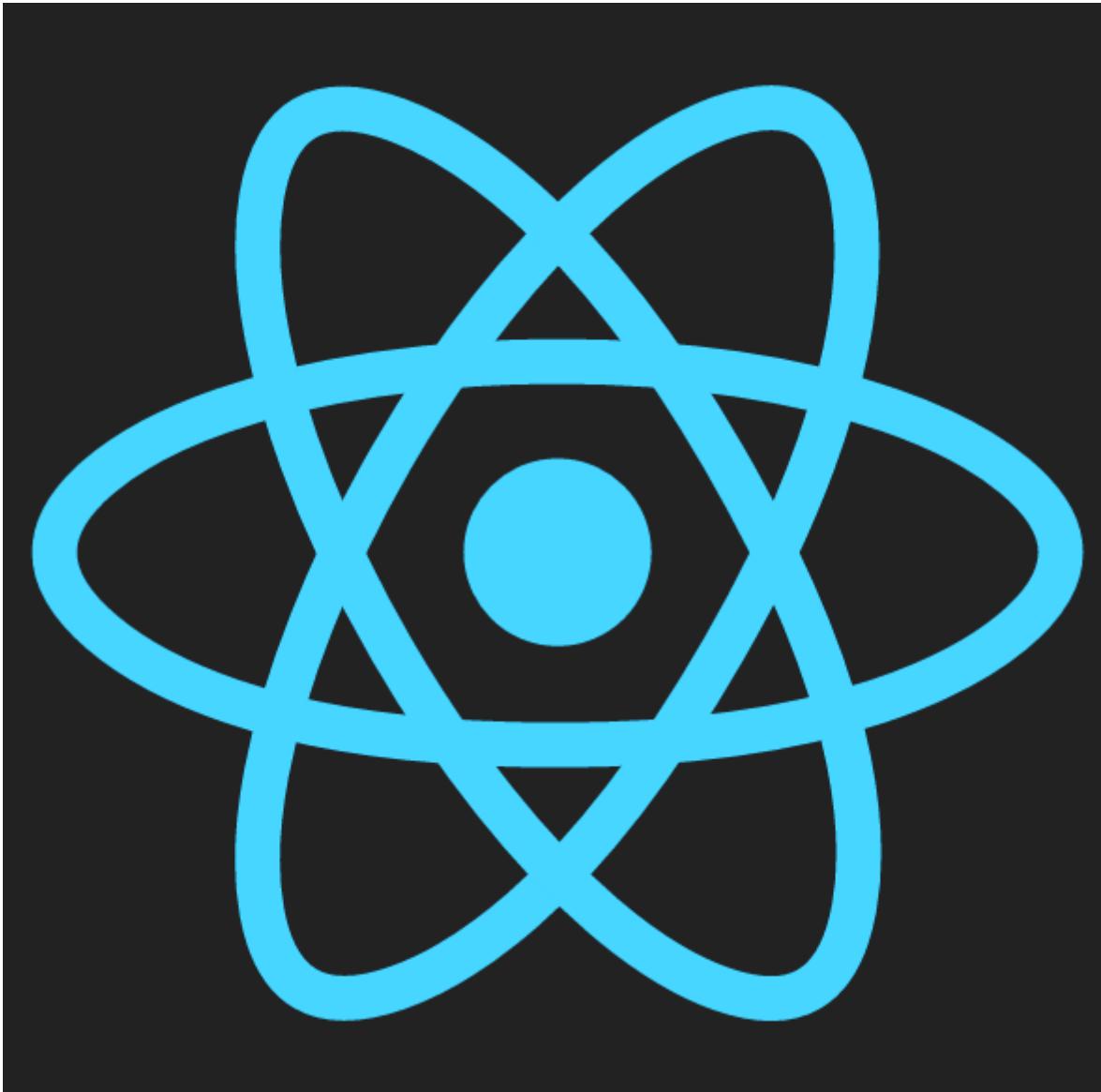


Professional ReactJS



Completed source code for all labs (for checking your work) can be found at:

<https://github.com/chrisminnick/professional-reactjs>

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by Chris Minnick
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Table of Contents

TABLE OF CONTENTS.....	2
DISCLAIMERS AND COPYRIGHT STATEMENT	4
DISCLAIMER	4
THIRD-PARTY INFORMATION	4
COPYRIGHT	4
HELP US IMPROVE OUR COURSEWARE	4
CREDITS	5
ABOUT THE AUTHOR.....	5
COURSE REQUIREMENTS	6
INTRODUCTION AND GIT REPO INFO.....	6
YARN OR NPM?	6
LAB 01: GET STARTED WITH CREATE REACT APP	7
LAB 02: YOUR FIRST COMPONENT	10
LAB 03: CREATE MORE COMPONENTS AND WRITING TESTS.....	11
PART 1: MAKING NEW COMPONENTS	11
PART 2: WRITING TESTS	11
LAB 04: STATIC VERSION	12
LAB 05: DOM MANIPULATION AND MODERN JAVASCRIPT	14
PART I. WORKING WITH AN API.....	14
PART II JSON	16
PART III. DOM MANIPULATION/WRITING FUNCTIONS.....	24
PART IV - EVENTS	33
LAB 06: STYLING REACT	35
LAB 07: PROPS AND CONTAINERS.....	39
LAB 08: ADDING STATE	41
LAB 09: INTERACTIONS, EVENTS, AND CALLBACKS.....	44
REACT'S SYNTHETIC EVENTS	44
UNIDIRECTIONAL DATA BINDING	44
STATE IN A CLASS COMPONENT	44
LAB 10: COMPONENT LIFECYCLE AND AJAX	50
LAB 11: CONVERTING APP TO A FUNCTION COMPONENT.....	52
LAB 12: PROPTYPES AND DEFAULTPROPS.....	53
LAB 13: CONVERTING TO TYPESCRIPT	55
LAB 14: TESTING WITH REACT TESTING LIBRARY	57
LAB 15: IMPLEMENTING REDUX	58
STEP 1: CREATE A STORE	58
STEP 2: WRITE THE REDUCERS	58
STEP 3: WRITE THE ACTIONS AND ACTION CREATORS	60
STEP 4: MODIFY APP.JS TO USE THE REDUX STORE.....	61
PART 2: REDUX TOOLKIT	62

LAB 16: REDUX THUNK	63
LAB 17: PERSISTING DATA IN LOCALSTORAGE USING REDUX.....	65
LAB 18: REACT ROUTER	67
BONUS LAB: CREATING MICRO FRONTENDS.....	68
PART 1: CREATE THE CONTENT SERVER	68
PART 2: CREATE THE CONTAINER	68
PART 3: MAKING A MICRO FRONTEND	71
BONUS LAB: GETTING THE BOOKSTORE WORKING AS A MICRO FRONTEND.....	74
BONUS LAB: SHARING STATE BETWEEN MICRO FRONTENDS.....	75
BONUS LAB: AUTHENTICATION WITH JWT	76
BONUS LAB: REACT ASTEROIDS	77

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Credits

About the Author

Chris Minnick is a prolific published author, trainer, web developer and founder of WatzThis, Inc. Minnick has overseen the development of hundreds of web and mobile projects for customers from small businesses to some of the world's largest companies, including Microsoft, United Business Media, Penton Publishing, and Stanford University.

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Minnick has authored and co-authored books and articles on a wide range of Internet-related topics including JavaScript, ReactJS, HTML, CSS, mobile apps, e-commerce, Web design, SEO, and security. His published books include *JavaScript All-In-One For Dummies*, *Coding All-In-One For Dummies*, *ReactJS Foundations*, *JavaScript for Kids*, *Writing Computer Code*, *Coding with JavaScript For Dummies*, *Beginning HTML5 and CSS3 For Dummies*, *Webkit For Dummies*, *CIW eCommerce Certification Bible*, and *XHTML*.

Course Requirements

To complete the labs in this course, you will need:

- A computer with MacOS, Windows, or Linux.
- Access to the Internet.
- A modern web browser.
- Ability to install software globally (or certain packages pre-installed as specified below).

Introduction and Git Repo Info

Most of the labs in this course build on the labs that came before. So, if you don't complete a lab or can't get a certain lab to work, it's possible that you can get stuck and won't be able to move forward until the error is corrected.

To help you check your work and to make it possible to come into the class at any point, the git repository for this course contains finished versions of every lab.

The url for the course repository is:

<https://github.com/chrisminnick/professional-reactjs>

You can find the finished code for each lab inside the **solutions** directory.

Yarn or npm?

Yarn and npm are both package managers for Node. Yarn was developed by Facebook, and npm is included with Node. You can use whichever one you prefer for all the labs in this course, but the instructions in this course use npm to keep the number of required pre-requisite installations to a minimum.

If you want to try Yarn, or if you prefer it to npm, you must have it installed globally on your computer. You can find instructions for installing Yarn here: <https://yarnpkg.com/getting-started/install>

Lab 01: Get Started with Create React App

- 1. Open your terminal application (**Terminal** on MacOS or **git-bash** on Windows) or the Terminal window in VSCode.
- 2. Change to your home directory or your **professional-reactjs** project directory.

```
cd professional-reactjs
```

- 3. Use Create React App to make a new React project. This will be the project we'll be working on for most of the labs in this course.

```
npx create-react-app react-bookstore
```

If this produces an error, you most likely need to upgrade the version of node and npm on your computer (see the setup instructions).

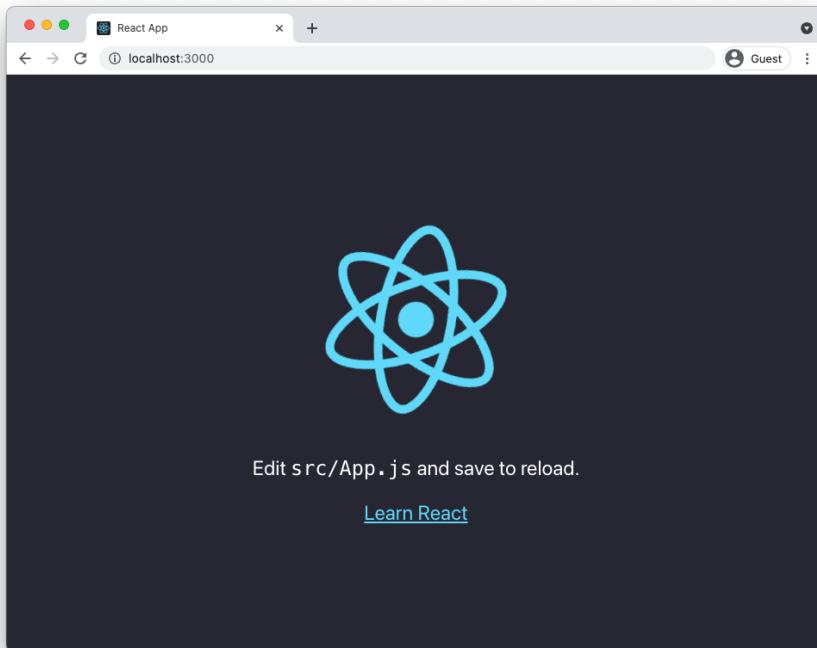
- 4. Go into the new directory.

```
cd react-bookstore
```

- 5. Test that everything was installed and works.

```
npm start
```

If the app was successfully created, a browser will open and you should see the following Welcome to React page.



- 6. Open your new project in the code editor of your choice.
- 7. Find **App.js** inside the **src** directory and open it for editing.

The screenshot shows the VS Code interface with the following details:

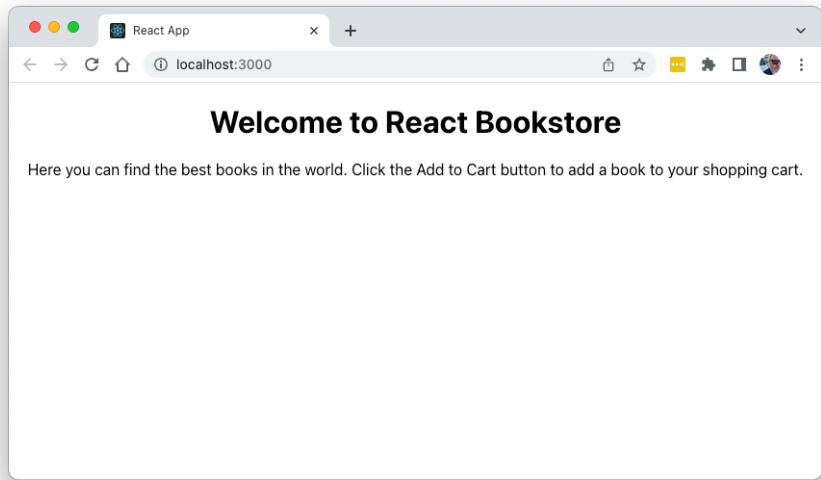
- EXPLORER** view: Shows the project structure under "PROFESSIONAL-REACTJS". The "src" folder contains "App.css", "App.js", "App.test.js", "index.css", and "index.js". Other files like ".gitignore", "package.json", "README.md", "yarn.lock", and another "README.md" are also listed.
- JS App.js** view: The code editor displays the content of App.js. It includes imports for logo from "./Logo.svg" and App.css, and a function App() that returns a div with a header containing an image of the logo. A tooltip suggests editing the code and saving to reload. The code ends with a closing <a> tag.
- TERMINAL** view: Displays the message "Compiled successfully!" followed by instructions to view the application in the browser. It also shows the local and network URLs for the development build.
- Bottom Status Bar**: Shows "Cloud Code minikube Ln 1, Col 1 Spaces: 2 UTF-8 LF JavaScript" and "Go Live" buttons.

- 8. Delete the `` element and replace it with an `<h1>` element containing Welcome to React Bookstore.
 - 9. Delete the import of `logo.svg` from the beginning of `App.js` since it's no longer being used.
 - 10. Move the paragraph inside the `<header>` to a new `<main>` element below the header and change its content to a welcome message, such as the following:

We have several books. Feel free to browse for as long as you like. Click on a cover image to see details, or click the Add to Cart button to add a book to your shopping cart.

- 11. Delete the link under the `<p>` element.
 - 12. Delete the `className="App-header"` attribute from the `<header>` element.
 - 13. Return to your web browser and notice that the text has been automatically refreshed (if your app is still running).

If it's doesn't refresh, click the browser refresh button, or return to your Terminal emulator and restart the development server (using `npm start`).



Lab 02: Your First Component

React components let you divide your user interface into independent and reusable pieces. The simplest components simply output some piece of HTML, given some input. All that's required is a simple JavaScript function.

In this lab, you'll create a functional component to hold the contents of the page footer.

- 1. Create a new file named **Footer.js** (or **Footer.jsx**) in the **src** directory
- 2. Type the code below into **Footer.js**

```
function Footer() {  
  const footerStyle = {  
    backgroundColor: 'black',  
    color: 'white',  
    padding: '10px',  
    position: 'fixed',  
    bottom: '0',  
    width: '100%',  
  };  
  return <p style={footerStyle}>This is the footer.</p>;  
}  
  
export default Footer;
```

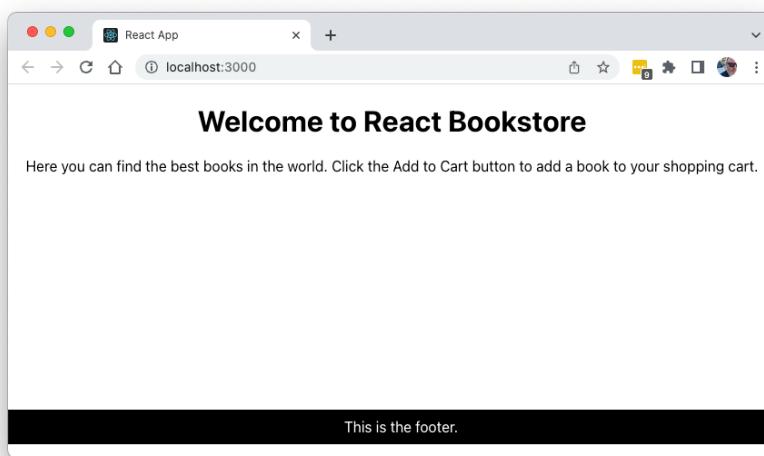
- 3. Add the following to the beginning of **App.js**

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

- 4. Add the following inside the `<div>` in **App.js** (after the `<main>` element).

```
<Footer />
```

- 5. Start the app (if it's not already running) and view it in your browser.



Lab 03: Create More Components and Writing Tests

In this lab, you'll make your React application more modular by turning the main parts of the view into components, then you'll create simple tests for your new components.

Part 1: Making new components

- 1. Using what you learned from creating **Footer.js**, make **Header.js** and **Main.js** to replace code in **App.js**.

At the end of this lab, your page should look the same as it does at the beginning when opened in a browser.

Your finished return statement in **App.js** should match this:

```
return (
  <div className="App">
    <Header />
    <Main />
    <Footer />
  </div>
);
```

Part 2: Writing tests

Create React App generates a simple test for whether the sample component (**App.js**) renders the text "Learn React". In this lab, you'll make the test for the App component pass and then use the sample test file to create tests for the new components you created in part 1.

- 1. Open **src/App.test.js** and modify it so that its test will pass. Visit the React Testing Library documentation to learn more (<https://testing-library.com/docs/react-testing-library>). Hint: the test in App.test.js will look at what's rendered by App.js as well as by any components that are used in the return statement of App.js.
- 2. Make copies of **App.test.js** for testing **Footer.js**, **Header.js**, and **Main.js**
- 3. Modify the contents of the new files to test the new components.
- 4. Run your tests by entering the following in the command line

```
npm test
```

- 5. Make sure that all the tests pass.

The screenshot shows a terminal window with the following output:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL

PASS  src/Footer.test.js
PASS  src/Header.test.js
PASS  src/App.test.js
PASS  src/Main.test.js

Test Suites: 4 passed, 4 total
Tests:      4 passed, 4 total
Snapshots:  0 total
Time:       0.879 s, estimated 1 s
Ran all test suites related to changed files.

Watch Usage: Press w to show more.■
```

Lab 04: Static Version

The first step in creating a React UI is to create a static version. In this lab, you'll start with a mockup of the react-bookstore application and you'll create components to make a mockup of the catalog.

- 1. If you haven't already done it, clone the class Github repository, as described in the [Setup Instructions](#) at the beginning of this book.

```
git clone https://github.com/chrisminnick/professional-reactjs
```

- 2. Open **professional-reactjs/starter/lab04/**.

You'll see three folders: **data**, **images**, and **mockup**.

- 3. Open **data/products.json** in your code editor.

This is a file in JavaScript Object Notation (JSON) containing 100 great books. We'll be building a store using this data.

- 4. Open **starter/lab04/mockup** and look at the **mockup.jpg** image.

This image shows what the final store and shopping cart should look like.

- 5. Figure out how you might divide the user interface shown in **mockup.png** into a hierarchy of components. Make a quick drawing on paper, or in MS Paint, or however you like. Check out **mockup-components.png** if you want to see one way it can be done.

Hint 1: If two components need to access the same piece of data, they should have a common parent that holds this data.

Hint 2: Look for repeating elements that can be made into components.

- 6. Move the **data** directory from the **/starter/lab04** directory into the **src** directory inside your **react-bookstore** project.
- 7. Move the **images** directory into the **public** directory.
- 8. Open the **Main.js** component in your project and modify it to the following.

NOTE: Some of the components referenced in this code don't exist yet. You'll be creating them in the next step.

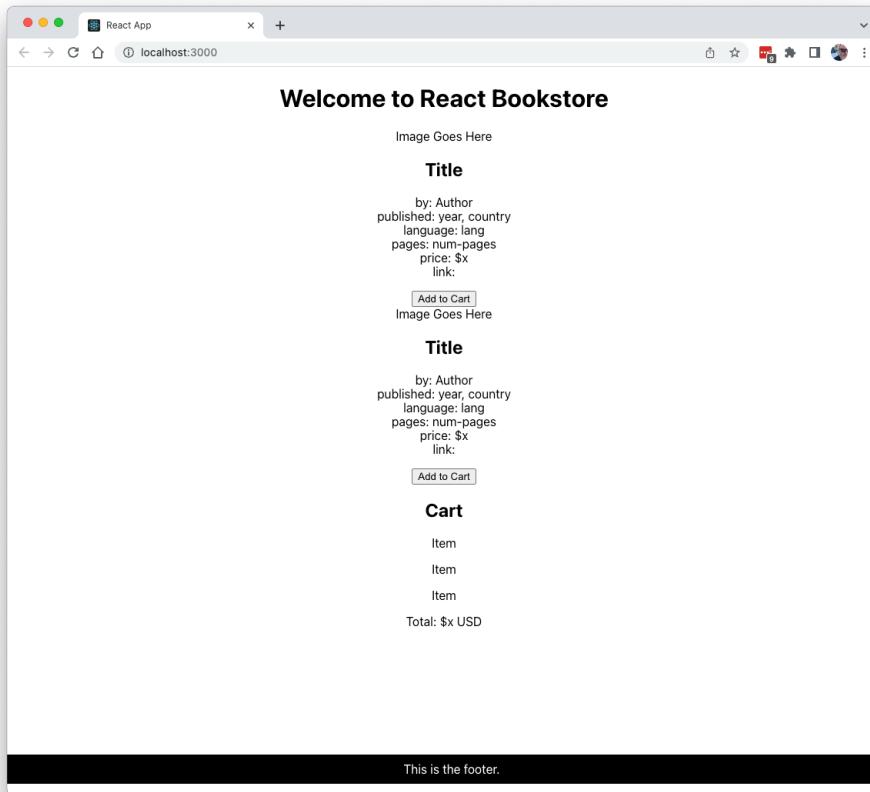
```
import ProductList from './ProductList';
import Cart from './Cart';

function Main() {
  return (
    <main>
      <ProductList />
      <Cart />
    </main>
  );
}
```

```
    }

    export default Main;
```

- 9. Create basic components for `ProductList` and `Cart` and their sub-components.
Don't worry about styling them, but try to make each one contain the basic information (without images at this point) as in the mockup.
- 10. Run `npm start` to verify that your code builds. Your UI should now look something like this:



Lab 05: DOM Manipulation and Modern JavaScript

PART I. Working with an API

In this first part, you'll write a JavaScript application to make a call to NASA's API to get data on the near-Earth asteroids based on their closest approach date to Earth. All the data is from the NASA JPL Asteroid team (<http://neo.jpl.nasa.gov>). We are looking for data regarding the asteroids' distance from the Earth, speed, size, and whether each asteroid is potentially hazardous.

- 1. In your code editor, create a new file and name it `asteroids.js`.
- 2. Create a variable called `today` and set it to a string containing the current date.

```
const today = new Date().toISOString().slice(0,10);
```

We will need an *API key* to access NASA's API. Without the key we would be limited as to how many calls we could make to the API per hour. With our key, we are allowed to call the API thousands of times per hour.

- 3. Navigate to <https://api.nasa.gov/index.html#apply-for-an-api-key>.
- 4. Enter your information and check your email for the API key. Congratulations, you have a developer's API key from NASA!
- 5. Create a variable called `key` and set it equal to the API key from NASA.

```
const key = "your-very-own-and-very-long-key";
```

Next, if we are calling an API, how do we call it? We call the URL that NASA provides and add parameters to specify the data we want. Here is an example:

```
https://api.nasa.gov/neo/rest/v1/feed?start_date=START_DATE&api_key=API_KEY
```

Notice the parameters `start_date` and `api_key`. In the example, each parameter is set equal to a variable, either `START_DATE` or `API_KEY`. Here is where we will use our variables by using a template literal string.

- 6. Create the variable called `url`.

```
const url
```

- 7. Set the variable `url` equal to the string below.

Notice that the string begins and ends with a backtick and contains two variables.

```
const url = `https://api.nasa.gov/neo/rest/v1/feed?start_date=${today}&api_key=${API_KEY}`;
```

We are now ready to build the `Asteroid` class and a static method that calls the API and that will make `Asteroid` objects.

- 8. Create a new class named `Asteroid`, and give it a constructor.

```
class Asteroid {  
    constructor() {}  
}
```

- 9. Each asteroid will have four properties: hazardous, distance, speed, and size. Add these as parameters to the constructor and initialize their corresponding properties:

```
constructor(isHazardous, distance, speed, size) {  
    this.isHazardous = isHazardous;  
    this.distance = distance;  
    this.speed = speed;  
    this.size = size;  
}
```

- 10. Create a new static method named `getAsteroids()` in the `Asteroid` class. A static method is one that belongs to the class, rather than to instances of the class. Since we'll be running asynchronous code in this method, make it also be an `async` function:

```
static async getAsteroids() {  
}
```

We'll use the `fetch()` method inside `getAsteroids()` to get the data from the NASA API.

The `fetch` method provides a way for JavaScript to make HTTP asynchronously.

- 11. Call `fetch()` asynchronously, passing it the `url`, and assign the result to a constant named `response`.

```
const response = await fetch(url);
```

The response of a `fetch` request is a `Stream` object. Eventually, we want our `fetch` method to return JSON when it is successfully finished, as the promise of this finished stream.

Async functions wrap function calls made with the `await` keyword with a promise. What is a promise? A promise is a first-class representation of a value that may be made asynchronously and is available in the future. A promise represents the eventual result of an asynchronous operation. We don't know if the call will be successful or not until the call is made, but we still have write our code moving forward as though it could be successful. If it is successful, we can do any number of things and continue with our coding. If it is not successful, we can return an error message.

- 12. To catch potential errors with the `fetch()`, wrap the `async` statement with a `try/catch` block:

```
static async getAsteroids() {  
    try {  
        const response = await fetch(url);  
    } catch (error) {  
        console.log(error);  
    }  
}
```

It's also possible that the `fetch()` will be successful, but the response will be something other than what we want. For example, if you exceed your limit for API calls. To address that, we can check the value of `response.ok`.

- 13. Add a check for whether `response.ok` is true (after the `fetch` in the `response` block) and throw an error if it's not.

```
if (!response.ok) {  
    throw new Error('Network response was not ok');  
}
```

- 14. Call the `json()` method on `response` to parse the stream as JSON and return a JavaScript object.

```
const data = await response.json();
```

- 15. Add `console.log(data)` so you can examine the data.

```
console.log(data);
```

Type `about:blank` into your browser's address bar to open a blank window. Copy your code and paste it into your browser's JavaScript console to run it. Type `Asteroid.getAsteroids()` in the console to call the static `getAsteroids()` method. After a moment, data should return from NASA and you'll see all the data for the asteroids based on the approach date that we chose.

To test your try/catch block, try refreshing your browser window, then paste the code into the console again and run `getAsteroids()`, but change the url to make it invalid (such as by changing `nasa.gov` to `nasa.com`).

PART II JSON

Now we'd like to use the data we got from the NASA API. JSON is a data-interchange format that stands for "JavaScript Object Notation." It is built on two structures:

- a. Name/Value Pairs: JSON acts similarly to JavaScript objects. We know that an object is a collection of properties, and a property is made up of a name/value pairs, i.e `const object = { 'name' : 'value' }`
 - i. We can access a value by name in two different ways., dot notation and bracket notation.
`object.name => 'value'`
`object['name'] => 'value'`
- b. Arrays: In JSON, we also find ordered list of values, which we know are arrays, i.e., `['Bob', 'Jim', 'Lara']`, which could be nested inside an object, i.e., `const object = { 'names' : ['Bob', 'Jim', 'Lara'] }`.

- i. To access an array inside JSON we need to first know what name is associated with the array, then access it by order (remember, arrays start at index 0).

```
object.names[0] => 'Bob'  
object.names[2] => 'Lara'
```

Take a look in the console and browse the data printed to the console. Now that we have our data, how do we make sense of it? Remember, JSON is built on two structures, name/value pairs and arrays.

Let's start to access the JSON to get the data we want. We want near Earth objects and we want them by a certain date. First, find the name `near_earth_objects` and expand it. You'll see a name, `yyyy-mm-dd`, similar to the format of the date string we created. If you expand one of those dates you'll see that it contains an array. This array is our list of asteroids!

Let's access this collection of asteroids.

- 16. Inside the `getAsteroids()` function, comment out `console.log(data)` and create a variable called `asteroids` and set it equal to `data`.

```
//console.log(data);  
const asteroids = data
```

- 17. Use dot notation to access `near_earth_objects` from `data`.

```
const asteroids = data.near_earth_objects
```

- 18. Use bracket notation, `[today]`, after `json.near_earth_objects`.

We do this because we cannot access the collection by using dot notation with the `yyyy-mm-dd` format. We do know that our `today` variable is equal to the value or property of the object we wish to access. Therefore, we used the variable `today` in bracket notation.

```
const asteroids = data.near_earth_objects[today];
```

- 19. Print the collection of asteroids to the console by writing `console.log(asteroids)`;

Reload your browser, paste your code into the console, then run the `getAsteroids()` method and search for names or properties that relate to distance, speed, size, and hazard info.

We see we have an ordered list of objects representing each asteroid. We can iterate or loop through this list and access the properties of distance, speed, size and whether or not it is hazardous for each object.

How do we loop through an array? There are a few ways to do this. We will use the `.map()` function. The `map()` function takes a callback function as an argument, performs that function on each element of the array, and creates a new array with the results of that callback. We need to write a function that, as we loop through each element of `asteroids`, accesses those values we want (distance, speed, size, hazard).

- 20. Chain `.map()` to our variable `asteroids`.

At this point, we can also remove our `console.log` statements.

```
const asteroids = data.near_earth_objects[today];
asteroids.map();
```

- 21. Pass the argument `function(element) {}` to the `map()` function.

We pass `element` to our callback function as an argument. This represents each element in our collection of asteroid objects. As we loop through the collection, we can execute code on each element.

```
const asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
});
```

- 22. In the block of code for the callback function of the `map` method, print `element` to the console. This will allow us to see each element in our collection. What names and values do you notice?

```
const asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    console.log(element);
});
```

If you run `getAsteroids()` in your console now, you'll see that each element that's logged by the `map()` function is an object and we can look for the properties of each asteroid. If you look closely, you'll see that these names correspond to the data we want (distance, speed, size, hazard info). We will start by looking into the name or property `close_approach_data`.

- 23. Create a variable called `approach` and set it equal to the `element`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    console.log(element);
    let approach = element
});
```

- 24. Print `approach` to the console and comment out `console.log(element)`.

We can now inspect our approach element to see what property we need to chain next.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let approach = element;
    console.log(approach);
});
```

- 25. Use dot notation to chain close_approach_data onto our element.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let approach = element.close_approach_data;
    console.log(approach);
});
```

When you print the variable approach to the console, you get an array with one element. Access that element, which is at the 0-index.

- 26. Use bracket notation, and write [0] after close_approach_data to access the array with one element.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let approach = element.close_approach_data[0];
    console.log(approach);
});
```

Further into this element, you'll see another object with an interesting property: miss_distance. We can now focus on distance, as we get closer to specific data.

- 27. Create a variable called distance and set it equal to approach. In the console.log command, replace approach with distance.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let approach = element.close_approach_data[0];
    let distance = approach;
    console.log(distance);
});
```

- 28. Using dot notation to chain miss_distance onto approach.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let approach = element.close_approach_data[0];
    let distance = approach.miss_distance;
    console.log(distance);
```

```
});
```

Printing `distance` to the console at this point reveals an object with properties that describe units of length. The values that are decimals in string format. For example:

```
[object Object] {
  astronomical: "0.3577465984",
  kilometers: "53518132",
  lunar: "139.1634216309",
  miles: "33254624"
}
```

- 29. Chain the property `.kilometers` to the property `miss_distance`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
  //console.log(element);
  let approach = element.close_approach_data[0]
  let distance = approach.miss_distance.kilometers;
  console.log(distance);
});
```

When you print `distance` to the console, you'll see it's a string that represents the distance of each asteroid from Earth in kilometers.

Let's move on to accessing the speed of the asteroid. Print `approach` to the console. One name/property of this object is `relative_velocity`.

- 30. Create a variable called `speed` and set it equal to `approach`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
  //console.log(element);
  let approach = element.close_approach_data[0]
  let distance = approach.miss_distance.kilometers;
  let speed = approach;
});
```

- 31. Chain `.relative_velocity` to `approach` in the `speed` variable.

Print `speed` to the console.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
  //console.log(element);
  let approach = element.close_approach_data[0]
  let distance = approach.miss_distance.kilometers;
  let speed = approach.relative_velocity;
  console.log(speed);
});
```

If you view speed by printing it to the console, you'll see another object with more name/value pairs that measure the speed in different units. Let's look at the name `kilometers_per_hour`.

- 32. Chain `.kilometers_per_hour` onto `relative_velocity`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let distance = approach.miss_distance.kilometers;
    let speed =
approach.relative_velocity.kilometers_per_hour;
    console.log(speed);
});
```

When you print speed to the console, you'll get back a float, or a number that has a decimal point. This is the speed of each asteroid. You now have two points of data: distance and speed. Size is next.

Look back at the `element`, the original argument in our `.map()` function. If you print `element` to the console and look beyond and below the property `close_approach_data`, you'll eventually see the name `estimated_diameter`. Use that property of our `element` to access the size of each asteroid.

- 33. Create a variable called `size`. Set `size` equal to `element` and chain `estimated_diameter` to it.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let distance = approach.miss_distance.kilometers;
    let speed =
approach.relative_velocity.kilometers_per_hour;
    let size = element.estimated_diameter;
});
```

If you print `size` to the console, you'll get an object with properties of length. Look at the 'meters' property.

- 34. Chain `.meters` onto `estimated_diameter`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    //console.log(element);
    let distance = approach.miss_distance.kilometers;
    let speed =
approach.relative_velocity.kilometers_per_hour;
    let size = element.estimated_diameter.meters;
```

```
});
```

When you print `size` to the console, you'll see an object that has two names relating to the estimated maximum and minimum size of the object. Since you never want to underestimate asteroids, go with the property `estimated_diameter_max`.

- 35. Chain `.estimated_diameter_max` after meters.

We now have the size data for each asteroid measured in meters.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element){
    //console.log(element);
    let distance = approach.miss_distance.kilometers;
    let speed =
        approach.relative_velocity.kilometers_per_hour;
    let size =
        element.estimated_diameter.meters.estimated_diameter_max;
});
```

Now you just need one more piece of data: Is the asteroid a hazard? Print `element` to the console and look beyond `estimated_diameter`. You'll see a property named `is_potentially_hazardous_asteroid`. This is it! The value of this property is a Boolean, simply true or false. It is a potentially hazardous asteroid or it is not. Good info to know, right?

- 36. Create a variable called `hazard` and set this equal to `element`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element){
    //console.log(element);
    let distance = approach.miss_distance.kilometers;
    let speed =
        approach.relative_velocity.kilometers_per_hour;
    let size =
        element.estimated_diameter.meters.estimated_diameter_max;
    let hazard = element;
});
```

- 37. Chain `.is_potentially_hazardous_asteroid` to `element`.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element){
    //console.log(element);
    let approach = element.close_approach_data[0]
    let distance = approach.miss_distance.kilometers;
    let speed =
        approach.relative_velocity.kilometers_per_hour;
    let size =
        element.estimated_diameter.meters.estimated_diameter_max;
    let hazard = element.is_potentially_hazardous_asteroid;
```

```
});
```

- 38. After the `hazard` variable, insert a `console.log` statement to log each piece of data about each asteroid to the console.

```
let asteroids = json.near_earth_objects[today];
asteroids.map(function(element) {
    let approach = element.close_approach_data[0];
    let distance = approach.miss_distance.kilometers;
    let speed =
approach.relative_velocity.kilometers_per_hour;
    let size =
element.estimated_diameter.meters.estimated_diameter_max;
    let hazard = element.is_potentially_hazardous_asteroid;
    console.log(`\nHazard: ${hazardous}\nDistance: ${distance} km\nSpeed: ${speed} km/h\nSize: ${size} m`));
});
```

- 39. Add a call to `Asteroid.getAsteroids()` to your `asteroids.js` file, after the class definition.

Here's what your `getAsteroids()` method should look like so far:

```
static async getAsteroids() {
try {
    const response = await fetch(url);

    if (!response.ok) {
        throw new Error('Network response was not ok');
    }

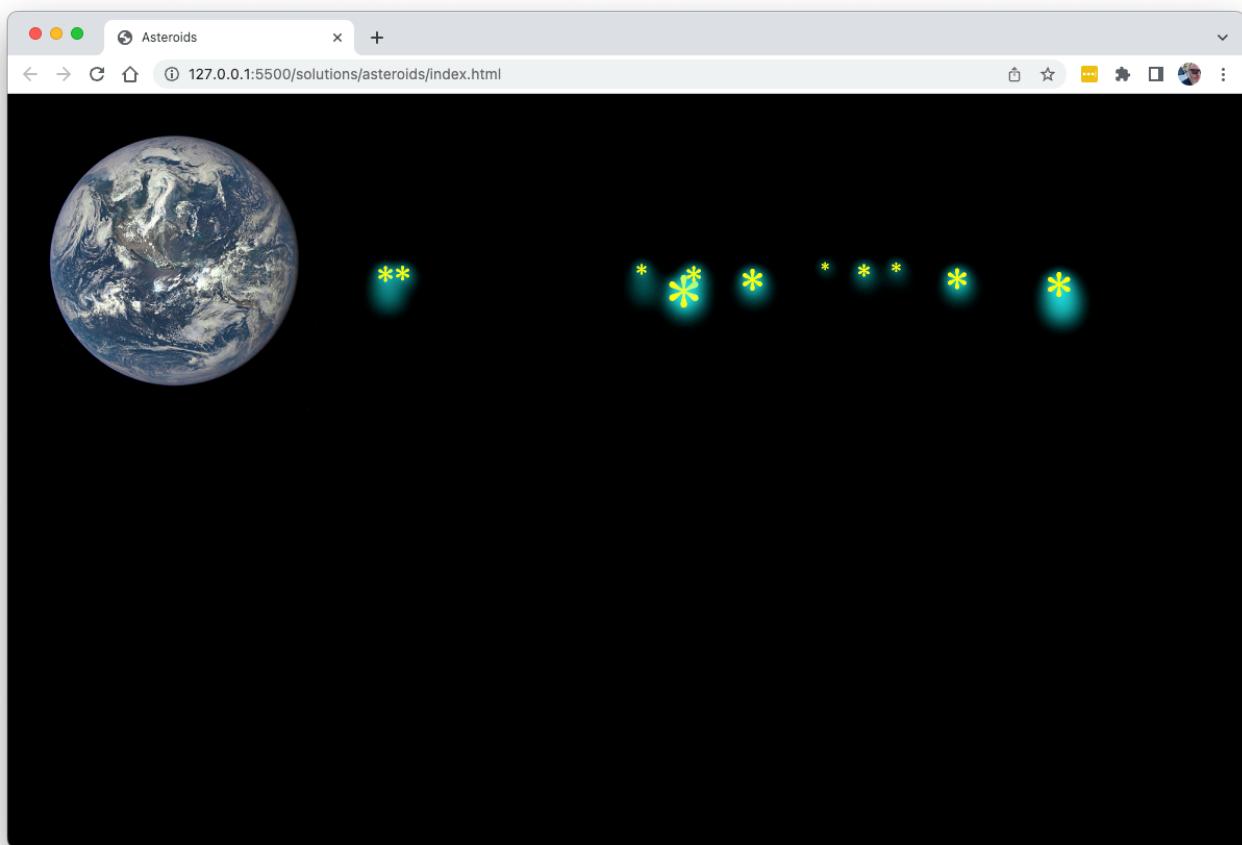
    const data = await response.json();
    console.log(data);
    const asteroids = data.near_earth_objects[today];
    console.log(asteroids);
    asteroids.map(function (element) {
        let approach = element.close_approach_data[0];
        let distance = approach.miss_distance.kilometers;
        let speed = approach.relative_velocity.kilometers_per_hour;
        let size = element.estimated_diameter.meters.estimated_diameter_max;
        let hazardous = element.is_potentially_hazardous_asteroid;
        console.log(`\nHazard: ${hazardous}\nDistance: ${distance} km\nSpeed: ${speed} km/h\nSize: ${size} m`));
    });
} catch (error) {
    console.log(error);
}
```

```
    }  
}
```

When you run this code, you'll see all the properties printed to the console for each asteroid in a nice, readable format. Compare asteroids. Which is the biggest? Which is the fastest? Which is the closest to Earth? Which are potentially hazardous? All of this is important, because very soon you'll begin to create a visual display of these asteroids!

PART III. DOM Manipulation/Writing Functions

Our next goal is to display our collection of asteroids in a web browser. To create a visualization of the asteroids we will use JavaScript, HTML and CSS. In doing this, we will manipulate the document object model (DOM). Here's what the finished UI will look like:



The DOM is an application programming interface or API for HTML documents. It represents elements as a tree structure. Imagine a tree turned upside down. The trunk of the tree (the parent node) has branches (child nodes of the parent). These branches may have more branches and so on and so forth. The objects or elements in the tree

can be addressed and manipulated using methods. We will begin to write functions in JavaScript. These functions will use our variables, create asteroid elements, and append them HTML nodes in the DOM.

The HTML, CSS, and image you'll need have all been provided in `starter/lab05` directory in this course's repository. Copy them into your project and take a look them to get familiar with them.

Once you've copied them over, open `index.html` in your browser and you'll see the planet Earth over the black background of space.

We will manipulate the DOM by writing functions.

- 40. Return to the JavaScript file and create an instance of Asteroid inside the `map()` function:

```
let asteroid = new Asteroid(hazardous, distance, speed,  
size);
```

- 41. Define a method in the Asteroid class called `placeAsteroid()`.

This function will place the asteroids in the DOM.

```
placeAsteroid() { }
```

To create an asteroid, you need to create the element that the program will append to the DOM.

- 42. In the method body, write the following statement:

```
let asteroidElement = document.createElement('a');
```

The `document` object provides properties and methods to access all node objects. Calling `createElement` on `document` and pass the string '`a`' as an argument creates an `<a>` (anchor) tag.

- 43. On the next line, call the `.textContent()` method on the `asteroidElement` variable and set this equal to `'*'`.

This changes the text content of the `<a>` element to `*`. Now, you have an asteroid in the shape of an asterisk. Here's what the `placeAsteroid()` method should look like now:

```
placeAsteroid(hazardous, distance, speed, size) {  
  let asteroidElement = document.createElement('a');  
  asteroidElement.textContent = '*';  
}
```

Next, you'll add a class, `asteroid`, to the asteroid element to style it. This class has already been defined inside the `style.css` file. Return to JavaScript and on a

new line, write the variable `asteroid` and call the method `className` on it. Set this equal to the string '`asteroid`'.

```
function placeAsteroid(hazardous, distance, speed, size) {  
    let asteroidElement = document.createElement('a');  
    asteroidElement.textContent = '*';  
    asteroidElement.className = 'asteroid';  
}
```

The next step is to access an element of the DOM to which the new element will be appended. When an element is appended, it is appended to a parent element as a child of that element. The HTML document has a `<div>` with the id "solar-system" that will be the parent of the asteroid elements.

The document object model has a method called `getElementById()` that can be used to get the `<div>` with an id of "solar-system".

- 44. Create a variable called `solarSystem` and set it equal to `document.getElementById('solar-system')`.

This will give you the parent that you will append the asteroid elements to. Here's what `placeAsteroid()` should look like now:

```
placeAsteroid() {  
    let asteroidElement = document.createElement('a');  
    asteroidElement.textContent = '*';  
    asteroidElement.className = 'asteroid';  
  
    let solarSystem = document.getElementById('solar-system');  
}
```

To append the `asteroidElement` to the `solarSystem`, define a private method named `append` with two parameters: `parent` and `el`.

The `parent` represents the element in the DOM that already exists on our page. The `el` represents the element which we will append to the parent. When we append `el` to the `parent`, our element is added as the last child of that parent node.

Private methods can be created in JavaScript by prefixing the name of the method with `#`. A private function can only be called from within the object.

- 45. Define a method named `#append` with parameters of `parent` and `el`. The `appendChild()` method is called on `parent` and takes `el` as an argument.

```
#append(parent, el) {  
    parent.appendChild(el);  
}
```

- 46. Call the `#append()` method from inside the `placeAsteroid()` method.

```
placeAsteroid(hazardous, distance, speed, size) {  
    let asteroidElement = document.createElement('a');  
    asteroidElement.textContent = '*';  
    asteroidElement.className = 'asteroid';
```

```

        let solarSystem = document.getElementById('solar-system');
        this.#append();
    }

```

- 47. Pass the arguments `solarSystem` and `asteroidElement` to `append()`.

The `solarSystem` variable represents the parent, so it is written first. The `asteroidElement` variable is the child or el, so it is written second.

```

placeAsteroid(hazardous, distance, speed, size) {
    let asteroidElement = document.createElement('a');
    asteroidElement.textContent = '*';
    asteroidElement.className = 'asteroid';

    let solarSystem = document.getElementById('solar-system');
    this.#append(solarSystem, asteroidElement);
}

```

Refresh `index.html` in your browser. Nothing will happen at this point, because `placeAsteroid()` hasn't been called yet.

- 48. Add a call to `asteroid.placeAsteroid()` at the end of the `try` block in the `getAsteroids()` method :

```
asteroid.placeAsteroid();
```

Right now, the program can create many asteroids, but they are all be the same distance from the earth and the visualization looks as though there is only one asteroid.

In the next steps, you'll add functions to visualize the speed, distance, size, and hazard data.

- 49. Define a method called `#setDistance()`. This function takes two arguments: `asteroid` and `distance`.

```

#setDistance(asteroidElement) {
}

```

This method will use the float value of the `distance` property to change the location of an asteroid element on the page by adjusting the style of the element. More specifically, it will adjust the `margin-left` property. It is currently set at `0px`, which places the asteroid next to planet Earth. If you increase the value of the `margin-left` property it will move the element away from Earth.

- 50. Call `.style` on `asteroidElement`.

```

#setDistance(asteroidElement) {
    asteroidElement.style
}

```

- 51. Chain `.marginLeft` after `.style` on the `asteroidElement` element.

```
#setDistance(asteroidElement) {
    asteroidElement.style.marginLeft
}
```

The variables for `distance` range in millions of km so it will need to be scaled down for the visualization. Try dividing `distance` by 100000 and set the pixel size of the `margin-left` to this value.

- 52. Set `asteroid.style.marginLeft` equal to `distance/100 000`.

```
#setDistance(asteroidElement) {
    asteroidElement.style.marginLeft = this.distance/100000;
}
```

- 53. Concatenate 'px' onto `distance/100000`.

When 'px' is concatenated onto `distance/100000`, this entire value is coerced into a string. This string becomes the value for the `margin-left` property in the CSS DOM.

```
#setDistance(asteroidElement) {
    asteroidElement.style.marginLeft = this.distance/100000 + 'px';
}
```

- 54. Call `this.#setDistance(asteroidElement)` in the `placeAsteroid()` function.

Now, each asteroid in the collection should have a property, `margin-left`, that has a value based on its distance from Earth.

You're not finished with styling the asteroid elements just yet, though. You still have to set the hazard, speed and size of the asteroids.

- 55. Start a new method named `#setSize()`. This method will style the CSS `font-size` property of each `asteroidElement` so that we can see their relative size.

```
#setSize(asteroidElement) {
}
```

- 56. Similar to setting the distance, call `.style` on `asteroidElement`, then chain `.fontSize` onto that. Set this all equal to `size`. Concatenate 'px' onto `size`.

```
#setSize(asteroidElement) {
    asteroidElement.style.fontSize = size + 'px';
}
```

The `size` values range from single to triple digits(in meters). This means the `font-size` will be huge for some asteroids. This may be distracting, so we can add a

conditional statement to this function. If the value of `size` is greater than a certain number, scale it down. Otherwise, let `size` remain the same.

- 57. In the `#setSize` method, before the `font-size` of asteroid is set, start a conditional statement:

```
#setSize(asteroidElement) {  
    if  
  
        asteroidElement.style.fontSize = this.size + 'px';  
    }  
}
```

- 58. In parentheses, add the condition (`this.size > 100`).

```
#setSize(asteroidElement) {  
    if (this.size > 100)  
  
        asteroidElement.style.fontSize = this.size + 'px';  
    }  
}
```

- 59. After the condition and in curly brackets, write `{ this.size = this.size/10 }`.

This reassigns the value of the `size` property to be a tenth of its original value.

```
#setSize(asteroidElement) {  
    if (this.size > 100) {  
        this.size = this.size / 10  
    }  
    asteroidElement.style.fontSize = this.size + 'px';  
}  
}
```

- 60. Add this method to the `#placeAsteroid()` method and the asteroid elements will vary in size and distance.

```
#placeAsteroid() {  
    let asteroidElement = document.createElement('a');  
    asteroidElement.textContent = '*';  
    asteroidElement.className += 'asteroid';  
  
    this.#setSize(asteroidElement);  
    this.#setDistance(asteroidElement);  
  
    let solarSystem = document.getElementById('solar-system');  
    this.#append(solarSystem, asteroidElement);  
}  
}
```

Next up, speed! To visualize speed, we will add a motion blur that looks like tail for each asteroid. The faster ones should look like they're traveling faster, and while asteroids generally don't have tails, we will give them a longer motion blur which will appear like a longer tail.

To achieve this visualization, we will add a class written in CSS to each asteroid. If you look at the css file, you'll see that it contains three classes for adjusting the speed:

.speed-low, .speed-medium, and .speed-high. The values of the `text-shadow` properties will differ in pixel length. By creating multiple shadows you can give the impression that faster asteroids show a longer tail (motion blur) than slower asteroids.

- 61. Define the method, `#setSpeed()` that will add these classes to the asteroid.

```
#setSpeed(asteroidElement) {  
}
```

Speeds can be 10000 to over 100000km/hr. Let's choose some integers within this range to add each class. For asteroids with speeds greater than 50000km/hr we add 'speed-high', greater than 25000 we add speed-medium, and all other speeds below 25000 we add speed-low. Therefore we will need more than one conditional statement.

To write multiple conditional statements that executes different code for different conditions you can use the `if`, `else if`, and `else` commands.

- 62. Write `if (speed > 50000) {}` for the first condition in the `#setSpeed` method.

```
#setSpeed(asteroidElement) {  
    if ( this.speed > 50000 ) {  
    }  
}
```

- 63. After the curly brackets of the first condition, write the second condition, `else if (this.speed > 25000) {}`.

```
function setSpeed(asteroidElement) {  
    if ( this.speed > 50000 ) {  
    } else if ( this.speed > 25000 ) {  
    }  
}
```

- 64. Write the keyword `else` and another set of curly brackets, `{ }` after the second set of curly brackets. The code for this condition will be executed if the first two conditions are false.

```
function setSpeed(asteroidElement) {  
    if ( this.speed > 50000 ) {  
    } else if ( this.speed > 25000 ) {  
    } else {  
    }  
}
```

Each condition will execute code that adds a class to the asteroid element. You can use the same method you used to add the 'asteroid' class to style the `asteroidElement` element, `.className`. Because the asteroid elements already have a class, you need to concatenate by using the `'+='` operator and putting an extra space before the speed class string. If you used the `=` operator, you would overwrite the `asteroid` class.

- 65. Write `asteroid.className += ' speed-high'` for the code block of the first condition.

```
#setSpeed(asteroidElement) {
    if ( this.speed > 50000 ) {
        asteroidElement.className += ' speed-high';
    } else if ( this.speed > 25000 ) {

    } else {

    }
}
```

- 66. Write `asteroidElement.className += ' speed-medium'` for the code block of the second condition.

```
#setSpeed(asteroidElement) {
    if ( this.speed > 50000 ) {
        asteroidElement.className += ' speed-high';
    } else if ( this.speed > 25000 ) {
        asteroidElement.className += ' speed-medium';
    } else {

    }
}
```

- 67. Write `asteroidElement.className += ' speed-low'` for the code block of the third condition, executed only if the first two conditions are found to be false.

```
#setSpeed(asteroidElement) {
    if ( this.speed > 50000 ) {
        asteroidElement.className += ' speed-high';
    } else if ( this.speed > 25000 ) {
        asteroidElement.className += ' speed-medium';
    } else {
        asteroidElement.className += ' speed-low';
    }
}
```

- 68. Add the method call `#setSpeed(asteroidElement)` to the `placeAsteroid()` method. We can display our asteroid motion blurs!

```
#placeAsteroid() {
    let asteroidElement = document.createElement('a');
    asteroidElement.textContent = '*';
    asteroidElement.className += 'asteroid';

    this.#setSpeed(asteroidElement);
    this.#setSize(asteroidElement);
    this.#setDistance(asteroidElement);

    let solarSystem = document.getElementById('solar-system');
```

```
        this.#append(solarSystem, asteroidElement);
    }
}
```

Next, we want to display whether or not the asteroid is a hazard. What is a good color to represent a hazardous object? Why not red? This function will add the hazardous class to our element depending on the whether the value of the `isHazardous` property is true or false.

- 69. In JavaScript, define a method named `#setHazard(asteroidElement)`.

```
function setHazard(asteroidElement) {
}
```

- 70. Write a conditional statement and a block of code to run if `isHazardous` is true, if (`isHazardous === true`) { //execute code to add class }.

```
function setHazard(asteroidElement) {
    if ( this.isHazardous === true ) {
        //execute code to add class
    }
}
```

- 71. Write `asteroidElement.className += ' hazardous'` in the conditional statement block of code. Remember the `+=` operator and the space before the word `hazardous` in the string that represents the class.

```
#setHazard(asteroidElement) {
    if ( this.isHazardous === true ) {
        asteroidElement.className += ' hazardous';
    }
}
```

- 72. Add a call to `setHazard(asteroidElement)` to the `placeAsteroid()` method.

```
#placeAsteroid() {
    let asteroidElement = document.createElement('a');
    asteroidElement.textContent = '*';
    asteroidElement.className += 'asteroid';

    this.#setSpeed(asteroidElement);
    this.#setSize(asteroidElement);
    this.#setDistance(asteroidElement);
    this.#setHazard(asteroidElement);

    let solarSystem = document.getElementById('solar-system');
    this.#append(solarSystem, asteroidElement);
}
```

Now, potentially hazardous asteroids are red! One may feel a bit of anxiety knowing the distance, speed, size and hazard info of all these asteroids. What can we do about that? Let's blow them up with JavaScript!

PART IV - Events

We have received asteroid data from NASA and displayed those asteroids and their distance from Earth, speed, size and whether or not they are potentially hazardous. The next step to consider is how to interact with those asteroids and blow them up! To do this, we will add an event listener that will blow up the asteroid when the user clicks it.

- 73. Define a method named `#targetAsteroid` that takes an argument of `asteroidElement`,

```
#targetAsteroid(asteroidElement) {  
}
```

- 74. Define another method named `#boom()`, outside the scope of the `#targetAsteroid()` method.

This is the function that will run when an asteroid element is clicked. Notice that it does not take an argument. Why do you think this is?

```
#boom() {  
}
```

We will return to writing the code for `#boom()` at a later step.

- 75. Return to `#targetAsteroid()` and inside the method, write the asteroid element.

```
#targetAsteroid(asteroidElement) {  
    asteroidElement  
}
```

- 76. Chain an event listener, `.addEventListener()` to the element.

```
#targetAsteroid(asteroidElement) {  
    asteroidElement.addEventListener();  
}
```

The event listener method will take two arguments, an event that it “listens” for and a callback function to run when the event occurs. There are many types of events that can occur within a page. Each event is represented by an object. This object can have custom fields or functions to get additional information about that event. Events can represent anything from basic user interactions (such as clicking a mouse or a ‘click’ event) to things that occur upon rendering or loading the DOM.

- 77. Add the event ‘click’ as the first argument of the `addEventListener` function, `addEventListener('click')`.

```
#targetAsteroid(asteroidElement) {  
    asteroidElement.addEventListener("click");  
}
```

- 78. Add the function `boom` as the second argument to the `addEventListener` function, `asteroidElement.addEventListener('click', boom)`.

Notice that when we write this function as an argument, we leave off the parentheses `()`. The `boom` function is a callback function, run only when the event occurs. When the parentheses are added to the end of a function, this executes the functions. We want to reference our function, only to be executed when the event occurs, and therefore, we leave off the parentheses.

```
#targetAsteroid(asteroidElement) {
    asteroidElement.addEventListener("click", this.#boom);
}
```

- 79. Return to defining the `boom` method. Add `this` to the function.

```
#boom() {
    this
}
```

Inside `boom()`, `this` refers to the `asteroidElement` element that triggered it to run.

- 80. Chain `.innerHTML` on `this`.

This will allow us to access the inner HTML of our asteroid element. Our asteroid element is currently an `<a>` tag and inside that tag is an asterisk that represents the shape of an asteroid. We intend to change that.

```
#boom() {
    this.innerHTML
}
```

- 81. Set `this.innerHTML` equal to a span containing the word 'BOOM!!!'. Use the `=` operator.

This will reassign the inner HTML of our asteroid 'a' tag from the string '*' to the explosion.

```
#boom() {
    this.innerHTML = '<span class="boom">BOOM!!!</span>';
}
```

- 82. Add a call to `targetAsteroid()` to the `placeAsteroid()` function to set the event listener for each asteroid. For `targetAsteroid` to be able to set an event listener, the call to it must appear after the element has been inserted into the DOM (using the `#append()` method).

```
this.#targetAsteroid(asteroidElement);
```

Click on the asteroids and blow them up! BOOM!!! What an event! If you have time, think about other improvements you could make to this program. For example, how would you make the app animate asteroids or show a series of days? Can you make a spaceship that starts out at the middle of the screen that the user can control and use to destroy asteroids by shooting at them?

Lab 06: Styling React

In this lab, you'll use Bootstrap to apply some global layout styles to the react-bookstore project, and you'll learn how to use style modules to add styles to individual components.

- 1. Install Bootstrap inside your **react-bookstore** project.

```
npm install --save bootstrap
```

- 2. Link to **bootstrap.css** inside of **src/index.js**.

```
import 'bootstrap/dist/css/bootstrap.css';
```

- 3. Add the Bootstrap container class to **App.js**.

```
import Header from './Header'
import Main from './Main'
import Footer from './Footer';
import './App.css';

function App() {
  return (
    <div className="container">
      <Header />
      <Main />
      <Footer />
    </div>
  );
}

export default App;
```

- 4. Open **Main.js** and create two columns.

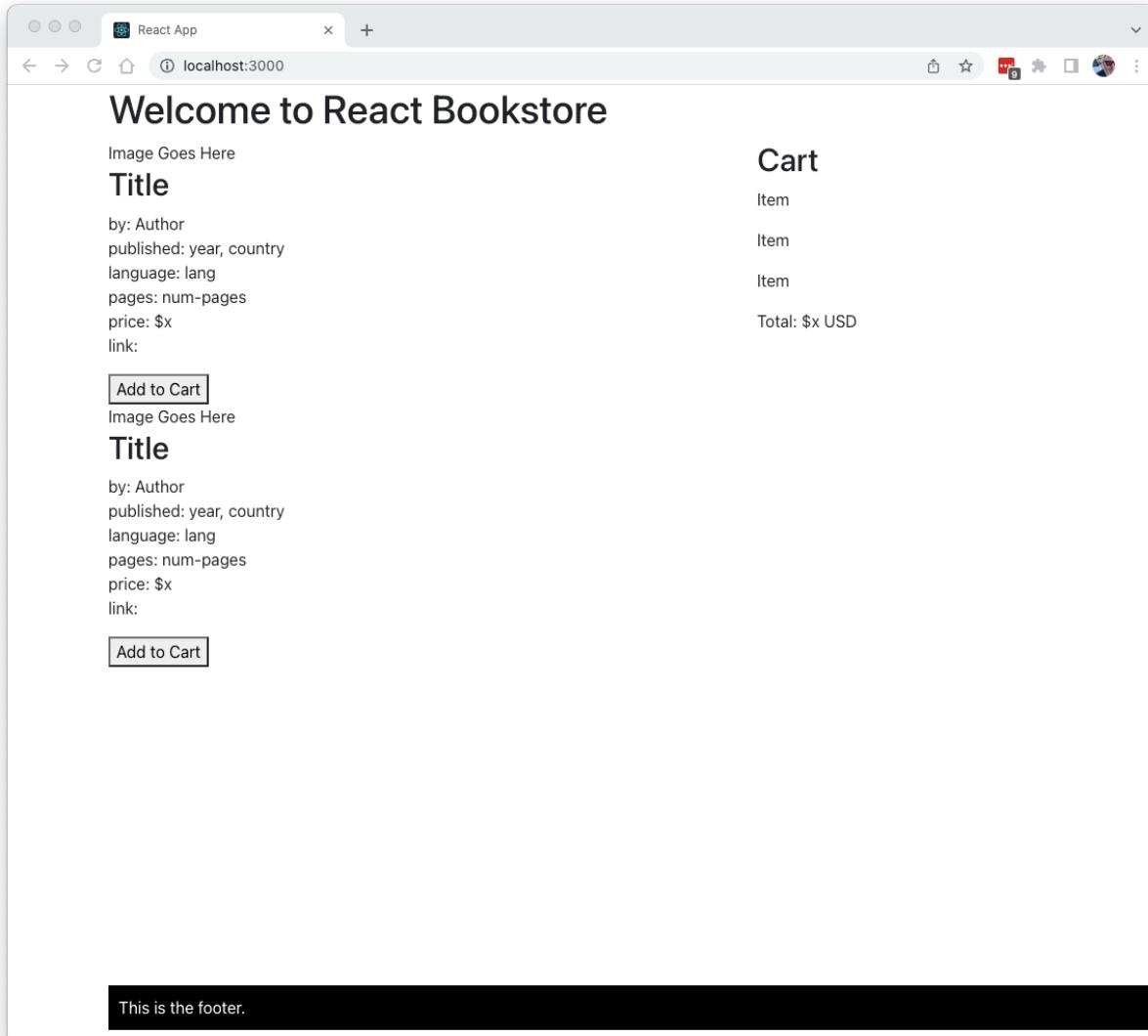
```
import ProductList from './ProductList';
import Cart from './Cart';

function Main() {
  return (
    <main className="row">
      <div className="col-md-8">
        <ProductList />
      </div>
      <div className="col-md-4">
        <Cart />
      </div>
    </main>
  );
}

export default Main;
```

- 5. Run `npm test` and make sure that your tests pass.

- 6. Run `npm start` to verify that your code builds. Your UI should now look like this:



- 7. Modify your `ProductList` component to make each product an item in an unordered list.

```
<ul>
    <li><Product /></li>
    <li><Product /></li>
</ul>
```

- 8. Create a new file in the `src` directory named **ProductList.module.css**.

This will be our first style module.

- 9. Inside **ProductList.module.css** create two styles, `productList` and `productListItem`.

```
.productList {
    padding: 0;
```

```

        display: flex;
        flex-wrap: wrap;
        justify-content: space-between;
        align-items: stretch;
    }

.productListItem {
    list-style: none;
    width: 32%;
}

```

These two styles will control the layout of the products inside the product list.

- 10. Import the style module into `ProductList.js` and give the module the name `styles`.

```
import styles from './ProductList.module.css';
```

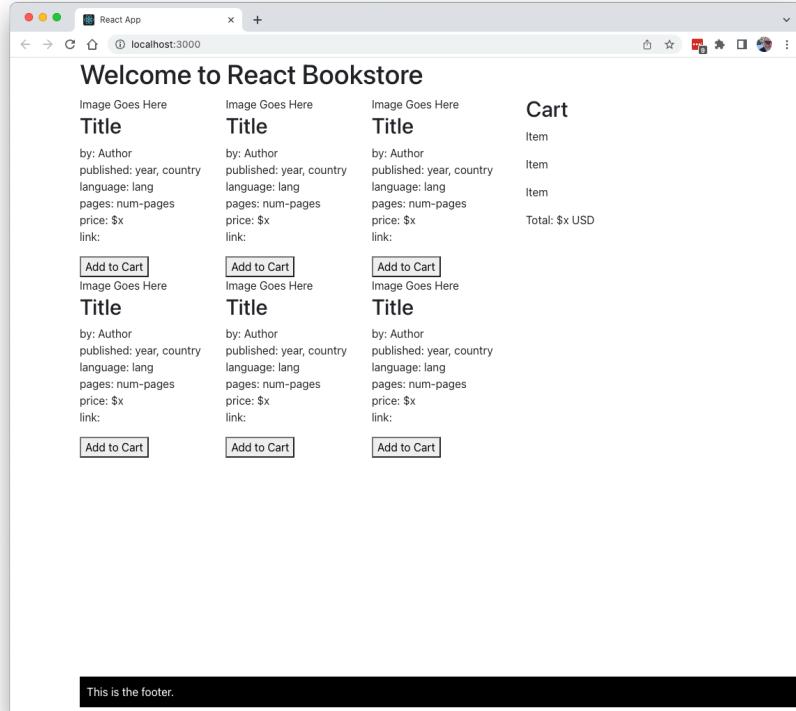
- 11. Attach the styles to the appropriate elements.

```

<ul className={styles.productList}>
    <li className={styles.productListItem}><Product /></li>
    <li className={styles.productListItem}><Product /></li>
</ul>

```

- 12. Add as many additional `<Product />` elements to the list as you want by copying and pasting additional lines in the return statement.
- 13. Preview the styled list in your browser.



- 14. Create style modules for `Product`, `Cart`, and `CartItem` and import them into each module using the same pattern shown above.

- 15. Make an empty style object for each component and attach this empty style object to the outermost element in each component's return.

For example, here's what the return statement for the `Cart` component might look like.

```
return (
  <div className={styles.cart}>
    <h2>Cart</h2>
    <CartItem />
    <CartItem />
    <CartItem />
    Total: $x USD
  </div>
);
```

Lab 07: Props and Containers

At this point, you should have a static and partially styled version of the application, built using the following React components:

```
App
Header
Footer
Main
ProductList
Product
Cart
CartItem
```

In this lab, we'll reorganize our project to pass data to the presentational components via the props object.

- 1. Create a directory inside `src` named **components**
- 2. Move **App.js**, **Header.js**, **Footer.js**, **Main.js**, **ProductList.js**, **Product.js**, **Cart.js**, and **CartItem.js**, along with their test suites and css modules, into the **components** directory.

Note: Make sure to update the import of `App` in `index.js`

- 3. Import the data file into **App.js**.

Note: Because the data module uses a default export, you can import it using any name that you like. I've used `productsData` below, but you can use anything that makes sense to you.

```
import productsData from '../data/products';
```

- 4. Modify each of your components to accept a props object. For example, here's what the function header of the `Main` component should look like:

```
function Main(props) {
```

- 5. Pass `productsData` from the `App` component to the `Main` component as a prop called `products`.

```
<Main products={productsData} />
```

- 6. Pass `products` from `Main` to the `ProductList` component.

```
<ProductList products={props.products} />
```

- 7. Update `ProductList` to loop over the `products` array and generate a `Product` for each element in the array, passing appropriate data to the `Product` components as props.

```
return(
  <ul className={styles.productList}>
    {props.products.map(product => (
      <li key={product.id}
          className={styles.productListItem}>
        <Product {...product} />
    ))
  )
)
```

```

        </li>
    ) )
</ul>
);

```

- 8. Inside `Product` (outside of the return statement), deconstruct the `props` object into individual constants (to save yourself from having to type '`props.`' repeatedly in the return statement.

```

const { title, author, published, country, lang, pages,
image, url, price } = props;

```

- 9. Update `Product` to make use of the `props` passed to it to display data about each product.
- 10. Create a new style rule in **Product.module.css** called `thumbnail` and set properties to format the book thumbnail images.

```

.thumbnail{
    width: 200px;
    height: 293px;
    object-fit: cover;
}

```

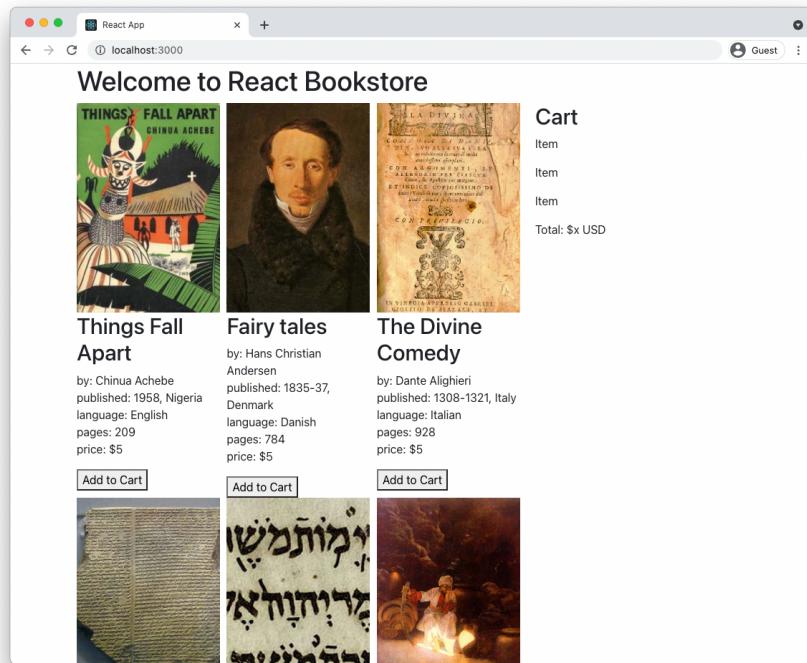
- 11. Add a `className` attribute to the `img` element in `Product`. Your `img` element should look something like the following:

```

![{title}]({image)

```

- 12. Run `npm start`



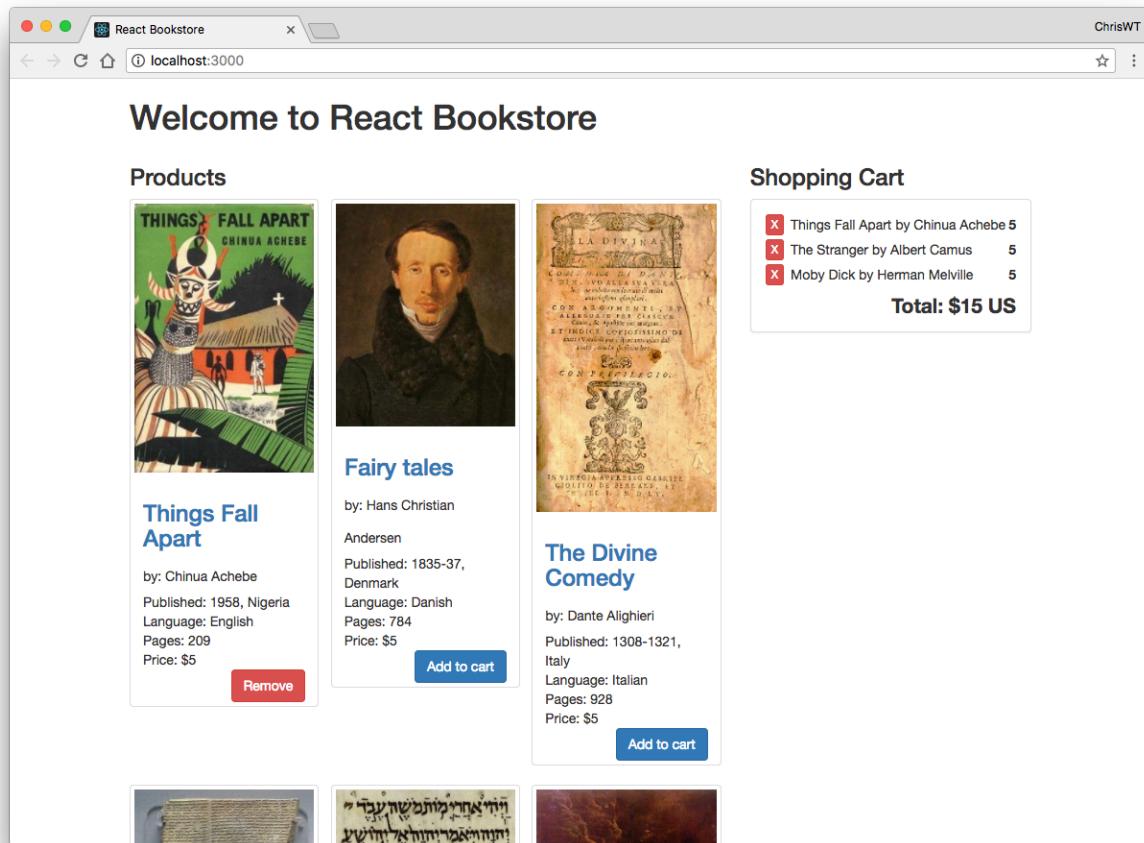
Lab 08: Adding State

So far, we have a static version of the React Bookstore, built using components that pass data down using props. At this point, there's no way for the data to change or for users of the bookstore to add products to their cart.

State is the data in your application that makes your application interactive. The first step in adding state to a React application is to figure out what data needs to be part of the state object, and then to set this initial state and pass it down to the components that need it.

To determine what is state, think about what data changes in response to user input, isn't passed down via props, and can't be computed based on props.

Looking at the following screenshot of the finished store and shopping cart, what information fits this description?



When you think you know, turn the page to see the answer.

In this React Bookstore application, the only thing that needs to be part of the state is the list of items that are currently in the shopping cart.

The next step in adding state to our application is to figure out where the state should live. Look again at the screenshot on the previous page. Which components need to know what's in the shopping cart?

If you said Cart and Product, you're correct.

To determine where the state should live, look for a component that is a common parent (or ancestor) to both Cart and Product. We have two components that fit this description, App and Main.

If you expect that the Header and Footer components may need access to the list of items in the cart at some point, it might be wise to keep this state in App. Also, it's a good practice in React to keep the number of stateful components to a minimum. It's mostly a judgement call at this point, but we'll put the state in App.

Follow these steps to add state to the application.

- 1. Open **src/components/App.js** in your code editor.
- 2. Import `React.useState`

```
import {useState} from 'react';
```
- 3. Create a state variable and setter function for `itemsInCart` and initialize it as an empty array.

```
const [itemsInCart, setItemsInCart] = useState([]);
```
- 4. Pass `itemsInCart` into the `Main` component as props.

```
<Main products={productsData}
      itemsInCart={itemsInCart} />
```
- 5. Add some default product ids to the `itemsInCart` array, for testing.

```
const [itemsInCart, setItemsInCart] =
  useState(["1", "2", "3"]);
```
- 6. Pass `itemsInCart` from `Main` to `ProductList`.
- 7. Inside the `ProductList` component, figure out how to pass a prop down to each product that is currently in the shopping cart and change the message on its button from **Add to Cart** to **In Cart**.

Hint: ES2016 contains an `Array.includes()` method which returns true if the value passed into it is the value of an element in the array.

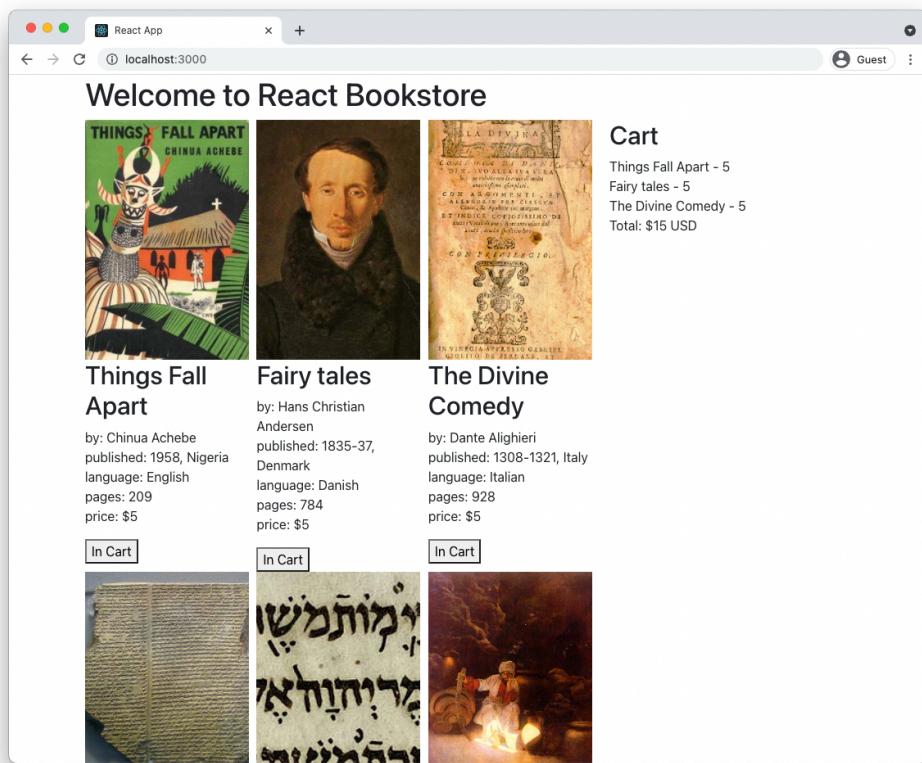
If you get stuck, look at the solution inside **intro-to-react/solutions/lab08**.

- 8. Inside the `Main` component, figure out how to use the `itemsInCart` array to generate a list of products called `cartItems` to pass to the `Cart` component.

Hint: One way to do this would be to create an array of just the product objects with `ids` that match the values in `itemsInCart`. You can then pass that array to the `Cart` component. You could use this method to find each matching product.

```
getProduct(products, item) {  
    return products.find(product => item === product.id);  
}
```

- 9. Render the list of `cartItems` inside the `Cart` component.
- 10. Modify the `CartItem` component to display the name and price of the item.
- 11. Calculate the total price of all the items in the shopping cart and display it in the `Cart` component.



Lab 09: Interactions, Events, and Callbacks

User interactions happen when a user clicks a button, moves their mouse, enters text into a form, interacts with a touch screen, and so forth. These interactions trigger events in the web browser (or another user agent), which can be listened for and responded to using JavaScript.

In addition to user interactions, many other things trigger events that can be listened for and responded to.

React's Synthetic Events

Over the years, web browsers have developed slightly different ways of handling events. To eliminate these differences, it's common for JavaScript libraries and frameworks to wrap the browser's native events in a cross-browser abstraction layer. React's cross-browser event handling system is called **Synthetic Events**.

Except for the fact that it works the same in every browser, Synthetic Events works the same as the native browser event handling.

Unidirectional Data Binding

Unlike many other JavaScript frameworks and libraries, React doesn't feature 2-way data binding. What this means is that changes to the model in a React application (i.e. the state object) trigger updates to the view, but changes to the view don't automatically update the model. This one-way data flow makes it easier to test and reason about React applications, but it is also the cause of one of the trickiest parts of React to understand.

In this lab, you'll learn about passing functions from parent components to child components and you'll learn how to call functions to update the state of a React view.

State in a Class Component

Class components are components created by extending the `React.Component` class. Although almost everything in React can be done using function components, understanding class components will give you a deeper understanding of how React works, and it will also enable you to use the features and techniques in React that aren't accessible using function components.

To create a class component, import React into your module and then extend React's `Component` class.

```
import React from 'react';

class MyComponent extends React.Component {
  ...
}
```

A JavaScript class can have a constructor method, which will only run once during the lifecycle of the component. The constructor is used to initialize the state object and to bind functions to

the class. The constructor method is optional, but if you do use it, you must call the `super()` method as the first thing inside constructor. The `super()` method calls the constructor of the parent class. You should also pass the `props` object to `super()`.

```
import React from 'react';

class MyComponent extends React.Component {

constructor(props) {
  super(props);
  this.state = {
    ...
  }
}

...

}

export default MyComponent;
```

The rest of a component may contain any number of methods, but one method, `render()` must be present. The `render()` method of a class component is essentially the same as a function component (except that it can't access hooks). The render method has a return statement that uses JSX to define the part of the user interface the component is responsible for.

```
import React from 'react';

class MyComponent extends React.Component {
  constructor(props) {
    super(props);
    this.state = {
      ...
    }
  }

  render() {
    return (<h1>Welcome to my component.</h1>);
  }
}

export default MyComponent;
```

The state object, which can be initialized in the constructor of a class component, holds the stateful properties of a component. When these properties change, React re-renders the component. The reason React knows to re-render the component when the state object changes, is because the developer only changes the state object using React's `setState()` method.

So, the first key to understanding how to create dynamic user interfaces with React is to understand React's `setState()` method.

The `setState()` method takes as its argument an object representing a change to the state object. Calling `setState()` also triggers the `render()` method, which causes the component and its children to be updated in the browser to reflect the new data.

In our application, the state consists of an array of item numbers. In the previous lab, we set the initial state of the application to an array containing three items. If another item were added to the cart, you might consider using an array method to update the state and then use `setState()` to trigger the re-rendering, like this:

```
this.state.items.push(newItem);           // <== don't do this
this.setState({items: this.state.items});
```

However, in React, state should be treated as immutable. What this means is that you should never perform operations on the state object directly, except in the component's constructor.

Directly manipulating the state object can cause problems with the rendering and lifecycle methods in React.

Instead, you should use the `setState()` method, which accepts as its argument an object to be merged into the state. For example, if you set the initial state in the constructor, like this:

```
constructor(props) {
  super(props);
  this.state = {items: [], isVisible:false}
}
```

You can mutate the state outside of the constructor by creating an object containing the property or properties that you want to change and passing it into the `setState` method.

```
this.setState({
  items: [...this.state.items, newItem]
});
```

This example uses the ES6 spread operator to split the `items` array into separate values. You can then add the new item to the end of the array and update `state.items` without mutating the state object directly.

If you want to remove an item from an array in the state object, one way to do it is by knowing the position of the element you want to remove. You can then create a new array without the item in question, using the following code:

```
let newData = this.state.data.slice(); //copy array
newData.splice(index, 1); //remove element
```

```
this.setState({data: newData}); //update state
```

Another way to remove an item from an array is by using the `Array.filter` method, like this:

```
let newData = this.state.data.filter(  
  id => id !== idToRemove); //filter out a value  
this.setState({data: newData}); //update state
```

Now that you understand how to update the state in React class components, the next thing to understand is how child components can call functions that affect the state of the parent component.

The key is in the `bind()` function. The job of `bind()` is to create a new function that has the `this` keyword set to a specific value, and with a list of arguments passed to the new function when it's called.

In React, we use `bind()` to create a function in one component that can be called in response to an event in another component but that will affect the original component.

To see how this works in practice, follow these steps to add interactivity to the React Bookstore user interface.

- 1. Convert **App.js** into a class component, following these steps:
 - Import `Component` from the React library
 - Change the function header to a class header.
 - Create a constructor
 - Call the `super()` method
 - Initialize the `this.state` object in the constructor, with one property, `itemsInCart`
 - Delete the call to `useState()`, along with the import of `useState()`
 - Create a `render` method and copy the existing `return` statement from the function component.
 - In the `return` statement, reference `itemsInCart` using `this.state.itemsInCart`
 - Remove the `setItemsInCart` attribute from the `<Main />` element.

Your App component should now match the following:

```
import {Component} from 'react';  
import Header from './Header'  
import Main from './Main'  
import Footer from './Footer';  
import './App.css';  
import productsData from '../data/products';  
  
class App extends Component {  
  constructor(props) {
```

```

        super(props);
        this.state = {
            itemsInCart: ["1","2","3"]
        }
    }

    render(){
        return (
            <div className="container">
                <Header />
                <Main products = {productsData}
                    itemsInCart = {this.state.itemsInCart}
                />
                <Footer />
            </div>
        );
    }
}

export default App;

```

- 2. Create the following method inside the App component.

```

addToCart(id) {
    let newItems = [...this.state.itemsInCart, id];
    this.setState({
        itemsInCart: newItems
    })
}

```

It's possible now to call the `addToCart` function from within the `App` component by using `this.addToCart()`. However, what we want to do is to call `addToCart()` in response to a click on the button in the `Product` component.

To make it possible to call the function with the context of the `App` component, we need to bind it.

- 3. Add the following inside of the constructor for the `App` component to create a new function that's explicitly bound to `App`.

```
this.addToCart = this.addToCart.bind(this);
```

- 4. Pass the bound `addToCart` function down to the `Main` component as a prop.

```
<Main products = {productsData}
    itemsInCart = {this.state.itemsInCart}
    addToCart = {this.addToCart}
/>
```

- 5. Open the `Main` component and pass the `addToCart` function to the `ProductList` component as a prop.

- 6. Open the `ProductList` component and pass the `addToCart` function to the `Product` components as a prop.
- 7. Inside the `Product` component, create a new function, called `handleClick`. The job of this function will be to call the `addToCart` function, passing it the `id` of the current Product.

```
function handleClick() {
    props.addToCart(props.id);
}
```

- 8. Call the `handleClick` function as the event handler for the click event on the button.

```
<button
    onClick={handleClick}>
    {props.inCart?"In Cart":"Add to Cart"}
</button>
```

- 9. Run `npm start` and test out your application.
- 10. Make clicking on the button when it displays the "In Cart" message remove the product from the cart.

Here's a function you can use to do the removal of items:

```
removeFromCart(idToRemove) {
    let newItems = this.state.itemsInCart.filter(
        id => id !== idToRemove);
    this.setState({itemsInCart: newItems});
}
```

Lab 10: Component Lifecycle and AJAX

Right now, the bookstore retrieves product data from an array and displays books in the order in which they're in the array. But, what if you want to retrieve the data from the web and display in a random order (or, better, according to some algorithm, such as which books the user is most likely to buy or a user-chosen filter) each time a visitor comes to the store?

You could change the order of the items inside the `ProductList` component, but this has unintended consequences. Try the following to find out what happens.

- 1. Add the following function inside the `ProductList` component:

```
function shuffleArray(array) {
    for (let i = array.length - 1; i > 0; i--) {
        let j = Math.floor(Math.random() * (i + 1));
        let temp = array[i];
        array[i] = array[j];
        array[j] = temp;
    }
    return array;
}
```
- 2. Create a new array by sorting the one passed as a prop.

```
let sortedProducts = shuffleArray(props.products);
```
- 3. Replace the array used for displaying the products with the new randomly sorted array.

```
{sortedProducts.map(product => (
```
- 4. Run `npm start`, and try adding some products to the cart.

Notice that the order of the cart changes every time you click a button. Clearly this is not what we want.

One way to fix this problem is to use React's `componentDidMount()` lifecycle method to only sort the products once, after the component has mounted. To do this, follow these steps:

- 5. Create a method named `componentDidMount()` in the `App` component.
- 6. Copy the `shuffleArray` method from `ProductList` and paste it into the `App` component (modifying it to use method notation if your `App` component is a class component).
- 7. Revert the `ProductList` component to how it was before you made the previous changes.
- 8. In `App`'s `componentDidMount` method, call `this.shuffleArray()` and pass in the `productsData`.

```
this.shuffleArray(productsData);
```
- 9. Run `npm start` and notice what happens when you click one of the `AddToCart` buttons. Can you explain why this happens?

What's happening is that the `productsData` is loading before the `App` component is mounted. So, the initial render of the component uses the default sorting of the array, but the

`componentDidMount` method is shuffling the array after the component finishes mounting. The result is that the next re-render of the component will cause it to display the products in their shuffled order.

To fix this, we can load the `productsData` in the `componentDidMount` lifecycle method. We'll do so using the `fetch` method.

- 10. Add a property named `products` with a default value of an empty array (`[]`) to the `state` object.
- 11. Add a property named `loading` with a default value of `false` to the `state` object (in the constructor).
- 12. Remove the import of the product data.
- 13. Pass `this.state.products` to the Main component instead of `productsData`.
- 14. Move `src/data/products.json` to `public/data/products.json`.
- 15. Confirm that the json file is in the right place by visiting the following url in your browser:
`http://localhost:3000/data/products.json`
- 16. Inside `componentDidMount`, use the `fetch` method to load the product data, sort it, and then update the state:

```
componentDidMount() {  
    this.setState({loading:true});  
  
    fetch('//localhost:3000/data/products.json')  
        .then(response => response.json())  
        .then(products => this.shuffleArray(products))  
        .then(products => {  
            this.setState(  
                {products:products,loading:false})  
        })  
};
```

- 17. Run `npm start`

Lab 11: Converting App to a Function Component

In this lab, we'll use the `useEffect` and `useState` hooks to convert `App` back to a function component.

- 1. Open `App.js` in your code editor and modify the import from 'react' to import `useState` and `useEffect` (instead of `Component`).
- 2. Change the class header to a function header. Since this is the root component, the function doesn't need to take `props` as a parameter.
- 3. Delete the `constructor` method.
- 4. Use `useState` to initialize the three state variables.

```
const [itemsInCart, setItemsInCart] = useState([]);  
const [products, setProducts] = useState([]);  
const [isLoading, setLoading] = useState(false);
```

- 5. Rewrite the `componentDidMount` method using `useEffect` and `async` functions.

```
useEffect(() => {  
    async function fetchData() {  
        try {  
            const response = await  
fetch('http://localhost:3000/data/products.json');  
            const json = await response.json();  
            setProducts(json);  
        } catch (e) {  
            console.error(e);  
        }  
    };  
    fetchData();  
}, [setProducts]);
```

- 6. Shuffle the product data array before the products state array is updated.
- 7. Convert the functions written using method syntax to use the function keyword or arrow functions.
- 8. Change `setState` in the `addToCart` and `removeFromCart` functions to use `setItemsInCart`, and change the references to `this.state` to refer to the stateful `itemsInCart` variable.
- 9. Take the `return` statement out of the `render` method and delete the `render` method.
- 10. Update references to `this` in the `return` statement.
- 11. Use the `isLoading` state variable to conditionally display a loading message or loader animation when data is loading.
- 12. Start the app and fix any errors that occur.

Lab 12: PropTypes and defaultProps

PropTypes are a built-in way to typecheck your React components' props. Default props set default values for props. In this lab, you'll use PropTypes and defaultProps to your components.

- 1. In `ProductList`, import `prop-types`.

```
import PropTypes from 'prop-types';
```

- 2. In `ProductList.js`, but outside of the function definition, add a `propTypes` object to `ProductList`.

```
ProductList.propTypes = {  
};
```

- 3. In `ProductList.PropTypes`, create a property for each prop that `ProductList` receives, and use a `PropType` validator to make sure that it's the correct type and that required props are received. I've done the first one for you:

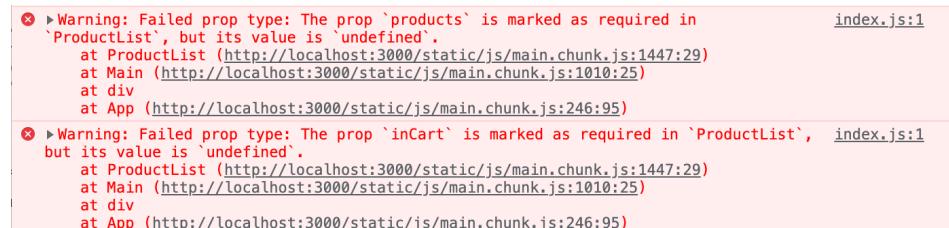
```
ProductList.propTypes = {  
    addToCart: PropTypes.func.isRequired,  
};
```

Hint: `PropList` receives a `products` prop that's an array of objects. You'll need to use `PropTypes.arrayOf` and `PropTypes.shape`

- 4. Run your application and open the JavaScript console (**CTRL-SHIFT-J** in Chrome for Windows or **CMD-Option-J** on Mac) to verify that there are no errors.
- 5. Comment out one or more of the props passed from `Main` to `ProductList`.

```
<ProductList /* products = {props.products} */  
    itemsInCart = {props.itemsInCart}  
    addToCart = {props.addToCart}  
    removeFromCart = {props.removeFromCart} />
```

- 6. Check the JavaScript console to see the PropType warnings.



```
index.js:1  
✖ Warning: Failed prop type: The prop 'products' is marked as required in  
  'ProductList', but its value is 'undefined'.  
  at ProductList (http://localhost:3000/static/js/main.chunk.js:1447:29)  
  at Main (http://localhost:3000/static/js/main.chunk.js:1010:25)  
  at div  
  at App (http://localhost:3000/static/js/main.chunk.js:246:95)  
  
index.js:1  
✖ Warning: Failed prop type: The prop 'inCart' is marked as required in 'ProductList',  
  but its value is 'undefined'.  
  at ProductList (http://localhost:3000/static/js/main.chunk.js:1447:29)  
  at Main (http://localhost:3000/static/js/main.chunk.js:1010:25)  
  at div  
  at App (http://localhost:3000/static/js/main.chunk.js:246:95)
```

- 7. Add a `defaultProps` object to `ProductList`:

```
ProductList.defaultProps = {  
}
```

- 8. Set default props for each of the arrays that `ProductList` receives. Set the defaults to empty arrays.
- 9. Restore the prop passing so that there are no errors.

- 10. Add a `propType` object and a `defaultProps` object to every other component that receives props.

Lab 13: Converting to TypeScript

In this lab, you'll make a TypeScript version of the BookStore app.

- 1. Make a new Create React App project, using the typescript template:

```
npx create-react-app my-app --template typescript
```

- 2. Copy /src and /public from the previous lab and replace src and public in the new typescript project.

- 3. Install Bootstrap in the new project:

```
npm install --save bootstrap
```

- 4. Run the new project to make sure it still works.

- 5. Rename App.js to App.tsx. You should now see a lot of errors in the terminal and in the browser.

- 6. Create a Book type or interface in App.tsx. Something like this should work:

```
interface Book {  
    id: string;  
    title: string;  
    author: string;  
    published?: string;  
    country?: string;  
    lang?: string;  
    pages?: string;  
    image?: string;  
    url?: string;  
    price?: string;  
}
```

- 7. Assign types to the three state variables:

```
const [itemsInCart, setItemsInCart] = useState<Array<string>>([]);  
const [products, setProducts] = useState<Array<Book>>([]);  
const [isLoading, setIsLoading] = useState<Boolean>(false);
```

- 8. Assign types to the parameters of addToCart and removeFromCart. For example:

```
function addToCart(id: string) {
```

- 9. Specify that the parameter to shuffleArray should be an array of Books.

```
function shuffleArray(array: Book[]) {
```

- 10. Remove the PropTypes and defaultProps from Main.js

- 11. Test out the app to make sure it still works.

- 12. Rename Main.js to Main.tsx

- 13. Create an interface for Book (it could also be put into a separate file so it can be imported into both App and Main).

- 14. Create an interface called Props that contains the props received by Main. Function types in the interface need to have their parameters and return values. If the function doesn't return anything, use void. For example:

```
addCart: (id: string) => void;
```

- 15. Specify the type of the props object received by Main:

```
function Main(props: Props) {
```

- 16. Convert the rest of Main.tsx to TypeScript
- 17. Remove the PropTypes and default Props from ProductList
- 18. Convert the rest of the components to TypeScript.

Lab 14: Testing with React Testing Library

In this lab, you'll use Jest and React Testing Library to write more tests for your components.

- 1. Modify your test script in package.json to the following:

```
"test": "react-scripts test --coverage --watchAll --no-cache",
```

- 2. Run `npm test` in the root of your project. You probably already have some basic tests that you created in previous labs. However, because of changes to the components you're testing, your tests may not all pass.
- 3. Update your existing tests so they all pass. You may need to use different methods from React Testing Library. Reference the testing library cheatsheet at the following URL to find additional queries to use:

<https://testing-library.com/docs/react-testing-library/cheatsheet>

- 4. Write more tests, refine your existing tests, and increase your test coverage %.
- 5. Challenge: Create a mock for the `handleClick` function in `CartItem.test.js` and test that clicking the button causes the function to be called.

Lab 15: Implementing Redux

As your application grows, you may find it useful to transition to Redux. It's unlikely that our existing app would benefit at this point from Redux, but the process that we'll go through to convert it to Redux will show you the steps involved in a simplified example.

Redux Toolkit simplifies many of the steps involved in implementing and using Redux, but in this lab, we're going to do it the hard way first.

- 1. Install Redux and the react-redux library.

```
npm install --save redux react-redux
```

Step 1: Create a store

- 2. In index.js, import createStore and combineReducers from redux.

```
import {createStore, combineReducers} from 'redux';
```

- 3. Import Provider from react-redux.

```
import {Provider} from 'react-redux';
```

- 4. Import the reducers (which we'll create in a moment).

```
import {cart, products} from './reducers';
```

- 5. Create the root reducer.

```
const rootReducer = combineReducers({  
    cart,  
    products  
});
```

- 6. Define the store's initial state.

```
const initialState = {  
    cart: {items:[]},  
    products: {products:[]}  
};
```

- 7. Create the store by passing the root reducer and the initial state into the createStore method.

```
let store = createStore(  
    rootReducer,  
    initialState  
);
```

- 8. Wrap the App component in a Provider and pass the store to Provider as a prop.

```
ReactDOM.render(<Provider store={store}><App /></Provider>,  
    document.getElementById('root'));
```

Step 2: Write the reducers

- 9. Create a directory in src named **reducers**.

- 10. Create **index.js** inside **reducers**.

The next step is to define the ways in which the state of the cart can change. Changes in redux happen in response to actions. So, our reducer needs to listen for certain actions that correspond to different changes in the state of the cart and then make those changes.

- 11. Write and export the `cart` reducer function as a module. The `cart` reducer contains a `switch` statement with a `case` for each possible action that can happen in the cart.

```
export function cart(state = {}, action = {}) {  
  switch(action.type) {  
    case 'CART_ADD':  
      return; //todo: finish this  
    case 'CART_REMOVE':  
      return; //todo: finish this  
    default:  
      return state; //no relevant action type  
  }  
}
```

- 12. Inside the `CART_ADD` case, use the functionality from the `addToCart` function (in **App.js**) to add the `productId` passed by the action to the `items` array.

```
case 'CART_ADD':  
  return {  
    ...state,  
    items: [...state.items, action.payload.productId]  
  };
```

- 13. Inside the `CART_REMOVE` case, use the functionality from the `removeFromCart` function (in **App.js**) to remove the `productId` passed to it from the `items` array.

```
case 'CART_REMOVE':  
  return {  
    ...state,  
    items: state.items.filter(id => id !==  
      action.payload.productId)  
  };
```

- 14. Write and export the `products` reducer function (also in **reducers/index.js**). It should have one case, named `LOAD_PRODUCTS` which will update the state with the list of products fetched by the `componentDidMount` method of **App.js**.

```
export function products(state = {}, action = {}) {  
  switch (action.type) {  
    case 'LOAD_PRODUCTS':  
      return {  
        ...state,  
        products: action.products  
      };  
    default:  
      return state; //no relevant action type  
  }  
}
```

Step 3: Write the Actions and Action Creators

- 15. Create a new directory in `src`, named **actions**.
- 16. Create a file named **index.js** inside **actions**, then write (and export) the functions inside it that will create the actions that trigger changes to the state inside the reducers we just wrote.

```
export function addToCart(productId) {
    return {
        type: 'CART_ADD',
        payload: {
            productId
        }
    }
}

export function removeFromCart(productId) {
    return {
        type: 'CART_REMOVE',
        payload: {
            productId
        }
    }
}

export function loadProducts(products) {
    return {type: 'LOAD_PRODUCTS', products}
}
```

Now that we have the action creators that will be dispatched when the user interacts with the application, and we have the reducers that will mutate the state in response to those actions, the last step is to hook up the user interactions (button clicks) to the dispatch of the actions.

- 17. Import the action creator functions, the `connect` method of react-redux, and the `bindActionCreators` method into **components/App.js**.

```
import * as actionCreators from '../actions';
import {bindActionCreators} from 'redux';
import {connect} from 'react-redux';
```

- 18. In **App.js** (below the function, but above the `export` statement) map the state to props and bind the action creators to the dispatcher.

```
const mapStateToProps = (state, props) => {
    return {
        itemsInCart: state.cart.items,
        products: state.products.products
    }
};

const mapDispatchToProps = (dispatch) => {
```

```
        return bindActionCreators(actionCreators, dispatch);
    };
}
```

- 19. Use the `connect` method to merge `mapStateToProps` and `mapDispatchToProps` into `App` in the `export` statement at the bottom of `App.js`.

```
    export default connect(mapStateToProps,
      mapDispatchToProps)(App);
```

Step 4: Modify `App.js` to use the Redux store.

- 20. In `App.js`, remove the following:

- The `useState` function calls for `itemsInCart` and for `products`.
- The `addToCart` method
- The `removeFromCart` method

- 21. Make sure the `props` object is a parameter of `App`

```
function App(props) {
```

- 22. Update the `useEffect` method to call the `loadProducts` method instead of setting the state directly.

```
useEffect(() => {
  async function fetchData() {
    try {
      setIsLoading(true);
      const response = await
        fetch('http://localhost:3000/data/products.json');
      const json = await response.json();
      props.loadProducts(json);
      setIsLoading(false);
    } catch (e) {
      console.error(e);
    }
  };
  fetchData();
}, [props.loadProducts]);
```

- 23. Update the `useEffect` callback that shuffles the products so that it accepts the list of products and returns a shuffled list, rather than shuffling the products array directly.
OR, call `shuffleArray` from within the same `useEffect` callback that loads the products.

- 24. Modify the `props` passed to the `Main` component to use the action creators and change the `inCart` prop to use the prop that was passed in from `index.js`.

```
<Main products = {props.products}
          itemsInCart = {props.itemsInCart}
          addToCart = {props.addToCart}
          removeFromCart = {props.removeFromCart}
/>
```

Test it out! Everything should now work with no additional changes.

- 25. Look at the terminal. You'll see a warning message about a missing dependency. Our app works fine as it is, but can you figure out how to make that warning message go away?
- 26. Add a 'Remove' button to the `CartItem` component that causes the item to be removed from the cart.

Part 2: Redux Toolkit

- 1. Install Redux Toolkit

```
npm install @reduxjs/toolkit
```

- 2. Remove the import of `createStore()` from 'redux' in `index.js`
- 3. Import `configureStore` from Redux Toolkit

```
import { configureStore } from '@reduxjs/toolkit';
```

- 4. Replace the creation of the store variable in `index.js` with the Redux Toolkit `configureStore()` function call:

```
const store = configureStore({ reducer: rootReducer });
```

- 5. Delete the `initialState` variable from `index.js`
- 6. Define the initial state in `reducers/index.js` using default parameters, like this:

```
export function cart(state = { items: [] }, action = {}) {
  ...
}
```

and

```
export function products(state = { products: [] }, action = {}) {
  ...
}
```

Check whether everything is still working correctly. Now that you're using Redux Toolkit, take a look at its other capabilities for making working with Redux easier by going to:
<https://redux-toolkit.js.org/introduction/getting-started>

Lab 16: Redux Thunk

Redux Thunk middleware allows you to write action creators that return functions rather than actions. This function can be used to delay the dispatch of an action, to cause the action to only be dispatched if a condition is met, or to fetch data asynchronously, for example.

In this lab, you'll use Redux Thunk to post a message to a server and receive a response when a **Checkout** button is clicked in the `Cart` component.

We're going to write an action creator containing a function that will perform an HTTP post. We'll be using the built-in `fetch()` method to do the API request, and we'll use Redux Thunk with Redux Toolkit's `createAsyncThunk` function to make the request prior to running a reducer.

- 1. We're going to write an action creator containing a function that will perform an HTTP post using the **axios** library. So, we'll need to install **axios** first.

```
npm install --save axios
```

- 2. In **actions/index.js**, import `axios` at the beginning of the file.

```
import axios from 'axios';
```

- 3. Import `createAsyncThunk` into `actions/index.js`:

```
import { createAsyncThunk } from '@reduxjs/toolkit';
```

- 4. In **actions/index.js**, add a new action creator for submitting the cart.

```
export const submitCart = createAsyncThunk('CHECKOUT', async (data) => {
  const res = await axios.post('http://localhost:8080/checkout', data);
  return res.data;
});
```

- 5. Write the `checkOut` action creator, which will be dispatched when the HTTP post in the thunked function resolves successfully.

```
export function checkOut(data) {
  return {type: 'CHECKOUT', payload: {data}}
}
```

- 6. Pass the `submitCart` action creator from App to Main, and from Main to the Cart.

```
<Cart removeFromCart={props.removeFromCart} submitCart =
{props.submitCart} inCart={cartItems}/>
```

- 7. Add a button to the Cart that calls the `submitCart` method when clicked and passes `props.cartItems` into it. Wrap it in a `div` element so that it will appear below the cart items and the total.

```
<div><button
onClick={()=>props.submitCart(props.cartItems)}>
Check Out
</button></div>
```

- 8. Run your app, add some items to the cart, and then open the Redux DevTools and click the Check Out button. You should see that the `CHECKOUT/rejected` action is dispatched.

- 9. Open a new terminal window and change to the **labs/lab16/server** directory.
- 10. Run `npm install` in the server directory
- 11. Run the server by entering `npm start`.
- 12. Click the **Check Out** button in the React app.

You should see that the `CHECKOUT/fulfilled` action was dispatched. In the browser console, you should see the return data from the server.

Right now, the React Bookstore doesn't do anything in response to the action, because we don't have a reducer that's listening for it. Let's fix that.

- 13. In **reducers/index.js**, write a new case in the cart reducer for the `CHECKOUT` action.

```
case 'CHECKOUT/fulfilled':  
  return {  
    };
```

- 14. Inside the `CHECKOUT` case, we'll return the state, with the `items` array emptied, which will just empty the cart.

```
case 'CHECKOUT/fulfilled':  
  return {  
    ...state,  
    items: []  
  };
```

- 15. Make sure that the server is running, then run `npm start` to build your React app and test it out by adding and removing items from the cart and then checking out.

Lab 17: Persisting data in localStorage using Redux

Our application is now using React and Redux together. We've implemented an Ajax call to fetch the initial data for our store. But we have an opportunity for improvement. Note that every time you refresh the page, it forgets what was in the cart. What if our user wants to close the browser and then come back at a different time?

In this lab, we'll fix that by writing our cart to `localStorage` every time it changes. And we'll read the stored cart whenever the client starts up our application.

- 1. Create a new reducer case for "READ_CART". It should pull a value from `localStorage` with a key of "cart". Do something like this:

```
let cart = localStorage.getItem("cart");
```

- 2. Since only strings are in `localStorage` and we need an array, you should `JSON.parse()` the value.

```
cart = JSON.parse(cart);
```

- 3. Then we want to load that array in a state object and return it. Something like this should work:

```
return {  
  ...state,  
  items: cart || []  
};
```

- 4. Create an action creator named `readCart` that creates the `READ_CART` action.
- 5. After the products are loaded (in the `fetchData()` function in `App.js`), call `readCart()` to dispatch the `READ_CART` action.
- 6. Run and test. You should have no errors, but you should still see an empty cart.

Why? Because there is nothing in `localStorage` yet.

Let's write to `localStorage` now. We'll do it after every change to the cart.

We should write something to local storage after every change to the cart. Since we're using Redux we know that there is only one place that cart can change; in the reducer.

When you edit the reducer, you'll find both cases where cart can change (`ADD_TO_CART` and `REMOVE_FROM_CART`).

In the next few steps we will be writing to `localStorage`.

- 7. Change the `CART_ADD` case. Just before you return the new state, write the cart to `localStorage` using `setItem()`. Of course, the cart array must be `JSON.stringify`ed before it can be written. It may look something like this:

```
const newCart = [...state.items, action.payload.productId];  
localStorage.setItem("cart", JSON.stringify(newCart));  
console.log(newCart);
```

```
    return {
      ...state,
      items: newCart
    };
  
```

- 8. Run and test. You'll know you've got it right when you can add one or more books to the cart, then refresh the page and see those same books in your initial cart.
- 9. Once you can add books and have them saved in localStorage, do the same thing in the CART_REMOVE case.
- 10. Run and test. Can you now add books and remove books and have them persist each time you re-visit the bookstore? If so, you've got it right!

Lab 18: React Router

In this lab, you'll use React Router to create a separate route for the shopping cart.

- 1. Install `react-router-dom`
- 2. Import `BrowserRouter` as `Router` into `index.js` and wrap the `Router` component around the `<Provider>` element in `ReactDOM.render`
- 3. In `Main.js`, import `Routes` and `Route` from `react-router-dom`.
- 4. In the Main's return statement, change the page layout to a 1-column layout by removing the `</div>` and `<div>` from between `Cart` and `ProductList` and changing the `className` passed to the outside `div` to `col-md-12`.
- 5. Replace `ProductList` and `Cart` with a `Routes` component containing two `Routes`. The first should render `ProductList` when the path is exactly `'/'` and the second should render `Cart` when the path is `'/cart'`.

```
<Routes>
  <Route
    path="/"
    element={
      <ProductList
        products={props.products}
        itemsInCart={props.itemsInCart}
        addToCart={props.addToCart}
        removeFromCart={props.removeFromCart}/>
    }/>
  <Route
    path="/cart"
    element={
      <Cart
        cartItems={cartItems}
        removeFromCart={props.removeFromCart}
        submitCart={props.submitCart}
      />
    }/>
</Routes>
```

- 6. Test it out. When you first start up the app (and the route is `'/'`) it should display the `ProductList`, and if you change the url in the address bar to `'/cart'` it should display the `cart`. Everything should still work
- 7. Challenge: Make a Shopping Cart button component that displays the number of items in the cart in the header and that links to the shopping cart (using `react-router-dom`'s `Link` component). You can use the fontawesome React component to render the icon: <https://fontawesome.com/v5.15/how-to-use/on-the-web/using-with/react>

Bonus Lab: Creating Micro Frontends

Part 1: Create the Content Server

All of our micro frontends will need access to certain common resources, including the react and react-dom libraries, global CSS, and images. In this first part, we'll create a server for these common resources.

- 1. Create a new directory named **content**.
- 2. Run `npm init -y` inside **content** to initialize a node project and create the **package.json** file.
- 3. Install the `serve` package @ version 6.5.2 inside **content**

```
npm install --save-dev serve@6.5.2
```

- 4. Write a `start` script in **content's package.json** to start up the server and serve the contents of the **public** directory.

```
"start": "serve --port 5000 --cors public"
```
- 5. Make a folder named **public** inside **content** and copy the **data** and **images** directories from the **bookstore** project into it.
- 6. Download the latest UMD builds of `react` and `react-dom` from the following link, and put them in the **content/public** directory:

<https://reactjs.org/docs/cdn-links.html>

- 7. Create a file named **style.css** inside **content/public**. We'll use this CSS file for common styles in all our micro frontends. For now, it will only contain a single style rule:

```
.App {  
  text-align: center;  
}
```

- 8. Run `npm start` in **content**, then open up your browser and go to <http://localhost:5000/data/products.json> to confirm that you can access the books data. If so, then you're ready to move on to the next step! Leave the server running and open a new Terminal window.

Part 2: Create the container

- 1. Make a new app named **container** using the following command:

```
npx create-react-app container
```

- 2. Install `react-app-rewired` in the **container** app. This will allow us to override settings in `create-react-app` that we need to change to make a micro frontend.

```
npm install react-app-rewired --save-dev
```

- 3. Change the scripts in **package.json** to use `react-app-rewired`, as follows (on Windows):

```
"start": "set PORT=3000 && react-app-rewired start",  
"build": "react-app-rewired build",  
"test": "react-app-rewired test"
```

- 4. On MacOS, change the scripts in **package.json** to use react-app-rewired, as follows:

```
"start": "PORT=3000 react-app-rewired start",
"build": "react-app-rewired build",
"test": "react-app-rewired test"
```

- 5. Put the config path for react-app-rewired in **package.json**

```
"config-overrides-path": "node_modules/react-app-rewire-micro-frontends",
```

- 6. Install the `react-app-rewired` script for micro frontends.

```
npm install --save-dev react-app-rewire-micro-frontends
```

- 7. Create a file named **.env** in the container directory and specify the urls for the bookstore and content micro frontends, as follows:

```
REACT_APP_BOOKSTORE_HOST=http://localhost:3001
REACT_APP_CONTENT_HOST=http://localhost:5000
```

- 8. Open **container/public/index.html** and put a link to the common css file in the `<head>`.

```
<link rel="stylesheet"
      href="%REACT_APP_CONTENT_HOST%/style.css"></link>
```

- 9. Add the following script tags right above `</body>` in **container/public/index.html** (customizing them to match the versions you downloaded to the content micro frontend if necessary):

```
<script src="%REACT_APP_CONTENT_HOST%/react.development.js">
</script>
<script src="%REACT_APP_CONTENT_HOST%/react-dom.development.js"></script>
```

- 10. Make a component named **MicroFrontend.js** in **container/src** with the following code:

```
import React from 'react';

class MicroFrontend extends React.Component {
    componentDidMount() {
        const { name, host, document } = this.props;
        const scriptId = `micro-frontend-script-${name}`;

        if (document.getElementById(scriptId)) {
            this.renderMicroFrontend();
            return;
        }
        fetch(` ${host}/asset-manifest.json`)
            .then(res => res.json())
            .then(manifest => {

                const script = document.createElement('script');
                script.id = scriptId;
                script.crossOrigin = '';
                script.src = `${host}${manifest.files['main.js']}`;
```

```

        script.onload = this.renderMicroFrontend;
        document.head.appendChild(script);
    });
}

componentWillUnmount() {
    const { name, window } = this.props;

    window[`unmount${name}`](`#${name}-container`);
}

renderMicroFrontend = () => {
    const { name, window, history } = this.props;

    window[`render${name}`](`#${name}-container`, history);
};

render() {
    return <main id={`${this.props.name}-container`} />;
}
}

MicroFrontend.defaultProps = {
    document,
    window,
};

export default MicroFrontend;

```

This is the component that will load the micro frontend components into the container. It does this by getting the **main.js** file from the micro frontends (which it finds in the **asset-manifest.json** file in each micro frontend and injecting a script tag and root element into the DOM.

- 11. Install `react-router-dom` in the **container** directory

```
npm install --save react-router-dom@5.3.0
```

- 12. Import `BrowserRouter`, `Switch`, and `Route` from `react-router-dom` into `App` in the **container** app.

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

- 13. Import `MicroFrontend` into `App`

```
import MicroFrontend from './MicroFrontend';
```

- 14. Remove the imports of `App.css` and `logo.svg` from `App.js`

- 15. Before the `App` function, make a constant to hold the `bookstore` host in `App.js`

```
const {
    REACT_APP_BOOKSTORE_HOST: bookstoreHost,
} = process.env;
```

- 16. Make a const to hold the MicroFrontend for Bookstore

```
const Bookstore = ({ history }) => (
  <MicroFrontend history={history} host={bookstoreHost}
  name="Bookstore" />
);
```

- 17. Wrap the contents of the return statement in App with <BrowserRouter>.

- 18. Use a Switch with a Route in it to render the Bookstore

```
<Switch>
  <Route exact path="/" component={Bookstore} />
</Switch>
```

- 19. The return statement of **containers/src/App.js** should now look like this:

```
return (
  <BrowserRouter>
    <Switch>
      <Route exact path="/" component={Bookstore} />
    </Switch>
  </BrowserRouter>
);
```

- 20. Make a new component named Header (it can return anything at this point), import it into App, and render it before the BrowserRouter component, wrapping everything in a React.Fragment component make sure only one element is returned.
- 21. Start up the container app. You'll get an error. This is because it's trying to fetch **asset-manifest.json** from the bookstore micro frontend, which doesn't exist yet. Let's start that now. Leave the **container** app running and open a new terminal.

Part 3: Making a Micro Frontend

- 1. Use `create-react-app` to make a new app named `bookstore`.
- 2. Install `react-app-rewired` in the `bookstore` app. This will allow us to override settings in `create-react-app` that we need to change to make a micro frontend.

```
npm install react-app-rewired --save-dev
```

- 3. Change the scripts in **package.json** to use `react-app-rewired`, as follows (on Windows):

```
"start": "set PORT=3001 && react-app-rewired start",
"build": "react-app-rewired build",
"test": "react-app-rewired test"
```

- 4. On MacOS, change the scripts in **package.json** to use `react-app-rewired`, as follows:

```
"start": "PORT=3001 react-app-rewired start",
"build": "react-app-rewired build",
"test": "react-app-rewired test"
```

- 5. Put the config path for `react-app-rewired` in **package.json**

```
"config-overrides-path": "node_modules/react-app-rewire-micro-frontends",
```

- 6. Install the react-app-rewired script for micro frontends.

```
npm install --save-dev react-app-rewire-micro-frontends
```

- 7. In **bookstore/public/index.html**, use the same imports for the global CSS, React, and React DOM that you used in the container project.
- 8. Change the id of the root node in bookstore/public/index.html to 'container'. This will make it possible for you to view the bookstore app on its own port as well as rendered inside the container.
- 9. Delete the root <div> and replace it with a <main> element with an id of container.

```
<main id="container"></main>
```

- 10. Add the following `script` element under the imports of React and ReactDOM in index.html:

```
<script type="text/javascript">
  window.onload = () => {
    window.renderBookstore('container');
  };
</script>
```

- 11. Make a **.env** file in bookstore with a link to the content server:

```
REACT_APP_CONTENT_HOST=http://localhost:5000
```

- 12. Replace ReactDOM.render in **index.js** with the following:

```
window.renderBookstore = (containerId, history) => {
  ReactDOM.render(
    <App />,
    document.getElementById(containerId),
  );
};

window.unmountBookstore = containerId => {
  ReactDOM.unmountComponentAtNode(
    document.getElementById(containerId)
  );
};
```

- 13. Make a file named **setupProxy.js** in **src** with the following content. This will allow the container to access the Micro Frontend.

```
module.exports = app => {
  app.use((req, res, next) => {
    res.header('Access-Control-Allow-Origin', '*');
    next();
  });
};
```

- 14. Start up the bookstore app. Make sure that your content server and your container are both running too and then go to **http://localhost:3000** in your browser.

If you did all the steps correctly, you should see the default create-react-app app (although the logo image will be broken) and your `Header` component (from the `container` app) will be rendered above it.

Congratulations! You've created a Micro Frontend User Interface!

- 15. Modify `App.js` to display some generic text, such as "Bookstore Micro Frontend".
- 16. Make a copy of the `bookstore` app, name it `cart`, change every instance of `bookstore` in it to `cart`, modify `package.json` so that it starts on port 3002, and add it to the `container` so that it displays when the url is `localhost:3000/cart`. You'll need to stop and restart the container app so that it gets the new `env` variable for the `cart` application.

Bonus Lab: Getting the Bookstore Working as a Micro Frontend

In this lab, you'll move the bookstore app into your micro frontend architecture. To start with, we'll keep the cart and the bookstore in a single application. We can separate them after we get the application working as it is.

- 1. Copy all of dependencies and devDependencies from the working react/redux bookstore app's package.json to the bookstore micro frontend. Make sure that the bookstore micro frontend still has react-app-rewired and react-app-rewire-micro-frontends
- 2. Run npm install in the bookstore micro frontend.
- 3. Copy the components, actions, apis, reducers, sagas, and utils directories from the src directory of the bookstore app to the src directory of the bookstore micro frontend.
- 4. Update src/index.js in the bookstore micro frontend to include all the code from the bookstore app's src/index.js, plus the two micro frontend functions.
- 5. Make sure that the micro frontend index.js uses only the window.renderBookstore function to call ReactDOM.render, and that you copy the elements to be rendered from the working bookstore app.
- 6. Start the content and container micro frontends, then start the bookstore micro frontend. If you go to <http://localhost:3000> now, you should see the header of the bookstore, but no books. The reason is that we need to update the fetching of the books.
- 7. In apis/index.js, get the content host and use it instead of the hard coded url.

```
const {
  REACT_APP_CONTENT_HOST: contentHost,
} = process.env;
...
```

- 8. Refresh the container app. You should now see the book data, but the images are all broken.
- 9. Update the app as necessary (without copying the book images to the bookstore micro frontend!) to make the images display.

Bonus Lab: Sharing State Between Micro Frontends

- 1. Working in teams, figure out how to move the Cart out of the Bookstore Micro frontend and into its own.
- 2. Implement the necessary shared state to make the application work correctly.

The following articles provide some useful information:

<https://martinfowler.com/articles/micro-frontends.html>

<https://dev.to/luistak/cross-micro-frontends-communication-30m3>

Bonus Lab: Authentication with JWT

In this lab, you'll learn how to implement authentication in the container component and then pass an authentication token to micro frontends.

- 1. Read the following article to learn about implementing JWT in React

https://www.alibabacloud.com/blog/how-to-implement-authentication-in-reactjs-using-jwt_595820

- 2. Use this technique, or another of your choosing, to implement authentication and create a protected "Account Info" area in the bookstore app.

Bonus Lab: React Asteroids

Convert the JavaScript application you built in Lab 4 to a React application.