.
    - This method returns null or a value. Returned value with be passed as a third parameter to componentDidUpdate() which is the next method we will learn about.
    - If the getSnapshotBeforeUpdate() method is present, you should also include the componentDidUpdate() method, otherwise you will get an error.
    - The value queried from the DOM in getSnapshotBeforeUpdate refers to the value just before the DOM is updated, even though the render method was previously called.
    - Ex:
      * Text

        Description automatically generated
  + componentDidUpdate(prevProps, prevState, snapshot)
    - snap is the value returned from the getSnapshotBeforeUpdate method.
    - This method will be called after the render is finished. Thus we can be sure that the component and all its child components have been properly rendered after the update.
    - This method is executed only once per re-render cycle.
    - We can use side effects such as fetch in this method. It’s good practice to compare the prevProps and prevState values with the currProps and currState values and then decide if we should make the fetch call. Since if we don’t compare, we would be making unwanted requests.
    - Ex:
      * A picture containing text

        Description automatically generated
  + Ex:
    - Text

      Description automatically generated Text

      Description automatically generated
    - When we refresh the page, clear the console, then click the button, we get the following output:
    - Console: A screenshot of a computer

      Description automatically generated with medium confidence
    - The first three methods from A are printed since that is the order of method execution.
    - Recall that whenever a parent component rerenders, all its subsequent child components will re-render, regardless of whether the child components’ props have changed or not.
    - Thus, Lifecycle A prints ‘Lifecycle A render’ and causes App2 to rerender.
    - This causes the next 4 methods from B to print what they need to print.
    - After ‘Lifecycle B render’ is rendered, the changes from the virtual DOM are about to made to the real DOM. This is when the getSnapshotBeforeUpdate is called which is why ‘Lifecycle B getSnapshotBeforeUpdate’ and ‘Lifecycle A getSnapshotBeforeUpdate’ are printed. Why they are in this order, I don’t know. Right after they are printed, the real DOM is changed.
    - Since componentDidUpdate is printed after the entire render process as the real DOM is changed, it makes sense that ‘Lifecycle B componentDidUpdate’ and ‘Lifecycle A componentDidUpdate’ are printed last. Why they are in this order, I don’t know.
  + Ex:
    - Text

      Description automatically generated
    - If we render this app then press the button, the webpage will display:
    - A picture containing text

      Description automatically generated
    - The console will display: 
    - This is because when we click the button, we change the state from { favoriteColor: "constructor\_color\_a" } to { favoriteColor: "new\_color\_a " }. This change in state causes the component to rerender which is why the webpage will display the new color. In the console, we printed out the prevState.favoriteColor in the componentDidUpdate method. The value of the state varaible is { favoriteColor: "new\_color\_a "}, but was previosuly { favoriteColor: "constructor\_color\_a" } which is why constructor\_color\_a was logged to the console.
  + Ex:
    - Text

      Description automatically generated
    - Notice after we click the button, nothing happens since shouldComponentUpdate returns false. Also notice that componentDidUpdate does not print “yes” since it did not update. Note the value of the state variable is still , so there truly was no affect of clicking the button.
* Unmounting Phase method
  + This phase only has one method, componentWillUnmount(), which is invoked when immediately before a component is unmounted and destroyed.
  + In this method, we can perform cleanup tasks such as cancelling network requests, removing event handlers, etc.
  + Ex:
    - Graphical user interface, text, application, email

      Description automatically generated
* Error Handling Phase
  + When there is an error either during rendering, in a life cycle method, or an error is thrown by any child component, these methods are invoked.
  + React has five built-in methods that get called, in the following order, when mounting a component:
  + static getDerivedStateFromError()
    - Whenever an error is thrown in a descendant component, this method is called first, and the error thrown passed as an argument.
    - Whatever value is returned from this method is used to update the state of the component.
    - Graphical user interface, text, application, email

      Description automatically generated
    - Right now, whenever an error is thrown in a descendant component, the error will be logged to the console, console.error(error), and an object is returned from the getDerivedStateFromError method. This will be used to update the state of the ErrorBoundary component i.e with hasError: true.
  + componentDidCatch()
    - The componentDidCatch method is also called after an error in a descendant component is thrown. Apart from the error thrown, it is passed one more argument which represents more information about the error:
    - Graphical user interface, text

      Description automatically generated with medium confidence
    - In this method, you can send the error or info received to an external logging service. Unlike getDerivedStateFromError, the componentDidCatchallows for side-effects.
    - Also, since the ErrorBoundary can only catch errors from descendant components, we’ll have the component render whatever is passed as Children or render a default error UI if something went wrong:
    - Graphical user interface, text, application, email

      Description automatically generated

**React Router**

* Might need to run: npm i react-router-dom
* React Router DOM enables the navigation among views of various components in a React Application, allows changing the browser URL, and keeps the UI in sync with the URL.
* Since we never fetch a new html page, we give the illusion of going to new pages by rendering certain components.
* BrowserRouter, Routes, Route
  + BrowserRouter (often imported a Router): BrowserRouter is a router implementation that uses the HTML5 history API(pushState, replaceState and the popstate event) to keep your UI in sync with the URL. It is the parent component that is used to store all of the other components that want to be included in the routing system.
  + Routes: this is a component that determines where in our router system we want to have routes. It’s a new component introduced in the v6 and a upgrade of the Switch component. The main advantages of Routes over Switch is that Routes are chosen based on the best match instead of being traversed in order.
  + Route: Route is the conditionally shown component that renders some UI when its path matches the current URL. Inside the Route component, we have a path and an element field. The path on the website matches the path in the Route, the component inside the element field will be rendered.
  + Text

    Description automatically generated
  + The Home, About, Pages, and Error components just return a div that has text Home, About, Pages, or Error respectively.
  + Now, when we load our react app which should have a default path of ‘/’, we render the Home component. If we type “/about” in the url as the path, we render the About component. If we type “/page” in the url as the path, we render the Pages component. If we type anything else in the url as the path, we render the Error component.
  + Note that if we didn’t have <Route path="\*" element={<Error />} /> and we tried typing in a random path, we would get an blank white page.
  + Note that the header and footer are always rendered no matter what Route is rendered since the header and footer do not depend any path in order to be rendered.
* Link
  + The user shouldn’t navigate from one page to another by typing in paths in the url.
  + To solve this problem, we can import the Link component from react-router-dom which provides links that can be clicked to navigate to different routes.
  + This is similar to the <a> tag that exists in normal HTML.
  + Inside the Link component, we can say to = “/somepath”. The path we pass in is the path that we want to be directed to when we click the link.
  + Text

    Description automatically generated
  + Notice when we click the different links, the paths in the url changes and the component rendered also changes. Also note that similar to header and footer, the Link components are always rendered since they don’t depend on any path in order to be rendered.
* useNavigate
  + While we can navigate to different routes by changing the url or clicking Links, we might also want to go to a route when a button/div/some other HTML element is clicked.
  + To solve this problem, we can import the useNavigate Hook from react-router-dom.
  + To use the useNavigate Hook, we call useNavigate() which is a function that doesn’t take any parameters and returns a function. This returned function takes in a path as the parameter and navigates towards the certain path when it is executed.
  + Text

    Description automatically generated
  + Notice that we define the function const navigate = useNavigate();
  + Then we pass in a function to the button which returns navigate(“/about”) when it is clicked. Executing navigate(“/about”) will take us to the about page.
* useParams
  + Suppose we want to go to an about page for a specific user. So if we go to “/about/user1”, we would want to get page that corresponds to user1.
  + To do so, we can import the useParams Hook from react-router-dom.
  + useParams allows us to add parameters to certain paths and access those parameters.
  + To add a parameter to a certain path, we add “/:my\_parameter\_name” to the end of the path. 
  + In the example above, the parameter\_name is “my\_id”.
  + Text

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  + To access the parameter, we go to the component that is rendered at that path and call the useParmas function. This function returns an object with one property. The object is { my\_parameter\_name : path\_parameter\_that\_user\_passed\_in}. We can destructure this object to get the value associated with the my\_parameter\_name property.
  + Ex:
    - 
    - Text

      Description automatically generated
    - Suppose we go to the path ‘/about/user3’
    - Since that path matches the Route with path = “/about/:my\_id”, we render the component at that Route which is the About component.
    - There, we use the useParmas() function to return an object that contains the value of ‘user3’ at the property with name my\_id.
    - This object can be logged to get: A picture containing diagram

      Description automatically generated
    - We can destructure the object so we now have a constant named my\_id that has a value of ‘user3’. Note that ‘user3’ is a string
    - Now, we can use my\_id in our application such as in the div.
    - Graphical user interface, text, application, chat or text message

      Description automatically generated
  + useParams can be useful to get the id of a certain user, allowing us to make an api request to get information about that certain user.

**Conditional Rendering**

* Inside react, we can’t use if statements.
* Instead, we use conditional rendering when we want to render a component/element based on a condition.
* We will have to use the useState hook to keep track of the condition.
* There are two ways to conditionally render, one with the && logical operator, and one with the ternary operator.
* && logical operator
  + Since the && short circuits, we can put the condition as the first operand and the component as the second operand. If the condition is true, the second operand will be evaluated, and the component will render. If the condition is false, the && operator short circuits so the second operand will never be evaluated, so the component is not rendered.
  + Ex:
  + Text

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  + Graphical user interface

    Description automatically generated
  + We have a Toggle component that we want to conditionally render.
  + We use the useState hook to keep track of whether we should render the Toggle component or not.
  + Initially, isToggled is false. Thus, when we render the component, we have to consider the expression {isToggled && <Toggle />}. Since isToggled is false, the && operator short circuits and the Toggle component is never rendered.
  + When we click the button, we change the isToggled state variable from false to true. This change in state causes the App component to rerender, Thus, we have to reconsider the expression {isToggled && <Toggle />}. Since isToggled is true, the && operator continues to evaluate the following operand, evaluating the Toggle component renders it.
* Ternary Operator:
  + The ternary operator behaves much like an if-statement.
  + Text

    Description automatically generated
  + In the example above, we check if isToggled (state variable) is true. If it is, we render the Toggle component. If not, we render the paragraph element.

**List Rendering and Keys**

* When we want to render arrays(lists) in react, we want to repeat some HTML for each item in the array.
* To do this, we can use the map method to add HTML to each item.
* Text

  Description automatically generated
* Webpage Output: Text

  Description automatically generated
* While this code works, it is better practice to refactor the JSX used in the map function into a separate component.
* Text

  Description automatically generated Text

  Description automatically generated
* This is better code since the person component is only responsible for rendering a person and and the App component is only responsible fro rendering the list of persons.
* However, there is actually a problem if we open the console.
* Text

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* This error is telling us that each item that was rendered using the map operator should have a prop called ‘key’. Moreover, each item should have a unique value for the ‘key’ prop. The value of this ‘key’ prop does not need to be an id, or a number, it can be whatever we want, as long as each item has a unique value for the ‘key’ prop.
* All we have to change is in the app component to have the key prop as shown below.
* 
* Notice that person.id is unique since each person in our example has a different id. The first person has id 1, the second has id 2, and the third has id 3.
* Note that instead of making the value of the key prop to be person.id, we could make it person.name since each person in our example has a different name.
* Note that the key prop is not accessible in the child component. Thus, the Person component does not have access to the key prop.
* Text

  Description automatically generated
* Webpage output: Text

  Description automatically generated
* Console: Text

  Description automatically generated
* Notice that we destructure the key prop in the Person component. However, this results in nothing being outputted on the webpage and an error in the console since the Peron component (the child component that the person info was passed to) does not have access to the key prop.
* To resolve this issue, we should pass the ‘key’ prob value as another prop.
* Text

  Description automatically generated
* Notice above how we passed a new prop called ‘my\_key’ which also has a value of person.id
* Text

  Description automatically generated
* Notice since we passed in the my\_key prop, we are able to destructure it and use it.
* Why are keys needed?
* Keys allow react to render faster since we can easily identify which items in a list need to be rerendered instead of possibly rerendering the entire list.
* Consider the following example where the list items don’t have keys
  + Graphical user interface, timeline

    Description automatically generated with medium confidence
  + The left is what was rendered before and the right is what was rendered after.
  + React will iterate over both lists at the same time and generates a mutation whenever there is a difference.
  + First, react will compare the first items in each list and see that there is no difference.
  + Then, react will compare the second items in each list and see that there is no difference.
  + Then, react will compare the third items in each list and see that the there is a difference and will insert the third item into the DOM tree.
  + In this case, react does not need to tear down the entire tree and then rebuild it from scratch. It just needs to insert the new item at the end.
* Consider the following example where the list items don’t have keys
  + A screenshot of a computer

    Description automatically generated with medium confidence
  + When comparing these two lists, react will realize the first items are different, the second items are different, and the third items are different.
  + React will mutate every child instead of realizing that it just needs to insert the new Diana list item at the front.
  + This inefficiency can be a problem which can be resolved by keys.
* Consider the following example where the list items have keys
  + Graphical user interface

    Description automatically generated
  + When comparing these two lists, react will realize that the list item with key = ‘3’ is a new item that needs to be inserted at the top. React will also realize the list items with key = ‘ 1’ and key = ‘2’ don’t need to be mutated so the rest of the tree is preserved.
* Generating Keys
  + We could use the item index in the array as its key, but that should only be done if the item in your list do not have a unique id, the list is static and will not change, and the list will never be reordered or filtered. In fact, react uses the index as the key if you don’t specify the key prop.
  + To generate keys, we can use the install an npm package called uuid that will allow us to generate unique id’s.
  + In the cmd, run: npm install uuid
  + Now, in the component we want to use the unique id’s in, we import uuid
  + 
  + To generate a random id, execute uuidv4() which returns a random id.
  + A screenshot of a computer

    Description automatically generated with medium confidence
  + Notice the use of uuidv4() in line 6.
  + Note that each time we execute uuidv4(), we get a different id. If we have to use an id many times, storing that value in a constant seems like the intuitive solution, but that doesn’t work.
  + Ex:
  + Text

    Description automatically generated
  + Webpage output: Text

    Description automatically generated with medium confidence
  + Console output: Text

    Description automatically generated
  + Note that the randomId’s don’t match.

**Event Listeners**

* Event listerens in react is basically the same as in JS. Make sure to use camelCase for events listeners such as ‘onClick’ instead of ‘onclick’. Also make sure to pass in a function such as clickHandler and not a function execution such as clickHandler().
* Functional components:
* Text

  Description automatically generated
* Class components:
* Graphical user interface, text, application

  Description automatically generated
* Note that it is convention for the function (this function refers to the function that will be executed when an event occurs) to include the word ‘handle’. Ex: onClickHandler, clickHandler, handleClick are good names for functions that will handle a button click. renderListHandler is a good name for a function that will render a list upon an event.

**useRef**

* Suppose we tried to count how many times our application renders using the useState Hook, we would be caught in an infinite loop since this Hook itself causes a re-render. The code for this is shown below.
* Text

  Description automatically generated
* The App component renders for the first time with the count state variable initially having a value of 0. After the first render, we then run the useEffect which changes this state to 1. Changing the state causes the component to rerender so the component rerenders. After the component rerenders, the function within useEffect is called once again so we change the state once again, causing the component to rerender.
* To avoid this, we can use the useRef Hook. useRef is a hook that we can import that allows us to store a value (much like useState) and access a DOM element directly.
* useRef(initialValue) is a built-in React hook that accepts one argument as the initial value and returns a reference (aka ref). A reference is an object with only one property called current. The value associated with the property current is called the reference value. The reference value will initially be initalValue which is the value that we passed into the useRef function as a parameter. If no argument is passed to useRef so we see useRef(), the default parameter is null.
* reference.current accesses the reference value, and reference.current = newValue updates the reference value to be newValue.
* Graphical user interface, text, application

  Description automatically generated
* The reference value is persisted (stays the same) between component re-renderings (like useState)
* Updating a reference doesn't trigger a component re-rendering (unlike useState)

Using useRef to store a value

* Ex:Now, we can count the number of times a component is rerendered with the code below.
  + Text

    Description automatically generated
  + The component renders for the first time to display: . This is because the reference value (renderCount.current) was initially set to 1 which was the initial value we passed to the useRef function.
  + After the component renders, the function inside useEffect is executed. The renderCount reference value of 1 is logged to the console. Then we change the reference value by incrementing it by 1. Then we log the renderCount reference value of 2 to the console. Note that useRef is unlike state since the state variable’s value is when it was last rendered. The refence value is not the value when the component was last rendered, but rather what the value currently is. When we finished executing this function within useEffect, the component does not render since no state was changed. Recall that unlike state, a change in the reference value does not trigger a rerender. Note that the reference value as of now is 2 but the refence value as of the last render is 1.
  + Output as of now: Graphical user interface, text, application

    Description automatically generated
  + Now let’s enter one character in the text field, lets say its ‘a’. This event is captured by the onChange event listener which executes the handleOnChange function.
  + The handleOnChange function changes the value state variable to take on the value that was in the text field. In this case, the value state variable now has a value of ‘a’. Since this function changed the state, when the function finishes executing, the component rerenders which causes the following output:
  + Graphical user interface, application

    Description automatically generated
  + This is because when the component rerenders, the current refence value is 2 so we display 2 on the webpage. Since we also changed the value state variable to be ‘a’, ‘a’ appears in the text field.
  + After the component rerenders, the function within useEffect is called again. It logs out the current refence value which is 2. Then it increments the refence value by 1 so it now has a value of 3. The function then logs out the current refence value of 3.
  + Console: 
* Using useRef to reference a DOM element
  + The most common use case for refs in React is to reference a DOM element.
  + Because of how common this use case is every DOM element has a ref property you can use for setting a ref to that element.
  + Text

    Description automatically generated
  + In the example above, we say ref = {inputRef}. In doing so, we set the reference value of inputRef to be the input element.
  + This component has an input field, a div that displays the value of the name state variable, and a button.
  + The user can input text into the input field, which is captured by the onChange event listener which executes the handleOnChange function, which updates the name state variable to be the value of whatever is in the input field. This change in state causes the component to rerender, which changes what is displayed in the div that says ‘My name is {name}’.
  + When the user clicks the button, the click is captured by the onClick event listener which executes the turnGreen function.
  + The turnGreen function uses the value of inputRef.current and recall that we said <input ref = {inputRef}>. Thus, the value of inputRef.current is the input Element. This is the same return type as if we were to do document.getElementById(“hey”). In fact, not only are they the same return type, the Element object returned by inputRef.current is exactly the same as the Element object returned by document.getElementById(“hey”) which is proven by the console logging true to the === statement. Thus, we can change properties for his Element object such as changing its font color to green. Note that this change in the Element does not cause the component to rerender but will cause the text inside the input field to change to green(the user can actually see that the text changed to green).
* Using useRef to store the previous value of state
  + Text

    Description automatically generated
  + In the example above, the value of the name state variable is initialized to be “” and the prevName refence value is initialized to be null.
  + Webpage output: 
  + Right after the component rerenders, the function inside useEffect is executed so the prevName refence value is now the value of the name state variable which is “”. Thus, the prevName refence value changed from null to now be equal to “”.
  + For the following: recall a state variable change will be followed be a rerender which will be followed by the function within useEffect being executed
  + When the user enters a character, say ‘a’, into the input field, the handOnChange function is executed. This causes the name state variable to now have a value of whatever is inside the input field which is ‘a’. Thus, the name state variable now has a value of ‘a’.
  + This change in state causes a rerender so the output is now: This is because the name == ‘a’ so ‘My name is a’ is displayed on the webpage. As well, since the value of the input field is name, the text inside the input field is ‘a’. Recall that the prevName reference value is current “” which is why “used to be” is displayed on the webpage.
  + After the component rerenders, the function within the useEffect is executed. Now, the prevName refence value is the value of the name state variable which is “a”. Thus, the prevName refence value changed from “” to now be equal to “a”.

Things to avoid with useRef

* + While useRef can store a value much like useState. if we can use useState, we should use useState instead. To change values should be done with state, but reading values can be done with useRef if needed.
  + Do not add/remove DOM elements in a component. This can lead to inconsistencies between the actual DOM and the React virtual DOM which is very bad.