The beginners

GUIDE TO REACT & REDUX

The Complete React Web Development Course (with Redux)

Section 1

REACT 101

- Install Visual Studio Code
- Install Node.js
- Setting up a Web Server
- Setting Up Babel
- Exploring JSX & JSX Expressions
- ES6 Variables & Arrow Functions
- Events & Attributes
- Manual Data Binding
- Forms & Input
- Arrays in JSX

In this section we will dive into the very basic fundamentals of React and setting up your own web developer environment to write and execute your own code. We will go through installing a very popular text editor release by Microsoft called Visual Studio Code to installing Node.js on your machine and then onto setting up your very own local web server and installing Babel.

Once we have setup your developer environment we will continue to learn the fundamentals of JavaScript (ES6) and JSX syntax to build our foundational skills on both languages and technologies on which the React Library is built upon.

After learning the basics we will move onto the next sections where we will start learning more about the React component architecture and will build our own applications.

It will soon become apparent why React is considered a very popular frontend JavaScript library as you are not required to learn a new language but rather learn an application architecture based on components.

INSTALLING VISUAL STUDIO CODE

Visual Studio Code

There are many free and paid text editors out there available to download and use to write your own code, popular editors include Atom, Sublime Text, Notepad++ and Visual Studio Code to name a few. We will be using Visual Studio code as our text editor of choice to write our code as it allows us to install some useful packages to help write our code.

To install Visual Studio code simply visit the following website and download and install the application onto your machine: https://code.visualstudio.com/

Visual Studio Code has some useful extensions which you can install:

- Bracket Pair Colorizer
- ES7 React/Redux/GraphQL/React-Native Snippet
- Liver Server
- Prettier - Code Formatter
- Babel ES6/ES7

INSTALLING NODE.JS

Node is JavaScript on the server. You can visit the following website to download node onto your machine: https://nodejs.org/en/

Download the latest version of node that is available on their website.

To check that you have node.js installed on your machine, simply open up your terminal and enter the following command:

```
$ node –v
```

This will allow us to double check that node was installed onto our machine as we now have this new command and it also shows us what version of node you have installed on your machine. When installing node we also got NPM (node package manager) which allows us to install various dependencies/packages such as React or Yarn and other libraries. NPM and Yarn aims to do the same job. To check that you have npm installed enter the following command in your terminal:

```
$ nom –v
```

To install yarn on your machine globally run the following command in your terminal:

```
$ npm install –g yarn
```

On windows machines you will need to restart your machine to complete the installation. To check that yarn has installed successfully, run the following code in your terminal:

```
$ yarn ––version
```

SETTING UP A WEB SERVER

To setup a developer web server we can achieve this in two ways using live-server.

Firstly you will need to create a directory (folder) for your application. This folder will act as a place for all your project code. This folder can be called anything for example 'indecision-app'. In this example we will create a sub-folder called public and store our basic HTML file.

If we open VS Code and have installed live-server extension we can simply open up our html document and right-click to open the file with live-server. Every-time we update our project files in the folder, the live-server will refresh the browser which will update our application with the changes automatically.

Alternatively, we can use npm or yarn to install live-server globally onto our machines using either command in the terminal:

```
$ npm install –g live-server    or    $ yarn global add live-server
```

To check that we have installed live-server on our machine correctly we would run the command:

```
$ live-server –v
```

To run live server from the terminal, navigate to your file directory using cd and the file path. Note: you can use **cd** to change directory, **ls** (or **dir** on windows) to list all the files within the folder. You can use **cd ~** to navigate back to your user folder. Once you have navigated to your project directory run the following code:

```
$ live-server public
```

Note: you would run live-server followed by the folder name in the directory you wish to serve through the live web server (in our example we had a sub-folder called public which contained our HTML file). Any changes made in the folder will automatically update in the browser.

SETTING UP BABEL

Babel is a compiler and allows you to write for example JSX, ES6, ES7 code and have it compile down to regular ES5 code, allowing your code to work on browsers which only support ES5 syntax.

https://babeljs.io/

Babel on its own has no functionality. Babel is a compiler but its not going to compile anything by default. We have to add various plugins and presets in order to get any sort of change in our code (e.g. taking JSX code and converting it into ES5 createElement calls). A preset is just a group of plugins.

We are going to install babel locally on our machines so that when we write our code in JSX/ES6/ES7 it will compile locally to our ES5 code (i.e. we want to write our code locally on our machine and update without using Babel on the web).

The babel website has a docs page which provide documentation on plugins available to you to install. We will install two presets: react preset and env preset. These presets have all the necessary plugins we require and we would not need to install the plugins individually by ourselves (*as this could get out of hand very quickly*). The env preset will include ES2015, ES2016 and ES2017 plugins which will give us access to the new JavaScript features (e.g. arrow functions, const and let variables, spread operator etc).

In our local environment we are going to install three things:
Babel itself, env preset and react preset.

In your terminal run the following command to install babel @v6.24.1 globally on your machine.

```
$ npm install –g babel-cli@6.24.1  or    $yarn global add babel-cli@6.24.1
```

This will give us a new command in our terminal which we can run while in our project directory. Run the following code to check if Babel has been installed successfully. This should print out the help output in your terminal and will indicate if Babel has been installed successfully on your local machine.

```
$ babel ––help
```

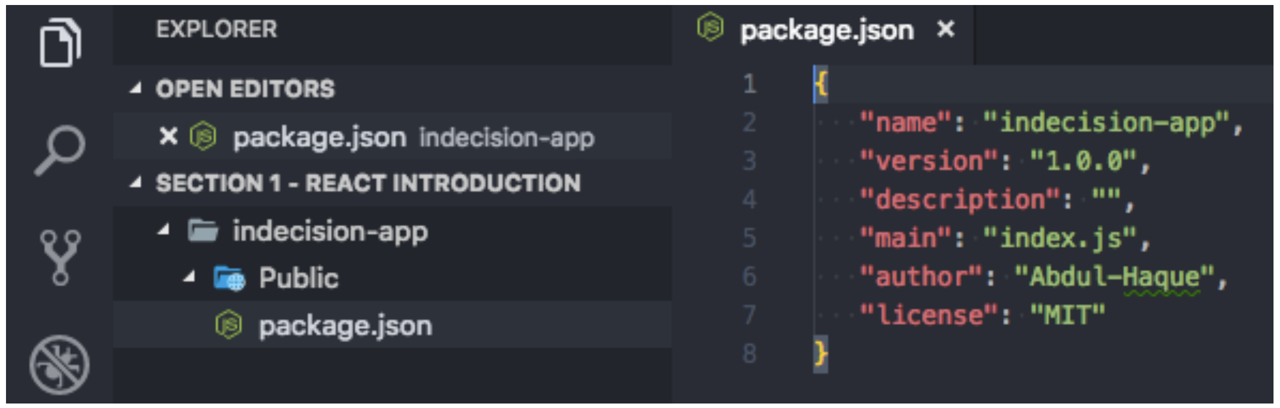
To clear the terminal enter the command line:

```
$ clear
```

The react and env presets will be installed locally in our projects (i.e. these codes will live in our projects so that babel CLI can take advantage of these codes to transform our code down to ES5 syntax). Within the project directory enter the following command:

```
$ npm init      or    $ yarn init
```

This command will setup our project to use node/yarn and specify the local dependencies. This will walk us through series of questions such as the app name, version, description, entry point, repository, author and license (MIT).
All this does is, it generates a brand new file in our project called package.json (*note we could have created this file ourselves without the npm/yarn init command*). The whole point of package.json is to outline all the dependencies that the project needs in order to run. This will make it easy to install everything.

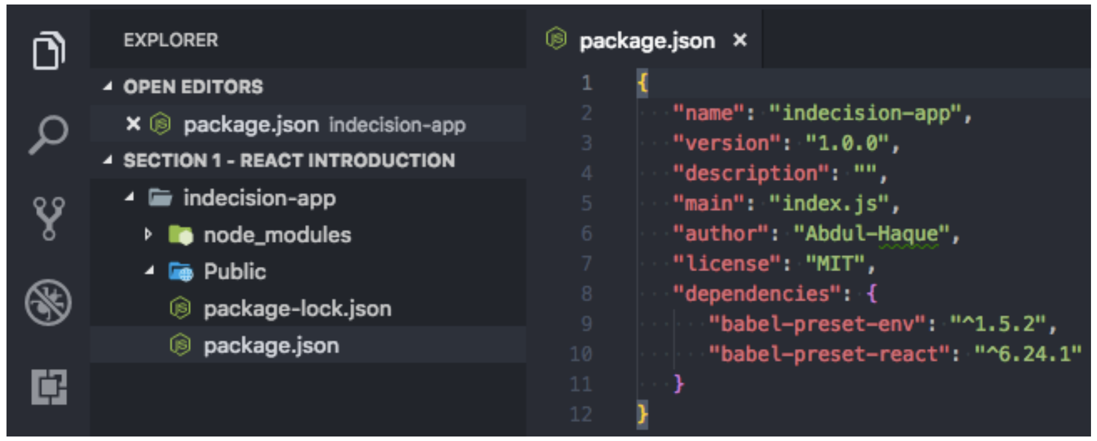


```
{
  "name": "indecision-app",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "author": "Abdul-Haque",
  "license": "MIT"
}
```

We are going to add our dependencies to this package.json file using the following commands in the terminal:

```
$ npm install babel-preset-react@6.24.1 babel-preset-env@1.5.2      or

$ yarn add babel-preset-react@6.24.1 babel-preset-env@1.5.2
```

This will install the two dependencies and will update the package.json file in our app folder which will now list our dependencies for our app. Notice that a new folder has been created called node_modules. This is where all the modules and dependencies will live.



```json
{
    "name": "indecision-app",
    "version": "1.0.0",
    "description": "",
    "main": "index.js",
    "author": "Abdul-Haque",
    "license": "MIT",
    "dependencies": {
        "babel-preset-env": "^1.5.2",
        "babel-preset-react": "^6.24.1"
    }
}
```

The dependencies will have their own package.json file which will list the dependencies they require to run. This will install the all the sub-dependencies of their own in the node_modules folder. The package.json file makes it easy to install all the dependencies and sub-dependencies your application will need.

We will never need to go into the node_modules folder to change any of the code. This folder is a auto-generated folder from the package.json file and we can always delete and reinstall this folder/modules using the dependencies information from the package.json file (*we would use the command $ npm install or $ yarn install to install the node_modules folder again*).

This command has also generated a package-lock.json file (*if you used yarn this file will be called yarn.lock*) in our project folder. We will not need to edit/manually change this file. This file lists out all the dependencies in the node_module folder, the version used and where exactly it got that package from. This helps npm/yarn behind the scenes.

We are now able to use Babel locally on our machines within our project directory to compile our React JSX code into regular ES2015 code. In the terminal we will need to run the following command with a few arguments:

```
$ babel src/app.js ––out–file=public/scripts/app.js ––presets=env, react ––watch
```

The first argument specifies the path to our code we wan to compile (*in our example above it lives in the src folder and the file is called app.js*).
The second argument specifies the output file (in our example above it lives in the public/scripts folder and is also called app.js). This file will always be overridden by Babel.
The third argument specifies the presets we would like to use (this is a *comma separated list of the presets we wish to use*).
Finally, the last argument will watch for any changes in the first specified file to update (compile) the second specified file automatically.

Babel will compile the JSX/ES6/ES7 code in one file into regular ES2015 code the browser will understand in the other file.

EXPLORING JSX

In JSX you can only have a single root element. If you want to add more elements side by side we will need to wrap it within a single root element for example:

```
var template = <div><h1 id="someid">Header Text</h1><p>Paragraph Text</p></div>;

var appRoot = document.getElementById('app');

ReactDOM.render(template, appRoot);
```

When we are creating JSX expressions, we can get really complex expressions to include a lot of information/nested elements - however, we must have a single root element.

We can make our JSX expression more readable by formatting the elements on separate lines i.e. format as we would do in our html code for example:

```
var template = (
    <div>
        <h1 id="someid">Header Text</h1>
        <p>Paragraph Text</p>
    </div>
);
```

The above would still be seen as valid JSX expression and table will successfully render the expression down to ES2015.

The above is more readable to the eye and easily understood. We can make the expression even more complex and as long as there is a single parent root element (the <div> wrapper) then this will be seen by Babel as valid JSX. Below is another example of a complex JSX expression with nested elements.

```
var template = (
    <div>
        <h1 id="someid">Header Text</h1>
        <p>Paragraph Text</p>
        <ol>
            <li>Item One</li>
            <li>Item Two</li>
        </ol>
    </div>
);
```

All this is doing is creating nested React.createElement() functions calls to create each element in the ES2015 syntax.

```
    React.createElement('ol', null,
        React.createElement('li', null, 'Item One'),
        React.createElement('li', null, 'Item Two')
    )
```

This is why we do not write our React code in React.createElement calls as it is difficult to read and write, instead we use JSX.

We can make our JSX code dynamic by using variables to store data and then referencing these variables within our JSX expressions. For Example:

```
var userName = 'John Doe';

var template = (

    <div>

        <h1> { userName .toUpperCase()} </h1>

    </div>
```

We use the curly brackets to write any JavaScript expressions. Therefore we can enter the JavaScript variable within the curly braces to output the variable value in our JSX code. This allows our JSX to be dynamic rather than static.

In our JavaScript expressions we can use different types such as strings, numbers, operators, arrays, objects, functions etc. To render an object in React we must specify the object property, for example:

```
var user { name: 'John Doe',   age: 28,   location: 'Derby' } ;

var template = (

    <div>

        <h1> Name: { user.name } </h1>

        <h1> Age: { user.age } </h1>

        <h1> Location: { user.location } </h1>

    </div>

);
```

We have now dynamically injected our data from our variables into our JSX expression.

We should now have knowledge on how to use JavaScript expression in React, how to render JavaScript strings and number types and that we cannot render object but we can render the object properties.

There are still many more other JavaScript types. We are going to continue to look at JavaScript expressions and how we can make truly dynamic and useful JSX.

Conditional Rendering and conditional logic in general is at the very core of software development. The same will be true for our React interfaces for example, is the user logged into the app? If true, then show the logout button, else show the login button.

To perform Conditional rendering in our JSX we will need to use JavaScript expressions. We can continue using the regular conditional statements we have been using in vanilla JavaScript and do not need to learn any weird syntax.

The conditional JavaScript tools that are available are:
1) If Statements.
2) Ternary operators.
3) Logical and operator.

IF STATEMENTS:
A if statement is not an expression and therefore cannot live inside the curly brackets (i.e. JavaScript expression). However, calling a function is an expression. We can add whatever we want in our function including if statements. The return value from the function will show up in the JSX. For example:

```
var user = {

    user: ‘John Doe’,

    age: 28,

    location: ‘Derby’

}
```

```
function getLocation(){

        if (location) {

                return location;

        } else {

                return 'unknown';

        }

};

var template = (

        <div> <h1> { getLocation(user.location) } </h1> </div>

) ;
```

We can use the function to operate the if statement and whatever is returned from our function can be used in our JavaScript expression to pass the data into our JSX to display.

We can use other JSX expression such as {123} and {<h3>Heading 3</h3>} and this will render in our browser. This is equivalent to writing JSX expression outside of the curly brackets. This is useful as it allows us to setup getLocation() to return a separate JSX expression. For example:

```
function getLocation(){

        if (location) {

                <h1> { getLocation(user.location) } </h1>

        } else {
```

```
        return undefined;
    }
};
var template = (
    <div> { getLocation(user.location) } </div>
) ;
```

Important Note: undefined is implicitly returned if you do not explicitly return it. Therefore the above getLocation() function can be simplified without returning the else statements:

```
function getLocation(){
    if (location) {
        <h1> { getLocation(user.location) } </h1>
    }
};
```

This will implicitly return undefined when the statement returns false. If the Statement returns true this will return the JSX expression value within the other JSX expression curly brackets. This will then render in our browser.

TERNARY OPERATORS:
A ternary operator is a expression and not a statement and therefore we do not need to add it to a function. A ternary operator allows us to write if statements more concisely. For example:

```
True ? ‘Return True’ :  ' Return False’;          [This will return ‘Return True’ as the statement is true]
```

False ? ‘Return True’ : ' Return False’;   [This will return ‘Return False’ as the statement is false]

These two ternary operator will check whether the statement is true or false. If true it will return the first value else it will return the false value. Therefore the first example will return ‘Return True’ while the second example will return ‘Return False’. We use the ? to return something when the statement equates to true while we use the : to return something when the statement equates to false.

The first part of the ternary operator is the statement we wish to check the value i.e. whether it will return true or false. Depending on the answer we want to return the first value else we return the second value. For example:

{ app.option.length >0 ? <p>’Here are your options’</p> : <p>’No options’</p> }

LOGICAL AND OPERATOR:
Much like the undefined, null and the boolean values true and false are all ignored by JSX. Therefore we can write a JSX expression of {true}, {false}, {null} or {undefined} and all will be ignored by JSX and will not be rendered on the screen. This is a very useful feature.

If we want to display a JSX expression e.g. <p> tag for age, only if the user is 18yrs or older else we do not want to display the age of the use if they are under age. We could use the function technique, however, we are going to explore this new technique which is just as concise as the ternary operator.

The Logical And Operator uses the && to check if two arguments returns true to run the code. If both do not return true we do not want to run the code. We will examine the Logical AND Operator to understand the technique and how it can be used to solve the above problem without using to the function technique.

true && ‘Some Age’;

If we run the above, this will return the value ‘Some Age’. So in Logical And Operator if the first value is true it is not going to use/return that first value; however, if the second value is also true it will use/return the second value.

```
False && 'Some Age';
```

If we now run the above, this will return false. So in this instance, where the first value is false, that value is what actually gets used/returned and ignores the second value ever exists.

Therefore if we check for age and the user is below 18 a boolean (false) is returned and this is ignored by JSX. We can use this tools and technique to add this conditional rendering in our JSX.

The ternary function is great for when you want to do one of two things, while the Logical And Operator is useful for when you want a condition to do one thing else you want to do nothing at all.

We can make our Logical And Operator even more complex by checking two things in our first value to equate to true or false for example we can check if the age exists at all and is above 18 to return our JSX. For example:

```
{ (user.age && user.age >=18) && <p>Age: { user.age } </p> }
```

We have now explored the very basics of conditional rendering techniques we will use over and over again. Eventually, over time and lots of practice, we will eventually master all three strategies. However, we should now be confident of being able to make our JSX expressions more dynamic.

ES6 ASIDE: LET & CONST

ES6 introduces let and const variables keywords which are alternatives to the var variable keyword. Is there anything inherently broken with var? No. The only problem with var is that it can be easily misused creating unnecessarily weird situations. For example: not only can you reassign a var variable but you can also redefine the variable. This means if recreate a var variable without knowing that you have created it elsewhere in your code, you are essentially overriding the original variable value and therefore you will run into hard to debug issues.

```
var nameVar = 'John Doe';

var nameVar = 'Mike';
```

The let and const variables prevents you from reassigning/redefining existing variables.

The let variable allows you to reassign the variable however you cannot redefine the variable (i.e. you cannot redeclare the same variable. You can however reassign it to another type e.g. a string to a number).

```
let nameLet =  'John Doe';

let nameLet = 'Mike';            > Uncaught SyntaxError: Identifier 'nameLet' has already been declared at…
```

The const variable does not allow you to reassign nor redefine the variable again.

```
const nameConst = 'Frank';

const nameConst = 'Barry';       > Uncaught SyntaxError: Identifier 'nameLet' has already been declared at…

nameConst = 'Barry';             > Uncaught TypeError: Assignment to content variable at…
```

By default you should always use the const variable when creating a new variable, however, if you need to reassign the variable then you should switch to the let variable instead. You should stop using the var variable.

There are a few other differences between var, let and const variables i.e. the scoping of the variables are also different.

The var, let and const variable are all function–scoped meaning that the variable within the function cannot be accessed outside the function.

```
function getName(){

        name = 'Paul';

}

getName();

console.log(name);                    > Uncaught ReferenceError: name is not defined at...
```

Note: we could create the variable called name outside the function and set the value to the function which will work.

The let and const variables are all block-scoped whereas var is not. Bock Scoping is where the variable are also bound to the code block (e.g. the code block for an if statement or a code block for a for loop). For example: if we had a variable in an if statement this variable can be accessible outside this code block provided this variable uses var instead of let and const.

```
const fullName = 'John Doe';

If(fullName) {

        const firstName = fullName.split(' ');

}

console.log(firstName)                > Uncaught ReferenceError: name is not defined at...
```

Remember the rule: '*const first; if we need to reassign, let; … var never!*'

ES6 ASIDE: ARROW FUNCTIONS

Arrow functions is a new ES6 syntax and is used heavily throughout React, therefore, it is important to have a basic grasp of how arrow functions operate.

We are going to compare and contrast a regular ES2015 function with a ES6 Function. The function we are going to create will square a number.

ES2015 Regular Function Syntax:

```
const square = function(x) {

        return x * x;

};

console.log(square(5));
```

ES6 Arrow Function Syntax:

```
const square =  (x) => {

        return x * x

};
```

Arrow functions do not need the function keyword. We start with the function argument(s) followed by an arrow and then the function body.

Arrow functions are always anonymous (*unlike ES2015 functions where we can give the function a name*). To give an arrow function a name we must always declare a const or let variable first and assign the arrow function to it as we did above. Example of ES2015 Function with a Name:

```
function square (x) {

     return x* x;

};

console.log(square(5));
```

If an arrow function body returns only a single expression we can use the new syntax. We no longer require the curly brackets. The expression is implicitly returned and therefore we do not need to write the return keyword (compared to the ES2015 syntax where we need to explicitly return):

```
const square = (x) => x * x
```

The argument object s and this keywords are no longer bound to the arrow function. This means that if you try to access the arguments, it is not going to work.

ES2015 Example:

```
const add = function (a, b) {

    console.log(arguments);

    return a + b;

};

console.log(add(1, 2, 3);
```

The arguments will have access to the 100 object even though this has not been defined in the function and is outside the function.

However this has gone away with arrow functions as we cannot access objects outside the arrow function.

```
const add = (a, b) => {
    console.log(arguments);
    return a + b;
};
console.log(add(1, 2, 3)          > Uncaught ReferenceError: argument is not defined at…
```

In ES2015 when we use a regular functions and we define it on an object property, the this keyword is bound by that object e.g. we have access to the values for example:

```
const user =  {
    name: 'John',
    cities: ['Bristol', 'Bath', 'Birmingham']
    printPlacesLived: function ()  {
        this.names;
        this.cities.forEach(function(city) {
            console.log(this.name + ' has lived in ' + city);
        });
    }
};
```

The forEach function takes in a single function as a parameter and will be called once for each item in the array with a single argument called city. However, this will return an error in the JavaScript console of Uncaught TypeError: Cannot read property 'name' of undefined at… This is because the this.name is not accessible inside the forEach function but is accessible in the printPlacesLived function which is and object inside of the user object. The past workaround was to create a const variable called that and assign the this value to it and then in the nested function use the that.name which will make the function work without causing the error message.

With arrow functions, they no longer bind their own values, instead they use the value of the context they were created in i.e. it would just use its parent 'this' value. We no longer require the ES2015 workaround.

```
const user = {
    name: 'John',
    cities: ['Bristol', 'Bath', 'Birmingham']
    printPlacesLived: function () {
        this.names;
        this.cities.forEach((city) => {
            console.log(this.name + ' has lived in ' + city);
        });
    }
};
```

There is no need for the const that = this workaround as arrow functions will use the value from the parent this keyword.

There are places where you would not want to use the arrow function for the very reason above such as methods for example if we turned the printPlacesLived method into an arrow function this will return and error message of Uncaught TypeError: Cannot read property 'name, cities' of undefined at… because the arrow function is no longer equal to the user object and will look to its parent level which is the global scope and therefore undefined causing the error.

ES6 does introduce a new method syntax where we can remove the ES2015 function keyword and have the above work.

```
    printPlacesLive() {…};
```

Map is an array method like the forEach() but it works a little differently. This function gets called one time for every item in the array. Just like the forEach we have access to the item via the first argument (e.g. we can call them city). The difference is that the forEach method just lets you do something each time e.g. print to the screen, whereas, the map allows you to actually transform each item and return a new item back. We can therefore transform our array and get a new array back.

```
const userMap = {

	name: 'Peter Parker',

	cities: ['New York', 'London', 'Rome']



	printPlacesLived() {

		return this.cities.map((city) => this.name + ' has live in ' + city);

	}

};

console.log(printPlacesLived());
```

This will return a new array object of ['Peter Parker has lived in New York', 'Peter Parker has lived in London', 'Peter Parker has lived in Rome']. Maps are used a lot in React development.

EVENTS & ATTRIBUTS

Responding to user interactions via events is at the core of all web apps.

Attributes sit within the opening tag of an html element for example id and class are attributes. The class attributes are used to add an identifier across multiple elements while id is a unique identifier.
However, in JSX some attributes remain the same while others have been renamed. An example of a renamed attribute is class which JSX refers to as className.

Regular HTML Attribute:

```
<div class='row'></div>
```

JSX HTML Attribute:

```
<div className='row'></div>
```

Certain keywords are reserved words in JavaScript such as let, const, class etc. and therefore certain HTML attributes required a name change in order to work with JSX. The React document page provides a full list of HTML attributes that have been renamed (scroll down to the All supported HTML Attributes section):
https://reactjs.org/docs/dom-elements.html

In JSX al the keywords have become camelCase for example autofocus is now autoFocus in JSX.

We would use the onClick attribute to create a function that would be run every time the button is clicked. We would reference the function within a JSX expression.

```
<button onClick={addOne}>Click Me</>
```

The function should be created elsewhere before the JSX expression i.e. define the function before calling it.

```
const addOne = () => {
        console.log('addOne');
} ;
```

This will display the addOne every time we click on the button which will indicate the function is being fired off every time the button is clicked. This allows us to create meaningful events for when the user interacts with our application but running functions.

Note we can add function inline with our JSX rather than separating the function out and this is perfectly viable, however, your code could end up looking unreadable. Good practice is to reference your function elsewhere and then call on that function within your JSX.

```
const template = {
        <button onClick={ () =>{
                console.log('addOne');
        } }></button>
}
```

We have now explored a little user interaction between the user and the React app.

MANUAL DATA BINDING

```
let count = 0;

count addOne = () => { count++ };

const template = (

    <div>

        <h1>Count: { count }</h1>

        <button onClick={addOne}>+1</button>

    <div>

);

const appRoot = document.getElementById('app');

ReactDOM.render(template, appRoot);
```

The above function will not update the count shown in the <h1> because the <h1> element has already been rendered to the screen and the application is not re-rendering to show the new count value.

JSX does not have built in data binding. When we create JSX, all the data that gets used inside of it, that happens at the time the code runs. Therefore, count is always going to be 0.

To fix this we need to rerun our template code and the ReactDOM.render function again when our data changes. We would use React Components to do that later on, but for now we will explore how to manually do this to understand how React works before we dive into React.

```
const renderCounterApp = () => {
    const template = (
        <div>
            <h1>Count: { count }</h1>
            <button onClick={addOne}>+1</button>
        <div>
    );
    ReactDOM.render(template, appRoot);
};
renderCounterApp();
```

With this new function renderCounterApp, this will render our application. We would want to initialise the function so that when we run our application for the very first time we would render the template to the screen. However, whenever we make changes to the data using event functions, we would want to call on that same function to re-render the template with the new data which allows our application to update in real-time.

This simple technique above illustrates exactly how React does this thing really well and we will look at the advanced techniques in more details later. It is important to understand that this is essentially what is happening behind the scenes in React.

React is actually very efficient behind the scenes as it does not re-render the whole application every time there is a change. React uses some virtualDOM algorithms in JavaScript to determine the minimal number of changes that needs to be made in order to correctly render the new application. Therefore, the whole application does not need to re-render which would be very taxing and make the application not scalable. Using ReactDOM.render we are getting all the capabilities of React and we are using the virtualDOM algorithm to efficiently render and re-render our application.

FORMS & INPUTS

The structure of forms will looks exactly the same as regular HTML, angular or any other templating frameworks. Forms are usually used to allow the user to input in information using the form and then doing something when the user submits the form. This allows applications to be more interactive. To create a form in html you will use a <form> tag and place everything you want in your form within these tags.

```
<form>
    <input type='text' name='identifier' />
    <button>Add Option</button>
</form>
```

The input tag has some attributes which remain the same as regular html. The type indicates the type of input field, while the name provides a unique identifier for the field which would allows us to collect the data from the input field when we listen for the form submission.

The above will create a textbook input field and a button. When we enter something in the input field and press the button this will refresh the page but add to the end of the url an ?option=input-field-value – for example if we used the text test and pressed the button our url would look something like:

```
http://127.0.0.1:5500/indecision-app/Public/index.html?option=test
```

We do not want to go through this method a full refresh of the page, that sort of technique is useful for older server side rendered applications. We want to handle the form submission on the client, we want to run some JavaScript code that pushes and item onto the array and re-renders the application. To do that we would need to setup an event handler for the form submission.

In the React documents there is a page on all the different event handlers we could use in our react application (*supported events: Form Events = onChange, onInput, onInvalid, onSubmit. These are the various event handlers for forms*): **https://reactjs.org/docs/events.html**

We would want to use the onSubmit event handler on our <form> tag. When we use the event handler we need to set it to a JavaScript expression where we want to reference a function we want to have fired when the event happens.

```
const onFormSubmit = (e) => {...}

<form onSubmit={ onFormSubmit } >

        <input type="text" name='option'>

</form>
```

When using event handler functions, we usually have access to an event (e) object that is passed in as a parameter within our event handler function. This event object holds various information and methods we can use. For forms we have a event object method which allows us to prevent the full page refresh when the user submits a form.

```
const onFormSubmit = (e) => {

        e.preventDefault();

} ;
```

In our onSubmit we want to reference the function but do not want to call the function because if we call the function it is equivalent to calling undefined.

<form onSubmit={ onFormSubmit } >...</form>   make reference to the function and not call it.

~~<form onSubmit={ onFormSubmit() } >...</form>~~   using () at the end of the function will try to call it.

We can use the event object to call on the target.elements to have reference to all the elements from our form which are referenced by name. In the above example we can look at the input field with the name='option' and return the value.

```
e.target.elements.option.value
```

We can use the value and set it to a variable and then have our function to perform actions using that information.

```
const onFormSubmit = (e) => {

        e.preventDefault();

        const option = e.target.elements.option.value;


        if(option) {

                app.options.push(option);

                e.target.elements.option.value = '';

        };

} ;
```

Forms are a useful way of recording information from users of your application and then perform some sort of function using that information that is returned from the e event object, the above example takes the input field value and stores it in the app.options array object.

ARRAYS IN JSX

So far we know that JSX supports both strings and numbers, it does not support objects and it ignores booleans, null and undefined.

The good news is that JSX also supports arrays and it actually works with them really well. We would put the array in an JSX expression to render onto the screen.

```
{
      [98, 99, 100]
}
```

The above is the same as writing the JSX expression of:

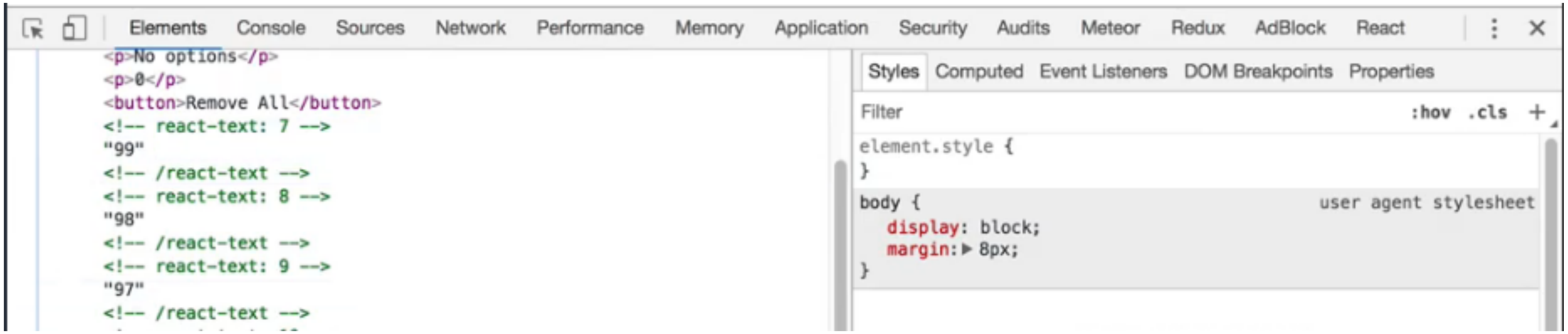
```
{98}{99}{100};
```

This will add each array item side by side which will display 9899100 in the browser. This is what is happening behind the scenes i.e. it is taking your array and breaking them our as individual JSX expression and is rendering them all to the screen. We know that numbers and strings will show up on the browser. Booleans, null and unidentified can also be used in arrays however they will not show up in the browser.

```
{
      [99, 98, 97, 'Mike', null, undefined, true, false]
}
```

We cannot use objects within arrays as they are not supported by JSX expressions.

If we inspect the developer tools in our browser and within the Elements tab, we can see exactly what gets rendered in the DOM for the array object. React creates various comments (react text nodes) for our array object, and this is how React keeps track of various items and where they are rendered inside the DOM. This also allows React to update an individual array item if the value changes as opposed to needing to update everything contained within the array. This makes React efficient when working with arrays.



```
<p>No options</p>
<p>0</p>
<button>Remove All</button>
<!-- react-text: 7 -->
"99"
<!-- /react-text -->
<!-- react-text: 8 -->
"98"
<!-- /react-text -->
<!-- react-text: 9 -->
"97"
<!-- /react-text -->
```

```
element.style {
}
body {                                   user agent stylesheet
  display: block;
  margin:▶ 8px;
}
```

We already know that we can render JSX within JSX for example:
{<p>Paragraph</p>}

Therefore, we can also render arrays of JSX.
{ [<p>a</p>, <p>b</p>, <p>c</p>] }

When we use JSX in arrays we are going to see a warning error of:
Warning: Each child in an array or iterator should have a unique "key" prop. Check the top–level render call using <div> see … for more information.

All we have to do in the JSX is to add in a key prop attribute which must be unique amongst the array.

{ [<p key='1'>a</p>, <p key='2'>b</p>, <p key='3'>c</p>] }

This allows React behind the scenes optimise the application using the key properties to monitor changes to each individual JSX so that only the changes value is re-rendered rather than the whole array.

We can use the map() function to loop through an array and return a new array items. This allows us to take the original array and and iterate through the items to create new JSX expression array items.

For example we have an array of numbers we want to use the map to iterate through the array to create JSX paragraph tags for each item in the array so that we can display each item in the array within in the browser.

```
const numbers = [50, 100, 150];

cost template = (

    {

        <div>

            numbers.map((x) => {

                return <p key={x}>Number: {x}</p>

            })

        <div>

    }

);
```

What this does it takes the numbers array and iterates through each item in the array. Each item will pass in as an argument called x and this value is used within our JSX to generate a paragraph tag for each item, essentially creating/rendering the html element for our application which will be rendered in the DOM:

```
<div>

    <p key=50>Number: 50</p>

    <p key=100>Number: 100</p>

    <p key=150>Number: 150</p>

<div>
```

SECTION ONE REVIEW

We have now covered the fundamentals of JSX. We started off knowing absolutely nothing about React and JSX, but we are now at a place where we can now build out a little application such as a task list and task selector app.

What we have learned:

- How to setup your environment and Babel.
- How JSX works.
- How to inject values in our JSX.
- Add conditional rendering.
- Setup event handlers e.g. form submits and button click and generate dynamic elements based off some application data.
- How to pre-render and re-render the UI to keep up to date with our app data.

Extra Knowledge/Tips:

We can make <button> elements disabled using the disabled attribute. If this is set to true then the button will be disabled and if set to false then the button will not be disabled. We can set the disabled attribute to a JSX expression which will allow our button to be disabled/not disabled based on a condition that can evaluate to true or false:

```
<button disabled={app.option.length ===0}></button>
```

This will evaluate to true if the options array is equal to zero, whereas if an item is added to the array then the JSX expression will evaluate to false. This will make the button act dynamically based on the application data.

Wrap up:

Now that we understand the fundamentals of JSX, in the next section we will look at the intermediate concept of React Components.

Section 2

REACT COMPONENT

- Thinking in React
- ES6 Classes
- Creating a React Component
- Nesting Components
- Component Props
- Events & Methods
- Component State
- Props vs State

In this section we are going to learn all about React Components.

React components allows us to break up our application into small reusable chunks. Each little component has its own set of JSX that it renders to the browser screen, it can handle events for those JSX elements and it allows us to create these little self-contained units.

At the end of this section we should be able to think in React for our application and be able to create our own React Components. We are also going to analyse the difference between Component Props and State and when we would use them.

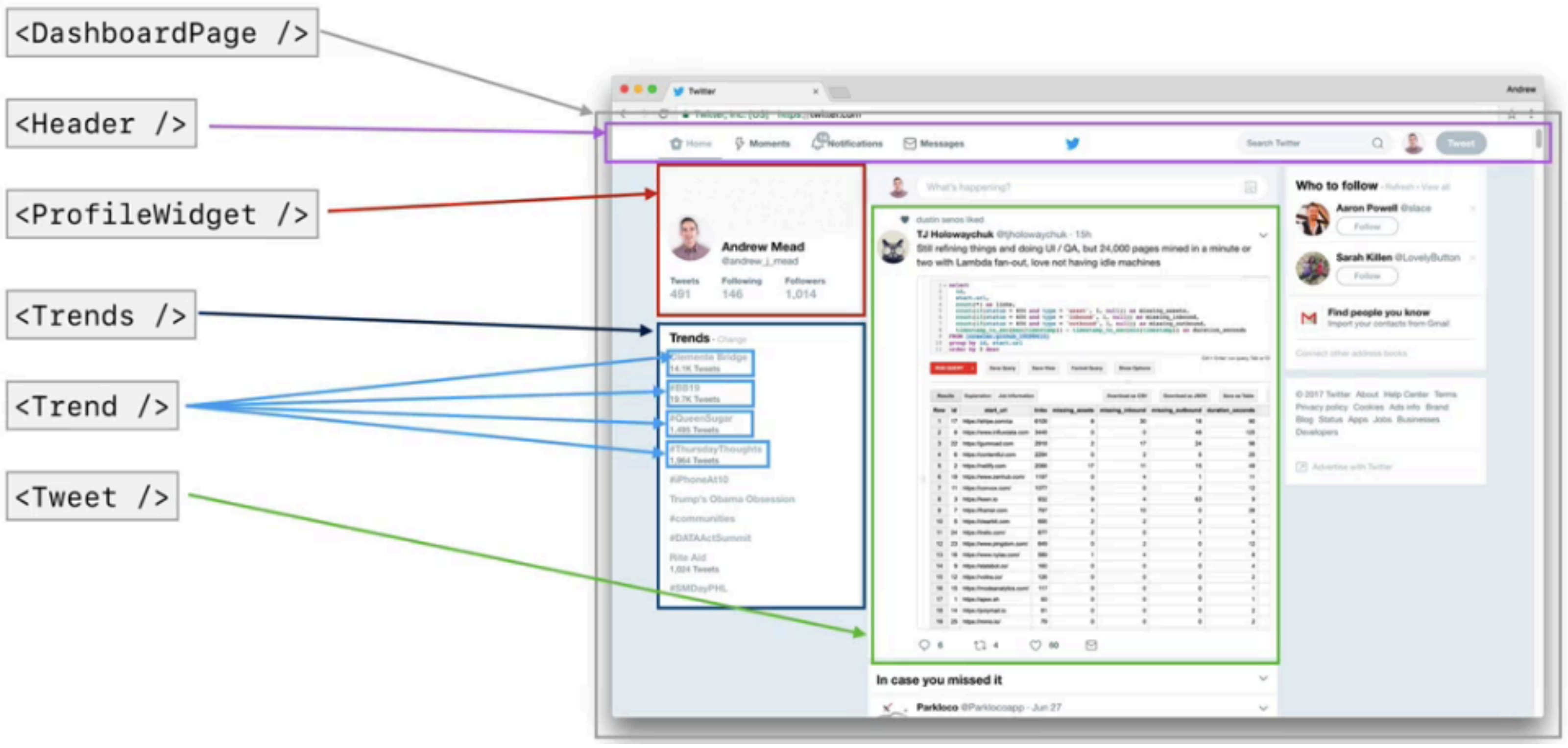
THINKING IN REACT

What is a React Component? We should think of it as an individual piece of the UI.

These components are reused all over the place within the application for example the navigation bar can appear in multiple pages. We would have a single component for the navigation and we could reuse it wherever we need the navigation bar to appear in our application.

We can analyse web applications and break them down into different UI components. The data in the components could change, but the underlying structure of the JSX for the component remains the same.

Below is a basic structure of React components we could make if we were to break up the Twitter UI elements for the below image.



We would have a parent component (page) which will wrap around all the individual child components (UI) that make up the parent page.

The child components are reusable UI and are siblings to each other. A Child Component can have its own children components.

Just like HTML, we will also be nesting React components.

ES6 CLASSES

The purpose of Classes is to be able to reuse code. A Class is like a blue print and we will be able to make multiple instances of that class for the individual items.

To create a class we would use the class keyword followed by the class name (just like how we name our variables and functions). The convention for class names is to have the first character of the class name to be upper case. This will let other developers know that this is the name of a class and not just some other object. Within the curly brackets this is where we would define our class.

```
class Person {} ;
```

To create an instance of the class we would create a new variable and set it using the new keyword followed by the class name and then the opening and closing brackets calling it as a function.

```
const customer = new Person();
```

When we create a new instance of our class, we have the ability to pass in any amount of data/arguments which can be of any data type (e.g. string, number, boolean, object, array etc.), however, nothing will happen with our data unless we define them within our class using something called a constructor.

Constructors are functions that get called when we make a new instance of the class and it will get called with all of our arguments passed into the new instance of the class. Example of adding a constructor to our Person class:

```
class Person {

    constructor(name) {
        this.name = name;
    }
};
const customer = new Person('John Doe');
console.log(customer);
```

<JavaScript console> *Person* { name: *"John Doe"* }

We now have a blueprint to allow us to create multiple instances of the Person class but the name argument can be unique to each instances.

Do you have to provide all the constructor arguments? No. This will return the class object with undefined for each property (**<JavaScript console>** *Person* { name: *undefined* }).

We can also add a default value to our arguments by assigning it a value (*we do not need a default value for all our arguments*):

```
constructor(firstName = 'Anonymous', lastName) {
    this.firstName = firstName;
    this.lastName = lastName;
}
```

We can create instances of Person and we can define what makes each Person unique. However, what about the things that each Person shares? We can setup methods that allows us to reuse codes across every instance of the class.
Unlike constructor which has a specific name and gets implicitly called when we make a new instance of the class, methods on the other hand has a name that we can pick (it can be anything we like) and the function will only run if we explicitly call it.

Note: we cannot use a comma after the constructor closing curly bracket to separate the constructor from the method as this illegal and will cause an error.

```
class Person() {
    constructor(firstName = ‘Anonymous’, lastName) {
        this.firstName = firstName;
        this.lastName = lastName;
    }
    getGreeting(){
        return ‘Hello’;
    }
};
const customer = new Person(‘John’, ‘Doe’);
console.log(customer.getGreeting());
```

The customer class has access to the getGreeting() method from the Person class and so we can explicitly call the method. This will return a static ‘Hello’ greeting for all instances that calls on this method regardless if this is a different person.
We can make the greeting message dynamic/unique to the class for example we can greet using the first and last name. In our method we have access to the ‘this’ keyword which relates to the current instance.

```
    getGreeting(){
        return this.firstName;
    }
```

We can use concatenation or use template literals to make the message more complex. The getGreeting() method is now accessible to all our instances and has the same behaviour without us having to redefine our properties.

```
    return ‘Hello ’ + this.firstName + ‘ ’ + this.lastName;
    return `Hello ${this.firstName} ${this.lastName}`;
```

Now that we know the fundamentals of a ES6 classes and how to set them up, we are now going to focus on a advance ES6 class topic which is how to setup/create a subclass using the ES6 syntax.

If we were going to create a website for students we would create a class call Students. We would realise that the student is actually just a Person with some modification i.e the Person would have a firstName, lastName and age. The student also has a qualification/subjects studied that we would like to keep a track of. So instead of copying and pasting the code from the Person class into the Student class and modifying to meet the needs of the Student class, we can extend Person from Student. This will provide us with all the functionality of the Person class but also allows us to override functionality we might want to change.

In order to achieve the above we would create the class name, after the class name and before the opening curly bracket we will add the 'extends' keyword to indicate that we want this new class to extend from an existing class.

```
class Student extends Person {};
```

The Student class extends from the Person class and this allows us to continue to use the Person properties and methods on the Student class and this will continue to run the code and function the same.

```
const customerOne = new Student('John', 'Doe', 28);

console.log(customerOne.getGreeting());
```

We have now created a sub-class of Person called Student but we want to modify.override the Person constructor to take in an extra argument for the subject. In order to do this we would use the constructor function and pass in our arguments list and then setup our function body. We would not need to setup the properties and defaults for the extended class again, however, we must call on the parent constructor function to run. To do this we would use the super() function – super refers to the Parent (extended) class and is the same as accessing the Parent constructor() function.

```
class Students extends Person {

    constructor(firstName, lastName, age, subject){

        super(firstName, lastName, age);

        this.subject = subject;
    }
};
```

We no longer need to re-write the code from the Person class as we are passing in the values that come through into the super function and allowing that to be passed into the parent Person constructor to set the correct values.

```
const studentOne = new Student('John', 'Doe', 28, 'Maths');

console.log(studentOne);

<JavaScript console> Student { firstName: "John", lastName: "Doe", age: 28, subject: "Maths" }
```

Adding a new method on the sub-class remains exactly the same i.e. define the name of the function and add the function to the function body. This can then be called/accessed on the class instance.

We can also override a Parent method behaviour in our sub-class by redefining the method. We can completely override the method or we can get the parent method and modify it:

Original Parent getDescription() method:

```
getDescription() {
    return `${firstName} is ${age} year(s) old.`;
}
```

Completely override the Parent method behaviour:

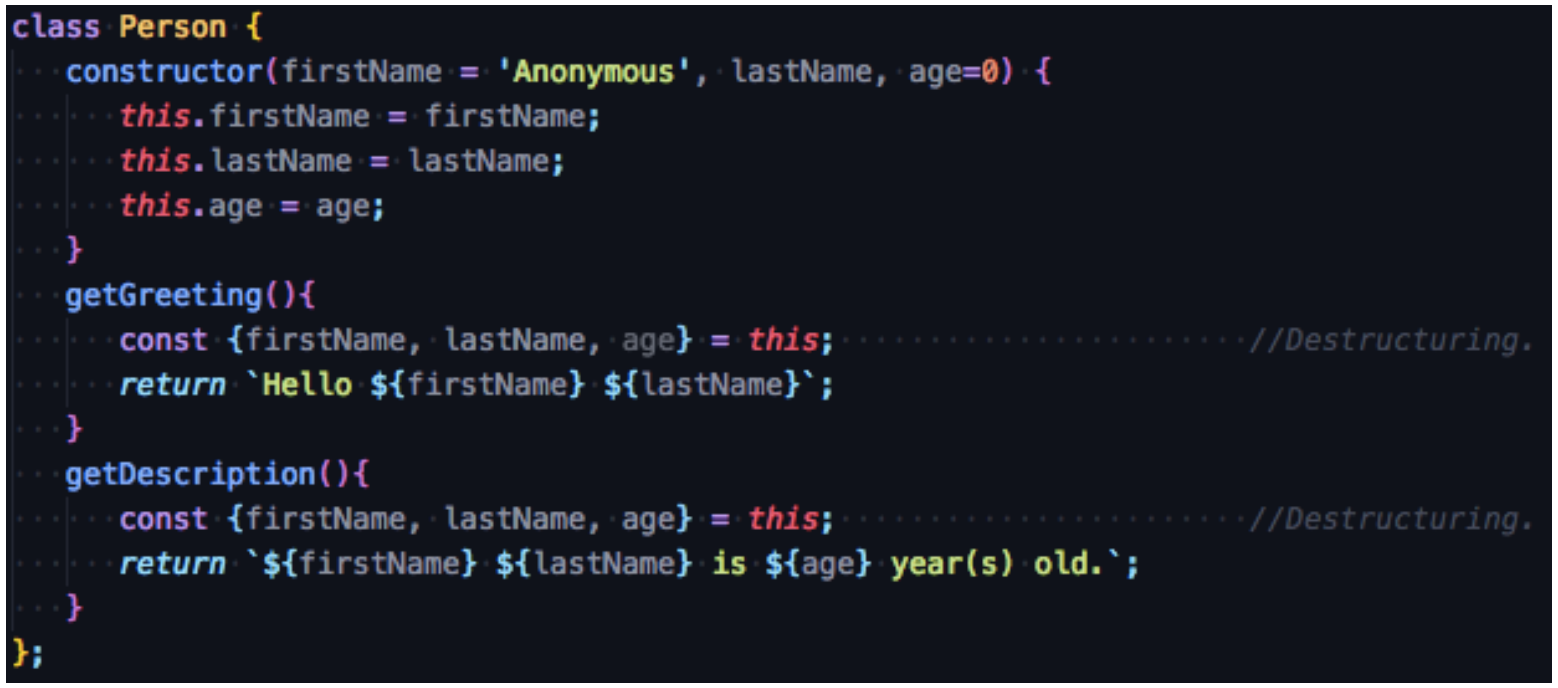
```
getDescription() {
    return 'original behaviour completely overridden';
}
```

Modify the Parent method:

```
getDescription() {

    let description = super.getDescriptiom();

    if(this.subject) {

        return description += ` They are studying ${this.subject}`;

    }

    return description;

}
```

We can use super again to get the parent class but this time we use the . followed by the method name and assign this to a variable we can return. We can now modify the original method and add the subject to the end using the if statement to check if there is a subject for the student.

We have now learnt how to extend from another class and do something new and this is really important because this is exactly what you would be doing with React Components. React requires new Components to extend from the original React Components class. It is therefore very important to get a good understanding and a grasp of creating ES6 classes and sub-classes.



```
class Person {
  constructor(firstName = 'Anonymous', lastName, age=0) {
    this.firstName = firstName;
    this.lastName = lastName;
    this.age = age;
  }
  getGreeting(){
    const {firstName, lastName, age} = this;                      //Destructuring.
    return `Hello ${firstName} ${lastName}`;
  }
  getDescription(){
    const {firstName, lastName, age} = this;                      //Destructuring.
    return `${firstName} ${lastName} is ${age} year(s) old.`;
  }
};
```

Tips/Techniques:
Destructuring is an important and useful technique as it allows you to extract values from the 'this' keyword and assign it to variables which we can then reference in our functions without making references to the 'this' keyword. This helps make the code look much more cleaner and readable.

CREATING A REACT COMPONENT

A React Component is simply a ES6 class. To create a component we will be creating our own class that extends from the React Component class. We already know that there are two globals we get from our two scripts, React and ReactDOM. We are going to grab the Component class from the React global library.

```
class Header extends React.Component {

    render() {

        return <p>This is from Header</p>;

    }

};
```

In ES6 classes we can have no method defined and that is completely valid. Whereas, with React Component we must define render (this is a special method and we must always call render when we use React Component class, else it will not work and error).

The render returns all the JSX expressions we want to render i.e. show up in our browser.

To render the component to the screen we would use the ReactDOM.render() method passing in our two arguments.

```
ReactDOM.render(jsx, document.getElementById('app'));
```

The jsx will be our variable holding all our JSX expression we want to inject/parse into our <div id='app'></div> element in our html. In this jsx variable we can pass in what looks to be custom html element tags but are simply tags that reference our class names which have our JSX expressions.

```
const jsx = (
    <div>
        <Header />
    </div>
)
```

This will render our header component's JSX expression and display it in our browser screen. We have now created a React component. What makes React Components great is that we are able to reuse these components (code) multiple times by just using the component tags for example we can have two or more instances of the <Header/> tag being rendered to the screen without us having to retype/repeating the same code:

```
const jsx = (
    <div>
        <Header />
        <Header />
    </div>
)
```

Note React enforces the upper case letters of class names (*ES6 does not require the upper case names of classes but is merely a convention*) therefore, when naming our React Components we must use upper case for the first letter in our class name. If we use all lower case for our class component name, this will not fail but it will not render the component to the browser screen. This is how React distinguishes the html element tags from our custom Components tags behind the scenes. Therefore, it is good practice to keep to this naming convention when creating ES6 classes.

NESTING REACT COMPONENT

Nesting components is essential for creating meaningful React apps. We can create a parent component and then have all the other components created nested within the parent component. This allows us to get rid of the const jsx variable and we can now use our parent component directly in the ReactDOM.render() function directly. For example:

```
Class IndecisionApp extends React.Comonent = {

    render() {

        return (

            <div>

                <Header />

                <Action />

                <Options />

            <div>

        )

    };

};

ReactDOM.render(<IndecisionApp />, document.getElementById('app'));
```

We have nested all the various components within the IndecisionApp component which acts as the parent component. We can render all the various components for this application through this Parent component.

COMPONENT PROPS

React Component Props are at the very core of allowing our components to communicate with one another. The data we pass in when we initialise an instance of our components is known as props. This allows our components to be reusable and unique based on the information passed into our component. We use key:value pairs in our components elements, similar to how we do this in HTML attributes.

```
<Header title='Title Header' />
```

To have access to this data value, we would go to the component class and within the render() method we have access to the this keyword which gives us access to the data passed in for the current instance of the class.

```
class Header extends React.Component {
    render() {
        console.log(this.props);             <JavaScript console>Object {title: "Title Header"}
        return(
            <h1>{ this.props.title }</h1>
        )
    };
};
```

What this does, it takes the HTML attribute looking data and it converts it into an object of a key:value pairs. We can use this string value using JSX expression to make the render of the title dynamic based on the data passed into our components. Whenever we use the <Header /> component we can now pass in data to change the header to a relevant header title.

When we create instances of our React Components we can also choose to pass some data into it. The data looks very much like HTML attributes but is in reality just a set of key value pairs where the key is always some sort of string and the value can be anything (any JavaScript data type) we would like for example a string, number, array etc.

When we pass in pass in data into a component we can use that data inside of the component itself. We can use that information to correctly render our components. All of the props are available on this.props and we can access the specific data by adding the key string.

Props allows us to setup one way communication for example:
The Parent component can communicate with its child components and the child component can communicate with its children components (sub-child). We can also add props when we use the ReactDOM.render() method by adding the props attributes to the React Component.

EVENTS & METHODS

In Section 1 we looked at how we could create event handlers that will call on global functions, however, in React we would want to create self-contained methods within the React Component class. This method will appear in the class components before the render() method.

```
class Action extends React.Component {

    handlePick() {

        alert('Run handlePick');

    };

    render() {

        return(

            <button onClick={this.hadlePick}>Click Me</button>

        )

    };

} ;
```

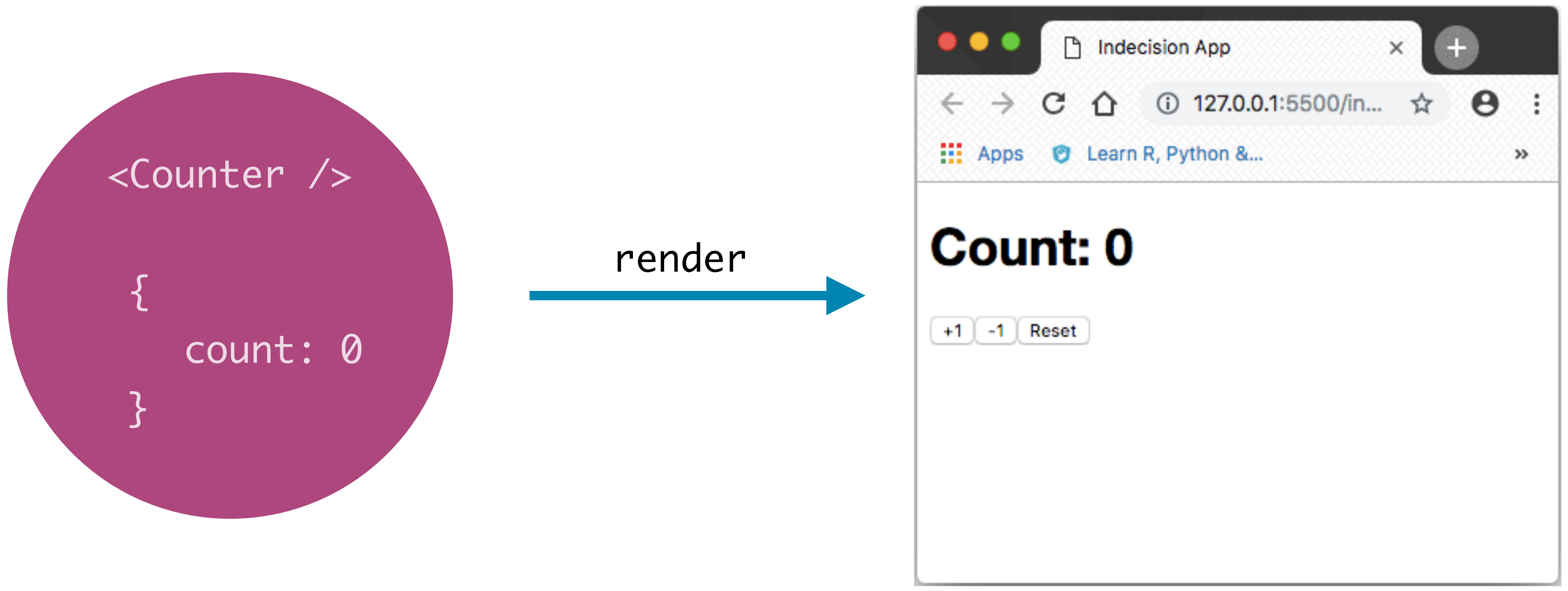
On the button we have a onClick event handler which will call the handlePick function which is a self-contained function of the class which is why we can use the this keyword to access it. We do not want to execute the method right away and therefore we would only make reference to the method in our onClick event handler (and do not add () at the end). When the button is clicked this would execute the handlePick() function.

COMPONENT STATE

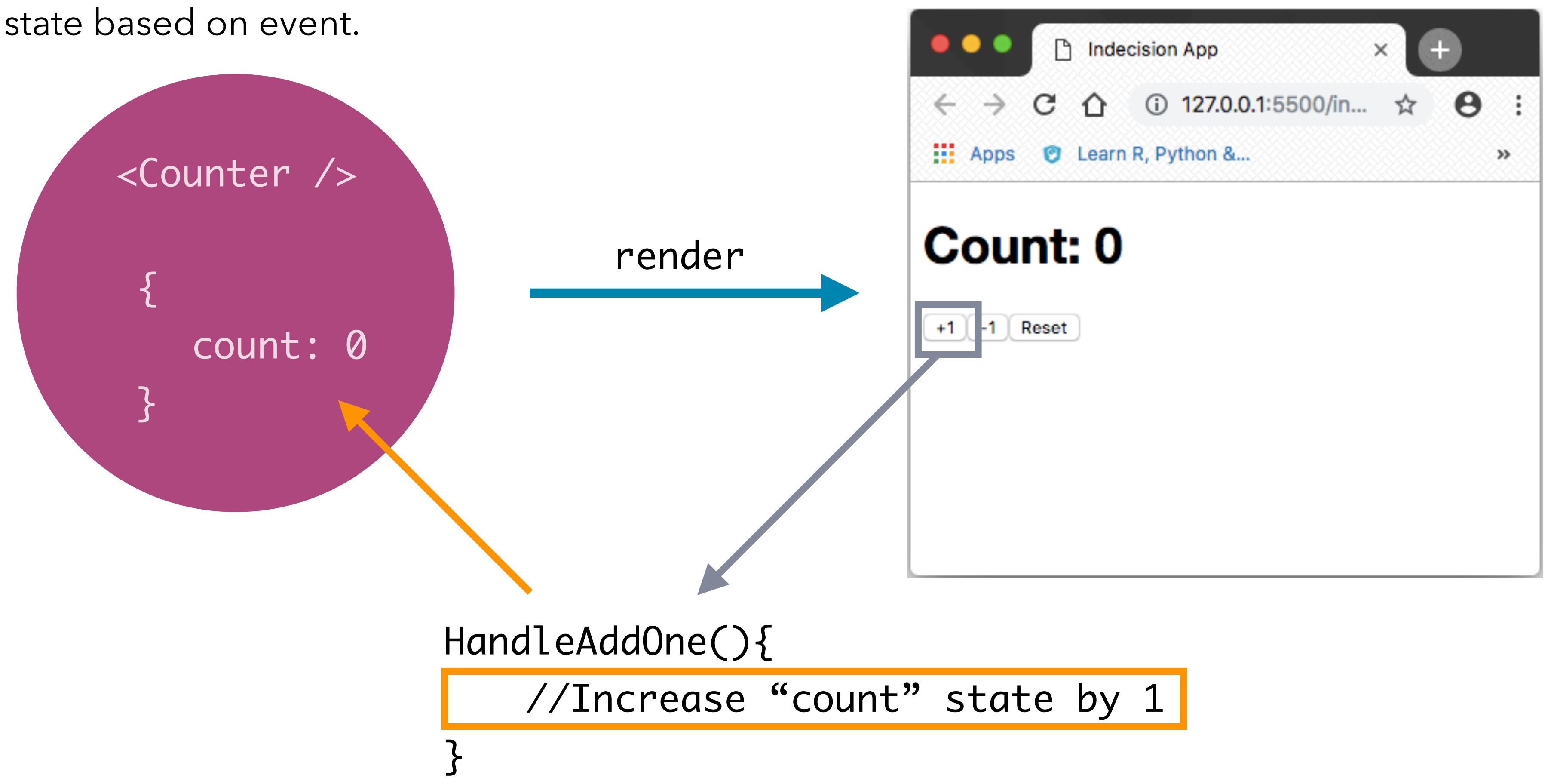
Component State allows our components to manage some data (think of data as an object with various key value pairs). When that data changes, the component will automatically re-render to reflect those changes. In component state, all we have to do is manipulate the data and the component will take care of the re-rendering of itself i.e. we do not need to manually call the render function every time the data changes.

How to setup a Component State:
Step 1. Setup a default state object.
Step 2. The component rendered with default state values. *

* Implicitly run behind the scenes.

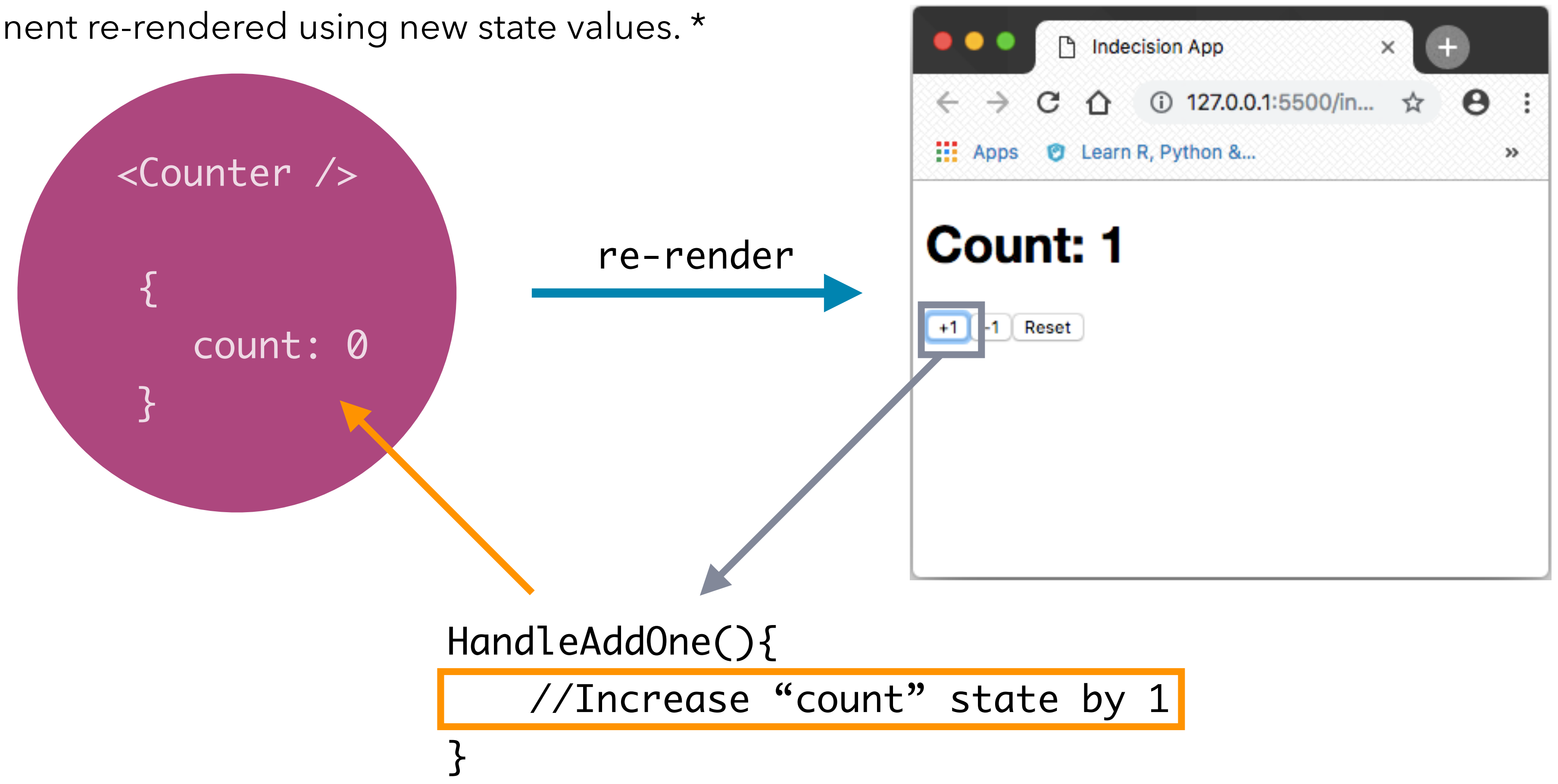


Step 3. Change state based on event.



```
HandleAddOne(){
    //Increase "count" state by 1
}
```

Step 4. Component re-rendered using new state values. *



```
HandleAddOne(){
    //Increase "count" state by 1
}
```

Step 5. Start again at step 3.

Component State is essential for interactive applications. The above diagram is an abstract flow of react component state. So to recap: the state is just an object with a set of key value pairs, we define our initial data (state) and this gets rendered to the screen when the application initialises. The state object can be changed by the user i.e. based off some event for example a button click, form submission or finishing of a http request that returns JSON data etc. When the state changes the application will automatically re-render itself. React will update the UI on the screen with the updated data.

To set a state we would add this.state in the constructor and set this to an object defining all of the pieces of state we want to track for example:

```
class Counter extends React.Component {

    constructor (props) {

        super(props);

        this.state = {

            count: 0

        };

    }

    render() {

        return (

            <h1>Count: {this.state.count}</h1>

        )

    };

} ;
```

We now have a default state for our components which renders on initialisation of the application (steps 1 and 2).

We can create events to change the state. However, we must use a special method to change the state object which will re– render our application when the state changes an that is called setState() for example:

```
class Counter extends React.Component {

    this.state = {

        count: 0

    };

    handleAddOne() {

        this.setState( (prevState) => {

            return {

                count: prevState.count + 1

            };

        });

    }

    render() {

        return (

            <h1>Count: {this.state.count}</h1>

            <button onClick={handleAddOne}>+1</button>

        )

    };

};
```

ALTERNATE METHOD (AVOID USING):
The setState() method allows us to manipulate the state object but then refresh the application to render the changes automatically (steps 3 and 4). This methods gets called with a single argument using an arrow function to define our updates we want to make (an updater function). To define our updates we return an object where we state the various state values we want to change and the new values we want to assign. I our updater function (arrow function) we have access to our current state via the first argument commonly called prevState (but we can call this anything e.g. prevState, state, x etc.). We can use this value and select a specific key property from the state to update/manipulate its value. The setState() will update the state and re-render the application component to render the change onscreen automatically. We can call on this event handler as many times as we want to update the state and have it refresh the render (step 5).

Common things related to this.setState():

1) If you have multiple pieces of state on your component, you do not need to provide them in the setState() return object. You only provide the key of the state(s) you wish to change. When we are defining the updates in the setState() updater function (anonymous function), we are not overriding the state object completely. We are just changing specific values i.e. it is the same as writing this.state.count = this.state.count +1 which is changing the value of the specific object key value.
2) The setState() function will automatically render the component after the updater function has run to update the specific state key value. This will render the new value onto the screen without you manually calling a render method to update the components render to the screen.
3) If we do not care about the previous state value we do not need to pass in the prevState argument in our updater function argument, for example if we do not care about the previous count state value:

```
handleReset() {

    this.setState( () => {

        return {

            count: 0

        };

    });

}
```

There is an alternative way that we can use this.setState() method. This method also allows you to pass in an object directly into the method instead of using a function. This is the previous (older) approach. The updater function is the more recent and more preferred method and rumours has it that in future versions of React, the updater function will be the only way to update the state and render the application using the setState() method.

The older obsolete syntax example:

```
handleReset() {
    this.setState({
        count: 0
    });
}
```

There is nothing wrong with this syntax, however, the problem is where you are trying to update the state based on the current state value. For example if we have back to back calls:

```
handleReset() {
    this.setState({
        count: 0
    });
    this.setState({
        count: this.setState.count +1
    });
}
```

The problem we have with this is that when we click the handleReset() function this will not reset the state to 0 and add +1, instead it will continue to +1 only. The reason for this is because our calls to the State are Asynchronous. This means just because we started the process of changing the count, this doesn't mean the count will be changed. In our second setState function we are still getting back the old state value. We have started the process of getting the count to zero but it hasn't completed yet. So when we have the second process called this is grabbing the old state value. React behind the scenes is very efficient and does everything all at once and batches together our setState() operations allowing it to rerun less often, only then does it bring the state up to speed. We would end up running into weird situations like this one where we are accessing stale and outdated data.

So what is the solution to the above? The solution is aways to use the this.setState() with an updater function. It never suffers from the same problem because it does not access this.state, instead React passes in the prevState as an argument. For example the below will return 1 correctly:

```
handleReset() {
    this.setState( () => {
        return {
            count: 0
        };
    });
    this.setState( (prevState) => {
        return {
            count: prevState +1
        };
    });
}
```

The reason this works correctly in this instance is because the first setState() called, React goes ahead and calls our function. It is going to pass in the previous state which we did not use here and it is going to get the object back. So React knows that you want to change the count to 0. It will go off to do its asynchronous computation in the virtual DOM. Before it actually finished all of that and before the component gets re-rendered, another this.setState() call comes in. React sees this and asks itself whether it wants to render this twice or should it render this once. React will try to batch these together in order to figure out what needs to change here and make sure the DOM reflects that and only then will it update. This will prevent it from being updating a bunch of times which can get really inefficient.

So what happens is React know right away when this second call comes in that the state just computed and the count was zero. This is now out of date, so it goes ahead and tries to figure out what changes were made and actually passes that state in. It passes in the state where the count is zero and not the original state before the first this.setState() call. This would mean when we add +1, it is being added to 0 and not whatever the original outdated state value was before the function was called.

There is nothing inherently wrong with passing an object into the this.setState(), as long as you don't need access to the previous state values.

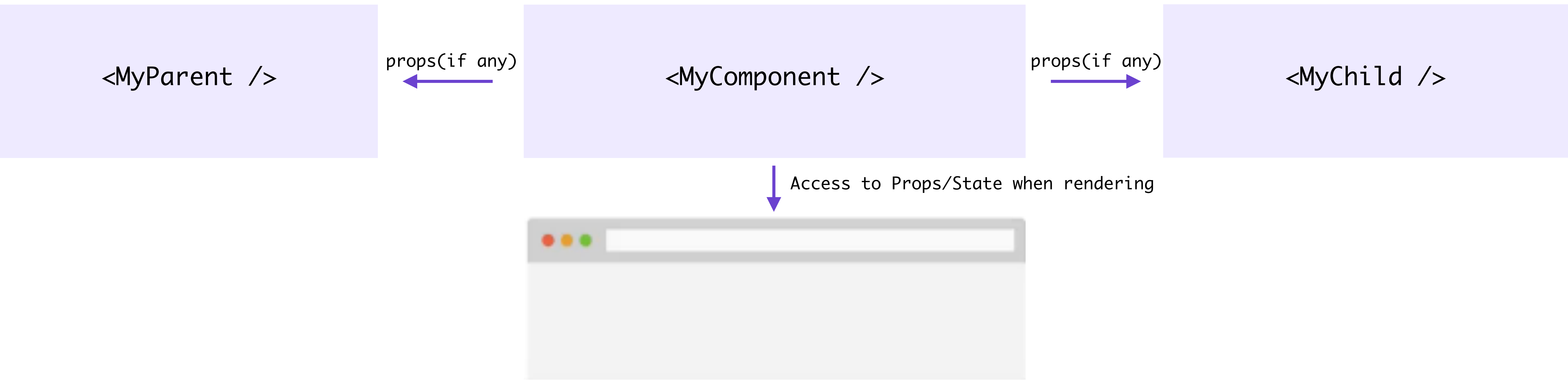
It is advisable to stay away from this alternative method as there are rumours that React going forward will only use updater functions within the this.setState() function method which is the preferred syntax. It allows us to build our applications without running into pitfalls like the above example.

SUMMARY: PROPS VS STATE

We know that something at some point rendered MyComponent (whether rendered by another Parent Component or ReactDOM render call). We also know that MyComponent could have optionally rendered a Child Component.

We know that data props flow in one direction. This allows us to pass things between components e.g. the Parent could pass some data, if any, to MyComponent and MyCompnent could pass some data, if any, to its Child.

We also know that my component if going to render something to the screen i.e. rendered output. This is JSX and we have access to props and state when we are rendering.



<u>Similarity:</u>
Both Props and State are just objects.
Both Props and State can be used when we are rendering the component.
Changes to Props and State causes re-renders.

<u>Differences:</u>
Props come from above, whether it's a Parent Component or just some JSX that gets passed into the React Render state.
Whereas the State is defined in the component itself.
Props cannot be changed by the component itself. If you want to want to track changing the data, you have to use a State because the State can be changed by the component itself.

<MyComponent />

Props	State
● An Object	● An object
● Can be used when rendering	● Can be used when rendering
● Changes (from above) causes re-render	● Changes causes re-render
● Comes from above	● Defined in component itself
● Can't be changed by component itself	● Can be changed by component itself

Section 3

STATELESS FUNCTIONAL COMPONENTS

- The Stateless Functional Component
- Default Prop Values
- Lifecycle Methods
- Local Storage

In this section we are going to learn a new way to create React Components. We already know how to create a class based components in the previous section and in this section we will learn how to create a stateless functional component.

We will compare and contrast the two types of React Component and view their own set of advantages and disadvantages. This will allow us to have an understanding of when we would use a class based function and when we would decide to use a stateless functional component.

THE STATELESS FUNCTIONAL COMPONENT

The Stateless Functional Component is an alternative to the Class Based Component. We would use a combination of both Components within your Projects.

A Stateless Functional Component has 3 characteristics:

1. A React Component (just like class based components).
2. It is also just a Function (unlike class based components).
3. It is Stateless.

Example Syntax for a Stateless Functional Component:

```
const User = () => {

        return (

                <div><p>User Name</p></div>

        )

};
```

```
const User = function () {

        return (

                <div><p>User Name</p></div>

        )

};
```

Stateless Functional Components don't allow you to manage state but they do allow you to manage props. These components do not have access to 'this'. To get the props, they get passed in from the function as the first argument (which is your object with all of your key value pairs). For example:

```
const User = (props) => {
        return (
                <div>
                        <p>Name: {props.name}</p>
                        <p>Age: {props.age}</p>
                </div>
        )
};
ReactDOM.render(<User name="John Doe" age={28} />, document.getElementById('app'));
```

While we cannot use state inside our Stateless Functional Components, we can indeed use Props.

The advantages of Stateless Functional Components are: they are faster than class based components (so when we can we should use them i.e. in cases of simple presentational component), they are a little easier to read and write and finally they are much easier to test.

Process of creating a Stateless Functional Component is simple:

1. Create a new const with component name (first letter capital).
2. Set it to a function (this function is equivalent to the render() function.
3. If there are props, the first argument to your function should pass in this object so that your component has access to the props key value pairs.
4. Return your JSX expressions to render.

DEFAULT PROP VALUES

Whether our components are classes or functions, they can have props passed into them, however, what if a prop is not passed into them? We can assign a default prop values.

To add a default value to our component props we can add a property after we define the component. For example if we want to add a default title property:

```
const Header = (props) => {

	return (

		<div> <h1>{props.title}</h1> <h2>{props.subtitle}</h2> </div>

	)

};


Header.defaultProps = {

	title: 'Default Title'

};
```

This will allow us to have a default title if no properties are passed into the Header component and where we want a different title for other pages we would add the prop values in our JSX to override the default values to render something different. This allows for a much flexible component.

We can add a default prop value to our class component state. This allows our component to be flexible for example:

```
class Counter extends React.Component {
    constructor(props) {
        super(props);
        this.state = {
            count: props.count
        }
    }
    render() {
        return ( <div> <h1>Count: {this.state.count}</h1> </div> )
    };
};
Counter.defaultProps = {
    count: 0
};


ReactDOM.render(<Counter count={30} />, document.getElementById('app'));
```

We can pass in a count prop value to override the default property value. This makes our Counter class component flexible as we can allow the user to define/override the default values. Note the this.state count key value references to the props.count value (this will default to 0 if no attributes for count is passed into the component).

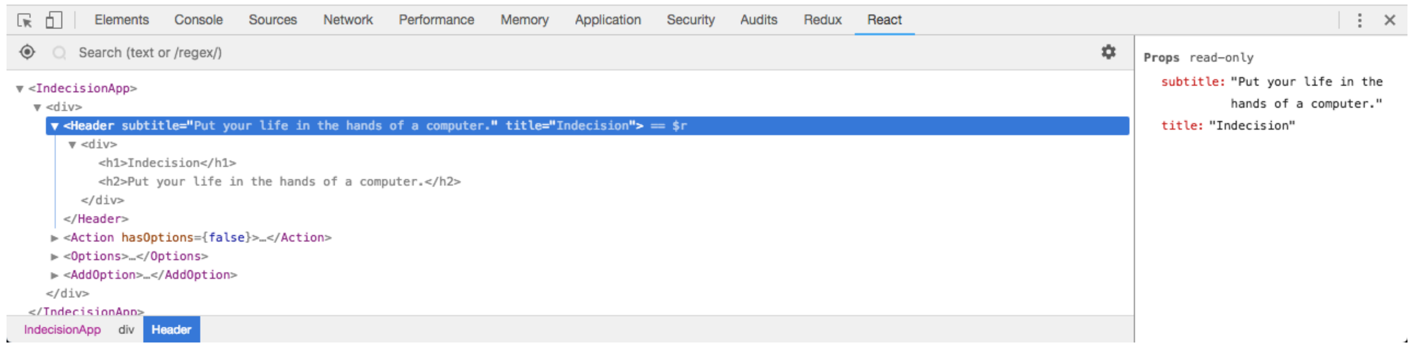
REACT DEV TOOLS

There is a set of React Dev Tools that we can install in our browsers as extensions (which are available on both Google Chrome and Mozilla Firefox). This will add a new tab into the developer tools for React with React specific information. This will make debugging a whole lot easier.

If you google the term Google React Devtools or Firefox React Devtools, this will bring up a link for you to install the extension in your browser of choice. Once you install the extension you will need to reopen the tab/browser to see the changes in the dev tool tabs.

What you see in the React tab is similar to what we would see in the Elements tab. In the Elements tab we get our html markup while in the React tab we get our JSX tree view. This will show the parent component and the child component and the JSX expressions within each component. The components are highlighted while regular html are shown in grey. On the right hand side we have access to more data to the component that is currently selected i.e. the Props and State of the component.

As you application grows, you can also search for components to make it easier to locate the component you are looking for. This allows you to isolate the component. We can play around within the React Tools to make changes and these will take affect in the application which is really useful for testing. However, the tool is also in development and not everything will work (e.g. we can change the value of state objects but cannot add a new one through the React devtools).



```
▼ <IndecisionApp>
  ▼ <div>
    ▼ <Header subtitle="Put your life in the hands of a computer." title="Indecision"> == $r
      ▼ <div>
          <h1>Indecision</h1>
          <h2>Put your life in the hands of a computer.</h2>
        </div>
      </Header>
    ▶ <Action hasOptions={false}>…</Action>
    ▶ <Options>…</Options>
    ▶ <AddOption>…</AddOption>
    </div>
</IndecisionApp>
```

```
Props read-only
  subtitle: "Put your life in the
            hands of a computer."
  title: "Indecision"
```

Finally, when you highlight a component, the React devtools assigns a ==$r variable. We have access to this variable in the JavaScript console tab of our developer tools by typing $r which will show all the Props/States and functions for the selected component.

LIFECYCLE METHODS

Lifecycle Methods fire off at various times in a given component life. These are built in methods available on our class based components but not available to our stateless functional components. This is one of the reason for why stateless functional components are much faster because they do not need to handle state nor lifecycle methods.

Example of lifecycle methods include the ability to populate an array with data from a database when the component first gets mounted to the browser or we can watch the state change to make saves/updates to our database whenever the component updates with new data.

Lifecycle Methods:
componentDidMount() – this will fire when the instance of the class based component first mounts.
componentDidUpdate(prevProp, prevState) – this will fire when the component updates i.e. when the props or state value changes. With this lifecycle method we have access to the this.prop and this.state for the new prop and state values. We can also access previous props and previous states by passing in the two arguments. The first is for the previous props while the second argument is for the previous state.
componentWillUnmount() – this will fire just before the component goes away i.e. when the given component unmount (the whole component is removed from the browser screen).

There are many more lifecycle methods which are available to read on:
https://reactjs.org/docs/state-and-lifecycle.html

The categories for lifecycle methods are:
1) Mounting
2) Updating
3) Unmounting

LOCAL STORAGE

Local Storage is simply a key value store, for example we can name a key person and give it a value of John. We can later on fetch the value of John based off of the key name.

We use the localStorage object and call on a few methods on that object:

```
localStorage.setItem('key', 'value');

localStorage.getItem('key');

localStorage.removeItem('key');

localStorage.clear();
```

The setItem method takes in two arguments i.e. the key and value and the getItem method takes in one argument of the key which will return the corresponding value. If we reload the webpage we can still have access to the key:value items because this is saved to local storage and the items persist. The removeItem method takes in one argument which is the key and it removes the item (key:value pair) from local storage. Finally, the localStorage.clear() method will clear everything stored in local storage.

This is a great starter database mechanism to explore the general principals before exploring actual databases.

It is important to note that localStorage only works with string data only. Even if we use numbers, it will actually implicitly convert it to a string. To convert the string back into a number we would use the parseInt() method.

How would we work with objects and arrays in localStorage? We would use JSON.
JSON is a string representation of a JavaScript object or an array. JSON stands for JavaScript Object Notation. There are two JSON method we would always use:

JSON.stringify()

JSON.parse()

The stringify method is going to take a regular JavaScript object and get the string representation, while the parse method takes the string representation and returns a true JavaScript object. In JSON all of the keys are wrapped in double quotes which is one of the many rules JSON enforces.

Example Code:

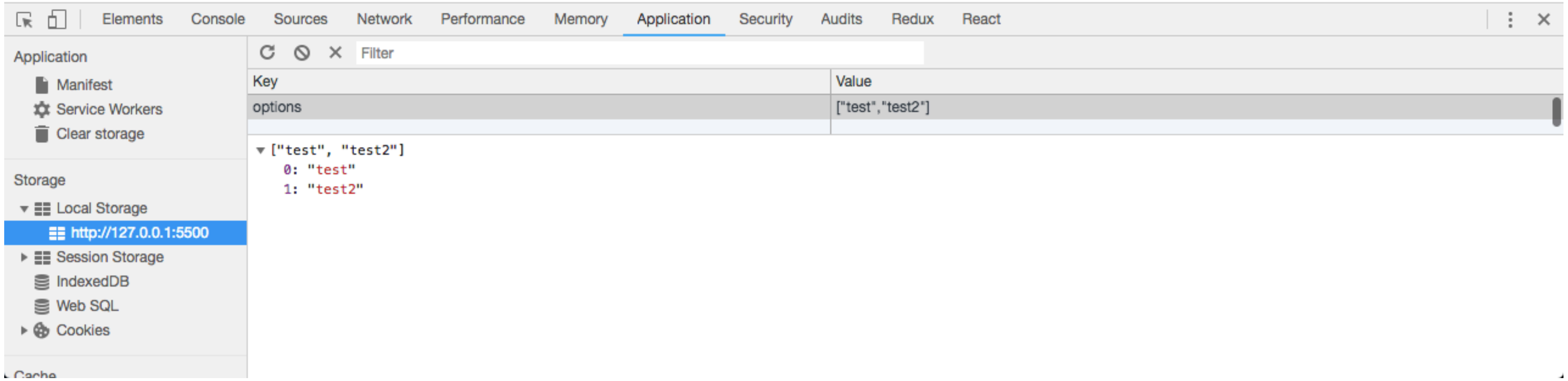
const json = JSON.stringfy({age: 26}); –> json returns string representation of "*{"age": 26}*"

JSON.parse(json); –> returns *Object {age: 26}*

JSON.parse(json).age –> returns 26

If we try to parse in erroneous data into the parse method this will through a 'Uncaught SyntaxError: Unexpected Token in JSON at…' in these cases would use the JavaScript try/catch function to try a JavaScript code and where it fails use the catch to do something else.

We can see the key value pairs in our browser dev tools by going into the Applications tab within the Local Storage area we can view all our key value pairs that is saved.



Key	Value
options	["test","test2"]

```
▼ ["test", "test2"]
    0: "test"
    1: "test2"
```

Section 4

WEBPACK

- What is Webpack?
- Installing & Configuring Webpack
- ES6 Import/Export
- Default Exports
- Importing npm Modules
- Setting up Babel with Webpack
- Source Maps with Webpack
- Webpack Dev Server
- ES6 Class Properties

In this section we are going to learn all about a tool called Webpack.

Webpack is an asset bundler, meaning that it will take in all our files that makes up our application, combine it with things from third party libraries and then spit out a single JavaScript file.

This allows us to break our application into multiple smaller files e.g. having a single file for each component.

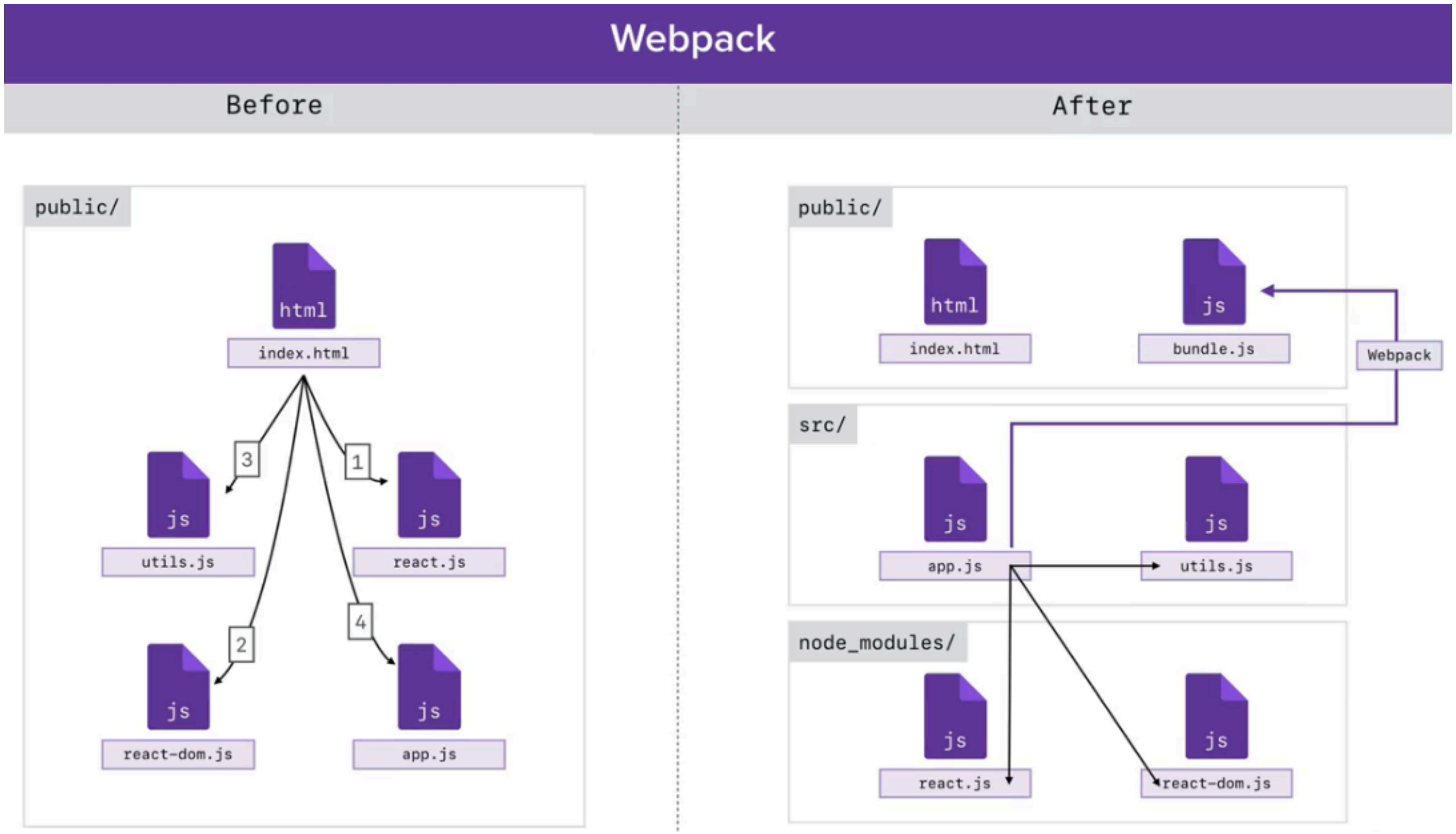
We will learn how to configure Webpack and how to use all the features that is available to us such as ES6 Import/Export, Default exports, importing npm modules, setting up Babel with Webpack, setting up a Webpack dev server and many more.

WHAT IS WEBPACK?

We could define Webpack as a module bundler for modern JavaScript applications, however, this does not really explain or show what Webpack does or how it helps build better applications. There are many advantages to Webpack:

1. Webpack allows us to organise our JavaScript. At the end of the day when we run our application through Webpack, we are going to get back a single JavaScript file (called the bundle) which contains everything our application needs to run. This will contain the depnedencies and application code. Our index.html will only need a single <script> tag to this single file as apposed to multiple <script> tags for multiple JavaScript files which will get unwieldy. Having too many <script> tags can also slow down your web application because it would need to make multiple request for all the file to load the website.
2. Gulp and Grunt are alternative tools which concatenates/minifies all your JavaScript into a single file. However, Webpack is a little unique: It is breaking up all of the files in our application into their own little islands, and these islands can then communicate using the ES6 import/export syntax. This mean Webpack allows us to break up our application into multiple files that can communicate with one another. This allows our application to be modular and more scalable.
3. Webpack allows us to grab our third party dependencies that were installed by npm or yarn and live in the node_modules directory. This means we can install/uninstall/update our dependencies using the package.json file and our application will take care of the rest.

Before Webpack we had a public folder which had everything our application needed. We have our html file and all of our JavaScript code and also our third party dependancies codes all living in the public directory. We would have loaded them all via <script> tags in our html file, but in the correct order because we are relying on the global JavaScript namespace e.g. react.js has to come first to setup the global variable, then react-dom.js, utils.js and finally app.js which has to come last in order to take advantages of the things created in the other files.
This caused issues with managing all the dependencies which was annoying and polluting the global namespace adding a bunch global variables which didn't need to be in the global namespace (causing weird situations such as accidentally wiping/overriding variables without noticing).



Wepack allows us to break up our application into a directory structure. We have a public directory to serve up the web application assets, while the src directory contains the client side JavaScript and a node_modules directory which contains all the application third party dependencies such as react.
Webpack is a module bundler, so the JavaScript files are going to be setup to depend on one another. We would create a little dependency tree by defining the dependencies clearly within the app.js file which will be considered as the main file. When Webpack is run, it will start with app.js file (as the main file) and get everything it needs to run the application. We will end up with a single file in the public folder called bundle.js and this single file will be loaded in the html file using the <script> tag. Not only does Webpack compress the JavaScript code but it can also run the Babel command for us.

AVOID GLOBAL MODULES

Installing packages globally is not ideal for the following reasons:

1) The package.json file no longer defines all of the dependencies. This means that if people are trying to collaborate on your project or making your project open source for others to download and use, we are not giving all of the tools required.
2) If you have multiple projects and installed the modules globally, this would mean all of the different projects would need to be on the same version of the dependencies. Therefore, it is best to define all of your dependencies and versions within the package.json file for each of the projects.
3) The final disadvantages of global modules is the fact that we have to type out the entire command in the terminal. It would be nice if we had a alias script.

To remove the global dependencies we can run the following command in the terminal:

```
$ npm uninstall -g babel-cli live-server          or          $ yarn global remove babel-cli live-server
```

We will no longer have access to the babel or live-server global commands within our terminal, reversing what we installed in Section 1. Instead we would install these dependencies locally to our projects. In the terminal within the project file directory run the following commands to install locally to the project:

```
$ npm install live-server  babel-cli@6.24.1          or          $ yarn add live-server babel-cli@6.24.1
```

You will now see the two dependencies within the package.json file and the modules will be installed in the node_modules folder within your project directory. Having installed these dependencies locally, we do not have access to the commands in the global terminal. Instead we will be setting up scripts inside of package.json where we are going to define how we want to use those dependencies.

To setup these scripts we would:
Step 1 – define these scripts inside of package.json – we need to add a new property onto the root object (we can add this wherever we want). The name "scripts" is important in the creation:

```
"scripts": { }
```

Step 2 – inside of our scripts object we are going to define all of the scripts we want. This uses a key value pair where the key is the name of the script and the value is the script itself:

```
"scripts": {

    "serve": "live-server public/",

    "build": "babel src/app.js  ––out-file=public/scripts/app.js  ––presets=env, react  ––watch"

}
```

Step 3 – we can now run the script by calling on the script name. There is no need to retype the value as we previously did in the terminal. This script will use the local installed module to run the script command.
To run the script in the terminal we will use the following command:

```
$ node run serve        or        $ yarn run serve

$ node run build        or        $ yarn run build
```

The advantages of this is:
1) All dependencies are defined in the package.json file, this makes it easy for anyone to use the app and have everything installed that they need to start coding within the project using the same tools.
2) The versions of the tools are defined. This ensures everyone is using the same version of the tools. This also allows us to use different versions across different applications.
3) This allows us to create scripts which defines what we want to run in the terminal. These scripts can be called within the terminal using the script name rather than typing out the long command(s).

We can avoid using global modules moving forward.

INSTALLING & CONFIGURING WEBPACK

To install webpack locally in your project directory enter the following command in the terminal:

```
$ npm install webpack@3.1.0        or            $ yarn add webpack@3.1.0
```

This will add webpack in the node_modules directory within your project files. We can now go to the package.json file to setup the script object for webpack:

```
"scripts": {
      "build": "webpack ––watch"
}
```

We don't need to provide any other arguments, instead we are going to setup the webpack config file where we define all the necessary things we require. By default webpack does nothing, we have to specify how to work with our application, otherwise this webpack command will do nothing.

We would need to create a file within the root of the application with the specific file name of **webpack.config.js** otherwise webpack will not be able to locate the config file. This file is actually a node script, so we actually have access to everything we would have access to inside of a node.js application. We will not be focusing on node.js but we require a little nodge.js to setup our webpack config (note: node is just JavaScript).

There are two critical pieces of information we have to provide in order to get webpack working:
1. Where the entry point is i.e. where does our application kick off for us (app.js); and
2. Where to output the final bundle file.

```
module.export = {

    entry: './src/app.js',

    output: {

        path: path.join(__dirname, 'public'),

        filename: 'bundle.js'

    }

};
```

The path needs to be an absolute path, which means that we have to provide the path to this project on our machine. This will clearly be different for everyone if you are on a different operating system or your username is different. The path is going to be different as well. There is a variable which makes this easier for us called __dirname which provides the absolute path location of the current location.

The below link provides documentation on the node path api – there are a bunch of methods for path manipulation e.g. path.join():
https://nodejs.org/api/path.html

We have a minimal webpack setup and can now run our webpack script command within the terminal. Whenever the script is run, this will create the bundle.js file within the public folder within your project.
Webpack offers a lot of features that we can add to our setup file such as automatically running babel, ES6 import/export syntax and many more features we are unaware of. For more documentation on Webpack and how to setup the config file visit the following website:
https://webpack.js.org/

ES6 IMPORT/EXPORT

ES6 Import/Export statements allows us to break up our code into multiple files. Instead of having a single large code file that contains all the code for your application to run, ES6 import/export will allow multiple smaller files that can communicate with one another which in effect allows you to make web applications that actually scale as you add more components and libraries.

If we remember from the previous section on installing webpack, we have a single entry point called app.js – this file is used to create the bundle.js file (i.e. the final minified JavaScript file that contains all the application code). If we create other .js files, these in effect would have no affect on webpack as there are no entry points for these additional files. In order to bring these other .js files into our application, we would need to import them into the app.js file using the import statement. Take the example of importing a utils.js file into our app.js file, we would write the following statement:

Folder Files:
app.js
utils.js

Code for app.js:

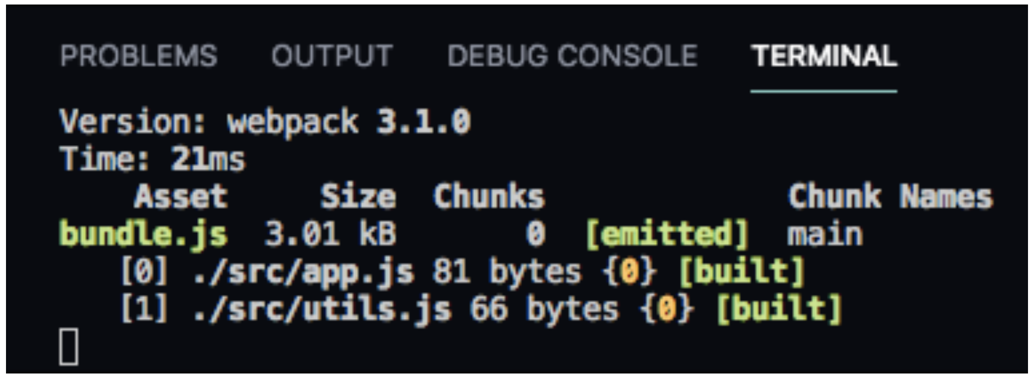
```
import './utils.js';
console.log('app.js is running');
```

Code for utils.js:

```
console.log('utils.js is running');
```

We would use the import keyword followed by within quotes the relative path to the file we want to import from app.js file – in the above case utils.js file lives in the same path as the app.js file. This will cause the app.js to run the utils.js code first to print to the console and then run its own code to print to the console (resulting in the two console.log messages printed to the console).

Webpack will now use both the app.js and utils.js files to generate the minified code in bundle.js file as seen in the screenshot to the rights.



```
Version: webpack 3.1.0
Time: 21ms
    Asset      Size  Chunks             Chunk Names
bundle.js  3.01 kB       0  [emitted]  main
   [0] ./src/app.js 81 bytes {0} [built]
   [1] ./src/utils.js 66 bytes {0} [built]
```

This allows us to modularise our code for example we could create a function within our utils.js file (e.g. square root of a number) and call on that function passing in the necessary function arguments in our app.js file. However this leads to our first important note about all our files inside of the webpack application:

Each file maintains their own local scope which means variables declared in one file are not automatically accessible by all other files. Just because we import a file into another does not mean we have access to everything inside of it (*if this was the case, this would mean webpack would pollute the global namespace, and if more and more files are added, the likely chance for some sort of naming conflict causing the application to crash*). This is where we would use the export statement.

Import does half the battle of letting us grab some values from a given file, but that file has to choose to export some values as well. There are two types of exports:

1. Every file can have a single default export and
2. You can have many named exports as you like.

Named Exports – use the export keyword followed by the name of the export within curly brackets:
Code for utils.js:
export { square };

It is important to note that the export is not an object definition (i.e. we cannot use key value pairs). Instead we define what we want to export from the file for example the square variable. Even though we exported square, we would need to import it within our app.js file in order to have access to it. We would use the following import statement:

Code for app.js:
import { square } from './utils.js';

Again we would use the import keyword, but now we would use the curly braces (*this is not an object*) and specify any of the named exports we provided (*it is important the export names match up*) then followed by the from keyword and then provide the file path.

The import/export now allows us to use the function/variables from utils.js file within our app.js file.

When you add multiple named exports, we provide a comma between the list to separate the multiple named exports:

```
export { square, add }
```

We can have access to multiple named exports within our app.js file by specifying the same in our import statement:

```
import { square, add } from './utils.js';
```

Just because you exported multiple named exports does not mean you need to import all the named exports. You can pick and choose which named exports you wish to import into the files. The order of the export names does not matter.

The alternative method for exporting our named export is adding the export keyword in front of each of our functions/variables we want to export, which has the same effect as the above syntax:

Code from utils.js:

```
export const square = (x) => x * x;

export const add = (a, b) => a + b;
```

(Note: the export name will come from the variable name(s)).

We have learned that all the files within the application live in isolation. Just because a variable has been created in a file, this does not mean that other files will have access to it. To give access to another file the variable we would need to export and specify what we want to export in the file. The same is true when importing. Just because a file has imported something from another file this does not mean the file will have access to it. In order to have access to the exports in another file, we must need to import the named exports by their names.

Default Exports – we can only have one default export. Each file, if you choose to, can have a single default export. We would add the keyword as default to the export we want as a default:

const { square, add, subtract as default }; —–> subtract is a default export and not a named export.

—–> square and add are both named export.

~~const { square as default, add, subtract as default };~~ —–> We can only have one default, this will error.

We cannot import subtract as a named export as it will cause an reference error because webpack cannot find a named export called subtract, that is because subtract is a default export. To reference a default export we would place it before the curly braces:

Code for app.js:

~~import { square, add, subtract } from './utils.js'~~ ——> uncaught reference error.

```
import subtract, { square, add } from './utils.js';
```

What makes the default special? Importing defaults the naming is not important. We could classify the import of the default anything we would like (e.g. minusCalculations) and webpack will know behind the scenes that it would get its values from the default export that was specified in the file.

```
import minusCalculation, { square, add } from './utils.js';
```

An alternative way to code the export default statement is to write a single expression:

~~export default const subtract = (a, b) => a – b;~~ ——> This is invalid export syntax

```
const subtract = (a, b) => a – b;                ——> declare the variable function.

export default subtract;                         ——> must use a single expression to export default.
```

Alternatively to make this all inline we could get rid of the whole subtract variable/function and add the expression in our export default:

```
export default (a, b) => a – b;
```

There are no hard and fast rules of when to use the default export and named export. As a general rule you may decide to use export default for a huge chunk of code and use named exports for smaller codes to export.

IMPORTING NPM MODULES

In the previous section we learnt how ti import/export JavaScript codes that we wrote ourselves. In this section we will learn how to include code that we did not write ourselves i.e. third party code/npm modules.

You would normally run the npm install command to install a module into your application. In order to access the code you would use the import statement much like we have already seen, however, there is a slightly adjusted in order to account for the fact that we are loading in a library we did not write as opposed to a file we did write.

For example importing validator module:
https://www.npmjs.com/package/validator

Step 1 – Install:
In the terminal run the following command in your project directory (as specified in the documentation for the npm package you wish to install locally in your application).

```
$ npm install validator          or          $ yarn add validator
```

The package.json file will be updated to add the validator as a dependency to your application and the code lives within the node_modules folder.

Step 2 – import:
This part is a little tricky as you need to know what exports is made available within the module. Usually you would have to dig around the documentation to figure out how to get what you want from the module. For example if we want to get the validator function for validating emails how is it exported? Is it a default export or a named export? All these answers should be within the documentation for the package installed. The documentation for all packages are different.

```
import validator from 'validator';
```

In the import statement above, we are importing the validator library and grabbing the default export. Notice how we are not starting with the ./ which is for relative files inside our application. When we provide just the name of the module, Webpack is actually going to look for a module with the same name in the node_modules folder. It is going to import that file location which is going to give us access to the export we specified.

Step 3 - Use Module Exports:
We have access to all the things provided to us from the validator module. Again you would need to look at the documentation to know what is available and how to use it. For example:

isEmail(str [, options])
check if the string is an email.

`options` is an object which defaults to `{ allow_display_name: false, require_display_name: false, allow_utf8_local_part: true, require_tld: true, allow_ip_domain: false, domain_specific_validation: false }`. If `allow_display_name` is set to true, the validator will also match `Display Name <email-address>`. If `require_display_name` is set to true, the validator will reject strings without the format `Display Name <email-address>`. If `allow_utf8_local_part` is set to false, the validator will not allow any non-English UTF8 character in email address' local part. If `require_tld` is set to false, e-mail addresses without having TLD in their domain will also be matched. If `allow_ip_domain` is set to true, the validator will allow IP addresses in the host part. If `domain_specific_validation` is true, some additional validation will be enabled, e.g. disallowing certain syntactically valid email addresses that are rejected by GMail.

```
console.log(validator.isEmail('email@gmail.com');                    ––> returns true in the console.
```

The format is exactly the same as what we already learned in the previous section, the only difference is that instead of specifying the path to the file we want to load in, we just provide the module name.

We would be using the react and react-dom modules within our application projects and should be installed locally:
```
$ npm install react react-dom        or        $ yarn add react react-dom
```

SETTING UP BABEL WITH WEBPACK

We have learnt in the previous chapter how to import modules into our project. We can read the documentation on how to use react and react-dom modules within our application and what functions/methods are available through default export and named export:
https://www.npmjs.com/package/react
https://www.npmjs.com/package/react-dom
https://reactjs.org/

We are able to use react and react-dom functions/methods within our project; however, there is one problem and that is Babel has not been configured with webpack. When Webpack creates the bundle.js file, our JSX code has not been compiled into regular ES2015 syntax and therefore the browser will not be able to read the JSX expression.

To setup Babel with Webpack we would need to explore a more advanced Webpack technique. This technique is known as a loader. A loader allows you to customise the behaviour of Webpack when it loads a given file. For example, when Webpack sees a .js file such as app.js, person.js or utils.js, we can do something with that file i.e. run it through Babel (*we can do a similar thing with converting SCSS/SASS files into CSS files*). We are going to use Babel to convert ES6 into ES5 and JSX to regular JavaScript.

The first step is to install some new local dependencies within our application file which will appear in the package.json file. In terminal run the following command:

```
$ npm install babel-core@6.25.0 babel-loader@7.1.1          or          $ yarn add babel-core@6.25.0 babel-loader@7.1.1
```

Babel-core is similar to the Babael-cli i.e. it allows you to run babel in tools such as Webpack whereas the latter allows you to run babel in the terminal. Babel-loader is a Webpack plugin which teaches Webpack how to run babel when Webpack sees certain files.

In our webpack.config.js file we need to setup the loader. This occurs via the module property which takes an object within the module.exports method:

```
module.exports = {
    entry: './src/app.js',
    output: {
        path: path.joint(__dirname, 'public'),
        filename: 'bundle.js'
    },
    module: {
        rules: [{
            loader: 'babel-loader',
            test: /\.js$/,
            exclude: /node_modules/
        }]
    }
};
```

Further information on configuring Webpack can be found on the Webpack documents page. In particular we can read more on module rules in the below link:
https://webpack.js.org/configuration/module/#module-rules

Modules has a rules array, which we are going to setup a single object where we are going to define what we want that rule to be - this takes in 3 properties: the loader, test and exclude.

- The loader property will take in the loader we wish to use which is the babel-loader.
- The test property uses regular expression to test to see if the file meets the test criteria (i.e. in our case we are checking if the file contains .js at the end of the file name which indicates that the file is a JavaScript file). Only files that meet the test criteria will run the babel loader through them.
- The exclude property lets us exclude a given set of files e.g. exclude the whole node_modules folder. We do not want to run Babel through those libraries as they have already been processed and ready for production and we do not want to make any changes to any of those file codes.

The three criteria above is saying that every time Webpack sees a JavaScript file and it is part of our application, run it through Babel.

The only problem is that Babel does nothing by default and we have not currently told Babel to use the env or the react presets. To do this we need to setup a separate configuration file for Babel in the root of your project and this file needs to be called .babelrc which is a JSON file. This file allows us to take in all the arguments we passed into the command line and place them in this file. This file will have a presets array:

Code for .babelrc file:

```
{

        “presets”: [“env”, “react”]

}
```

We can now use the webpack and our script ($ npm run build or $ yarn run build) which will watch for any changes in our files.

To recap: we learned that we cannot just use JSX inside of Webpack without first teaching Webpack how to run Babel. We do that by using babel-loader. This allows us to use babel under certain conditions. In our case we setup a rule that says, whenever Webpack sees a file ending in .js and not in the node_modules folder go ahead and run it through Babel. This includes our entry file app.js and any files app.js might import.
Important note: the code in the bundle.js file is not minified and will not be the code that would be used in a production - we will see in later chapters how to setup Webpack build for production which will vastly reduce the size of bundle.js but for now this is perfectly fine and everything is setup to run with JSX inside of our Webpack applications.

ONE COMPONENT PER FILE

Working with react and Webpack, it is a common practice to put each component in its own file. This makes it really easy to scale up your application (if you want to add more components, you would add more files). This also helps with have files with shorter code and it helps to find the component you are looking for and also easy to maintain, update and test those components.

In the application src folder we would generally create a folder called components and within this folder would live all of our app components. We would have one file for each component and will use the import/export statements to import these components within the main root file (app.j).

The naming convention for naming your component files is to use the same name as the component itself and the first letter of the file should be a capital letter. The component file needs to import React in order for the component class to work. Secondly, we would need to export the component in order to use the component within the app.js root file.

Example:
Code for AddOptions.js File:

```
import React from 'react';

export default class AddOption extends React.Component {…}
```

Important Note: we can add in the export default keyword in front of our class and this is completely valid (we cannot add the export default keyword in front of variables as we learned in the previous section).

Alternatively, we can define our class and export default at the bottom of our file:

```
export default AddOption;
```

We would then need to import the component in the app.js file e.g. import AddOption from './component/AddOption';

SOURCE MAPS WITH WEBPACK

Using Source Maps within webpack will allow us to easily debug errors within our application.

If we had some sort of error within our code for a component file for example a console.log(variable) and the variable did not exist, we will notice that we will not get an error message in the JavaScript until the function runs. When we do get an error it will relate to variable is not defined. Now if we had a large application and we started to get these errors, it will be really hard to track down where the error is actually coming from. In the JavaScript console we would get a stack trace and on on the right a link to exactly where the error is happening. However, this link takes you to the line within the bundle.js file which is a minified code that looks like nothing like the code we are use to. Using Source Maps will allow us to debug our errors within our applications much easier.

In the webpack.config.js file, we would need to setup a single property called devtools and this takes in a string to specify the type of source map we want. There are quite a few different values you can put inside of this devtool, some are better suited for development while others for production. For more documentation on webpack devtools:

https://webpack.js.org/configuration/devtool/

```
module.exports = {

    … ,

    devtool: 'cheap-module-eval-source-map'

}
```

Whenever you make a change to your webpack.config.js file you will need to restart your build script again for it to take effect with the new changes. When an error occurs, this will now create a link to the component file that is causing the error. This makes it easier to debug your code for errors especially when the project files starts to grow larger.

WEBPACK DEV SERVER

In this section we will learn how to install and setup a Webpack dev server. This is a little development server, similar to a live server, but this comes with some nice to have features specific to webpack for example speeding the process of changing our application files and actually seeing those changes reflected in the browser.

We can read up on more details about Webpack Dev Server from the documentations:
https://webpack.js.org/configuration/dev-server/

There are a tonne of different ways to setup the server.

The first thing we would need to do is to install this new tool. Open the terminal and navigate to your project directory to install this locally (*we could install this globally but we already know that this is a bad idea*). Execute the following code:

```
$ npm install webpack-dev-server@2.5.1          or          $ yarn add webpack-dev-server@2.5.1
```

Once installed locally, we can setup the script within the webpack.config.js file properties.
For our purpose, we only need to setup one property in order to take advantage of the webpack dev server and this is contentBase (see documentation). This lets us tell the dev server where it can find our public files. In our case this is the public folder where our index.html and bundle.js (public assets) files lives. This is similar to how we setup live server to look for the public folder in our scripts within the package.json file – we are essentially doing the same thing within our webpack.config.js file by setting up the devServer property.

```
module.export = {

    … ,

    devServer: {
```

```
                contentBase: path.join(__dirname, 'public');
        }
};
```

We have now setup our Webpack dev server. Important note: we can add more settings using the documentation within our devServer property object if we would like to add more features other than contentBase. However, for our purposes this should be enough for our Webpack Dev Server.

Finally, in the package.json file, we would need to write a script that would run the Webpack Dev Server when we run the script from the terminal.

```
"scripts": {
        "build": "webpack"
        "dev-server": "webpack-dev-server"
},
```

We do not need to provide any arguments for the dev-server because they all sit inside of the webpack.config.js file. The webpack-dev-server is going to read the webpack.config.js file and use that to bootstrap itself. We can now run our dev-server which only needs one process running (i.e. we don't need live server and webpack ——watch (2 processes) anymore). We can execute the following command to run our Webpack-dev-server:

```
$ npm run dev-server     or     $ yarn run dev-server
```

This will start the development server with an output link, where the file is served from and where exactly the content is coming from on our machine i.e. the path we specified to the public folder. We have both the dev-server and webpack tools integrated into one script. We can go to http://localhost:8080/ to view our project within the browser.

This is essentially a replacement for live server with more features for Webpack specific features. On a final note the webpack-dev-server does not create a physical bundle.js file (we need the build script for that). The dev-server is holding the bundle.js file in memory in order to make the dev-server snappy but it never really serves the physical file. Even if we deleted this file in our project directory, the dev-server will continue to work as the file is stored in memory.

ES6 CLASS PROPERTIES

We are going to explore a new cutting edge JavaScript feature by adding in a new Babel plugin. This is going to add support for the class properties syntax which will allow us to add properties right onto our classes as opposed to just methods.

https://babeljs.io/docs/en/babel-plugin-proposal-class-properties

Run the following code in the terminal to install the babel feature/plugin locally in your project:

```
$ npm install babel-plugin-transform-class-properties@6.24.1          or

$ yarn add babel-plugin-transform-class-properties@6.24.1
```

After installing it locally, we need to configure our .babelrc file to include the plugins.

```
{
    “presets”: [“env”, “react”],
    “plugins”: [“transform-class-properties”]
}
```

Our Babel configuration is now ready to use this brand new Babel feature. You would need to restart your dev-server in order to use the feature if it was already running before the changes were made to the files named above. This now allows us to use the new syntax.

Old ES6 Classes Syntax:
If we wanted to setup an instance property on every instances of OldSyntax, we would do that by creating a constructor function and setting this.something = 'some value'

```
class OldSyntax {

        constructor() {

                this.name = 'John';

        }

};
```

If we now create an instance of OldSyntax, we would be able to view that property.

```
const oldSyntax = new OldSyntax();

console.log(oldSyntax);                                          -->returns OldSyntax {name: "John"}
```

This will show what makes up this instance i.e. the class object of OldSyntax and the single property of name set to John. We had to setup the constructor function to setup the single property value.

New Babel ES6 Classes Syntax:
The babel plugin allows us to use the new syntax to add in properties through key value pairs.

```
class NewSyntax {

        name = 'Beth';

};

const newSyntax = new NewSyntax();

console.log(newSyntax);
```

This plugin allows us to create new instances with properties without defining the constructor() function. This new syntax allows us to write a much more cleaner code and Babel compiles all this syntax down to regular ES2015 syntax.

The second advantage of using the class properties syntax is to be able to create functions that are not going to have their binding messed up (which is easy to do) and we do not need the binging workaround e.g. this.greeting = this.greeting.bind(this) in our code which is not an elegant solutions. Example function in the new syntax:

```
class NewSyntax {

    name = 'Beth';

    getGreeting = () => {

        return `Hi. My name is ${this.name}`;

    }

};

const newSyntax = new NewSyntax();

const getGreeting = newSyntax.getGreeting;

console.log(getGreeting());
```

We know that arrow functions do not have their own this binding, instead they just use whatever 'this' binding is in the parent scope and for classes, that is the class instance. This means that the getGreeting() function will always be bound to the class instance. The above function will work without breaking the this binding and we no longer require the old workaround solution for the binding using this new Babel class properties syntax.

SUMMARY: WEBPACK

<u>What we have learned:</u>

- How to setup Webpack from scratch
- How to use the ES6 import/export statements to modularise our JavaScript codes
- How to import third party npm modules and use them within our projects.
- Setting up Babel with Webpack
- Creating a Source Maps with Webpack to easily debug our application files when there are errors.
- How to setup a webpack-dev-server
- Install Babel Plugins for new cutting edge JavaScript features.

<u>Recap of Babel ES6 Class Properties:</u>

We setup a brand new babel plugin which allows us to access a cutting edge feature, in this case the transform-class-properties syntax. This allows us to customise how we use classes in our application. We are now able to setup state outside of the constructor function. We are also able to setup the class properties equal to arrow functions. This is a great candidate for event handlers which usually has problems maintaining the this binding, but with arrow functions this is not something we have to worry about.

<u>Wrap up:</u>

We now have a much more scalable architecture with each component living in their own JavaScript file within the components folder i.e. one component per file. This makes it to locate and find the component easily within your application.

Section 5

USING THIRD PARTY COMPONENTS

- Passing Children to Component
- React-Modal Example

In this section we are going to learn how we can utilise and integrate third party tools such as date-pickers, modals, animated lists and other sorts of great features that are available.

Once we know how to integrate one third party tool we would be in a position to be able to know how setup and use all other third party tools that are available to use in your projects.

PASSING CHILDREN TO COMPONENTS

In this section we are going to learn about the built in Children Prop which is a fantastic tool that makes it easy to pass in custom JSX to a given component.

Currently, all the components we create would already know exactly what they need to render i.e. it is explicitly defined within the component render method. However, what if we had a component like a layout component i.e. we render the header and footer and wanted everything in the middle to be dynamic that is specific to each individual page. How would we exactly set that up?

We already know that when we want to pass data into a component we just pass it as a prop. We can then reference that prop within our component. The first parameter argument that gets passed into our component is the props and we can then use that to render the props using a JSX expression. This is one approach we can take to make our content dynamic per page.

```
ReactDOM.render(<Layout content={template} />, document.getElementById('app'));
```

However, there is an alternative way to to pass in JSX into your components. Instead of using a self closing component tag in the ReactDOM.render() function we can use opening and closing tags for our component just like a HTML element. We can define our JSX in-between the opening and closing tags.

```
ReactDOM.render(<Layout><p>This is inline<p></Layout>, document.getElementById('app'));
```

When we pass something in the component like this, we have access to it via the children prop. This is created for us, which is why it is called a built in prop as opposed to a prop we would manually setup ourselves. This will be available through props for a stateless functional component or this.props for a class based component.

This allows us to create applications that give a little more context when you look at the code. We can use opening and closing brackets between our component tags to break up the code into multiple lines:

```
ReactDOM.render((
    <Layout>
        <p>This is inline<p>
    </Layout>
), document.getElementById('app'));
```

This is much more easier to visualise the code as opposed to have some JSX defined elsewhere and passed in as a prop. We can make the JSX within the component as complex as possible and this will all be passed in as a built in children prop.

Now this technique is important to understand because we are going to see it being used when we work with third party components that we did not write. This means that they are going to have their own API and are going to expect certain things to be passed in. This is going to involve us passing in JSX.

So for the moment all we need to know is that we can pass JSX into a component and that component can choose as to whether or not it wants to use the JSX.

REACT-MODAL EXAMPLE

In this section we will explore installing a third party React Component called React-Modal which allows us to create great looking modals. The React-Model uses children prop and therefore will help demonstrate and understand how to use third party react components as well as how it works behind the scenes. More documentation on this third party component can be read in the readme.md file at:
https://github.com/reactjs/react-modal

We are going to render a modal component and pass in some props such as if the modal should be open, or do stuff when the modal closes and we have access to a lot of nice features. Between the Modal component tags there are also the content that makes up the modal itself.

We would use the terminal to install the third party component by running the following command:

```
$ npm install react-modal@2.2.2          or          $ yarn add react-modal@2.2.2
```

Once this installs into your project directory, we are able to use the third party component. We would create a new component file called OptionModal.js and inside this file we will get the necessary imports e.g. React from 'react'. To find the necessary imports from the third party component it is best to look at the documentation to find what is required to be imported and whether they are default or named exports. A good tip is to search the document page for the word import and this should provide a code snippet for setup. This will require you to do some research on the third party components you wish to implement (as all documentations are different).

```
import React from 'react';

import Modal from 'react-modal';
```

We will then create a stateless functional component which we will export default the component to use in our application file to render the modal component:

```
const OptionModal = (props) => (

	<Modal

		isOpen = {!!props.selectedOption}

		onRequestClose={props.handleClearSelectedOption}

		contentLabel = “Selected Option”

	>

		<h3>Selected Option</h3>

		{props.selectedOption && <p>{props.selectedOption}</p>}

		<button onClick={props.handleClearSelectedOption}>Okay</button>

	</Modal>

);

export default OptionModal;
```

We would import the above component within the Component file we want to render the modal inside of:

```
Import OptionModal from ‘./OptionModal’;
```

This file will also need to track using the state the props for the Modal.

```
State = {

	selectedOption: undefined

};
```

We can create a function called handleDeleteSelectedOption which will clear the state option when the button in the OptionModal is clicked.

```
handleDeleteSelectedOption = () => {
    this.setState( () => ({ selectedOption: undefined }));
}
```

We would need to render the OptionModal within our component file in order to view the modal. This is where we would have to pass in our child properties in our modal to which will pass in the the props into the OptionModal component to make the Modal dynamic with the data that is passed in:

```
<OptionModal
    selectedOption={this.state.selectedOption}
    handleClearSelectedOption={this.handleClearSelectedOption}
/>
```

The two children properties in <OptionModal /> are used to pass down the properties values in our OptionModal.js component file which is passed as the props argument. We can now use the props value within the OptionModal component file to make the component dynamic. For example:
The first property allows us to change the isOpen to either true or false. This checks if selectedOption state has a value and if it does this will return true, opening the Modal. If the selectedOption state is set to undefined then this will return false and close the modal. We can also use the selectedState value to populate the modal using <p> tags to display the text.
The second property allows us to call on the handleClearSelectedOption function passed down to our OptionModal component when we click on the onClick event handler button. This function sets the selectedOption state back to undefined which will close the Modal when the button is clicked.

Aside from the isOpen and contentLabel props, there are other props that the Modal Component supports for example onRequestClose takes in a function which gets called when the user clicks on the webpage outside the modal or presses the escape key on their keyboard (we can use the handleClearSelectedOption function to close the Modal).

This provides a working example of installing a third party component and using it with our application component passing in our component data to work with the third party component using children properties to pass down the props to the third party component.

Section 6

STYLING REACT

- Setting up Webpack with SCSS
- Architecture
- Reset CSS
- Theming with Variables
- Mobile Considerations
- Bonus: Favicons

In this section we are going to learn all about styling a React Application.

Up until now, we have focused on the functional aspects of coding a React Application and using ES6 features to create our react component and using Webpack as a tool for compiling our code using Babel and using the import/export features to modularise our application. However, the application would currently look horrible. This section will focus on adding some CSS to our application for styling.

We will be using SASS/SCSS pre-processor and configuring webpack to take our SASS/SCSS and compile it down into regular CSS. We will be able to take advantages of variables and mixins and all the other great features from SASS/SCSS.

SETTING UP WEBPACK WITH SCSS

SASS SCSS is a preprocessor for CSS. This adds support for things like variables, mixins and other great features that makes writing CSS styles a whole lot easier. In this section we will look at integrating SCSS with Webpack which will compile our SCSS into regular CSS and add it in our application. Note: we could write our own CSS styles and add it via a link tag in our html file.

We would create a new folder and file called styles and styles.css in our src directory.

In our webpack.config.js file we need to specify a new rule whenever webpack encounters a styles file (we already have one for when webpack encounters our .js files).

```
Module: {
    rules: [{
        ….
    }, {
        test: /\.css$/,
        use: [
            ‘style-loader’, ‘css-loader’
        ]
    }]
}
```

The test specifies that we want to look for any files that end with .css which would be our styles.css files we created. We will add two loader files to teach Webpack. One will take CSS and convert it into a JavaScript representation of CSS while the other will allow Webpack to take the CSS in JavaScript form and actually adds it to the DOM bu injecting a style tag which will show in the browser.

https://www.npmjs.com/package/css-loader
https://www.npmjs.com/package/style-loader

We will add them to our project by running the following commands in terminal:

```
$ npm install style-loader@0.18.2 css-loader@0.28.4          or          $ yarn add style-loader@0.18.2 css-loader@0.28.4
```

Once they are installed locally, they can be added to the webpack.config.js file within the loader properties in order to make Webpack work with our CSS/SCSS. The use property allows us to use an array of loaders whereas the loader property only allows us to use one loader.

This is all it takes to setup CSS inside of Webpack. The end result is that whenever webpack encounters a CSS file, it is going to read that file and it is going to dump its content into the DOM in a style tag and the style will show in the browser. Save the webpack.congif.js file and restart your Webpack server for the config changes to take effect.

Inside of app.js we would need to import our styles.css file:

```
import './styles/styles.css'
```

We can now style our application using the styles.css file within our application and Webpack will be able to read the css file and add it to our app.js and inject it within style tages to display our styles in the browser. We can now style the whole application using regular CSS.

We now need to setup SCSS with CSS. This tool can be found on:
https://sass-lang.com/

We need to load in the loader and the compiler itself, much like how we installed the babel loader and babel-core compiler.

We would need to tweak our webpack.config.js file as we no longer want to be looking for .css files but rather for .scss files.

```
Module: {
    rules: [{
        ....
    }, {
        test: /\.scss$/,
        use: [
            'style-loader', 'css-loader', sass-loader',
        ]
    }]
}
```

In the terminal we will need to run the following commands to install the two new tools locally in our project.

```
$ npm install sass-loader@6.0.6 node-sass@4.5.3        or        $ yarn add sass-loader@6.0.6 node-sass@4.5.3
```

All we need to do is add the sass-loader to our use (loader) properties array. Behind the scenes the sass-loader is going to use the node-sass precompiler to convert the SASS/SCSS file into CSS. All we have to do is run the Webpack Dev Server similar to how we compile using Babel and Webpack.

We have to make sure the app.js is referencing/importing the scss file as we no longer have a .css file in our styles folder.

```
import './styles/styles.scss'
```

We should now be able to run SASS/SCSS code which will convert down into CSS and style our application.

ARCHITECTURE

In the app.js file, we use this file as a starting point to import code defined elsewhere. This allows us to have This allows us to have many small files as opposed to having one big code file. This is the very same architecture we would use to styles.scss file. Therefore, we are not going to actually define and selectors or styles in this file, instead we are going to import selectors and styles from other files. This is going to allow us to break up our application styles into multiple files as opposed to having everything defined inside of the styles.scss file.

SASS/SCSS supports the import syntax by default and so we can use this syntax to create the separate files that get loaded in. We can have a sub-folders within our styles folder that hold various styles:

Folder Name	File Name	Description
base	_base.scss	Setup things like the global font family that is going to be used throughout the entire application.
components	_componentName.scss	Style for each component.

The entry point will be called a [name].scss file, while the separate files that are going to be loaded in (known as partials) all start with an underscore _[name].scss as an example. To import the files in our main scss file we would use the SASS/SCSS syntax:

```
@import './base/base';
```

We leave off the extension and the underscore when importing the file.

We would use the BEM naming convention in our SCSS which refers to Block Element Modifier. The Block is the core building block e.g. the header, while the element is the things that go inside of that block to make them useful. We use the block and element together to target everything in our application. **http://getbem.com/**

RESET CSS

A CSS reset ensures all browsers are starting from the same place. Each browser has their own set of default styles and if they are not all starting from the same place, they will end up looking a little different when we actually apply our styles. To fix this we use a reset. Resets usually contains a ton of code, so we are not going to write our own. There are great libraries out there that contain reset for all sorts of weird situations so they handle all of the edge cases for us and we do not need to worry about sort of things.

To setup a CSS reset for our styles we are going to use normalize.css:

https://necolas.github.io/normalize.css/

Run the following command in terminal to install it locally to our project.

```
$ npm install normalize.css@7.0.0        or        $ yarn add normalize.css@7.0.0
```

Once installed, in our app.js file we are going to import the normalize.css just above our styles.scss import.

```
Import ‘normalize.css/normalize.css’;
```

This will actually crash our application because we removed the ability to support regular css files in our webpack.config.js file. We would need to update this file to test for the regex:

```
test: /\s?css$/,
```

By adding in the ? before the s and after the css is going to make the s optional. This will therefore look for both CSS and SCSS files. Restart the dev-server and this will fix our issue with importing .css files in our app.js file. All browsers for example Chrome, Firefox, Internet Explorer, Safari etc. are now all working off that same base. We can continue to write our styles knowing that they are going to work in a cross-browser setting.

THEMING WITH VARIABLES

It would be nice to have one place where a lot of common settings lived. We would be able to change settings in this file and have the application update to reflect those changes. This new file is going to live in the styles/base folder and the file is going to be called _settings.scss – this file is not going to contain a single selector nor any styles. Instead this file will be used to define a theme for our application. We will be defining a bunch of variables within this file.

We would need to import the _settings.scss file way at the top of our stles.scss file, this is to ensure the variables are defined before any other styles are loaded into our application.

```
@import './base/settings';
```

We can now use the settings file to define variables which we can use in our other .scss files such as the colour, sizing etc. To define a variable in SASS/SCSS we would use the $ sign before the name of the variable. We then assign the variable with a value.

```
$dark-black: #20222b;
```

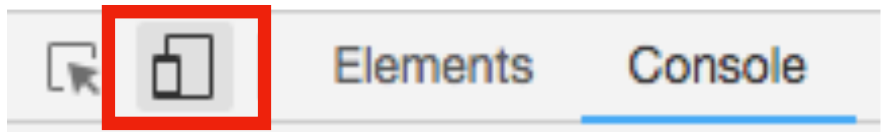
We can now reference the variable in our other .scss files.

```
.header {

	background: $dark-black;

}
```

As long as our variables are loaded in first within our styles.scss file, the other .scss files are able to make use of the variables. In essence we can create a theme for our application and we can change the theme by changing the variable values.

MOBILE CONSIDERATIONS

It is important to consider mobile user interface to ensure that the user experiences (UX) is also good for mobile users. So when we are testing for mobile, it is not enough just to make our browser skinny, this is because things are actually rendered a little differently. What you should use, is the device simulation tools that the browser has built in. On the right is a picture example of Google Chrome's Toggle device toolbar setting.



This provides a better idea of how the application will actually look like on a wide variety of mobile devices e.g. iOS/Android devices which we can toggle between. This will indicate whether a website/webapp has been optimised for mobile - if it has not then the page will look very zoomed out.

To fix this issue we need to tell the device that the application would like to use the actual width of the device as the application width for the content. We would need to use the meta tag in the index.html file for the viewport.

```
<meta name="viewport" content="width=device-width, initial-scale=1.0">
```

The content property takes in key=value pairs, we have two key=value pairs for this meta viewport tag. If you are using emmet in your text editor, the html snippet will add this in automatically for you. The application will now scale correctly to the device screens.

To change/target block elements in your UI to view differently on mobile screens, we can use media queries in our CSS files. We would use the @media keyword (which is a CSS feature) followed by the condition and then the styling output if the condition is met.

```
@media (condition) {css styling properties};
```

`@media (min-width: 45rem) {…};` —–> Apply these styles at the minimum width of 45rem.

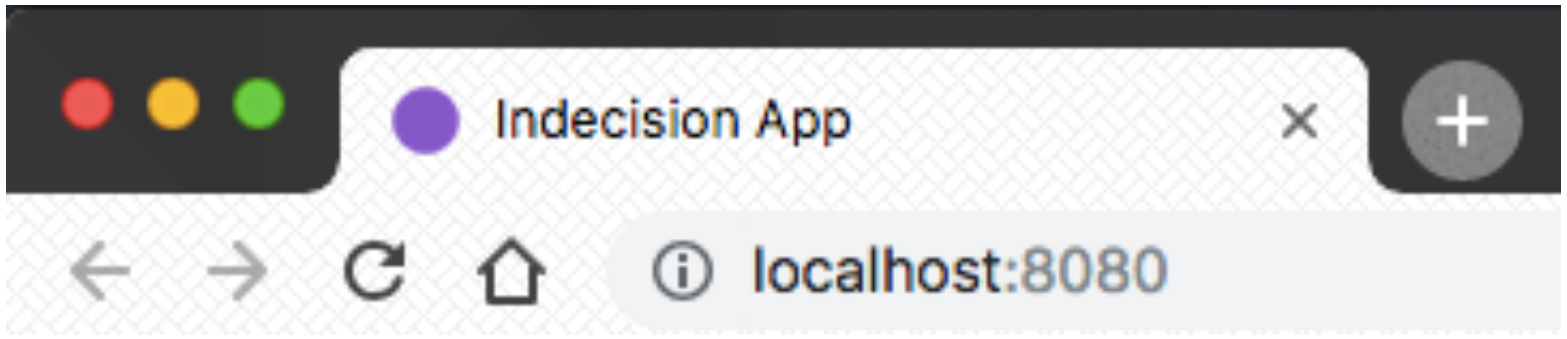
FAVICON

The Favicon is the little icon that appears in the browser tab for the webpage/app that you are visiting in that tab. To set a Favicon for your webpage/webapp:

1. Create a png icon image for your application.
2. Copy and paste the image file into the project's public folder which holds the index.html and bundle.js files. We could create a new folder called images and store all the project image files within this folder.
3. In the index.html file we would need to load in the favicon image using a <link> tag in the <head> section.

```
<link rel='icon' type='image/png' href='/images/favicon.png' />
```

After saving the files. When you reload the application or refresh the page, you should see the favicon appearing in the tab.



Section 7

REACT-ROUTER

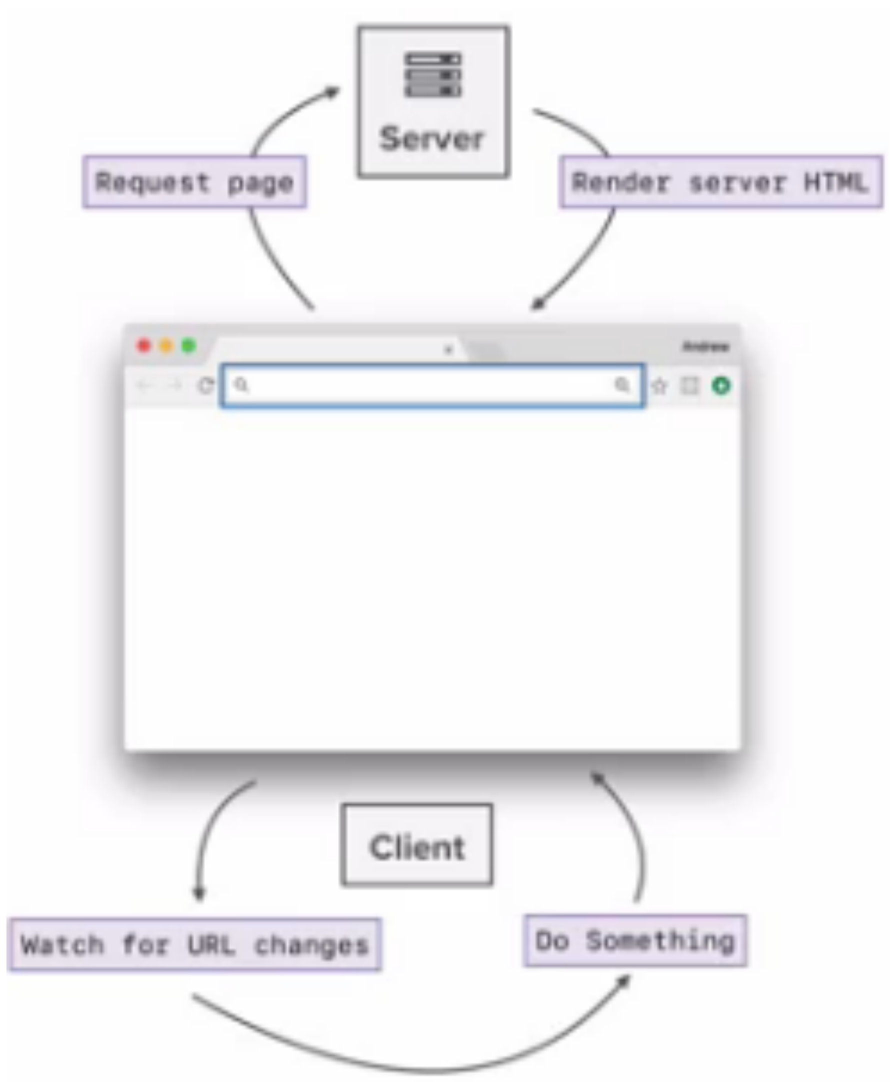
- Server vs Client Routing
- React-Router 101
- Setting up a 404 Page
- Linking between Routes
- Organising Routes
- Query Strings and URL Parameters

In the following chapters, we are going to explore a lot of libraries that are not part of React-core and React-Router is the first of many libraries that we are going to look at.

React-Router allows us to create a simulation of a multi-page websites/web applications using routes. In this section we will explore this library and how we can add it into our projects to extend the React-Core library.

SERVER VS CLIENT ROUTING

Server-side routing is the more traditional approach where we define the routes on the server, while client-side routing is the more modern approach where we use JavaScript to dynamically change what gets shown to the screen. Client-side routing has been made popular by all sorts of tools such as Angular, Backbone, Ember, View and React (they all use client side routing). The implementation may be different in each tool but at the core they all work the same.

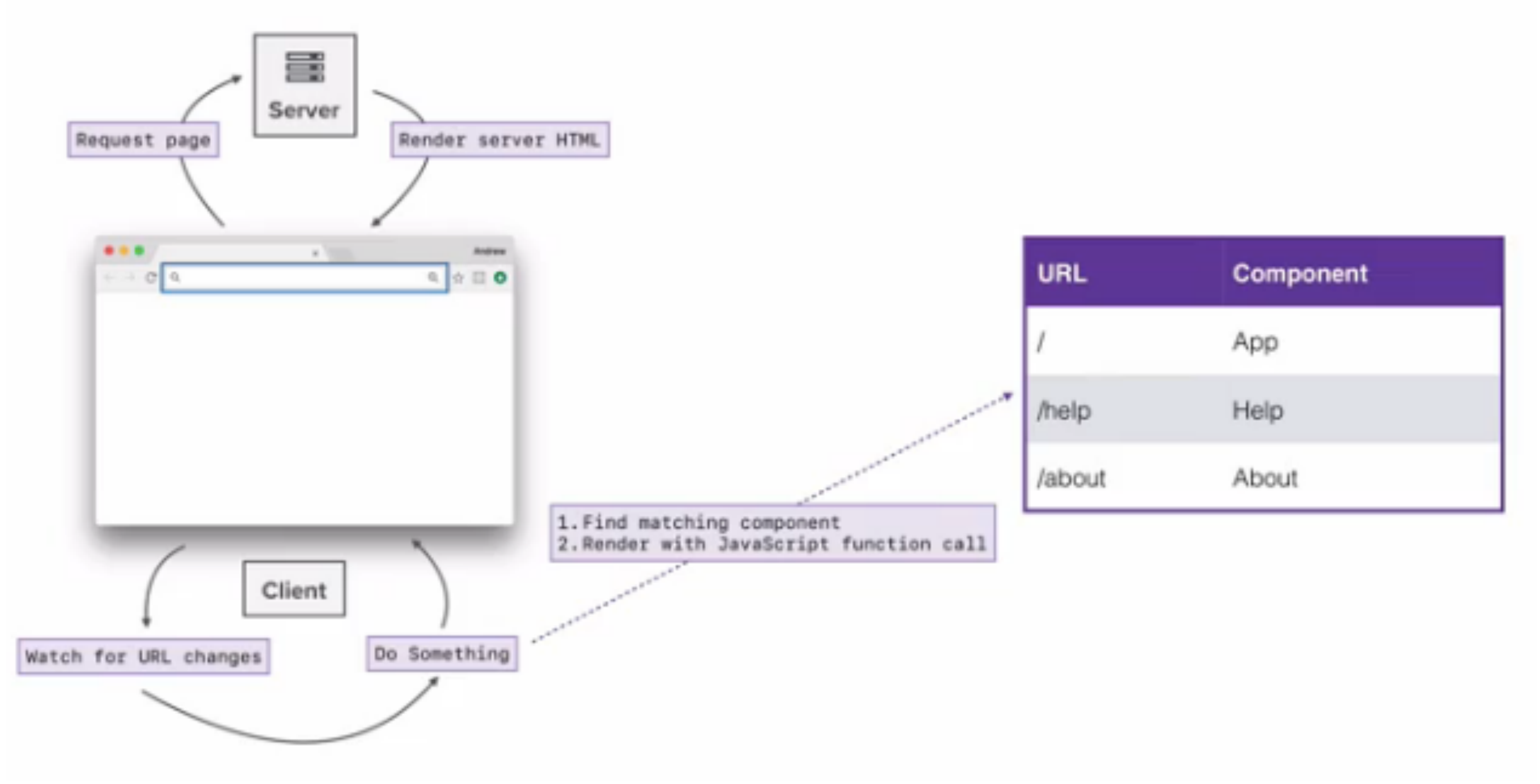


In the server-side routing the browser detects the change in the URL and it knows in order to render the correct thing for that URL, it needs to communicate with the server. The browser makes a HTTP request off to the server and server responds with the html that should get shown and then the browser goes ahead and re-renders things on the browser screen. This process is expensive, making the HTTP request and waiting for the response takes time. Not only are we using computational power but we are now introducing the network i.e. the network latency etc. is going to come into play and it is going to cause a small delay before the browser can actually re-render things.

With client-side routing, we handle the re-rendering of our application on the client, using the client-side JavaScript. On the very first time the application loads, we would need to go off to the server to request the html and the client-side JavaScript will start to render the React app. But for every other page change, whether the user clicks a link switching pages or get redirected based off some action they took, we would be handling that with client-side JavaScript. This means we do not need to make the roundtrip to the server in order to re-render the page. Instead we are going to be using the HTML5 history API available by browsers. This allows us to watch for some changes and run some JavaScript code when the URL actually does change.

We can now start to render a new component to the screen, render part of the application and leaving other components in place or re-render the entire page regardless what we want to do. This process no longer requires us to communicate with the server and it is going to run a whole lot faster.

React-Router library will allow us to have a set of URLs and a set of components to render for those URLs. So when the URL changes we find the matching components and then render with a JavaScript function call. Client-side JavaScript is going to allow us to create a single page application where we can swap out components simulating a page change.



URL	Component
/	App
/help	Help
/about	About

REACT-ROUTER 101

The React-Router documentation can be found in the below link:
https://github.com/ReactTraining/react-router
https://reacttraining.com/react-router/

React-Router is a tool that can be used in a few different environments. We can use it natively for Android and IOS as well as the web. The document in the **reacttraining.com** webpage provides a lot of guides and explains how things work the way they do.

To install the React-Router library locally to your project run the following code in the terminal within your project directory:

```
$ npm install react-router-dom@4.2.2          or          $ yarn add react-router-dom@4.2.2
```

Installing react-router would install both the web and native libraries to the project file whereas installing react-router-dom only installs the web library and react-router-native only installs the native (Android/IOS) library.

Once the library has been installed locally in your project, we can import the library and start using the React-Router in our projects. Within the app.js file we would need to import the new library:

```
import { BrowserRouter, Route } from 'react-router-dom';
```

We are going to be using the BrowserRouter once to create the new router and we are going to be using the Route for every single page in the application. We are going to provide things to Route such as the path we want to match and what we want to do when the user visits that path.

We define the router configuration for our application inside of JSX. We create a tree like structure using all the things from react-router-dom and that lets us define exactly how our application should render based on the current URL.

We need to create one instance of BrowserRouter with opening and closing tags because we would add some children inside similar to what we saw with components in the previous sections.

```
const routes = (

	<BrowserRouter></BrowserRouter>

);
```

We can now render our routes variable with the ReactDOM.render() method:

```
ReactDOM.render(routes, document.getElementById('app'));
```

This will render an empty screen because we have not provided any instances of route. This is how we will setup individual pages that make up our application e.g. a home page, about page, contact page etc. We would need to use Route from react-router-dom to create the different routes for the different pages.

In the Route we do not need to pass in any children and therefore do not need any opening and closing Route tags - but we are going to specify a couple of props for the Route. Route takes in two main properties which are:

1. the path i.e. what URL do we want to use for this route, and
2. the component i.e. when we match the URL, we would show the component to the screen.

```
<BrowserRouter>

	<div>

		<Route path='/' component={ HomeDashboardComponent } />

		<Route path='' component={  } />

	</div>

</BrowserRouter>
```

The path of forward slash / relates to the root of the application, even though the forward slash does not appear in the URL by default e.g. localhost:8080. For our components we would use JSX expression and reference a component to render. BrowserRouter requires a single element, therefore we would use a single <div> element to wrap all instances of our Routes.

You will notice that when we navigate to the localhost:8080/create page this will give us an error of Cannot GET /create. This is because the browser is using server-side routing. When we first load our application we need to request the index.html page from the server. However, we want to serve up index.html and allow react-router to determine what should get shown onto the screen. In order to do that, we need to make a small change to our webpack.config.js file in order to tell the dev server to always serve up the index.html file for all unknown 404's. All we have to do is add one new attribute onto the devServer object:

```
devServer: {

    contentBase: path.join(__dirname, 'public'),

    historyApiFallback: true

}
```

The hisyory.ApiFallback property when set to true will tell the devServer that we are going to be handling routing via our client-side code and that the devServer should return the index.html page for all 404 routes. Once the changes have been made you will need to restart the dev-server again. Once we refresh the page again, when we navigate to the /create page the dev-server will see a 404 and serve up the index.html page, the index.html page will load up the bundle.js file which is going to actually run our router code and determine the URL matches our Route and then show the component specified in the JSX code. This will end up providing a weird result whereby both components will be displayed. This is because both Routes paths matches. This is useful in some circumstances where you want multiple paths to match to render multiple components; however, where you do not want this to occur, there is another property you can add to your Route. This is the exact prop.

```
<Route path='/' component={ HomeDashboardComponent } exact={true} />
```

The exact prop by default is set to false, but we can specify this to be true. This will ensure that the component will render to the page if the route path exactly matches. This will ensure the component is not rendered when a user goes to the /create page because the path keeps going and no longer matches just the root path.

This is the core basics (fundamentals) of the react-router library which we can build off of. We will build on this foundation and learn how to do things such as redirect, link between pages, setup a 404 page etc.

SETTING UP A 404

If someone visits a URL that we do not have a route setup for that path, the React application will not throw an error, instead it will display an empty <div> i.e. empty page because none of the defined instances of Routes matched the users URL and no components was rendered to the screen.

To create a 404 page where we have not specified the route path elsewhere, we need to first create a 404 page component to render.

```
const NotFoundPage = (

        <div> 404! </div>

);
```

We would use another Route but leave out the path prop and only specify the component prop.

```
<BrowserRouter>

        <div>

                <Route path='/' component={ HomePage } />

                <Route component={ NotFoundPage } />

        </div>

</BrowserRouter>
```

This will render the NotFoundPage on all pages this is because React-Router still considers this to be a match. This is close to what we want to achieve but not exactly what we want. Instead we would need to import the Switch from react-router-dom.

```
import { BrowserRouter, Route, Switch } from 'react-router-dom';
```

Once we import the Switch component we can then replace the <div> element with the <Switch> element.

```
<BrowserRouter>
    <Switch>
        <Route path='/' component={ HomePage } />
        <Route component={ NotFoundPage } />
    </Switch>
</BrowserRouter>
```

When React-Router now sees Switch, it will go through each of the route definitions in order and it is going to stop when it finds a match (i.e. it will not look at the below Routes when it finds a match). This would mean when a user enters a URL which we have not setup a route for, React-Router will go through each route until it reaches the last Route which will always match and this will therefore display our 404 page not found component to the user for routes that are not defined.

LINKING BETWEEN ROUTES

Linking between Routes allows us to switch between pages without going through the full page refresh. When the app goes through a full page refresh it is essentially communicating with the server. The whole point of client-side routing is to avoid communicating with the server which is very expensive.

We can use a <a> link tag to switch between pages by providing the href prop value. However, this will continue to perform a full page refresh and communicate with the server.

```
const PageNotFound = () => (

    <div> 404! - <a href='/'>Home</a> </div>

)
```

Instead we would need to add an event listener for our links and override the browser default behaviour to prevent the full page refresh and use JavaScript instead to change what is rendered to the screen in order to simulate a page change. React-Router provides us with the Link components that use client side routing to achieve the above. We would import the named export in our app.js file and then use an instance of the Link component instead of a <a> tag:

```
import { BrowserRouter, Route, Switch, Link } from 'react-router-dom';

const PageNotFound = () => (

    <div> 404! - <Link to='/'>Home</Link> </div>

)
```

This is similar to the <a> tag, however, behind the scenes we are using client-side routing as opposed to server-side routing.

When linking internally within our application we want to make sure to use the <Link> component as opposed to the <a> tag to take advantage of the client-side routing, unless we are linking to pages outside of the application whereby the <a> tag would be perfectly fine because there will be no advantages of using client-side routing.

To create a component to appear on every single page we would add the component before the <Switch> component. This will ensure the component is always rendered. We would need a <div> wrapper to comply with the single element requirements of the React-Router API.

```
<BrowserRouter>
    <div>
        <Header />
        <Switch>
            <Route path='/' component={ HomePage } />
            <Route component={ NotFoundPage } />
        </Switch>
    </div>
</BrowserRouter>
```

The Link component is one way of navigating between pages but we also have the Nav Link component to switch between pages. The Nav Link component is better suited for situations like navigation i.e. where we have multiple links that are side by side and want to change the style of the link in some sort of custom way e.g. changing the link text colour for the active page. The Nav Link component is identical to the Link component, but it has a couple of extra props that we can take advantage of. The NavLink would be used for a navigation bar.

We would need to import it in order to use the Nav Link component. We can target with our CSS styles the activeClassName.

```
import { BrowserRouter, Route, Switch, Link, NavLink } from 'react-router-dom';

<NavLink to='/' activeClassName='is-active' exact={true}>Home</NavLink>
```

ORGANISING ROUTES

Now that we understand how React-Router routes works within the application, in order to organise the application routes and making your applications scalable, we would break the code into its own file rather than just having one big app.js file with all of the routes.

In the src folder of your application we would create a new sub-folder called routers. Within this folder we are going to have a single file called AppRouter.js (or whatever you like to call this file) for all of our application routes. The naming convention is exactly the same as our React Components, this is because at the end of the day this file will export a React Component but we are breaking it out in the Router folder as opposed to placing it within the components folder.

The AppRouter.js files requires a few imports:

```
import React from 'react';

import { BrowserRouter, Route, Switch, Link, NavLink } from 'react-router-dom';
```

The AppRouter is going to be a stateless functional component and implicitly return some JSX i.e. the instances of Routes.

```
const AppRouter = () => (

    <BrowserRouter>

        <div>

            <Switch>

                <Route path='/' component={ HomePage } />
```

```
                    <Route component={ NotFoundPage } />
                </Switch>
            </div>
        </BrowserRouter>
);
```

We can now export AppRouter as the default export.

```
export default AppRouter;
```

We can now import AppRouter into our app.js file and take advantage of it by rendering an instance of it.

```
import AppRouter from './routers/AppRouter';
ReactDOM.render(<AppRouter />, document.getElementById('app'));
```

Everything should continue to work even though the Routes have been broken into its own separate file to the app.js file. This allows us to better organise all our routes in one file rather than clogging up the app.js file.

We can now break up all the application components into separate components files and export default the components. Within the AppRouter.js file we can import all of the components within the application and create Routes for the component for the server-side routing.

QUERY STRINGS & URL PARAMETERS

When React-Router finds a route and it is a match, it renders an instance of that component. Non only is it rendering the component, it is also passing in a few props down. So any time we use a component inside of a route we get access to some special information.

If we access the props of our component and log them to the screen we can see the props object that React-Router passes down our component.

```
const HomePage = (props) => {
    console.log(props);
    return (<div>Home Page</div>);
};
```

When we visit the home page in the console this will log the props object. If we look at this object we can see all the special information such as the history, location, match, etc.

History is very useful. This is an object and contains a bunch of properties most of which are methods and this allows us to manipulate the history e.g. redirect the user programmatically via JavaScript.
Match contains a little useful information - but we would later on use the params object. Currently it contains the information about why the current route is considered a match i.e the path and url values is an exact match.
Location contains information about the current URL. As we start to use hash values and query search strings they will end up showing in the locations as well. A query string in a URL is a question mark ? followed by a bunch of key value pairs for example:

```
Localhost:8080/edit?query=rent&sort=date
```

The query string in the URL will appear in the Location object as the value for the search parameter. We could do something meaningful with those values like filter the data that is shown to the screen.

We can populate the hash value using the # symbol followed by something in the URL for example:

localhost:8080/edit#contact-us

What this would do is scroll the user down to the element on the page that had the id of contact-us which is useful for very long pages. We would be able to access the hash value from the Locations object within the hash parameter value.

React-Router like all other routing tools provides us a way to get dynamic URL. For example, if we wanted our /edit route to be dynamic to show the id of the data we wish to edit in the url we would need to update the Route. We would add a colon followed by a variable name:

```
<Route path='/edit/:id' component={EditPage} />
```

The :id is going to dynamically match whatever comes after the forward slash ie. this could be 1, 34, testing etc. This is going to give us access to that value so that we can do something that is going to be meaningful, like fetch the item from the database and populate the form fields so that the user can actually edit the record.

If we were to visit the URL page localhost:8080/edit/50 as an example, if we look at the React-Router props object we would now see in the match params object a key value pair of id: “50” – this will allow us to grab this information and do something meaningful i.e fetch the item from a database and display to the screen.

This will allow us to now have a URL that has some structure but also allows us to have a part that is dynamic. However, if we how navigate to localhost:8080/edit we would now see a 404 page for that because there is nothing after the edit query with the id and this is something you would normally want in your application, and remove any Route directly to the edit page.

We now have more tools in our tool belt although we are not expected at this point to be clear exactly when you would use these. At this moment we should be aware that React-Router passing information from the URL into an object which is useful for when creating real world applications. Only components passed through <Routes> will have access to these special information.

Section 8

REDUX

- Why do we need something like Redux?
- Setting up Redux
- Dispatching Actions
- Subscribing and Dynamic Actions
- ES6 Object Destructuring
- ES6 Array Destructuring
- Reducers
- ES6 Spread Operator (Arrays and Objects)

In this section we are going to learn all about a new library called Redux.

Redux is a JavaScript State Management library which integrates nicely with React. It allows us to track changing data very similar to component state i.e. where we have a component state and we do something when it changes.

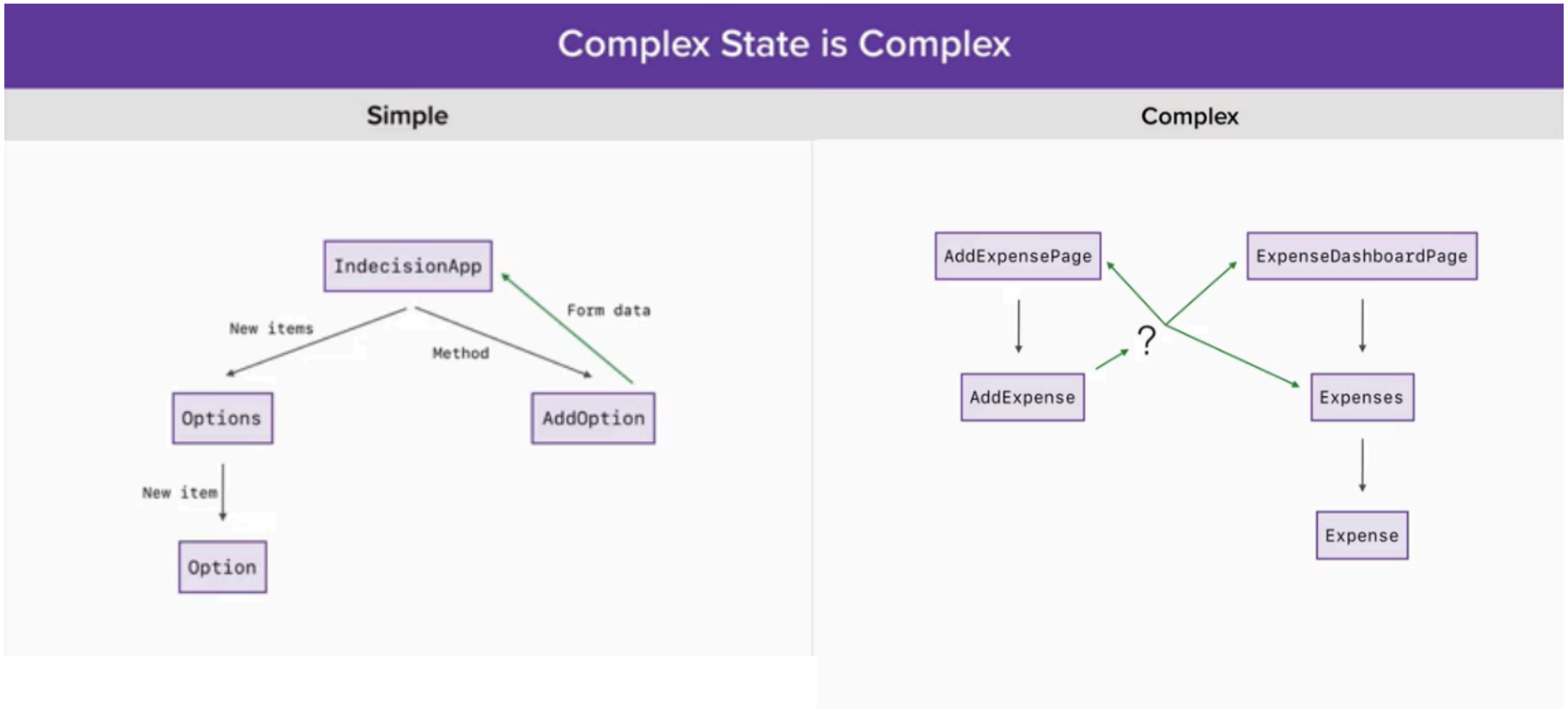
We are going to explore why we need something like Redux and how it is going to help us overcome a particular hurdle that component state runs into especially in larger applications.

WHY DO WE NEED SOMETHING LIKE REDUX?

It is important to understand the issue or problem we would run into if we continuing to use component state. This will explain why we would need something like Redux State Management library to solve this very problem.

Component State & Redux both aim to solve the same problem which is to manage the state of your application. State is data that changes which means that we need a way to actually change the data for the component state and we need a way to get the data out of the state container and render it to the screen. For component state we would use this.state. followed by the value for the component state. So they both solve the same problem of tracking changing data.

We are going to look at this from a simple application and a complex application.

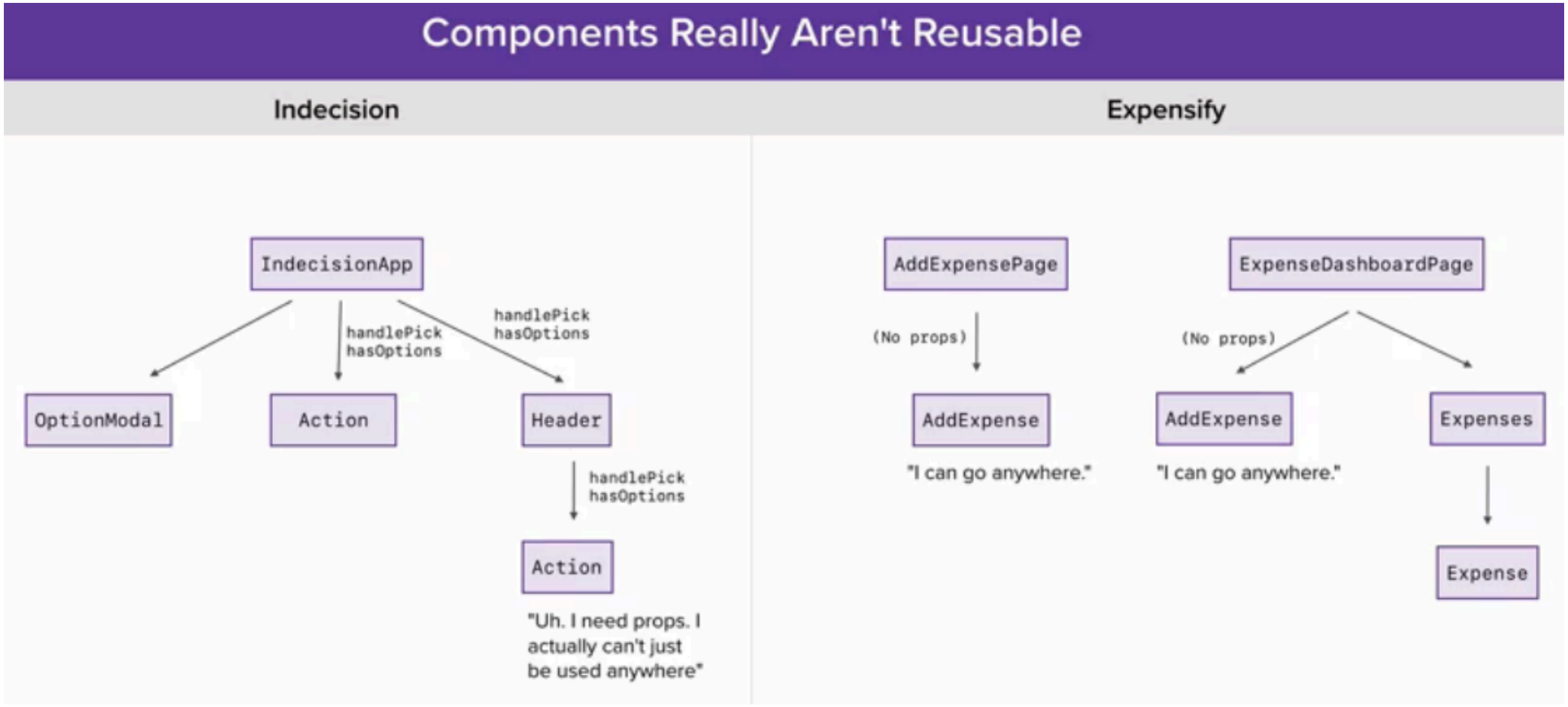


If we look at the simple application we can see the component tree starts from IndecisionApp component. We have other components below of Options and AddOptions and there is a subset of Option component. The state for this simple application lives inside the IndecisionApp component which was a class based component that used component state to keep track of the changing data for the application. The props from IndecisionApp is passed down to its children. AddOption was passed down a method that it could call to add a new option while Options needed the array of current options which was passed down from the IndecisionApp. Option needed the individual item which was passed down from the Options component as well. This prop tree is possible because all of the components are connected i.e. there is a direct connect between every single thing. Therefore, the data is stored in the IndecisionApp component and it can pass the necessary items down to its children components, making this simple application work. If we wanted to add a new option we would submit a new form and pass the form data up to the IndecisionApp component state. This change causes the application to re-render which causes the new item Options list to show on the screen.
This is great for simple application where we can store the state in a single component and get everything working as expected.

On the other hand, if we look at the complex application, we do not have a single tree view where everything is interconnected. Instead we have two tree views, one for the AddExpensePage and another for the ExpenseDashboardPage components. There is no parent component that renders both the components, instead both are rendered by the the React-Router. Also each have children components of their own. In this situation, how do we structure the data? There is no one parent component where we can store the component state and there is no connection between every single component. If we wanted to change the state when we add a new expense using the AddExpense component, where would this data go?

This is the first problem we are going to run into with just using component state. For simple applications it is very clear where the state should live, whereas for complex applications it is not quite so clear because there is not just one parent component that needs to keep track of all the data.

The second issue we are going to run into is that the components that we are creating are not really re-usable. To understand what is meant by this we are going to look at both the simple and complex applications again using the diagram on the next page.



If we look at the IndecisionApp again, we have 3 children components. If we focus on the Action component, this rendered the Action button to the screen and needed two props in order to work i.e. hand-pick and hasOptions. If we wanted to add the Action component elsewhere i.e. in the Header - this will not work because the action component can't be used just anywhere. The Action component is actually really closely bound to the IndecisionApp component. We have this illusion of reusability because we have broken things into components, but in reality they are all very closely tied together. If we did want the Actions component to live inside of the Header component, we would have to tie things even closer together by passing the props from IndecisionApp down to Header (*Header should not really need to know these props exist because it does not need to use them*) and then Header passes the props down into the Action component.
So now we have even more spaghetti code where all of our components are so closely bound that they really can not be reused.

What we need is a way for components to be able to interact with the application state both getting and setting values without having to manually pass props down the entire component tree. It would be nice if each component could describe what it needs from the state and what it needs to be able to change on this state.

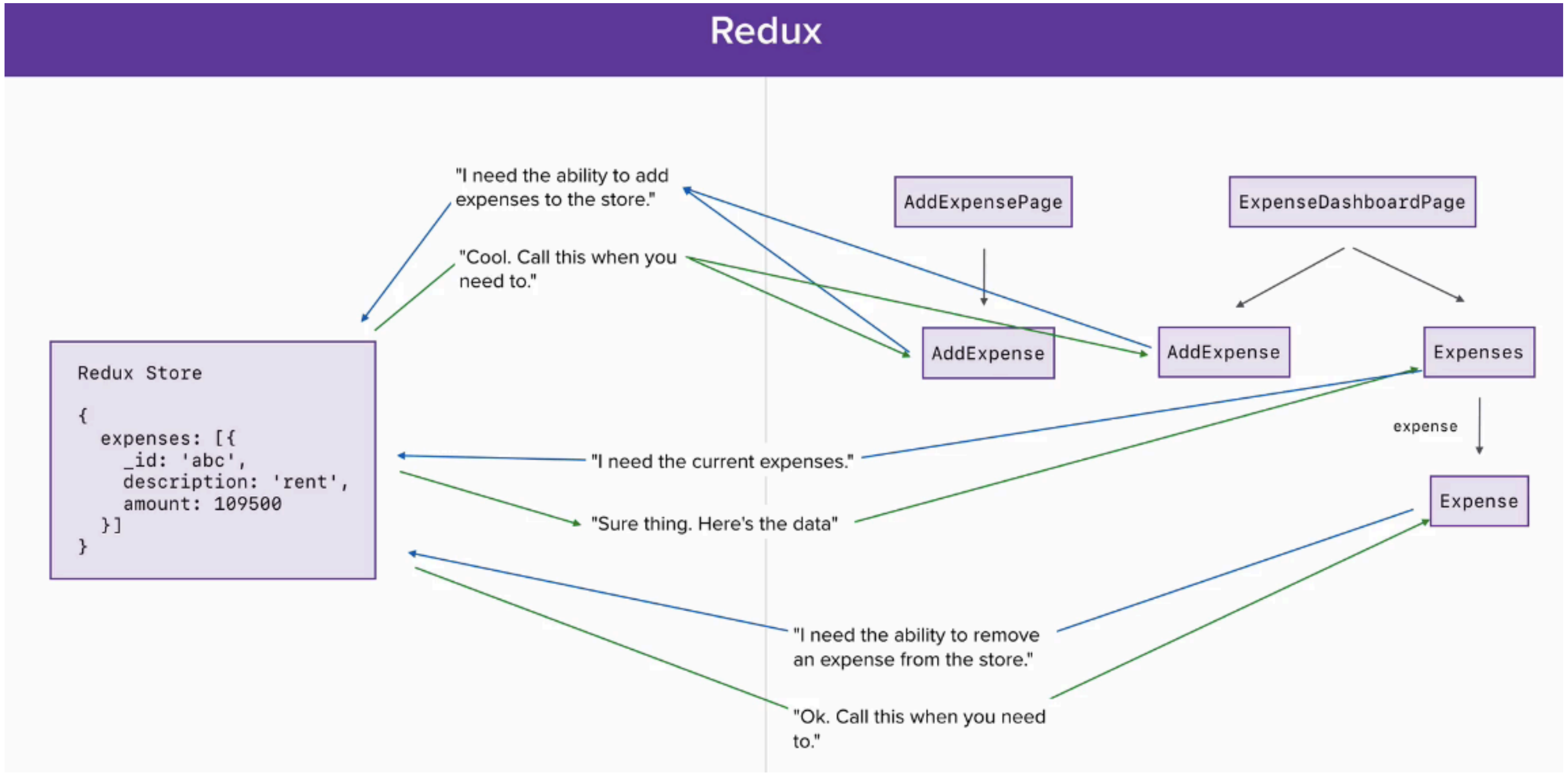
If we now examine the same scenario on complex application. What if we want to reuse AddExpense component i.e. we want to show it on the AddExpensePage but maybe we also want to show it as part of the ExpenseDashboardPage. In order for this to work, we have to come up with a solution where we can render both of these components without having to pass any props down from the parent.
Both the AddExpense component would need to interact with this global Redux State container. This is going to allow both components to either get values like expenses or set values like add expense and they are truly going to be reusable.

<u>What are the Questions we need answers to?</u>

1. Where do I store my app state in a complex React application?
2. How do I create components that are actually reusable?

The answer to both the questions above is to use Redux.

The below diagram demonstrates how this would actually look like.


Redux
"I need the ability to add expenses to the store."
"Cool. Call this when you need to."
AddExpensePage
ExpenseDashboardPage
AddExpense
AddExpense
Expenses
expense
Expense
"I need the current expenses."
"Sure thing. Here's the data"
"I need the ability to remove an expense from the store."
"Ok. Call this when you need to."

```
Redux Store

{
  expenses: [{
    _id: 'abc',
    description: 'rent',
    amount: 109500
  }]
}
```

You will notice that there are no props getting passed into both the AddExpense and Expenses components, but there is one prop passed from Expenses into Expense. There is nothing wrong with props and we would continue to use props in our applications. It is a perfectly valid way of communicating data between parent and child. Where the child actually uses the prop passed down from the parent in a meaningful way, this is a great use case and we should continue to use the props in these types of cases.

The only time we want to avoid props is when we are passing props down a long chain of components just to reach the last component in the chain. The components between are not actually using the value but are just passing the props along — in this case we want to avoid using props and we should use something like Redux instead.

What is Redux? Redux is a state container which is exactly what our class based components are. There is an object and we can change or read from the object. We create a Redux store and it is just an object just like this.state in our components. On the Redux Store, we have a single piece of state we are tracking i.e an expenses array. As we AddExpense, we would add things into this array, in this case a object. So each object in the expenses array is a new expense. The reason it is a object is because we need to record multiple things about the expense e.g. the ID, Description and amount.

In the Redux Store we are going to be able to both of those things mentioned above i.e. we are going to be able to read data off of the store and change the data in the store. So each individual components can determine how they are going to get data from the store and how they can make changes to that data in the store.

Therefore, the AddExpense component can interact with the store to add new expenses to the expenses array, the Expenses component can retrieve all the expenses data within the expenses array held in the store. The Expenses passes down the expense prop to the Expense component. However, the Expense component can also have its own methods to interact with the Redux Store for example deleting the Expense object using its ID from the Redux Store.

As you can see, the components are not communicating between each other so much as the individual components are communicating with the store. This creates components that are very reusable.

Redux is a very complex topic. Now that we understand the shortcomings of using component state, we can see the solution of using Redux. Each component can define two things: one, what data it needs to read and two, what data it needs to be able to change. In the next chapters we are going to explore how we actually use Redux and by the end we are going to see exactly what advantages this tool is going to give us.

INSTALLING & SETTING UP REDUX

We are going to explore redux in isolation to understand the fundamentals of the Redux library and how it operates before integrating it with React components. For more information on the Redux library we can visit the following website for documentation:

https://redux.js.org/

To install redux in our projects locally we would need to run the following code in our project directory within the terminal:

```
$ npm install redux@3.7.2          or          $ yarn add redux@3.7.2
```

Once redux has been installed in your project directory locally, we can now start using the library within our projects. First, we would need to import the createStore function from redux:

```
import { createStore } from ‘redux’;
```

We are going to call the createStore() function once to create the redux store and once we have the store in place, we would not need to call on the function ever again.

```
const store = createStore((state = { count:0 }) => {

      return state;

});
```

The createStore function requires an arguments to be passed in. The first and only argument is going to be an arrow function. Within our arrow function argument we are going to pass is prop which is state. We can set the state to a default state object. At this point we have a valid call to return the current state object. We have methods on the store object which we can now call on our store object for example store.getState(); this method returns the current state.

DISPATCHING ACTIONS

Actions allows us to actually change the redux store state values. An action is nothing more than an object that gets sent to the store and this object describes the type of action we would like to take. For example we could have an action to increment, decrement or reset – this will allow us to change the store over time by just dispatching various actions.

```
{
    type: 'INCREMENT'
}
```

To create an action, we are going to define an object. On this object we are going to define a single property which is the action type i.e. type: 'ACTION'. Notice how the action is in uppercase characters, this is a naming convention in redux for action type names. It is not enforced so technically you can use _actionName but it is good practice to stick to one naming convention. Using this uppercase character convention, if we have multiple words we would use the underscore to separate them for example INCREMENT_OTHER.

This action has no effect on the redux store. We would need to send/dispatch this action to the redux store by calling on a method on store:

```
Store.dispatch({
    type: 'INCREMENT'
});
```

Dispatch allows us to send off an action object and the store can do something with this information for example it can take the count value and increase it by 1. We now have a valid call to dispatch to call on the action.

When the store is first setup using the createStore() method this runs automatically for the first time. When we run the dispatch method, this runs the createStore() function again. We can actually use the action object to make changes to the state. The action object gets passed in as the second argument to the createStore() function.

```
const store = createStore(( store = { count: 0 }, action) => {

    if (action.type === 'INCREMENT') {

        return {

            count: store.count + 1

        };

    } else {

        return store;

    }

});
```

The createStore() method has 2 arguments, the first is the state which we can set the default state and the second is the action, but we do not need a default action as we are going to pass in the action through the dispatch method.
We can combine the current action with the state to figure out what the new state should be. So the above uses an if statement to see if the action.type is INCREMENT, if so it will return a new object which will increment the count by 1 else this is the first time the createStore() function is being run so we are going to return the store object.

Notice that we are not changing the state value using this.setState updater functions as we did for component state. We do not want to change the state or the action which is a bad thing to do. Instead we just want to use those values to compute the new state and that is what gets returned.

It is a more common pattern to use a switch statement inside of the createStore function as opposed to if else statements. So the function would look more like:

```
const store = createStore(( store = { count: 0 }, action) => {
    switch (action.type) {
        case 'INCREMENT':
            return {
                count: store.count + 1
            };
        case 'DECREMENT':
            return {
                count: store.count -1
            };
        default:
            return store;
    }
});
```

This is exactly the same as the above if else statement, however, when we start to add more action types the switch statement is much easier to scale and read than using nested if statements. The default case will return the store object if the action.type that is passed in has no case matches.

To recap, actions are our way of communicating with the store and action is nothing more than a object. Currently, we know that the action object requires the type property, later we will see other properties we can pass in the action object. To get this action object into the store we use the store.dispatch() method. Each action type has a meaningful effect on the redux store state. We handle the dispatch calls by passing it in the createStore() function. The createStore() function gets called right away when we create the store which sets up the default state. It also gets called one time for every store.dispatch call. We can get access to the action type as the second argument to the createStore() function and we can use the switch statement to make meaningful changes to the state. This allows us to create a redux store we can read from and change.

SUBSCRIBING & DYNAMIC ACTIONS

In this section we are going to learn two things:

1. How to watch for changes to the store, and
2. How to dispatch an action and pass some data along with it.

To watch for some change in the redux store state we would use the subscribe method on our store object.

```
store.subscribe(() => {

	console.log(store.getState());

});
```

We pass a single function to subscribe and this function gets called every single time the store changes. For the example above, this will print the state to the console every time the store changes. This will show the changes to the redux store over time for each dispatch calls we make.

To stop subscribing at some point we would create a function that is set to the subscribe and call on it to unsubscribe.

```
const unsubscribe = store.subscribe(() => {

	console.log(store.getState());

});

unsubscribe();
```

We would call on the unsubscribe function to stop the subscribe method i.e. stop watching for changes to the store.

To dispatch a dynamic action we can add many properties to our dispatch action. Important Note: Redux requires us to provide a property of type otherwise Redux is going to throw an error of *Uncaught Error: Actions may not have an undefined "type" property*. However, we can add as many additional properties after the type property:

```
store.dispatch({
    type: 'INCREMENT',
    incrementBy: 5
});
```

When we dispatch the action we now have access in the action prop of our createStore() function both the action.type but also action.incrementBy properties. Note: we do not need to add incrementBy if we were to perform the dispatch for INCREMENT again i.e. we can leave this prop out of the object.

We would need to add in the createStore() function a conditional logic to figure out exactly what we should do with this extra property before running the switch statement.

```
const store = createStore((state = { count: 0 }) ={
    const incrementBy = typeof action.incrementBy === 'number' ? action.incrementBy : 1;
    Switch (action.type) {
        case 'INCREMENT':
            return {
                count: state.count + incrementBy
            };
    }
});
```

Using the ternary operator we can check for incrementBy to be the type of number and if so use the incrementBy value else default to 1. We can now use this const variable to change the store state. This will now allow us to increment by1 by default unless there is some other number value for incrementBy passed in with the action dispatch. We are now able to pass in dynamic information along inside of our action objects and use that information to calculate the new store state.

We now have a way to to dispatch generic actions as well as dynamic actions. Now aside from taking in no extra values or some optional ones, we can also just create actions that have required types by just using them directly as opposed to checking if they exist.

```
store.dispatch({
    type: 'SET',
    count: 101
});
```

We are not going to check if count exists in the action because it is not optional i.e. we are going to force those who use the SET action to actually provide the value 101. All we have to do is set up a case for it in the switch statement.

```
Switch (action.type) {
    case 'SET':
        return {
            count: action.count
        };
}
```

When someone calls on the SET action, we return an object where the count equals the value of the action.count – we have forced the state to change using the property passed in with the SET action. We now know how to dispatch dynamic actions.

ES6 OBJECT DESTRUCTURING

ES6 destructuring is a new syntax which allows us to easily work with arrays and objects.

```
const person = {
    name: 'David',
    age: 30,
    location {
        city: 'Manchester',
        temp: 13
    }
};
```

So we have all of this information and maybe this is coming back from a database query or maybe an Ajax request to some sort of HTTP API etc. Regardless of how we get this data back, this data is accessible to us and we want to start using it. Maybe we want to print something to the console.log:

```
console.log(`${person.name} is ${person.age}.`);
```

With object destructuring, we are able to take an object, just like person above, and rip it apart. We can pull various parts out into their own variables. This means we can just create a named variable and avoid using person.property for example:

```
const name = person.name;
const age = person.age;
```

```
console.log(`${name} is ${age}.`);
```

The problem with the above is that it does not scale very well because we have to create a const variable line each time we want to pull off something from the object, although the end result would give us David is 30. However, we can achieve the above result with one line of code using ES6 destructuring.

```
const { name, age } = person;
```

On the right hand side we have the object we are trying to destructure. On the left hand side we have the variable type we are trying to create i.e. a const variable (this could also be var or let). Inside of the curly brackets we provide the name of the properties we want to grab, much like named import/exports. Therefore, the one line of ES6 destructuring code is the same as using the multiple ES2015 const variables example above.

The ES6 destructing creates two variables of name and age and it gets those values off of the person object. It looks for the person properties with the exact name as the variable names we want to to create i.e. name will look for person.name for the value to assign name.

If we wanted to print something more complex (using some logic) such as the temperature and city without destructuring it would look something like:

```
if (person.location.temp && person.location.city) {

    console.log(`It's ${person.location.temp} degrees celsius in ${person.location.city}`);

};
```

This would work perfectly fine, however, the problem with code like this especially when we are grabbing from a nested object is that we end up writing it in multiple places throughout our code i.e. we are pulling the temp and city from person.location every time. Destructing allows us to make the code simpler and more readable.

```
const { city, temp } = person.location;

if (temp && city) {

    console.log(`It's ${temp} degrees celsius in ${city}.`) ;

};
```

There are two features available to us with destructuring. The first is the ability to rename the local variable we create. So far we have seen destructuring variables from an object using exactly the same name as the object properties. What if we do not want to use the same name as the object properties? We would need to use the renaming syntax:

```
const { city, temp: temperature } = person.location;
```

We use the colon : to give an alias/alternative variable name. This will still grab the temp property value from the person.location and assigning it to the const temperature variable. We no longer are going to have access to the temp variable as this is now no longer defined because we renamed it to temperature and the temp variable is never created even though we are grabbing the value.

The second feature with destructuring is the ability to setup a default value. For example if we want a default name of 'Anonymous' is no value exists for the name property of the object. JavaScript by default would return undefined if a property value did not exist, however, we can set our own fallback value.

```
const { name = 'Anonymous', age} = person;
```

If a name exists this will pull the value from person.name, but if a name property does not exist for the person object then the default will be Anonymous i.e. a fallback value. This will only use the default value if there is no value for the property of the object you are destructuring.

We can provide a default value and a new variable name, although the syntax could end up looking a little clunky, but it will indeed work.

```
const {name: firstName = 'Anonymous', age } = person;
```

This will give a local variable of firstName and try to get the value from person.name and if one does not exist it will fallback on the default value of Anonymous instead of JavaScript returning undefined. This is a very handy syntax and will be using it in various different places including function arguments.

ES6 ARRAY DESTRUCTURING

Array destructing is very similar to object destructing, the syntax is slightly different. So below is an array example, regardless of how we get this data we want to use it.

```
const address = [‘123 Fake Street’, ‘City’, ‘County’, 'Post Code’];

console.log(`You are in ${address[1]} ${address[2]}.`);
```

Arrays use zero indexing. This will work, however, the problem with this kind of code is that it is not clear what is actually happening in the code i.e. what is address[1]? Is this the city, street number, post code etc. the same is true for address[2] i.e. there is not enough information to know what it means if we were to read the code in isolation and the data was defined elsewhere.

We could use ES2015 to create individual variables.

```
const city = address[1];

const county = address[2];

console.log(`You are in ${city} ${county}.`);
```

However, this is not what we want to do because you would have to create a variable for every single item we are trying to pull off of the array. We already saw with objects that this does not scale well. What we can do is destructure the array:

```
const [street, city, county, postcode ] = address;
```

We use the const, let, var variable on the left followed by square brackets (*as opposed to curly brackets which we used for object destructuring*). On the right we pick the array object we want to destructure. Within the square brackets goes an ordered list of variable names.

Unlike objects the name of the variable does not exist within the array object and therefore the variable value is not matched by the variable name. Instead, it is being matched by the position of the variable i.e. street is being matched with the index [0] of the array while city is index position [1], county is index position of [2] and so on until the last array of postcode. We now have clear variable values that we can use in our code which would make our code more readable even in isolation to the array object.

Just because the array has four items within the array object, this does not mean we have to destructure all four items. You can actually have an empty variable name and it will not do anything and will skip that array item.

```
const [street, city, county] = address;
```

This will skip anything after the third item in the arrays (i.e. stops) and will not restructure anything after the third item.

```
const [, city, county] = address;
```

This will skip the first item using the comma only and will destructure the city and county variable items in the array.

```
const [street, , , postcode] = address;
```

This will skip the second and third items in the array and will only create a destructure variable for the first and last items in the array object. Therefore, just because you have x number of items in an array, does not mean you have to create x local variables - you can skip using the comma.

Arrays does not have any renaming syntax because there are no name properties in arrays, they use zero indexing instead.

Like objects you can set defaults using the equal = sign followed by the default value.

```
const [, city = ‘Spain’, county] = address;
```

If we did not set a default value for the city and no array object exists for the second item this will return undefined.

We should now know the fundamentals of ES6 object and array destructuring syntax.

ACTION GENERATORS

Action generators are functions that return action objects. Action generator functions allows us to catch typo errors in our code, whereas inline action objects will not return any error in the JavaScript console and if we misspelled an action incorrectly this will not trigger the switch statement on the store and would be very difficult if not impossible to debug for spelling mistakes. Action Generators also allows us to dispatch our actions and pass in parameters within a single line of code.

```
const incrementCount = ( payload = {} ) => ({
    type: 'INCREMENT',
    incrementBy: typeof payload.incrementBy = 'number' ? payload.incrementBy : 1
});
store.dispatch(incrementCount({ incrementBy: 5 }));
```

We are implicitly returning the action object using the arrow function implicit return syntax. Within our action generator function we can pass in a payload object and also set a default value of an empty object. When we call on the action generator incrementCount() function and pass in a incrementBy object as an argument, this value gets passed into our function as the payload. We can then use the payload object to check for a number and user the number passed in else use the default 1 as the value.

When we call on the dispatch this will update the store with a new action object and the value can be called from the action argument.

```
const store = createStore((state = {count, 0}, action) => {
    switch (action.type) {
        case 'INCREMENT':
            return {
                count: state.count + action.incremetBy
            }
    }
};
```

We can now make the action generator function above much more simplified using ES6 Destructuring syntax.

```
const incrementCount({ incrementBy = 1 } = {}) => {
    type: 'INCREMENT',
    incrementBy
});
```

The incrementBy is the same as saying incrementBy: incrementBy – we also no long need to check for the typeof value as if there is no property passed into the action generator function then this will default to 1 else it will use the value of the incrementBy number and this will be passed into the action argument for the switch statement and increment the state by the desired number.

We can clearly see how action generators makes it more simple to manage your actions and make single line calls each time we want to use the action rather than retyping the same long action object each time we want to make a dispatch call to the redux store to do something to the store.

REDUCERS

Actions describe the fact that *something happened*, but do not specify how the application's state changes in response. This is the job of the reducers. What does this mean?

We know how to setup a store using the createStore() function and within this function we pass in the default state and action. However, when we pass in the action from the action dispatch this does not alone change the state, it is the switch statement i.e. the reducer that determines what to do based off of the action, how do we want to change the state based off the type of action the store receives.

```
const reducer = (state = {count=0}, action) = > {

    switch (action.type) {

        case 'INCREMENT':

        return {

            count: state.count + action.incrementBy

        }

        …

    }

};

const store = createStore(reducer);
```

We now have a separate reducer which we can use in our createStore. In a real world application we would have multiple reducers.

There are some key attributes/rules to reducers:
1. Reducers are pure functions .
A pure function has certain qualities: first the output is only determined by the input. It does not use anything else from outside of the function scope and it does not change anything outside of the function scope either. The function needs to recalculate based on the old state and the action.

An example of what is not a pure function:

```
let a = 10;

const add = (b) => ( a + b );
```

2. Never change state or action.
We want the state and action to be passed into all our reducers and we do not want to directly change these things i.e. we do not want to reassign a value to state or mutate an action object.

If you see yourself trying to change the state or action, it is best to take a step back and ask what you are trying to accomplish. In most cases if you are mutating the state it is recommended to return it on a new object instead because mutating the state directly is going to have an undesired effect.

Reducers follow the two rules mentioned above.

In our projects we would import createStore and combine reducers from the redux library.

```
import { createStore, combineReducers } from ‘redux’;
```

The combineReducers is going to allow us to create multiple functions and define how our redux application changes. As we create complex redux stores, we are going to have more complex data and having a single reducer is going to create a really long complex function. Instead we are going to learn how we can use combineReducers to create multiple smaller functions and combine them together.

The best technique when building a redux application is to create a dummy store of the data you would want to track in the store. This helps you to have a better understanding of your application and the reducers that are required to make changes to the store.

ES6 SPREAD OPERATOR (ARRAYS)

Now that we understand how to setup basic Reducers, we need to start dispatching some actions and handling those actions in the appropriate reducer. In order to do this we need to explore the ES6 spread operator which will make it easier to work with arrays and objects.

Firstly, you would need to create a action generators to pass in the action to your reducers. We would then need to setup a case for the reducers that will do something to the data when the action gets dispatched. Once this is setup we now have the ability to dispatch actions to the store using the action generators.

What actually occurs when we dispatch an action? The action is dispatched to all reducers and only the reducers with the switch statement for the action will be affected.

```
const expensesReducer = (state = expenseReducerDefaultState, action) => {
    switch (action.type) {
        case 'ADD_EXPENSE',
            ~~state.push(action.expense)~~    —>We do not want to change state or action, we just want to read off them.
            return state.concat(action.expense)
    };
};
```

There is an array method called concat which allows us to read the state and combine it with the item passed in as the argument for the method returning a new array. It does not change the state at all and therefore this will work. However, we would want to explore the ES6 spread operator. This is going to allow us to get the same thing done and more.

If we observe a different example (try this in your browser JavaScript console), we have an array below called names. We want to add a new item without changing the names variable.

```
const names = ['Allan', 'Barry'];
```

If we use the names.push() method this will change the names variable and the returned value is the new length. If we check the variable this will indeed add the item on the array, however, the names variable has change and this is not what we want.

```
names.push('Christine');
```

If we use the names.concat() method, we can concat something new onto the array. When we use this method we get the new array returned back and we can see the variable names was not changed.

```
names.concat('Dior');
```

Aside from concat we can use the spread operator which has a very strange syntax.

```
[...names];
```

The spread operator uses three dots followed by the variable name. Essentially what this is saying is, as we create this new array, we want to add all of the items from names. So if we ran the above spread operator statement it will return all the names from the previous array. If we want to add any other names onto the name we would add it in like we would for any other array:

```
[...names, 'Ellen']
```

This will return the new array object, but the spread operator will not change the names variable. If you were to console.log(names) this will show the original names variable without the new item added in the spread operator. We can add more complex arrays such as adding a new item at the front, then all the items in the names array and followed by some new items at the end:

```
['Alex', ...names, 'Ellen', 'Frank'];
```

The spread operator allows us to create new arrays from old ones. We would use the exact same approach in our application code. This will achieve the same result as concat but we are replacing it with the ES6 spread operator.

```
case 'ADD_EXPENSE'

    return: [...state, action.expense]
```

ES6 SPREAD OPERATOR (OBJECTS)

In this section we are going to look at the object spread operator which is more useful compared to the array spread operator (*with arrays we can use concat as an alternative method to the spread operator*). In principal the spread operator does the same thing for objects i.e. it allows us to grab the existing object and define a new object and grabbing things from the existing object.

```
const user = {
	name: 'Jennie'
	age: 25
};
console.log({ ...user });
```

Now this is going to cause a console error of Syntax Error: Unexpected token. This is because we need to customIse the configure of babel to support this syntax for spreading objects. The array spread operator is already in the mainstream while the object operator is on its way but not quite there yet.

The plugin we are going to install is going to be within our babelrc file alongside all our other plugins:
https://babeljs.io/docs/en/babel-plugin-proposal-object-rest-spread

First step is to install the plugin in the terminal by running the following command:

```
$ npm install babel–plugin–transform–object–rest–spread@6.23.0    or

$yarn add babel–plugin–transform–object–rest–spread@6.23.0
```

The second step is to add the plugin to the babelrc file (plugins array):

```
'plugins': [

        'transform-class-properties',

        'transform-object-rest-spread'

]
```

Now that this plugin has been installed if we restart the dev server again, we should now be able to use the spread object syntax within our projects without running into the Syntax Error. We should now see the new object cloning the existing object.

We can now add some new property values to the new object:

```
console.log({

        ...user,

        location: 'Philadelphia'

});
```

We can also override the existing properties using the spread operator:

```
console.log({

        ...user,

        location: 'Philadelphia',

        age: 27

});
```

This will take the spread object properties then override the age property from 25 to 27. If we added the age:27 property before the spread operator, the spread operator age property from the original object will override the new value i.e. 27 will be overridden by 25. This is useful as we do not want to change the state object for our store.

Section 9

REACT WITH REDUX

- The High Order Component
- Connecting Store and Component with React-Redux
- Redux Dev Tools

In this section we are going to learn how to connect React and Redux together.

This is going to allow us to create what are called connected components. These are components that are connected to the redux store i.e. they can read off of the store (fetch values from the store and render those values) and also they can dispatch actions to the store.

When a user interacts with the user interface e.g. add an item or change the filters, we want the components to be able to do something based on that action.

THE HIGH ORDER COMPONENTS

The Higher Order Components (HOC) is a pattern that is heavily used by the React-Redux library. In this chapter we are going to explore HOC by creating our own and observing exactly what it takes to create one. This will make it easier to use and understand what is happening when we use the React-Redux library.

A Higher Order Component (HOC) is a component that renders another component. The component that renders the other regular component is known as the HOC. This is very difficult to understand until you actually see the pattern in action.

Below is a regular Component that we can create (we can create many of these):

```
Const Info = (prop) => (

        <div><h1>Info</h1><p>The info is: {prop.info}</p></div>

);

ReactDOM.render(<Info info='These are the details'/>, document.getElementById('app'));
```

The advantages of HOC are:

- able reuse code
- we are going to be able to perform something called render hijacking
- we are going to be able to add a little bit of prop manipulation
- lastly, we are going to be able to abstract state.

To create a HOC we would create a regular function (not a React Component) and is going to be called with the component that we want to wrap. We can wrap as many component as we want to depending on how many components we want to add to the regular function. What we get back from the function is an alternative version of the component(s) that is going to be the Hight Order Component.

```
const withAdminWarning = (WrappedComponent) => {
    return (props) => (
        <div>
            { <p>This is private info. Please do not share!</p>}
            <WrappedComponent {...props}/>
        </div>
    );
};
const AdminInfo = withAdminWarning(Info);
ReactDOM.render(<AdminInfo isAdmin={false} info='These are the details'/>, document.getElementById('app'));
```

In the withAdminWarning function we could have made the first argument as Info, however the purpose of HOC is to reuse code and so the commonly pattern is to use WrappedComponent as the argument name. What we return in the function is the Higher Order Component. We can add our own HOC elements we want showing in within this component and then have the <WrappedComponent /> element we want to wrap.

We now have a Higher Order Component created and we can now render the AdminInfo within ReactDOM.render() method. We can use JSX within our elements and use the spread operator to pass in the props. This means all the key value pairs we pass in as children props are being passed into our Higher Order Component as props and these props are being passed directly down to the child. This is a very useful technique which we would use a lot in very complex applications.

We can take this a step further by using conditional rendering by checking for the isAdmin=true prop in order to render the paragraph in our Higher Order Component. By adding more props on our HOC, we create a HOC that is even more reusable and versatile. We can also pass this down to the react components and allow them to decide whether or not to use these HOC properties.

We are going to see this pattern extensively with the react-redux library.

CONNECTING STORE & COMPONENT WITH REACT-REDUX

Now that we understand HOC, we are now able to understand and connect the store and components together with react-redux. The library itself is actually very small. There are basically two things we need from the library i.e a single component (<Provider>) and a single function (connect()). We are going to use the Provider component once at the root of the application and use the connect() function for every single component that needs to connect to the redux store.

https://react-redux.js.org/

To install this library locally within our project we would need to run the following command in the terminal:

```
$ npm install react-redux@5.0.5          or          $ yarn add react-redux@5.0.5
```

Once we install the react-redux library we would need to restart the dev-server. Within the app.js file we will need to import react-redux and take advantage of the single provider component.

```
import { Provider } from ‘react-redux’;

const store = createStore();

const jsx = (

    <Provider store={store}>

        <AppRouter />

    </Provider>

);

ReactDOM.render(jsx, document.getElementById(‘app’));
```

The provider component is going to allow us to provide the store to all of the components that make up the application.

This is a super useful feature because it means that we do not need to manually pass the store around. Instead the individual components that want to access the store can just access it. The API is very simple, we would use opening and closing Provider tags and provide the rest of the application in-between the tags.

Provider takes in a single prop which is the store that we want to share with the rest of the application. So we use store as the prop and set the value to the name of the redux store (if you called this store then you would use the same name).

What we have is an application that have access to the store which means we can take advantage of other things that react-redux provides us i.e. the connect function. You cannot use connect() without having the Provider component setup. Once setup, you can now actually create components that grab information from the store.

For example we have a ExpenseList component:

```
import React from 'react';

import { connect } from 'react-redux';

Const ExpenseList = (props) => (

    <div> <h1>ExpenseList</h1> {props.name} </div>

);

const ConnectedExpenseList = connect((state) => {

    return {

        name: 'John'

    }

})(ExpenseList);

export default ConnectedExpenseList;
```

In this component we first need to create a const variable for the Higher Order Component. Similar to how we called functions in the previous section. However, the connect function API is slightly different. The connect() gives back a function and not a HOC. We need to call connect with the component.
Within the connect() function, we provide the information about what we want to connect. So the store may have a tonne of information but the component only needs a subset. We define using the connect function what information from the store we want the component to be able to have access to. In the arrow function, the store state is passed in as the first argument. We return an object and on this object we can put as many key value pairs as we like. Usually, these are things from the state but we can also add our own.

In our component we can now use the state value which gets passed in as props. We can use JSX expressions to have access to the props values passed down from the connect() function.

We would export the const variable that we used to setup the connect() function which will now render the connected component. We can now use our connected component to return values from our state to render to the screen for example:

```
const ConnectedExpenseList = connect((state) => {

    return {

        expenses: state.expenses

    }

})(ExpenseList);
```

In our component we can now render using JSX expressions through the props the state.expenses properties. We now have our first react component connected to the redux store.

Important Note: it is not common to see a separate variable for the connected components (the above is used to demonstrate what is happening), you would normally see as the pattern is the export default on the connected component. It is also common practice to take the function and break it into its own variable and reference the variable in the connect.

```
const mapStateToProps = (state) => {
    return {
        expense: state.expenses,
        filters: state.filters
    };
};
export default connect(mapStateToProps)(ExpenseList);
```

So if we look at real code bases that are using react and redux, you will notice that they will have regular unconnected components, some functions for example mapStateToProps and then see a call to connect at the very bottom that actually pulls all of this together. The end result is a component that has access to whatever data it needs from the store.

It is important to note that when you connect a component to the redux store, it is reactive which means that as the store changes, the application component is going to get re-rendered with those new values. This is because the connect() function is automatically called each time there is a change to the redux store. This is going to allow us to create very simple components. The components will not need to worry about using store.subscribe() or store.getState() and it does not have to use any component state to manage the data. Instead, all of that is done for us by react-redux. All we have to do is define how we want to render things.

To recap:
Step 1 - setup the Provider component in the root of out application. This lets us define the store we want to provide to all of the application components.
Step 2 - We create new High Ordered Components using the connect function provided by react-redux library. We call connect and define the things we wan to get off of from the redux store and we define the component that we want to create the connected version of. The end result is a brand new component which is just our component with props from the store.
This allows us to create simple components and scale our application without worrying about joining all our code and passing information down to the various components.

REDUX DEV TOOLS

Much like the React Dev Tools, when we install Redux and set them up, we are going to have a brand new Redux tab in our browser developer tools. This will provide us with Redux specific information:

- To view the Redux Store
- To view all the Actions
- To view all the data and data changes

There is a little bit of setup and code required to setup the Redux Dev Tools with our application.

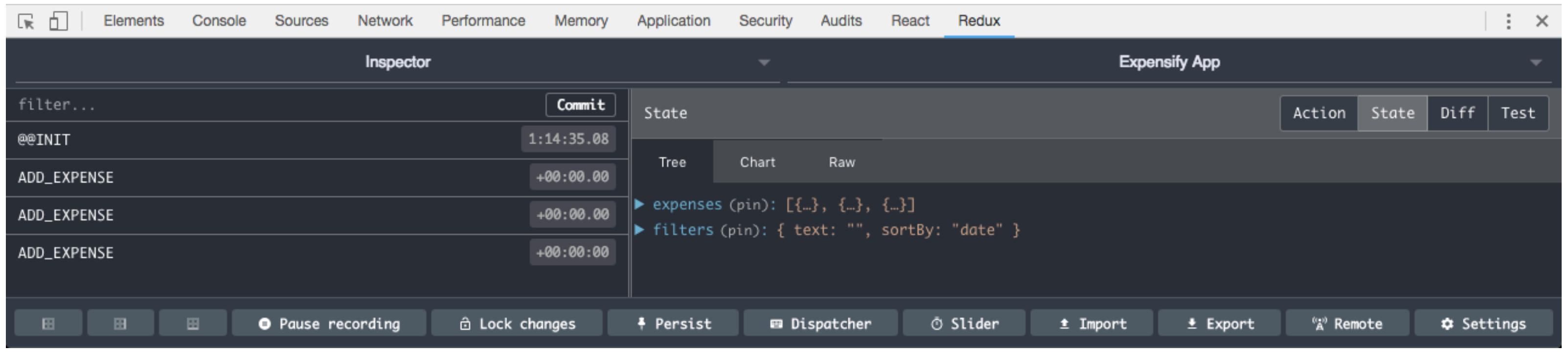
Step 1: install the Redux DevTools for your browser.
https://chrome.google.com/webstore/detail/redux-devtools/lmhkpmbekcpmknklioeibfkpmmfibljd
https://addons.mozilla.org/en-US/firefox/addon/remotedev/

Step 2: update the code in our application when we createStore().
The code tends to change over time, so it is advisable to visit the page below and copy the relevant code into your project.
https://github.com/zalmoxisus/redux-devtools-extension

```
window.__REDUX_DEVTOOLS_EXTENSION__ && window.__REDUX_DEVTOOLS_EXTENSION__()
```

Add the above line of code within the configureStore.js file. Pass this as the second argument to the createStore i.e. add a comma after the combineReducers() function argument.

Once this is added, we can now use the Redux DevTools within our browser. This allows us to view the Actions, State, State change as well as a time slider to se how the application changed over time.



```
@@INIT          1:14:35.08
ADD_EXPENSE     +00:00.00
ADD_EXPENSE     +00:00.00
ADD_EXPENSE     +00:00.00
```

```
▶ expenses (pin): [{…}, {…}, {…}]
▶ filters (pin): { text: "", sortBy: "date" }
```

Section 10

TESTING APPLICATION

- Setting up Jest
- Snapshot Testing
- Enzyme
- Snapshot Testing with Dynamic Components
- Mocking Libraries with Jest
- Testing User Interactions
- Test Spies

In this section we are going to learn how to setup an automated test suite that is going to allow you to verify the application is working correctly by running a single command.

The automation test suite is going to verify when we call a function with given arguments, that a return value is given back. It is also going to verify that if we pass in certain props into a component that it is rendered correctly.

The purpose of automation testing is to be able to verify the entire application works within a few seconds by running a single command rather than testing everything manually which is prone to human errors. It may take some time to setup the automated testing but once setup, testing will take only a few seconds.

This will give confidence, so you can change part of the code and run the test suite and as long as you see passing test cases, you know that your changes did not break anything within the application. You will have confidence of making changes without putting bugs into production.

SETTING UP JEST

The Jest test framework is a testing framework that was released by Facebook and it integrates really well with react applications. There are other test frameworks such as jasmine and mocha (if you worked with Node) and karma (if you worked with Angular). They all serve their own purposes in a specific environment, but jest is best used for react applications.

There are many documentation on Jest found on their website:
https://jestjs.io/

To install Jest locally in our project we need to run the following command in the terminal:

```
$ npm install jest@20.0.4          or          $ yarn add jest@20.0.4
```

This is not going to be something that we are going to be importing into our project. This is more like a live-server or webpack, where we are going to be essentially using it from the command line. We didn't install it globally because we know that it is bad practice. Instead we are installing it locally, and running jest from the package.json using a script.

In the package.json file we will add a new line for the script:

```
"scripts": {

      … ,

      "test": "jest"

}
```

This allows us to run jest using the test command. We will learn more about the jest command later. For now this is going to be enough to get our test suit up and running.

We can now run the following command in the terminal within our project directory:

```
$ npm test       or           $ yarn test
```

When we run this command we get an output that looks like an error output and it kind of is. Jest has looked through the project for test files and has not found any and outputs that it has not found any tests. In order to get any values from Jest, we need to create test files. In the test files we can define test cases.

Within the project directory, we would need to create a new folder in the src directory called tests. All the application test cases will sit within this directory. To create a test case file we would give it a name followed by the .test.js file extension. When Jest scrapes the entire project for test files, it will look for files with this file extension name. For example: add.test.js – when we run the test command, Jest will see this file as a test file to execute. If we run the test command in the terminal, Jest will be able to find a file but it will be considered a fail because the test suite must contain at least one test case.

Below is an example of a basic test case. This will help us understand the fundamentals of Jest testing.

```
const add = (a, b) => a + b;
```
——> the function we are going to be testing

Jest provides global variables/functions and these allows us to construct our test cases. The first and most important one is test(). Test takes in some arguments, the first describes what the test should do e.g. 'should add two numbers' and the second argument is going to be the code that runs for the test case.

```
test('should add two numbers', () => {

    const result = add(3,4);

    if (result !== 7) {

        throw new Error('You added 4 and 3. The result was ${result}. Expected 7')

    }

});
```

Remember the first argument is always going to be a string and the second argument is always going to be an arrow function. In our test cases we are going to pass in some input and then we are going to look at the output (return value) and make sure that the output is correct. This allows us to verify whether the function is actually working as expected.

We use the if statement to check for the expected value. If the expected result is not returned we can throw a new error message which will provide some information about what has happened.

The above is essentially an assertion. We asserted something about a given value in the application. If it was something we expected we did nothing and if it was not what we expected we throw an error. There are all sorts of different types of assertions that we are going to make and keep track of. This boilerplate code turns into a real burden.

Jest gives us an assertion library. It gives us access to a function to make assertions about values in our applications. This can be found in the documentation. An example of a global assertion function provided by jest that checks if two values are the same is the expect() function which has many methods:

```
test('should add two numbers', () => {

        const result = add(3,4);

        expect(result).toBe(7);

});
```

This works the same as the above but using a global function provided by Jest. This would continue to provide the useful information should the test fail.

At a very basic level, this is what you would create to test the application. This is a very simple function and test case but the application would also have more complex functions and more complex test cases.

We can view and examine all the global functions provided by Jest in its documentation page under API references.

Finally, we can setup Jest to run in watch mode which is similar to webpack watch mode. This allows Jest to watch our files for any changes and rerun the test suite. We can either add this to our package.json file as son:

```
"test": "jest ––watch"
```

However, there are times you do not want to run Jest in watch mode. The best option is to add the watch command in the terminal when you run Jest i.e.

```
$ npm test –– ––watch          or          $ yarn test –– ––watch
```

SNAPSHOT TESTING

Testing functions and testing components are two very different things. Functions is a lot easier to test because we pass data/arguments into the function, the function returns something back and we make an assertion as to what should come back from the function to test whether the function passed or fail. With react components we have a different set of concerns.

First, we are concerned what renders under what situation. So if we pass a prop into a component we would expect the component to render one way and if we pass in a prop with a different value we might expect it to render a different way. How would we test this? Would we have to type a whole bunch of JSX into the Jest .toEqual() method call?

We are going to explore how we can test components and to test user interactions with components e.g. changing a form value or clicking a form button, is the form component reacting correctly.

Snapshot testing is going to help answer the questions above and how to test React components using the Jest testing framework.

There is a react library created by the react-team called react-test-renderer. This allows us to render components inside of just regular JavaScript code and we can then asset something about what got rendered. This library is very useful because it provides a way of providing code of what is returned from the JSX since we are not using the browser to view the component.

To install the library we need to run the following command within our project directory within the terminal:

```
$ npm install react-test-renderer@16.0.0          or          $ yarn add react-test-renderer@16.0.0
```

Once installed we can import it within our test suite (test file(s)).

```
import ReactShallowRenderer from ‘react-test-renderer/shallow’;
```

There are two main ways we can test React Components:
1. Shallow Rendering
2. Full DOM rendering

Shallow Rendering only renders the given component whereas Full DOM Rendering renders child components.

Shallow Rendering Example – Header.test.js file:
We would need to import React since we are going to be writing JSX and you would need to import the component we would want to test.

```
import ReactShallowRenderer from ‘react-test-renderer/shallow’;

import React from ‘React’;

Import Header from ‘../../components/Header’;
```

Once everything has been imported, we can create our test case for the component as we would normally do. Within the arrow function we would use the react shallow renderer:

```
test(‘should render Header component correctly’, () => {

    const renderer = new ReactShallowRenderer();

    renderer.render(<Header />);

});
```

We need to create a variable which will be a new instance of ReactShallowRenderer() and then we would render() the const renderer. Within the .render() method we would define the JSX we are trying to render in the test case, in the above example it is the single case of the <Header /> component – i.e. the component we are trying to test.

We actually get access to the rendered output on the renderer (*you can console.log(renderer.getRenderOutput()) to get a peak of the rendered component*). This will give back what was created by react.createElement i.e. a JavaScript version of HTML elements. We are not going to make any assertion directly about this object because that will take a ridiculous amount of time and deter fro testing in a meaningful way. Instead, we would use snapshot.

Snapshots allows us to track changes to data overtime. We can create a snapshot of of the Header component within its current point in time and we are going to be able to get notified if this ever changes. Therefore, if the Header component changes in a way we do not want, we can catch that change. Jest provides a single method called .toMatchSnapshot() which allows us to make the assertion.

```
expect(renderer.getRenderOutput()).toMatchSnapshot();
```

When we run this for the first time, this assertion will always going to pass because there is no existing snapshot, so Jest is going to go ahead and create a new snapshot. The second time we run this test case it is going to compare the existing one. If it is the same then the test will pass and if not the test will fail.

You will notice in the terminal when we run the test, a new Snapshot Summary will appear with all the snapshots in the test suite along with information about our overall snapshots e.g. one added and one in total. This will also create a new __snapshot__ folder in the components folder (i.e. ./src/tests/components/__snapshots__). This is a folder generated by Jest and you should not change any of the files inside, but you can indeed look at them. If we do look at the file you will notice a snapshot of the Header component (note: this will not have any <a> elements because we used Shallow Render). Jest will now use these file(s) to test the test case if we were to rerun the test again i.e. it will compare the new Header render with what got rendered in the past.

If we now start editing the Header.js components file and accidentally add something. When Jest is run again it will compare the new Header render with the snapshot Header render and the test case will fail and where the error is at. At this point we have two options, accept the changes (*which is probably not what you want*) or reject these changes.

To reject the changes, we would need to make the necessary changes to the code to get the test to pass.
To accept the new changes, we would use the u key in the Jest terminal to update the snapshot (i.e. it is going to take a new snapshot and replace the old one). The test case should then pass.

Snapshot testing is going to make it easy to assert things about the application components. This is going to allow us to keep track of changes so if a component rendered output does change, we will be notified if it is a good/bad change and either update the snapshot or adjust the component code accordingly.

ENZYME

In this section we are going to explore a new tool called Enyme released by airbnb. We will learn how to install it within our React application. Enzyme is a full featured renderer for React. The react-test-renderer was always designed to be a very simple utility for rendering and Enzyme does use it. However, Enzyme though comes with a lot of great features for those actually writing test cases. Enzyme if going to allow us to test more complex things such as clicking buttons, change inputs, search rendered output for a specific element (all of these things are difficult to do in react-test-renderer which is a very simple utility).

To install the Enzyme tool, we need to install the library locally within our project by running the terminal command:

```
$ npm install enzyme@3.0.0 enzyme-adapter-react-16@1.0.0 raf@3.3.2     or

$ yarn add enzyme@3.0.0 enzyme-adapter-react-16@1.0.0 raf@3.3.2
```

Once these have been installed into the project we would need to configure these with Enzyme 3. The first thing is to create a setup test file in our project which is going to allow us to configure the test environment. This is where we can setup the enzyme adapter and this only requires setting up once in the setup file as opposed to doing it every single time we use enzyme.

Within the ./src/test directory we are going to create a file called setupTest.js which is going to be a file that runs to allow us to configure the environment we are running in. We are going to import the libraries and call a single method that will wire up enzyme to work with the adapter.

```
import Enzyme from 'enzyme';

import Adapter from 'enzyme-adapter-react-16';

Enzyme.configure({ adapter: new Adapter() });
```

Whenever we use enzyme in our test cases, it will be adding support for React v16.

The second thing we would need to do, is setup a Jest configuration JSON file which is going to allow us to actually specify that the tests file should run because it is not like it is within a special location with a special name (i.e. it will not get picked up automatically). More on this within the JEST documentation page. This file is going to live in the root of the application i.e. along with the babelrc.js, package.json, webpack.config.js etc. This file is going to be called jest.config.json:

```
{
    “setupFiles”: [
        “ref/polyfill”,
        “<rootDir>/src/test/setupTests.js”
    ]
}
```

In the array we are going to have an array of paths, paths to files we want to have our setup files. The first one is going to be the request animation frame polyfil and the second one is going to be the setupTest.js file we setup above. This is going to make sure polyfill file loads and then the setupTest file loads and then the test suite actually runs.

There is just one more small change we have to make before we are ready to continue to use the new Enyme tool. Inside the package.json file, we need to change the test script command telling it where it can find the config file we just created.

```
“scripts”: {
    “test”: “jest ——config=jest.config.json”;
}
```

We now have everything setup with Enzyme 3 and we can now use Enzyme in our test cases. We can now restart the test suite and explore what Enzyme provides us. The Enzyme documentation can be found on:
https://airbnb.io/enzyme/

The API Reference provides guides on everything that Enzyme has to offer. Example of Shallow rendering using Enzyme:

```
import { shallow } from 'enzyme';

Test('should render Header component correctly', () => {

    const wrapper = shallow(<Header />);

    expect(wrapper.find('#test').text()).toBe('Header')

});
```

The process is much easier, all we need is a const variable commonly called wrapper and then call shallow() as a function. We pass in the JSX we are trying to shallow render as the argument. Now that we shallow rendered the Header component, we have full access to the API methods e.g. a popular method we can use is find (if you are familiar with jQuery or document query selectors) which allows you to make assertion by selecting various elements inside of the component.

The find method allows you to pass in a selector and we get a wrapper back. The text method returns the text of whatever you are looking at i.e. the selector from the find method e.g the id of 'test' with the text of Header. We can do this for any other element e.g. button, paragraph, tag etc.

This provides a little taste of what Enzyme is capable of, which provides us with many method to write complex assertions of our application components which justifies the switching from react-test-renderer over to Enzyme. With Enzyme we get a much more full featured user friendly API.

```
expect(wrapper).toMatchSnapshot();
```

This is going to create a snapshot if one does not exist and if one does we have the option to update the snapshot, same as we did before when we used the react-test-renderer utility i.e. keying 'u' in the terminal to update. If we look at the file created we would notice that we are getting the shallow wrapper from enzyme but if we were to scroll down, we would also see some other stuff related to the rendered output but these are related to the internals of the enzyme library. So if the internals were to change, the snapshot would change and our test would start to fail.

To make sure Enzyme work with the snapshot testing functionality there is one small utility library we have to install called enzyme-to-json:

https://github.com/adriantoine/enzyme-to-json#readme

In the terminal run the following command to install the library locally:

```
$ npm install enzyme-to-json@3.0.1        or        $ yarn add enzyme-to-json@3.0.1
```

Once it has installed, we can restart the test suite again and be able to use the function we just imported. To use this utility we will import the utility and call on the function within our expect() assertion along with our enzyme method.

```
import toJSON from 'enzyme-to-json';

test('should render Header component correctly', () => {

    expect(toJSON(wrapper)).toMatchSnapshot();

});
```

The toJSON function is going to take the wrapper and it is going to extract just the meaningful rendered output. If we now save the file, the test will fail because the snapshots are different but if we hit u and look at the new snapshot. We now receive what we want i.e. what we had before with the react-test-renderer i.e. the correct snapshot showing up in the snapshot file.

Finally we can setup enzyme-to-json to work automatically so that we do not need to add it into our code. In the jest.config.js file we need to add the following property to the config file:

```
{

    "setupFiles": […],

    "snapshotSerializers": [

        "enzyme-to-json/serializer"

    ]

}
```

Enzyme is now fully configured within our project. We no longer need to import and use enzyme-to-json in our code.

SNAPSHOT TESTING WITH DYNAMIC COMPONENTS

Now that we know how to setup Enzyme and have a basic understanding of snapshot testing, we are going to look at snapshot testing components that require props.

We want to test the unconnected version of our react components because we want to be able to provide a set of dynamic prompts. We do not want the props coming from the store, instead we are going to provide them directly. In order to test the unconnected component we need to export the component (we may need to use a named export because the application could be using the component through a default export through connect.

Once exported we would need to import it within our .test.js file to snapshot test the component. Note we would also need to import any other relevant things such as react from react, shallow from enzyme, the component itself and our test data from fixtures in order to snapshot the component.

```
import React from ‘react’;

import { shallow } from ‘enzyme’;

import { ExpenseList } from ‘../../components/ExpenseList’;

import expenses from ‘../fixtures/expenses’;
```

After importing the necessary files we can write our test case for the snapshot testing using the test data.

```
test(‘should render ExpenseList with expenses’, () => {

        const wrapper = shallow(<ExpenseList expenses={expenses} />);

        expect(wrapper).toMatchSnapshot();

});
```

The first time we run the snapshot test, there is no existing snapshot and therefore the test can never actually fail. Enzyme will go through the process of creating a new snapshots file for the component. When we run the test suite this will automatically create the snapshot file for the component. If we open the file we can see what has been snapshot. This will show what items have been passed into the component from our test fixtures data. This will notify us of any changes to the component file. If the test fails it will notify us of the changes and we can update the snapshot if we intended the change, else we should fix the component file.

This is one test case we can run. Another test case is to see what happens to our component when we have no expenses e.g. an empty array. We can update the component to have a ternary operator to check if an array is passed in. If none, then a paragraph is rendered to say that there is no array else the array component is rendered. If we were to save the component, the test suite will continue to pass because the test case has an array passed in which is returning a match to the snapshot. We can now also add a snapshot when there are no items in the component so that test case will pass as well.

```
test('should render ExpenseList with empty message', () => {

    const wrapper = shallow(<ExpenseList expenses={ [] } />);

    expect(wrapper).toMatchSnapshot();

});
```

If we save the test case, this will generate a new snapshot with both no expenses and expenses rendered components. We now have a test cases that can verify when there are arrays objects and when there are no array objects. If either changes, the snapshot test will fail, alerting us so that we can respond to the change accordingly.

We now know how to perform snapshot testing with our React components using enzyme and shallow rendering. We can now dive into more complex testing with components that have a lot more complexity such as manipulating user interface i.e. clicking buttons, input values etc.

MOCKING TEST LIBRARIES

If we use a library such as moment() in our projects and try to create a snapshot test for our components, we will notice that the test will fail after the first snapshot test run because the snapshot is never going to match the previous one because the data is going to keep changing if we grab the moment() at the current point in time. To fix this issue, we would mock out a moment i.e. create a fake version of the moment library which is going to allow us to define what happens when the code actually calls the moment() function.

To create a mock library, the first step is to create the mock folder. Jest likes you to put this in the test folder, so we would create a new folder within tests called __mocks__ which is the same naming convention as the snapshots folder.
Inside of this folder, we are going to be able to create the mocked version of the moment library (*or whichever library you wish to make a mock of*). So in this instance we would create a file called moment.js within our mock folder.

The goal now is to define exactly what we want the mocked moment library to look like. We would then be able to start the mocking in the test file and the snapshot will work as expected. We use a export default an arrow function, which is going to be the function we call within the test file.

```
export default (timestamp = 0) => {

    return moment(timestamp);

};
```

The application calls on the real moment library, while our test file will use the mock version of the library. We would need to import the actual library within our mock library file but not in the normal way we would import a library. This is because the mock library will try to import on itself which will cause a stack trace error.

```
const moment = require.requireActual('moment');
```

If we now rerun the test, it will fail, however, if we update the snapshot and rerun the test this should now pass. The snapshot is always going to match because we forced the library to start at a specific point in time by mocking the library.

TESTING USER INTERACTIONS

To test user interactions with the application such as form interaction and onChange handlers, we would need to simulate those events for example testing the submission of bad data to test the application error messages being rendered correctly.

We would create a test case as normal and use shallow render to render the component. We need to find the form using the find method and search for the form by an id, class or element/tag name. Once we have access to the form element, we then need to simulate the event (refer to the enzyme documents on the simulate event).

```
test('should render error for invalid form submission', () => {

    const wrapper = shallow(<ExpenseForm />);

    expect(wrapper).toMatchSnapshot();

    wrapper.find('form').simulate('submit', { preventDefault: () => {} });

    expect(wrapper.state('error').length).toBeGreaterThan(0);

    expect(wrapper).toMatchSnapshot();

});
```

We use the simulate method to simulate the user interaction. The first argument is a string which could be click, submit or change etc. Once we simulate the event we need to verify that things changed as expected. We can provide a second argument that acts as the e object to pass into the e.preventDefault() function which prevents the form default behaviour to bypass the test error. Finally, we can make our assertion about the test i.e. what we expected to happen - the state should have the error message rendered. The code checks the length of the error state method to be greater than 0 which will indicate the component rendered a error message. Finally we can wrap up the test case with a snapshot to ensure the error always renders correctly. We could also create a snapshot before the error message to make sure no error shows up. You can add as many snapshot to your test case.

TEST SPIES

Test Spies, also known as mocked functions, is another tool/technique we can utilise to completely test our application code. If we wanted to test a onSubmit form event and validate that the submit prop was called with the form object and correctly formatted information, we would need to use Test Spies.

The whole point of spies are to create functions that are fake functions. They are created by Jest for us, and we can make assertions about them i.e. whether the fake function was called, how many times or called with specific argument(s) etc.

```
test('should call onSubmit prop for valid form submission', () => {

    const onSubmitSpy = jest.fn()

    onSubmitSpy();

    expect(onSubmitSpy).toHaveBeenCalled();

});
```

We call the jest.fn() method without passing any arguments to create a new spy which we assign/store on a variable. Now that we have a spy in place, we have access to a brand new set of assertions such as .toHaveBeenCalled() method which checks whether the spy was called (*it does not care about how many times or what arguments it was called with*).
In the above we called the onSubmitSpy spy function and so the test will pass. If it was not called, the test will fail. This is the very basics of test spies i.e. able to create fake functions and pass them into our components and make sure that they were called as expected to be called.

```
expect(onSubmitSpy).toHaveBeenCalledWith('John Doe', 'Manchester');
```

We can check if the function has been called with the specified arguments using the above assertion method. Test spies allows us to do some powerful tests such as passing the spy into the component that was rendered.

Below is an example of simulating a onSubmit form submission using a test spy to ensure the event handler function ran correctly with the correct arguments.

```
test('should call onSubmit prop for valid form submission', () => {

    const onSubmitSpy = jest.fn();

    const wrapper = shallow(<ExpenseForm expense={expenses[0]} onSubmit={onSubmitSpy} />);

    wrapper.find('form').simulate('submit'), {

        preventDefault = () => { }

    });

    expect(wrapper.state('error')).toBe('');

    expect(onSubmitSpy).toHaveBeenLastCalledWith({

        description: expenses[0].description,

        amount: expenses[0].amount

    });

});
```

We use the shallow render to render the ExpenseForm component passing in data from our fixture, in the above case we passed in the first expense item from the array fixture data. The second thing we need to pass into the component is the onSubmit, this is because the component itself is going to call on the onSubmit event handler function so it must be defined. We set the onSubmit equal to our test spy function.

Now that we have the component rendered with the test spy, we can go onto the next step of simulating the form submission (i.e. user interactions). Now that the form has been submitted, we can make assertion about what should have happened e.g. error state to be an empty string and the form submission (i.e test spy function) added the form item object to the existing array. We would define the exact object since the fixture data may have an id property which the object may not have when it is being submitted through the form for the first time. If we test this test case it should pass.