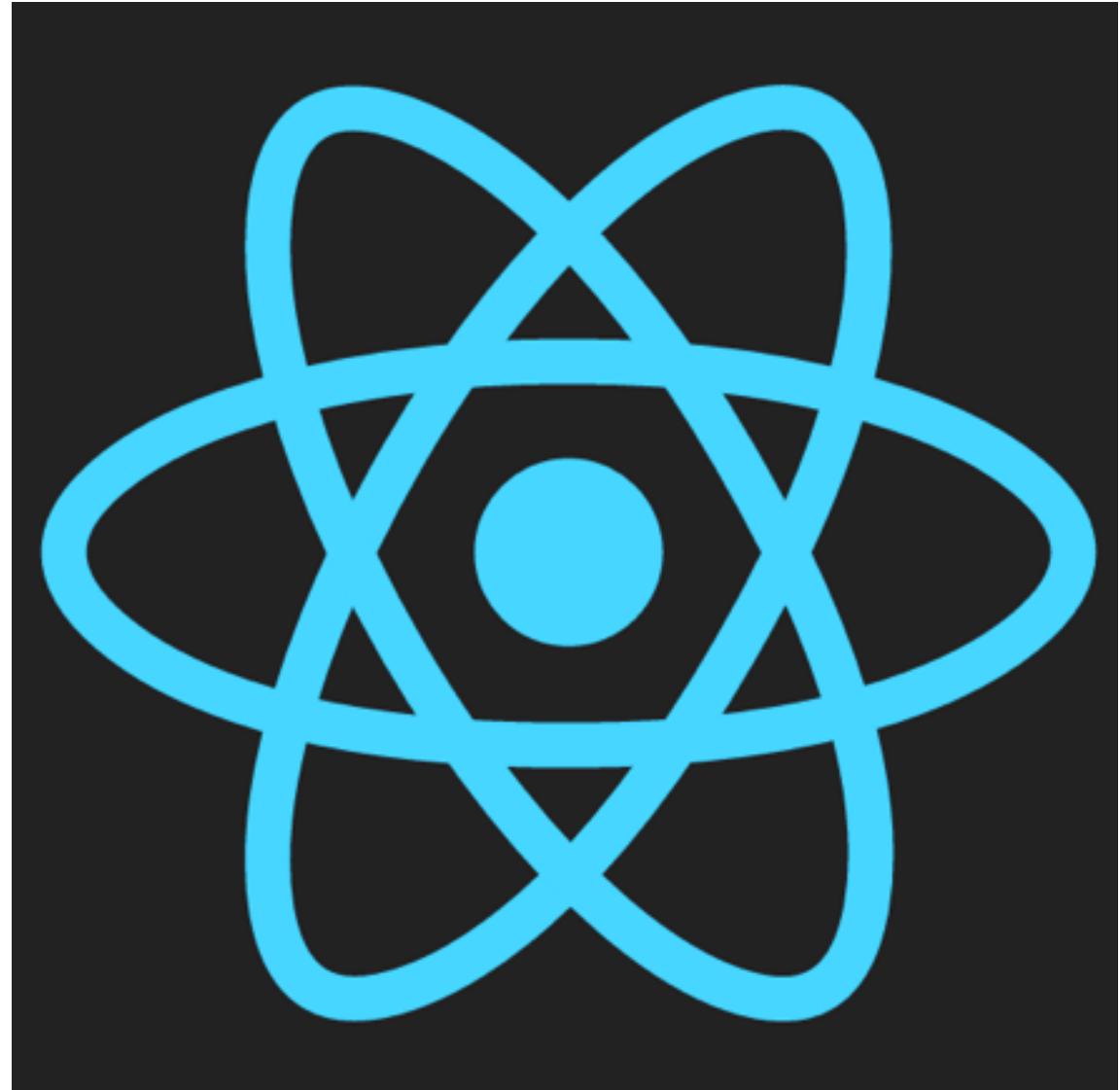


# Professional React Development

---

copyright 2022,  
Chris Minnick  
version 17.9.0,  
April 2022



# Introduction

---

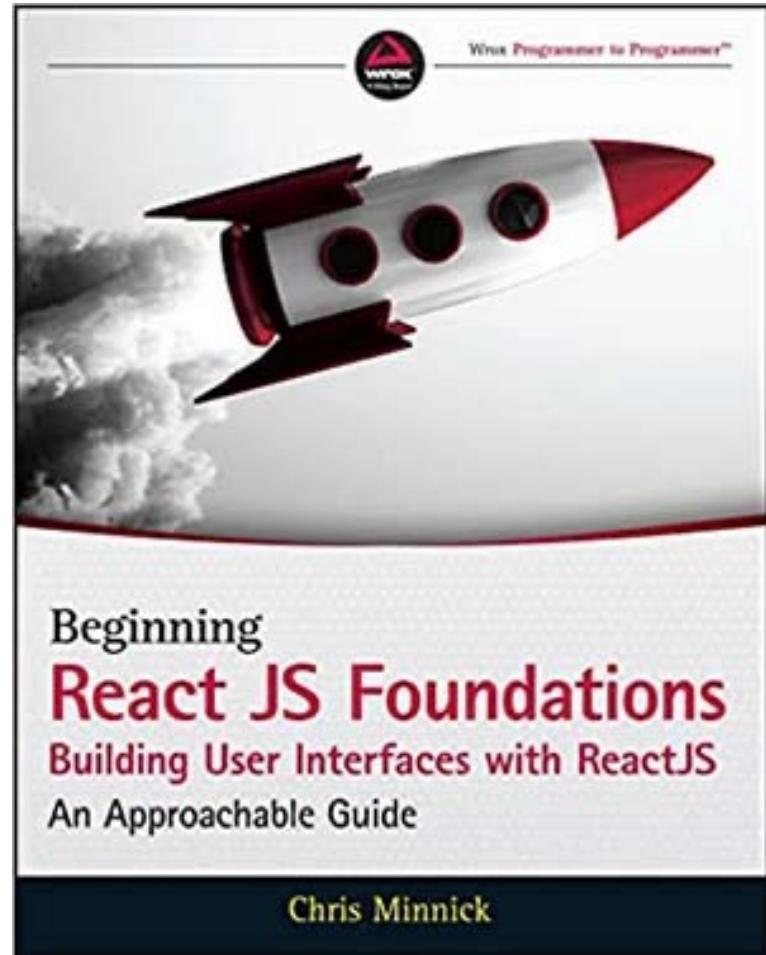
- Objectives
- Who am I?
- Who are you?
- Daily Schedule
- Course Schedule and Syllabus



# About Me

---

- Chris Minnick
  - From Detroit, currently live in Astoria, OR
  - Author of 12+ books, including **React JS Foundations** (Wiley, March 2022)
  - 20+ years experience in full-stack web development
  - Training & coding with React since 2015
  - Swimmer, painter, musician, novelist



# Introductions

---

- What's your name?
- What do you do?
- Where are you?
- JavaScript level (beginner, intermediate, advanced)?
- What do you want to know at the end of this course?
- What do you do for fun?



# The Big Picture

Some of the Topics Covered in this Course

React.js

Modern  
JavaScript

Testing with  
Jest

AJAX with  
React

Redux

Redux  
Middleware

React Micro  
Frontends

# Course Repo and More Examples

---

- [github.com/chrisminnick/professional-reactjs](https://github.com/chrisminnick/professional-reactjs)
  - Here you'll find all the files you need to complete the labs, as well as the completed solutions for each lab.
- <https://reactjsfoundations.com>
  - This is the website for *ReactJS Foundations*, by Chris Minnick (Wiley, March, 2022). It contains all the example code from the book, and more.
- <https://codesandbox.io>
  - Code playground that works well for React
  - A great option for restricted corporate training environments!

# Daily Schedule

---

- 09:00 - 10:30 (CST)
- 15 minute break
- 10:45 - 12:00
- 1 hour lunch break
- 1:00 - 2:00
- 15 minute break
- 2:15 - 3:15
- 15 minute break
- 3:30 – 6:00

# The Plan

---

Each day will be 50% lecture and 50% labs

- Monday: Introduction to React, Advanced JavaScript, TypeScript
- Tuesday: JSX, React Components, React State
- Wednesday: Events, Forms, Component Lifecycle, Async code, Hooks
- Thursday: Patterns and best practices, React with TypeScript, Testing, Redux
- Friday: Routing, Deploying, Advanced Topics, Micro Frontends, Optional JavaScript tooling microcourse

# The Labs

---

- Lab instructions: Professional-React-v17-labs.pdf
- Time to complete labs may vary between 15 mins and 1 hr+.
- Let me know if something doesn't work.
- If you finish a lab early:
  - try lab challenges,
  - help other students,
  - do additional reading,
  - take a break.

# What is React.js?

Component-based

Library for building user  
interfaces

Abstracts the Document  
Object Model

Implements one-way data  
flow

# What is React NOT?

---

- React is not a framework.
- React is not a web server.
- React is not a programming language.
- React is not a database.
- React is not a development environment.
- React is not the solution to every problem.



# When can you use React?

---

- Complex single-page applications (SPAs) can be built entirely using React.
- React can be used as a substitution for views in a traditional MV\* framework.
- React can generate static HTML on the server.
- React can be used to create native mobile apps.

# Who Uses React?

---

- AddThis
  - Angie's List
  - Airbnb
  - Atlassian
  - BBC
  - Codecademy
  - Coursera
  - Dropbox
  - Expedia
  - Facebook
  - IMDb
  - Imgur
  - Instagram
  - Intuit
  - Liberty Mutual
  - Lyft
  - Netflix
  - NFL
  - OkCupid
  - Paypal
  - Reddit
  - Salesforce
  - Squarespace
  - Tesla Motors
  - The New York Times
  - Trulia
  - Trunk Club
  - Twitter
  - Uber
  - Visa
  - WhatsApp
  - Wired
  - Wix
  - Wolfram Alpha
  - Wells Fargo
  - WordPress
  - Yahoo
  - Zendesk
- and many more!**

# React Quick Start

- Objectives
  - Add React to an HTML file using the UMD Build
  - Install CreateReactApp
  - Create a React App
  - Test and Run a React App with CRA

# Adding React to an HTML File

---

Most of the time, React apps use a build toolchain.

---

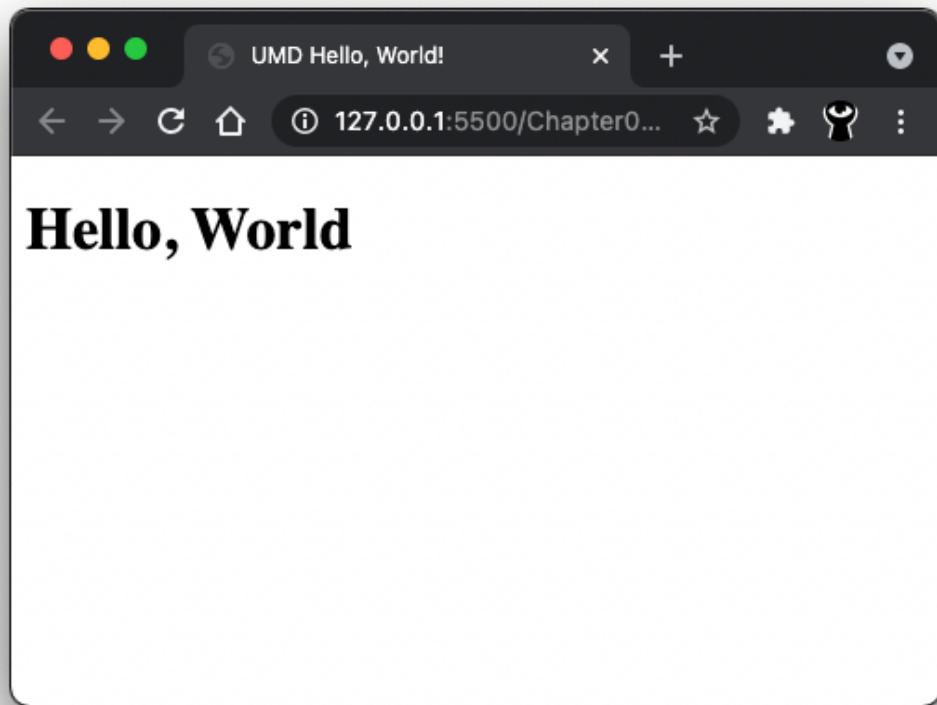
It is possible to use React by including it in HTML.

---

This method can be used to include React in an existing web site.

# Lab 0: Using the UMD Build

Find the  
instructions in the  
Labs workbook (on  
page 9).



# React with a Toolchain



---

Most Web Apps today are built using a set of tools that enable professional, team development.

---

The tools, collectively, are known as the JavaScript development toolchain.

# What is Create React App

---

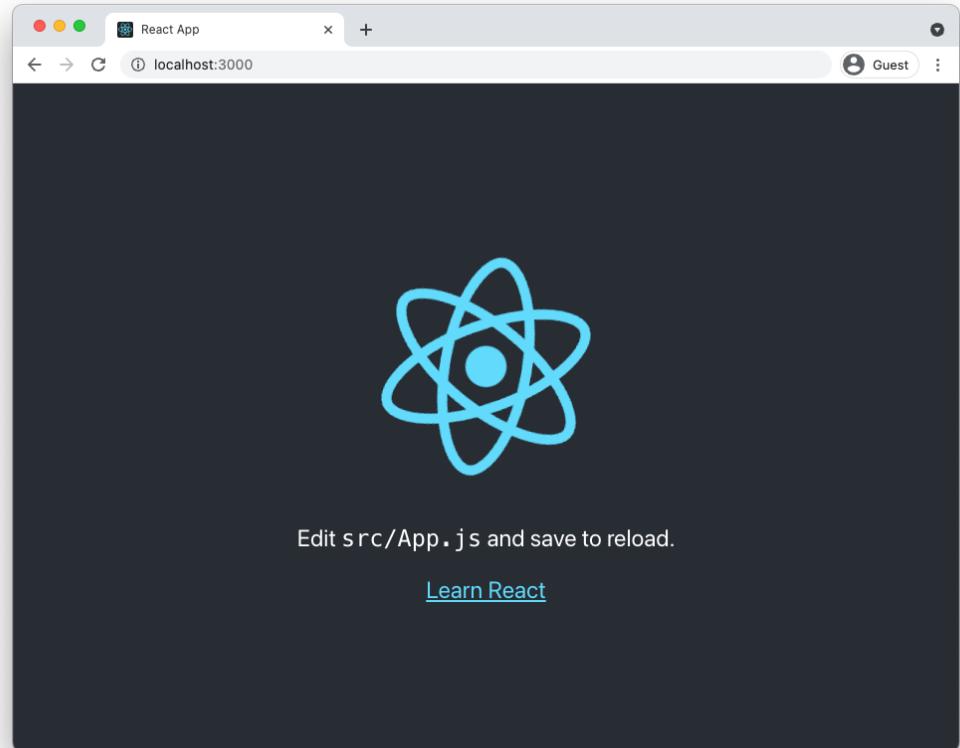
- Creates React App with no build configuration
- Simplifies setup of toolchain
- Sacrifices flexibility for simplicity
- Not a substitute for understanding the tools, but great when you just want to write React code quickly

# Lab 01:

## Get Started with

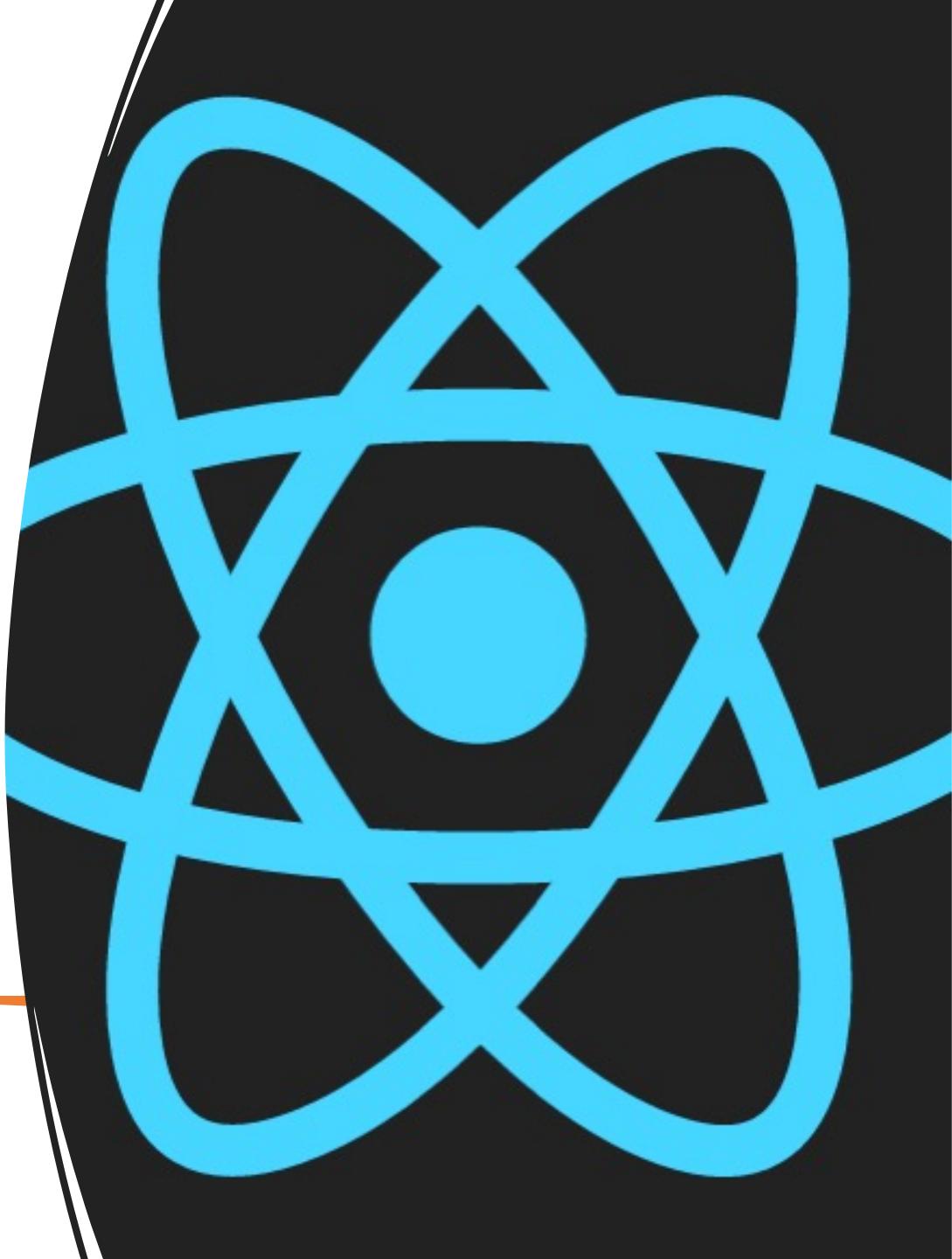
### Create React

### App



# Introduction to ReactJS

---



# What is React.js?

---

A JavaScript library  
for building UIs

Wraps an  
imperative API  
(DOM) with a  
declarative one

# React 18 Update

---

- Released March 29, 2022
- New APIs are exported from ReactDOM/client
- Deprecates ReactDOM.render
  - Using ReactDOM.render will cause app to run in React 17 mode.
- Behind-the-scenes improvements to rendering.
- Improvements to server-side rendering
- The example code in this course hasn't been upgraded yet, but it will work and I'll show you how to upgrade.

# React Philosophy

---

## Thinking in Components

---

### Composition vs. Inheritance

---

### Declarative vs. Imperative

---

### Idiomatic JavaScript

## Understanding Components

---

A component describes a piece of the UI

---

Each component returns an element

---

An element can be used in other components

---

A React UI is a tree of elements

# Thinking in Components

A component should be an independent piece of the UI that can be reused.

Single Responsibility says that a component should only have one reason to change.

# Composition vs. Inheritance

Inheritance uses parent classes to create more specific classes.

- class WelcomeMessage extends Message

React favors creation of configurable and composable components instead.

```
class WelcomeMessage(){  
  return (  
    <Message text="Welcome  
    to my app!" />  
  )  
}
```

# React is Declarative

## Imperative

- Focuses on the steps to complete a task
- Example:
  - Walk to the stairs
  - Walk down stairs
  - Go to the kitchen
  - Open refrigerator
  - Take out salami, cheese, mustard
  - Put salami, cheese, mustard on bread

## Declarative

- Focuses on what to do without saying how
  - Bring me a sandwich.

# Imperative vs. Declarative Screen Updates

## Imperative

- Change the greeting to: "Dear Mr. Smith,"
- Change the beginning of the first paragraph to "We are pleased to"
- Changing the closing to "Sincerely,"

## Declarative

- Make it look like this:
- Dear Mr. Smith,
- We are pleased to inform you that you have been selected!
- Sincerely,
- The Management

# React is Idiomatic



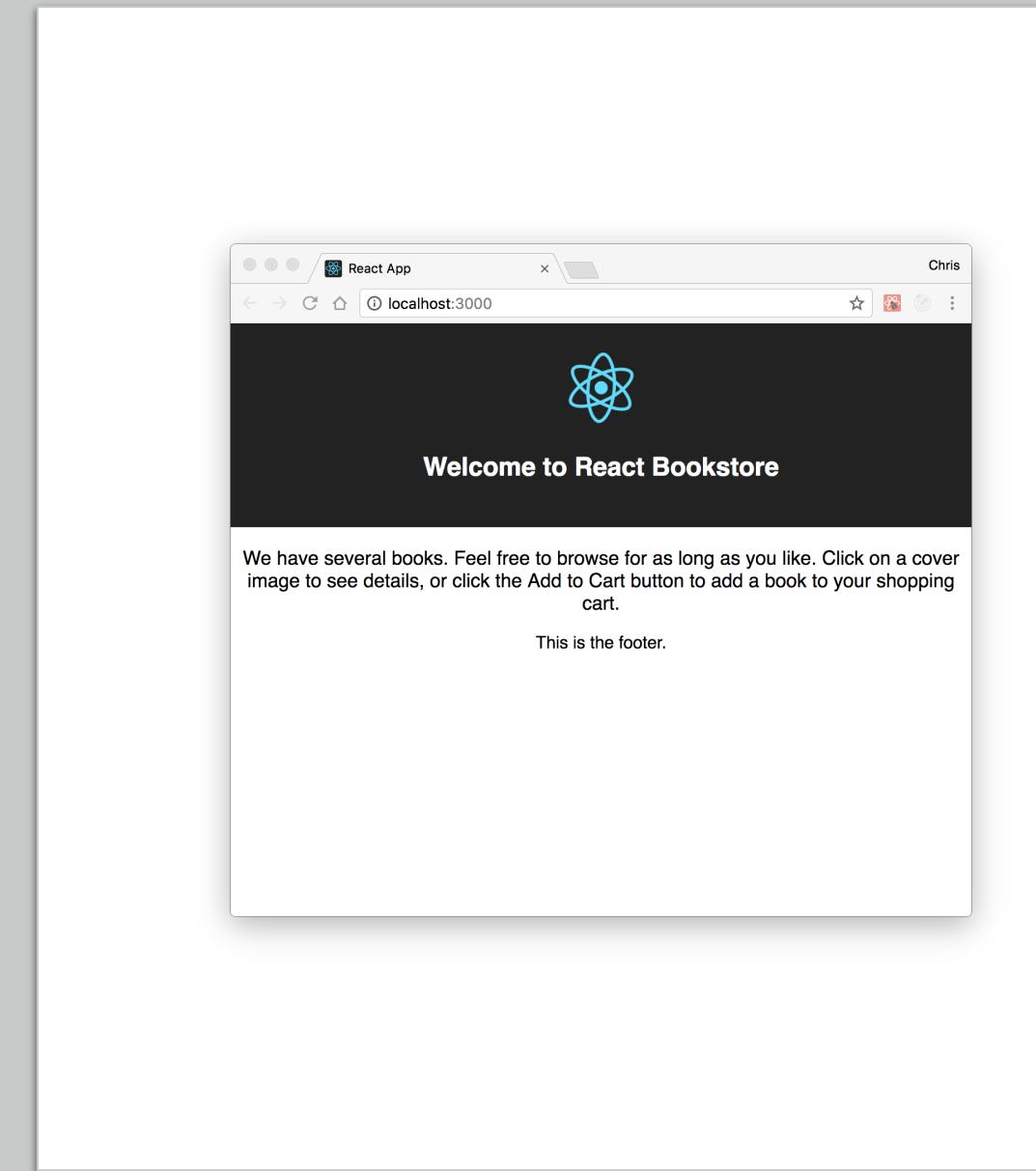
React is just  
JavaScript

React  
components are  
easily  
understandable  
to anyone who  
knows JavaScript.

If you know  
JavaScript, you  
can quickly start  
writing React.

# Lab 02:

## Your First Component



# How React Works

---

Implements Web Components using JavaScript

---

Components are rendered using a Virtual DOM

---

Components are updated in response to changes to application state

---

State is stored in a “state” object

---

Updating state is done through a `setState` method

---

The `setState` method calls the `render` method, causing the Virtual DOM to be re-generated.

---

Updates to the Virtual DOM are applied to the actual DOM using the `ReactDOM` library’s `render` method.

# Virtual DOM

---

Virtual DOM is updated (in memory) as the **state** of the data model changes.

---

React calculates the difference between the Virtual DOM and the real DOM.

---

React updates only what needs to be updated in the DOM.

---

Batches changes

# Virtual DOM vs. HTML DOM

Virtual DOM is a local and simplified copy of the HTML DOM

- (It's an abstraction of an abstraction)

The goal of the Virtual DOM is to only re-render when the **state** changes.

- This makes it more efficient than direct DOM manipulation.

Developers can write code as if the entire tree is being re-rendered.

- This makes it easier to understand.

Behind the scenes, React/Virtual DOM works out the details and creates a patch for the HTML DOM, which causes the browser to re-render the changed part of the scene.

# State Machines

React thinks of UIs as being simple state machines.

A state machine has:

An initial state or record of something stored someplace

A set of possible input events

A set of new states that may result from the input

A set of possible actions or output events that result from a new state

# React.render()

$fn(d) = V$

- Give the function data and you get a View.

Return value must

- be a single element:

- Correct:

```
return (<div><p></p></div>);
```

- Error:

```
return (<div></div><p></p>);
```

- or an array with unique key values

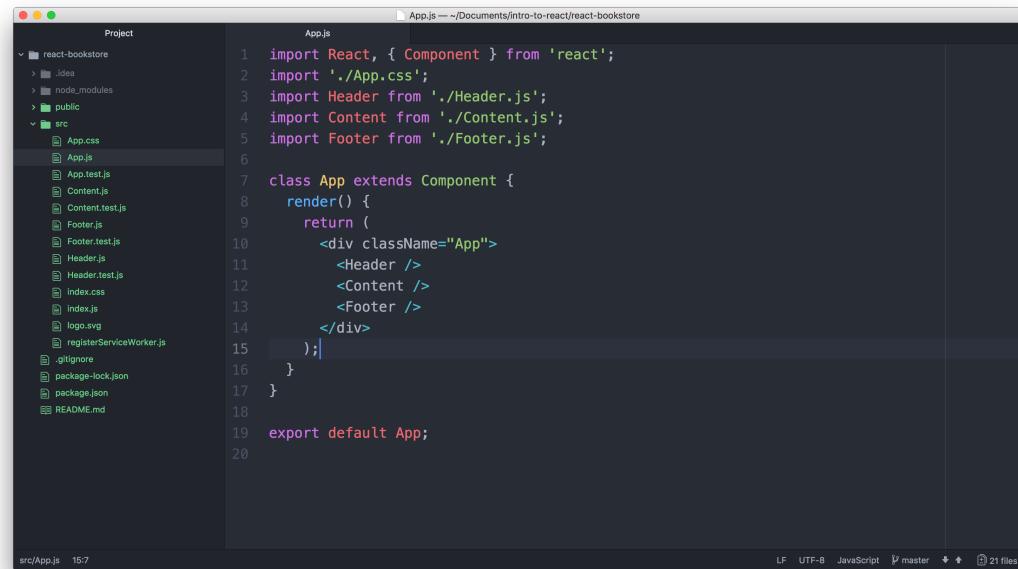
```
return [<li key="1">item 1</li>
        <li key="2">item 2</li>
    ];
```

- or a string

```
return "this is valid too";
```

# Lab 03:

## Create More Components



The screenshot shows a code editor with a dark theme. On the left is a sidebar titled "Project" listing files and folders: react-bookstore, .idea, node\_modules, public, src, App.css, App.js, App.test.js, Content.js, Content.test.js, Footer.js, Footer.test.js, Header.js, Header.test.js, index.css, index.js, logo.svg, registerServiceWorker.js, .gitignore, package-lock.json, package.json, and README.md. The main pane is titled "App.js" and contains the following code:

```
1 import React, { Component } from 'react';
2 import './App.css';
3 import Header from './Header.js';
4 import Content from './Content.js';
5 import Footer from './Footer.js';
6
7 class App extends Component {
8   render() {
9     return (
10       <div className="App">
11         <Header />
12         <Content />
13         <Footer />
14       </div>
15     );
16   }
17 }
18
19 export default App;
20
```

At the bottom of the editor, it says "src/App.js 15:7". In the status bar at the bottom right, it shows "LF" "UTF-8" "JavaScript" "master" and "21 files".

# ReactDOM

---

- React package for working with the DOM
  - Generally only needed at the top level of your application.

# ReactDOM methods

findDOMNode

render

unmountComponentAtNode

- Removes a mounted component from the DOM and cleans up its event handlers and state.

react-dom/server

- For rendering static markup on the server.
- ReactDOMServer.renderToString()
- ReactDOMServer.renderToStaticMarkup()

# ReactDOM.render

---

- `ReactDOM.render(reactElement, domContainerNode)`
  - Renders a `reactElement` into the DOM in the supplied container
  - Replaces any existing DOM elements inside the container node when first called
  - Later calls using DOM diffing algorithm for efficient updates
  - React 17 method.
  - If you install React 18 but use `ReactDOM.render`, the app will run as if it's React 17.

# ReactDOM.createRoot().render()

---

- New in React 18

```
import React from 'react';
import ReactDOM from 'react-dom/client';
import App from './App';
const root = document.getElementById('root');
ReactDOM.createRoot(root).render(<App />);
```

# Other Rendering Engines

---

- React Native
  - Renders to native mobile apps
- ReactDOMServer
  - Renders to static HTML
- React Konsul
  - Renders to the browser console
- react-pdf
  - Renders to PDF

# Lab 04: Testing React

```
react-bookstore — node -t npm TERM_PROGRAM=Apple_Termina...
PASS  src/Header.test.js
PASS  src/Footer.test.js
PASS  src/App.test.js
PASS  src/Content.test.js

Test Suites: 4 passed, 4 total
Tests:       4 passed, 4 total
Snapshots:   0 total
Time:        0.428s, estimated 1s
Ran all test suites related to changed files.

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

# Advanced JavaScript

---

- **Objectives**
- Learn what's new
- Use arrow functions and block-scoped variables
- Create generator functions
- Use classes and modules

# Variable Scoping with const and let

---

- **const creates constants**
  - Immutable and block-scoped
  - Cannot be reassigned new content
  - The assigned content isn't immutable, however,
    - If you assign an object or array to a constant, the properties or elements of the variable can be changed.
- **let creates block-scoped variables**
  - Main difference between `let` and `var` is that the scope of `var` is the entire enclosing function.
  - Redeclaring a variable with `let` raises a syntax error
- **Unlike with var, variables created with const and let aren't hoisted.**
  - You can't reference a variable before its declaration.

# let vs. var

## **var**

```
var a = 5;  
var b = 10;  
  
if (a === 5) {  
    var a = 4;  
    var b = 1;  
}  
console.log(a); // 4  
console.log(b); // 1
```

## **let**

```
let a = 5;  
let b = 10;  
  
if (a === 5) {  
    let a = 4;  
    let b = 1;  
}  
console.log(a); // 5  
console.log(b); // 10
```

# Arrow Functions

---

- Compact alternative to function expressions.
  - (params) => {expression}
- Doesn't have its own `this`
  - Lexical scope – `this` refers to the enclosing scope
  - Should not be used as methods.
- Can't be used for constructor functions
- Can't be used with `call`, `apply`, or `bind`
- Are always anonymous function expressions.

# Arrow Functions – basic example

```
const sum = (num1, num2) => {  
    return num1 + num2;  
}
```

- Parentheses around parameters are optional if there's only one param.  

```
const sum = myNumbers => {  
    return myNumbers.reduce((sum, current)=>sum+current);  
}
```
- return keyword and curly braces are optional if the function only returns data.

```
const sum = myNumbers =>  
    myNumbers.reduce((sum, current)=>sum+current);
```

# Arrow Functions

---

- More expressive closure syntax

- OLD:

```
odds = evens.map (function (v) { return v+1;  
} );
```

- NEW:

```
odds = evens.map (v => v+1);
```

# Arrow Functions (cont.)

---

- More intuitive handling of current object context.

- OLD

```
var self = this;
this.nums.forEach(function (v) {
    if (v % 5 === 0)
        self.fives.push(v);
}) ;
```

- NEW

```
this.nums.forEach((v) => {
    if (v % 5 === 0)
        this.fives.push(v);
}) ;
```

# Default Parameter Handling

---

- OLD

```
function f (x, y, z) {  
    if (y === undefined)  
        y = 0;  
    if (z === undefined)  
        z = 13;  
    return x + y + z;  
};
```

- NEW

```
function myFunc (x, y = 0, z = 13) {  
    return x + y + z;  
}
```

# Rest Parameter

---

- Aggregation of remaining arguments into single parameter of variadic functions.

```
function myFunc (x, y, ...a) {  
    return (x + y) * a.length;  
}  
console.log(myFunc(1, 2, "hello", true, 7));
```

- <http://jsbin.com/pisupa/edit?js,console>

# Spread Operator

---

- Spreading of elements of an iterable collection (like an array or a string) into both literal elements and individual function parameters.

```
var params = [ "hello", true, 7 ];  
var other = [ 1, 2, ...params ];  
console.log(other); // [1, 2, "hello", true, 7]
```

```
console.log(MyFunc(1, 2, ...params));
```

```
var str = "foo";  
var chars = [ ...str ]; // [ "f", "o", "o" ]
```

- <http://jsbin.com/guxika/edit?js,console>

# Template Literals

---

- String Interpolation

```
var customer = { name: "Penny" }
var order = { price: 4, product: "parts", quantity: 6 }
message = `Hi, ${customer.name}. Thank you for your order
of ${order.quantity} ${order.product} at ${order.price}.`;
```

- <http://jsbin.com/pusako/edit?js,console>

# Tagged Template Literals

---

- Call a function (the tag function) with an array of text segments.

```
get `http://example.com/cart?order=${orderId}`;
```

# Enhanced Object Properties

---

- Property Shorthand
  - Shorter syntax for properties with the same name and value

- NEW

```
obj = { x, y };
```

- OLD

```
obj = { x: x, y: y };
```

# Enhanced Object Properties

---

- Computed names in object property definitions

```
let obj = {  
    customer: "Nigel",  
    [ "order" + getOrderNum() ]: 10  
};
```

- <http://jsbin.com/wejuqe/edit?js,console>

# Method notation in object property definitions

## NEW

```
obj = {  
    foo (a,b) {  
        },  
    bar (x,y) {  
        }  
} ;
```

## OLD

```
obj = {  
    foo: function(a, b)  
    {  
        },  
    bar: function(x, y)  
    {  
        }  
} ;
```

# Array Matching

---

- Intuitive and flexible destructuring of Arrays into individual variables during assignment

```
var list = [ 1, 2, 3 ];  
var [ a, , b ] = list; // a = 1 , b = 3  
[ b, a ] = [ a, b ];
```

- <http://jsbin.com/yafage/edit?js,console>

# Object Matching

---

- Flexible destructuring of Objects into individual variables during assignment

```
var { a, b, c } = { a:1, b:2, c:3 };
console.log(a); // 1
console.log(b); // 2
console.log(c); // 3
```

- <http://jsbin.com/kuvizu/edit?js,console>

# User-defined Iterators

---

- Customizable iteration behavior for objects
- In order to be iterable, an object must implement the iterator method -- the object, or one of the objects up its prototype chain) must have a property with a `Symbol.iterator` key.

```
var myIterable = {}  
myIterable[Symbol.iterator] = function* () {  
    yield 1;  
    yield 2;  
    yield 3;  
};  
[...myIterable] // [1, 2, 3]
```

# For-Of Operator

---

- Convenient way to iterate over all values of an iterable object

```
let fibonacci = {
  [Symbol.iterator] () {
    let pre = 0, cur = 1
    return {
      next() {
        [ pre, cur ] = [cur, pre + cur]
        return { done: false, value: cur }
      }
    }
  }
}

for (let n of fibonacci) {
  if (n > 1000)
    break;
  console.log(n);
}
```

- <http://jsbin.com/nururoz/edit?js,console>

# Creating and Consuming Generator Functions

---

- A generator is a special type of function that works as a factory for iterators.

```
function* idMaker() {  
  var index = 0;  
  while(true)  
    yield index++;  
}  
  
var gen = idMaker();  
console.log(gen.next().value); // 0  
console.log(gen.next().value); // 1
```

- <http://jsbin.com/pozite/edit?js,console>

# Class Definition

---

- ES6 introduces more OOP-style classes
- Can be created with Class declaration or Class expression

# Class Declaration

---

```
class Square {  
    constructor (height, width) {  
        this.height = height;  
        this.width = width;  
    }  
}
```

# Class Expressions

---

- Can be unnamed

```
var Square = class {
    constructor(height, width) {
        this.height = height;
        this.width = width;
    }
};
```

- Or named

```
class Square {
    constructor(height, width) {
        this.height = height;
        this.width = width;
    }
};
```

# Class Inheritance

---

```
class Rectangle extends Shape {  
    constructor (id, x, y, width, height) {  
        super (id, x, y);  
        this.width = width;  
        this.height = height;  
    }  
}  
  
class Circle extends Shape {  
    constructor (id, x, y, radius) {  
        super (id, x, y);  
        this.radius = radius;  
    }  
}
```

# Understanding this

---

- Allows functions to be reused with different context.
- Which object should be focal when invoking a function.

# 4 Rules of this

---

- Implicit Binding
- Explicit Binding
- New Binding
- Window Binding

# What is this?

---

- When was function invoked?
- We don't know what `this` is until the function is invoked.

# Implicit Binding

---

- `this` refers to the object to the left of the dot.

```
var author = {  
    name: 'Chris',  
    homeTown: 'Detroit',  
    logName: function() {  
        console.log(this.name);  
    }  
} ;
```

```
author.logName();
```

# Explicit Binding

---

- `.call`, `.apply`, `.bind`

```
var logName = function() {  
    console.log(this.name);  
}
```

```
var author = {  
    name: 'Chris',  
    homeTown: 'Detroit'  
}  
logName.call(author);
```

# Explicit Binding with .call

---

- Calls a function with a given `this` value and the arguments given individually.

```
var logName = function(lang1) {  
    console.log(this.fname + this.lname + lang1);  
};  
  
var author = {  
    fname: "Chris",  
    lname: "Minnick"  
};  
  
var language = ["JavaScript", "HTML", "CSS"];  
logName.call(author, language[0]);
```

# Explicit binding with .apply

---

- Calls a function with a given `this` value and the arguments given as an array

```
logName = function(food1, food2, food3) {  
    console.log(this.fname + this.lname);  
    console.log(food1, food2,  
        food3);  
};  
  
var author = {  
    fname: "Chris",  
    lname: "Minnick"  
};  
  
var favoriteFoods= ['Tacos', 'Soup', 'Sushi'];  
  
logName.apply(author, favoriteFoods);
```

# Explicit Binding with .bind

---

- Works the same as .call, but returns new function rather than immediately invoking the function

```
logName = function(food) {  
    console.log(this.fname + " " + this.lname +  
        "\\'s Favorite Food was " + food);  
};  
  
var person = {  
    fname: "George",  
    lname: "Washington"  
};  
  
var logMe = logName.bind(person, "tacos");  
  
logMe();  
• http://jsbin.com/xikuzog/edit?js,console
```

# new Binding

---

- When a function is invoked with the new keyword, then this keyword inside the object is bound to the new object.

```
var City = function (lat, long, state, pop) {  
    this.lat = lat;  
    this.long = long;  
    this.state = state;  
    this.pop = pop;  
};  
  
var sacramento = new City(38.58, 121.49, "CA", 480000);  
console.log (sacramento.state);
```

# window Binding

---

- What happens when no object is specified or implied
- `this` defaults to the `window` object

```
var logName = function() {  
    console.log(this.author);  
}  
  
var author = {  
    name: 'Chris',  
    homeTown: 'Detroit'  
}  
  
logName(); //undefined(error in 'strict' mode)  
window.author = "Harry";  
logName(); // "Harry"
```

# Array.map()

---

- **Array.map()**
  - Creates a new array with the results of calling a provided function on every element in this array.
- **Syntax**
  - `const newarray = arr.map(arrayElement => arrayElement + 1);`
- **Parameters passed to the callback**
  - `currentValue`
    - The current element being processed
  - `index`
    - The index (number) of the current element
  - `array`
    - The array map was called upon

# Array.filter()

---

- **Array.filter()**
  - Creates a new array with the results of a test.
- **Syntax**
  - `var new_array = arr.filter(test)`
- **Example**

```
const customersNamedBill =
customerNames.filter(name=>name === "Bill");
```

# Array.reduce()

---

- **Array.reduce()**
  - Executes a reducer function on each element of an array.

- **Syntax**

```
var value =  
    arr.reduce((previous, current) => previous +  
              current, initialValue);
```

- **Example**

```
let orderTotal = items.reduce((total, item) =>  
    total + item.price, 0);
```

# Chapter 5: Modularity

## Objectives

- Explain modularity
- Learn different methods of using modules in JS
- Understand methods of front-end module management

# Why is Modularity Important?

---

- Individual modules can be tested
- Allows distributed development
- Enables code reuse
- Reduce coupling
- Increase cohesion

# CommonJS

- Modularity for JavaScript outside of the browser
- Node.js is a CommonJS module implementation
- uses require to include modules

- export an anonymous function

**hello.js**

```
module.exports = function () {  
    console.log("hello!");  
}
```

**app.js**

```
var hello =  
require("./hello.js");
```

- export a named function

**hello.js**

```
exports.hello = function () {  
    console.log("hello!");  
}
```

**app.js**

```
var hello =  
require("./hello.js").hello;
```

# RequireJS

- File and module loader for in-browser use
- Can also be used in other environments (like Node)
- Uses Asynchronous Module Loading (AMD)



- index.html

```
<script data-main="scripts/main"  
src="scripts/require.js">  
</script>
```

- main.js

```
require(["purchase"],  
function(purchase) {  
    purchase.purchaseProduct();  
});
```

- purchase.js

```
define(["credits", "products"],  
function(credits, products) {  
    return {  
        purchaseProduct: function() {  
            ...  
        }  
    };  
});
```

# ES6 Modules

- Compromise between AMD and CommonJS
  - compact syntax
  - support for asynchronous loading
- 2 Types
  - named exports
    - multiple per module
  - default exports
    - 1 per module

- Named export
- lib.js

```
export function square(x) {  
    return x * x;  
}
```
- main.js

```
import {square} from 'lib';
```
- Default export
- myFunc.js

```
export default function() {  
    ...  
};
```
- main.js

```
import myFunc from 'myFunc';
```

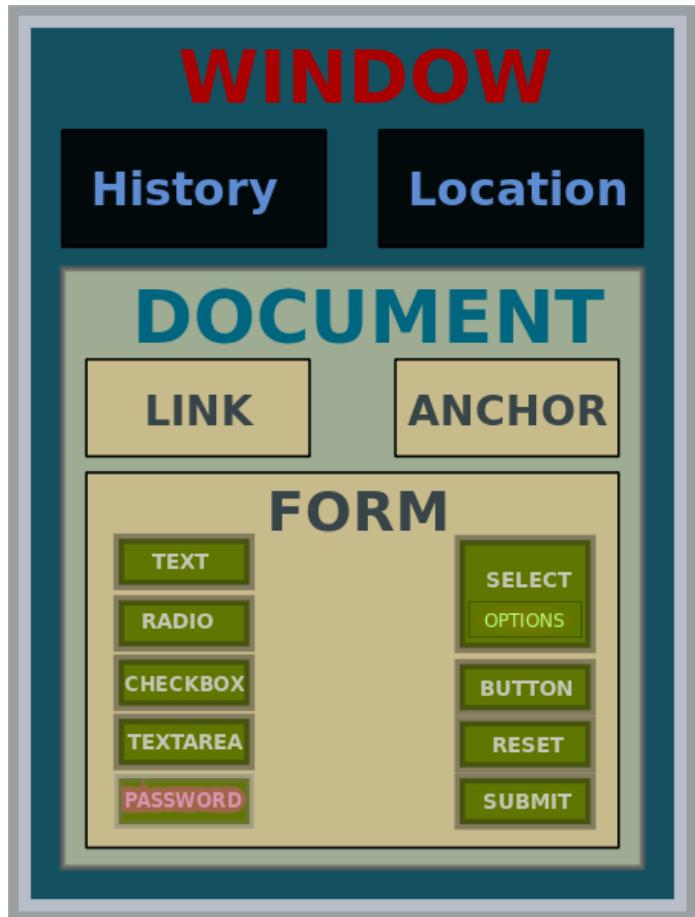
# Chapter 8:

## The Document Object Model

- Objectives
  - Understand how the DOM works
  - Select DOM nodes
  - Manipulate the DOM with JavaScript

# What is the DOM?

- JavaScript API for HTML documents
- Represents elements as a tree structure
- Objects in the tree can be addressed and manipulated using methods.



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# Understanding Nodes

---

- DOM interfaces that inherit from Node
  - Document
  - Element
  - CharacterData
    - Text
    - Comment
  - DocumentType
- Nodes inherit properties from EventTarget

# EventTarget

---

- An interface implemented by objects that can receive events (aka event targets)
- Examples:
  - Element
  - Document
  - Window
- Many event targets support setting event handlers.

# DOM Events

---

- Things that happen in the DOM
  - abort
  - beforeinput
  - blur
  - click
  - compositionend
  - compositionupdate
  - dblclick
  - error
  - focus
  - focusin
  - focusout
  - input
  - keydown
  - keyup
  - load
  - mousedown
  - mouseenter
  - mouseleave
  - mousemove
  - mouseout
  - mouseover
  - mouseup
  - resize
  - scroll
  - select
  - unload
  - wheel

# Other Events

---

- Many interfaces implement events or inherit events.
- Visit *<http://developer.mozilla.org/en-US/docs/Web/Events>*.

# Element

---

- Interface for elements within a Document
- Inherits properties and methods from Node and EventTarget
- **Most common properties:**
  - innerHTML
  - attributes
  - classList
  - id
  - tagName
- **Most common methods**
  - getElementById
  - addEventListener
  - querySelectorAll

# Manipulating HTML with the DOM

---

- You can get and set properties of HTML elements with JavaScript through the DOM

```
//starting HTML and DOM Element
<p id="favoriteMovie">The Matrix</p>
```

```
<script>
getElementById("favoriteMovie")
    .innerHTML = "The Godfather";
</script>
```

```
//updates DOM, which updates the browser
<p id="favoriteMovie">The Godfather</p>
```

# Manipulating HTML with the DOM

```
<ol id="favoriteSongs">
  <li class="song"></li>
  <li class="song"></li>
  <li class="song"></li>
</ol>
```

```
<script>
var mySongs=document
  .querySelectorAll ("#favoriteSongs .song");
mySongs[0].innerHTML = "My New Favorite Song";
</script>
```

# Manipulating HTML with JQuery

```
<ol id="favoriteSongs">
  <li class="song"></li>
  <li class="song"></li>
  <li class="song"></li>
</ol>

<script>
  $("#favoriteSongs .song").first()
    .html("My New Favorite Song");
</script>
```

# Manipulating HTML with React

```
<div id="favoriteSongs"></div>

<script>
class FavoriteSongs extends React.Component({
  render() {
    return (
      <ol>
        <li className="song">{this.props.song}</li>
        <li className="song"></li>
        <li className="song"></li>
      </ol>
    );
  }
}) ;

ReactDOM.render(<FavoriteSongs song="My New Favorite Song" />,
  document.getElementById('favoriteSongs'));
</script>
```

# Using JSX

---

- Objectives
- Write JSX
- Use React with JSX
- Use React without JSX

# What is JSX?

---

- Preprocessor that adds XML syntax to JavaScript.
- Takes XML input and produces native JavaScript.

# JSX is not HTML

---

- You can use HTML entities within JSX text
  - <div>&copy; all rights reserved</div>
- React will not render properties on HTML elements that don't exist in the HTML spec.
  - preface custom properties with data-
  - <div data-custom-attribute="foo" />
  - Arbitrary attributes are supported on custom elements
  - <MyComponent customAttribute="foo" />

# JSX is not HTML (cont.)

---

- XML syntax required
  - Elements must be closed
- Attributes use DOM property names
  - className instead of class, htmlFor instead of for
- Attributes become props in the child
- React components start with upper-case
- HTML elements start with lower-case

# React.createElement

---

```
createElement(  
  string/ReactClass type,  
  [object props],  
  [children ...]  
)
```

- Create and return a new ReactElement of the given type.
- Type argument can be an HTML tag name string ('div', 'span', etc.), or a ReactClass (created via `React.createClass`).
- JSX gets compiled to `React.createElement`

# Children in JSX

---

- A component can only return one thing.
  - string
  - number
  - array
  - Boolean
  - a single JSX element
- As long as your elements are properly nested, the single element can have as many children as necessary.

# Using Literal JavaScript in JSX

---

- Enclose expressions that shouldn't be interpreted as JSX in curly braces
- Object literals must be in double curly braces
- Enclose comments in curly braces

# Using React with JSX

```
class LoginBox extends React.Component {  
  render() {  
    return (  
      <div>  
        <label>Log In <input type="text" id="username"  
          placeholder={this.props.placeholderText} />  
        </label>  
      </div>  
    ) ;  
  }  
}) ;  
  
ReactDOM.render(<LoginBox placeholderText="Enter Your  
Email" />, document.getElementById("login")) ;
```

# Using React without JSX

...

```
render()  {  
  return React.createElement("div", null,  
    React.createElement("label", null, "Log In",  
      React.createElement("input",  
        { type: "text", id: "username" } )  
    )  
  ) ;  
}  
} ) ;  
  
ReactDOM.render(React.createElement(LoginBox, null),  
document.getElementById("login")) ;
```

# Conditional Rendering with JSX

---

- Three Methods
  - With Element Variables
  - With &&
  - With the conditional operator

# Conditional Rendering with Element Variables

---

```
function Welcome({loggedIn}) {  
  let header;  
  if (loggedIn) {  
    header = <Header />;  
  } else {  
    header = <Login />;  
  }  
  return ( <div> {header} </div> ) }  
export default Welcome;
```

# Conditional Rendering with the && Logical Operator

---

```
function Welcome({loggedIn}) {  
  return (  
    <div> {loggedIn&&<Header />}  
    Note: if you don't see the  
    welcome message, you're not  
    logged in. </div>  
  )  
}  
export default Welcome;
```

# Conditional Rendering with the Conditional Operator

---

```
function Welcome({loggedIn}) {  
  return (  
    <div>  
      {loggedIn?<Header />:<Login />}  
    </div>  
  )  
}  
export default Welcome;
```

# React.Fragment

---

- The single-element return rule in React can create unnecessary elements in the browser.
- React.Fragment can be used to wrap multiple elements without rendering an element.

```
return(  
  <React.Fragment>  
    <h1>The heading</h1>  
    <h2>The subheading</h2>  
  </React.Fragment>  
)
```

# React.Fragment Shorthand

---

- You can use `<> ... </>` as a shorthand for `React.Fragment`.

```
function MyComponent() {  
  return(  
    <>  
      <h1>The heading</h1>  
      <h2>The subheading</h2>  
    </>  
  );  
}  
  
export default MyComponent;
```

# React Components

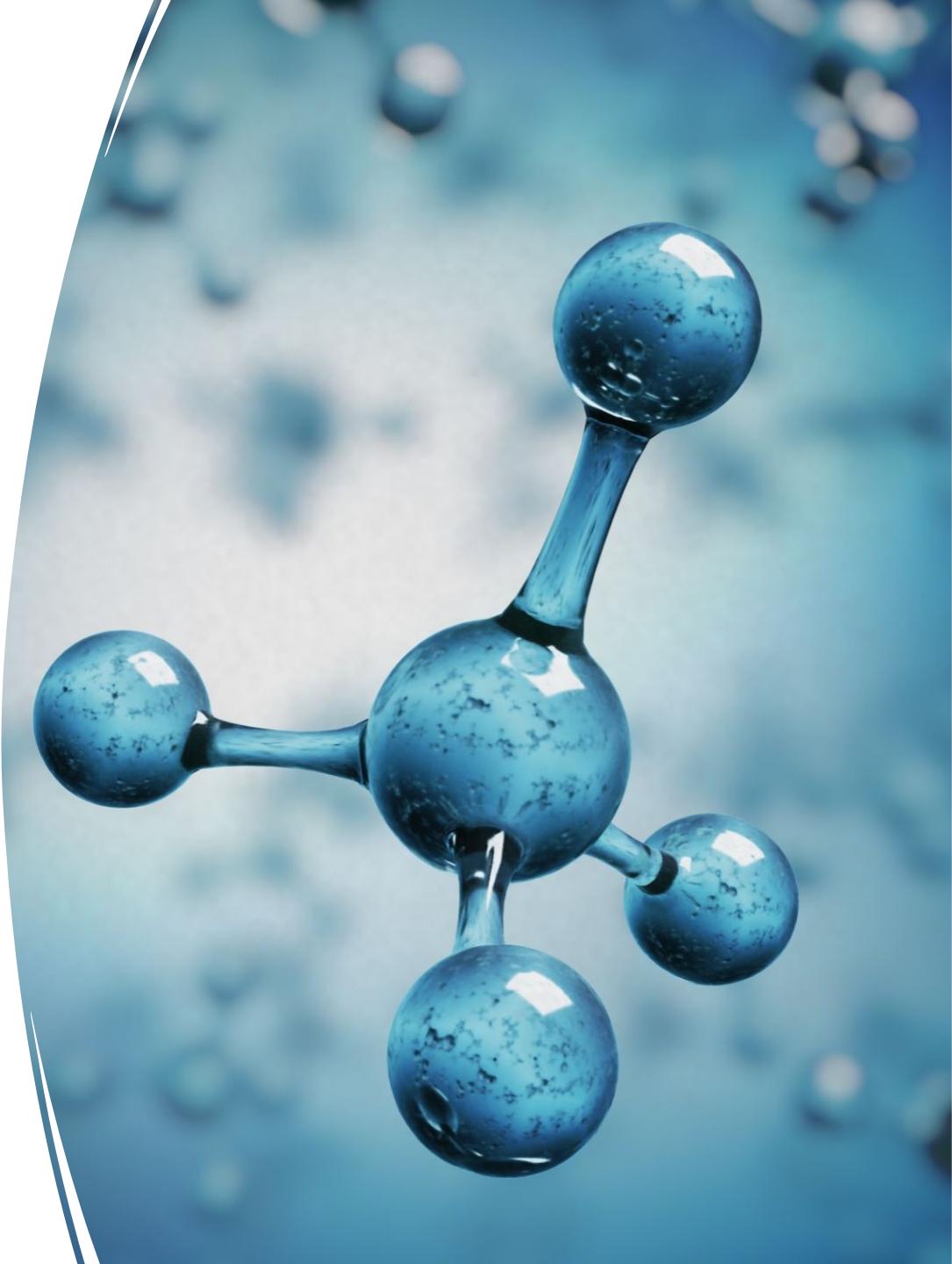


- Objectives
  - Understanding components and elements
  - Understand how to write components
  - Understand component life-cycle
  - Use events and event handlers
  - Communicate between components

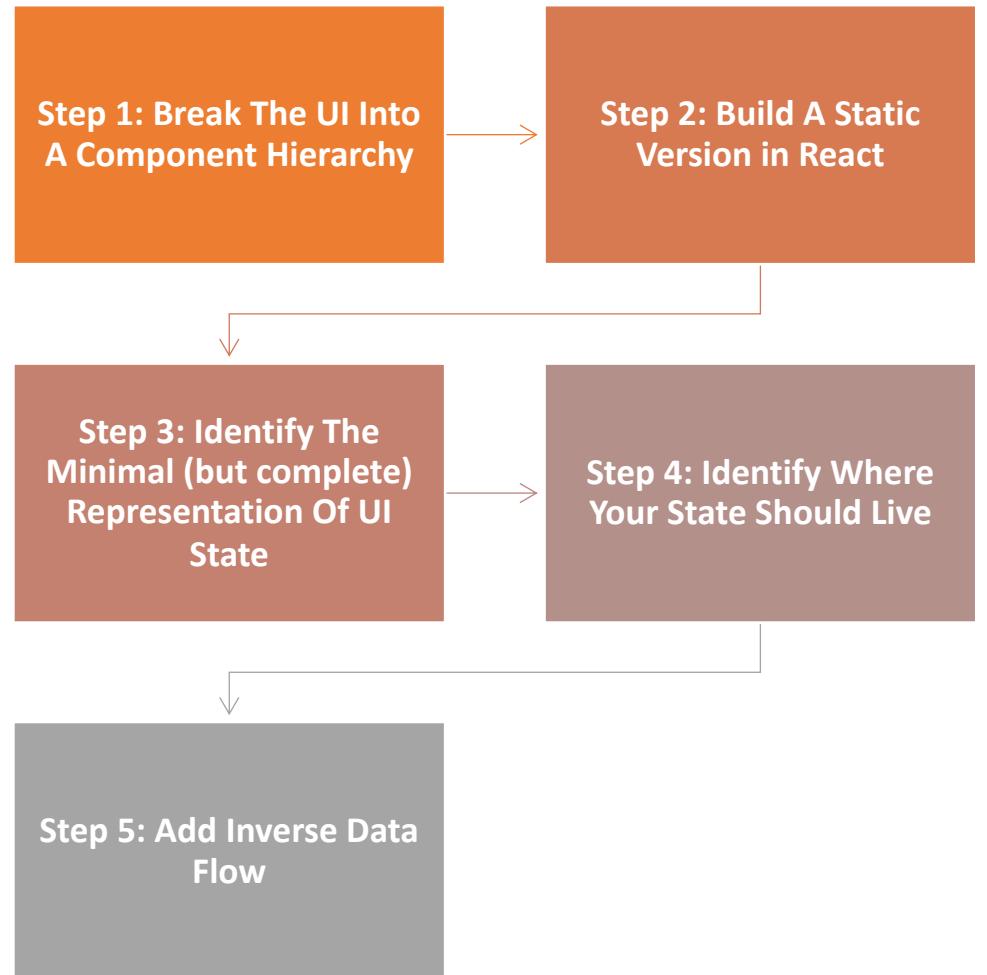
# What are components?

---

- React components define React Elements
- Elements are composed to create UI

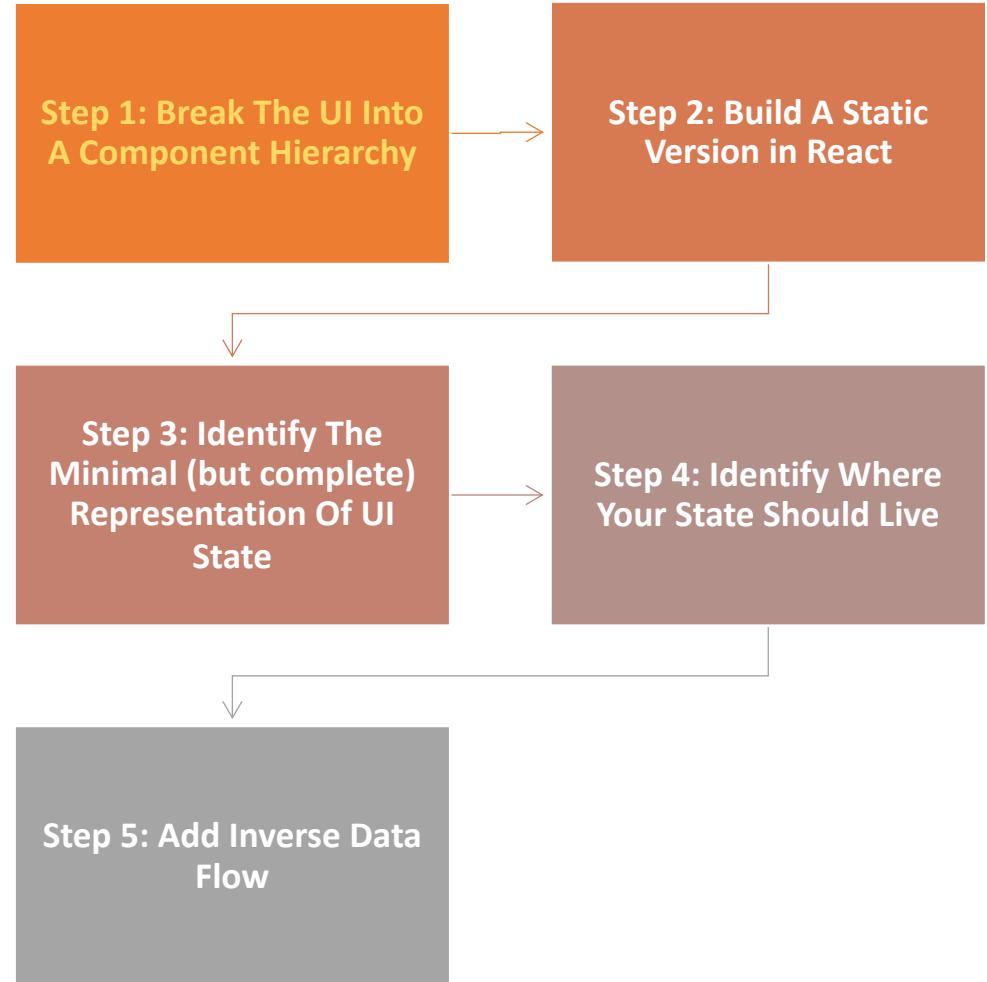


# React Development Process



# React Development Process

## Step 1: Break The UI Into A Component Hierarchy



# Creating a Component Hierarchy

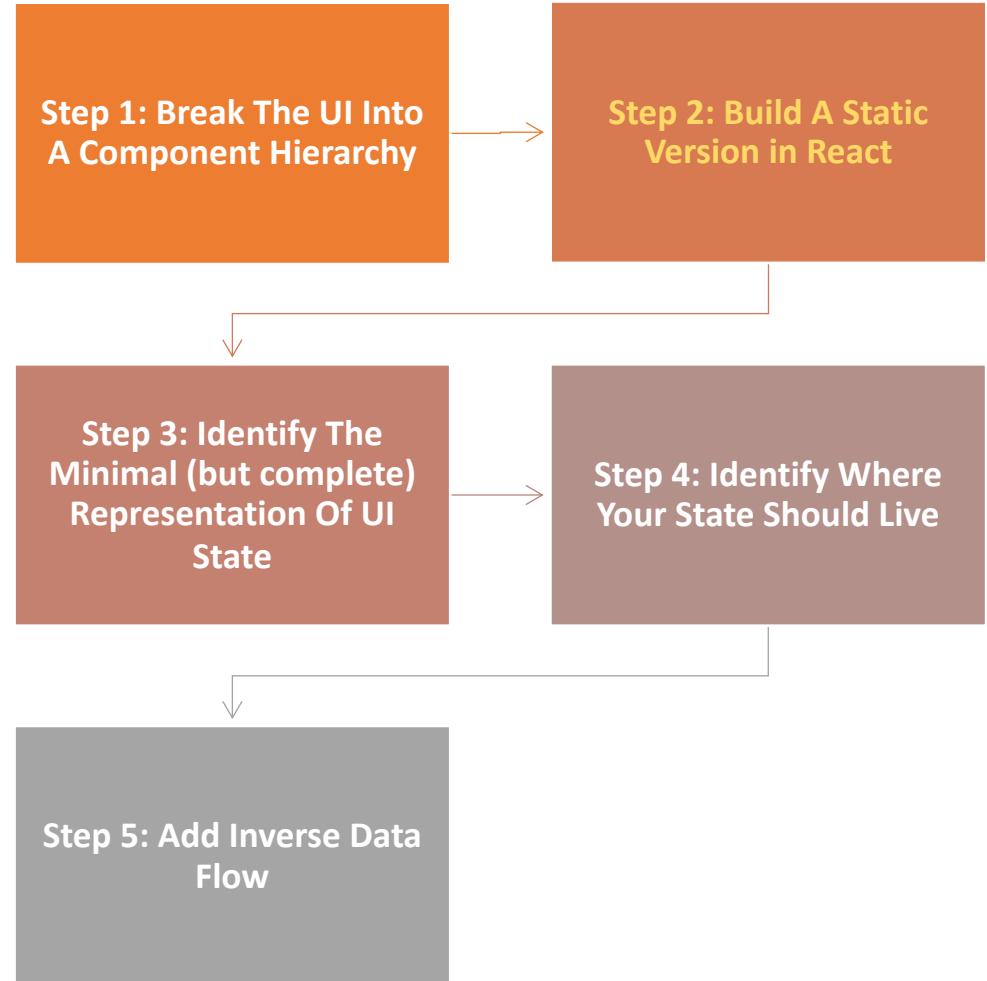
---

How do you know what should be a component?

<input type="text" value="Search..."/>	
<input type="checkbox"/> Only show products in stock	
Name	Price
<b>Sporting Goods</b>	
Football	\$49.99
Baseball	\$9.99
Basketball	\$29.99
<b>Electronics</b>	
iPod Touch	\$99.99
iPhone 5	\$399.99
Nexus 7	\$199.99

# React Development Process

## Step 2: Build A Static Version in React



# Goals of a Static Version



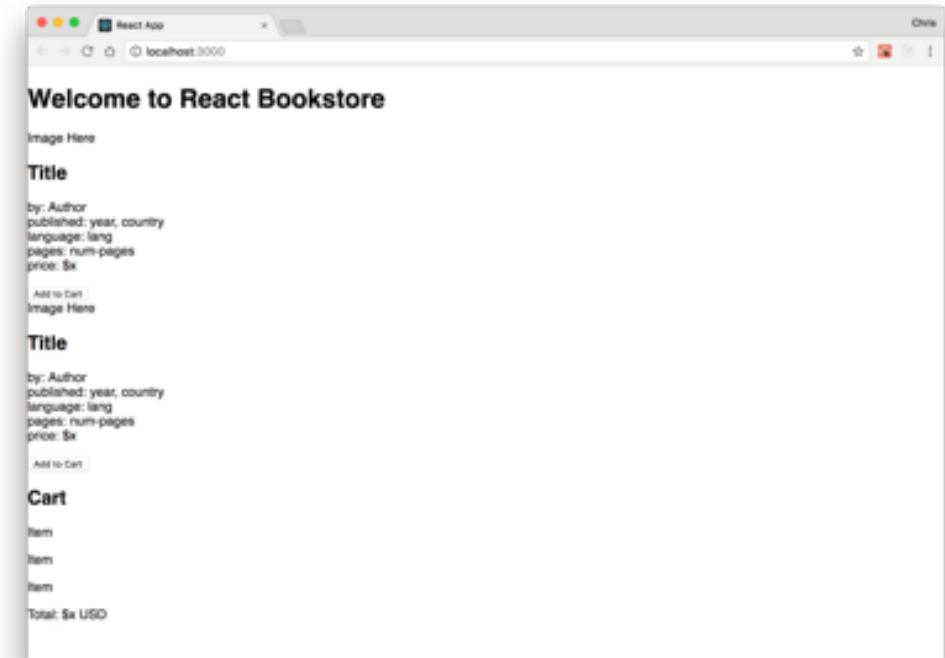
Render the UI with  
no interactivity



Create a library of  
reusable components  
that render the data  
model

```
class ProductCategoryRow extends  
React.Component({  
  render () {  
    return (  
      <tr>  
        <th colSpan="2">  
          {this.props.category}  
        </th>  
      </tr>  
    ) ;  
  }  
}) ;
```

# Lab 05: Static Version



# Creating Components

---

- Two techniques
  - Extend React.Component
  - Function Component

# React.Component

---

- Base class for React Components when defined using JavaScript classes.

```
class HelloMessage extends React.Component {  
  constructor(props) {  
    super(props);  
  }  
  render() {  
    return (<div>Hello {this.props.name}</div>);  
  }  
}  
ReactDOM.render(<HelloMessage name="Ann" />, mountNode);
```

# super()

---

- Used for calling methods on the parent.
- Makes `this` available in the constructor.
- ES6 classes must call `super()` if they are subclasses.
- If you don't have a constructor, you don't need to call `super()`.
- If you want to use `props` in your constructor, you need to call `super(props)` in the constructor.

# Classes Can be Confusing...

---

- When to use a constructor?
- What does super() do?
- When do you bind function?
- Where should the state live?

# The Solution: Function Components

---

- Function components gave developers a way to create “stateless” components using JavaScript functions

```
function MyComponent (props) {  
  return (  
    <p>Welcome to my component, {props.name}</p>  
  );  
}
```

- Or using arrow functions:

```
const MyComponent = (props)=>{  
  <p>Welcome to my component, {props.name}</p>  
}
```

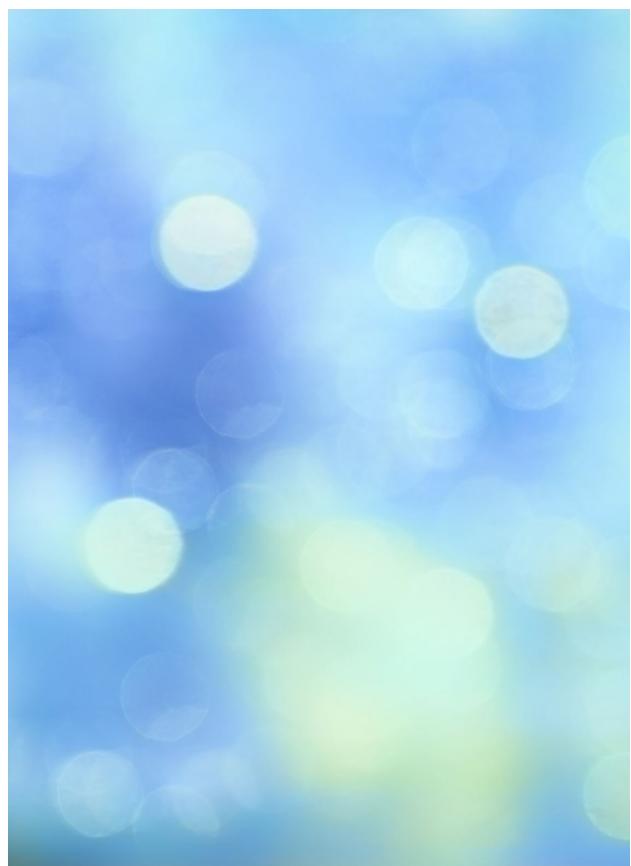
# Component Children

---

Components used inside components are called Child Components

A Component that contains other components is called a Parent Components

Components can be both parents and children, depending on how they're used.



# Styles in React

---



# Two Approaches to Style

---

- Use CSS
  - Import CSS files
  - Use a CSS library  
(Bootstrap for example)
  - Use CSS Modules
- Use JavaScript
  - Inline styles
  - Style modules

# Importing CSS

---

- If your module bundler is configured to bundle CSS files (Create React App does this by default), you can simply import CSS into a component.

```
import "styles.css";

function MyComponent (props) {
  return (
    <div className="article-link">
      <h1 className="title">
        {props.title}</h1>
    </div> );
}

export default ArticleLink;
```

# CSS Modules

---

- Importing CSS creates global styles.
- A CSS Module is a CSS file with class names scoped locally by default.
- Is supported by Create React App
- CSS Modules must be named using [name].modules.css
- Can be imported as JS
  - import styles from './MyStyles.module.css';
- Can be used with dot notation
  - return <button className={styles.warning}>Warning</button>

# Inline Styles

---

- The style attribute on React's built-in elements will apply styles in the DOM using JavaScript

```
function WarningMessage (props) {  
  return (  
    <p style={ {  
      color:"red",  
      padding:"6px",  
      backgroundColor:"#000000" } }>  
      {props.warningMessage}  
    </p> );  
}
```

# Style Objects

---

- Assign a style object to a variable to make it more reusable.

```
function WarningMessage(props) {  
  const textColors = {  
    warning:{color:"red",  
             padding:"6px",  
             backgroundColor:"#000000"}  
  };  
  return (  
    <p style={textColors.warning}>  
      {props.warningMessage}  
    </p> );  
}
```

# Style Modules

---

- Export style objects to create a library of reusable styles.

```
export const warningStyle =  
{color:"red",padding:"6px",backgroundColor:"#000000"}  
;  
  
export const infoStyle =  
{color:"yellow",padding:"6px",backgroundColor:"#000000"}  
;  
  
export const successStyle =  
{color:"yellow",padding:"6px",backgroundColor:"#000000"}  
;
```

# CSS-in-JS

---

- There are MANY different CSS-in-JS libraries available.
- Most support Scoped CSS, Server-side Rendering, Automatic vendor prefixing, and more.
- Examples include:
  - styled-components
  - Emotion
  - Goober
  - Compiled
  - Fela
  - JSS
  - Treat
  - Styled JSX

# Styled Components

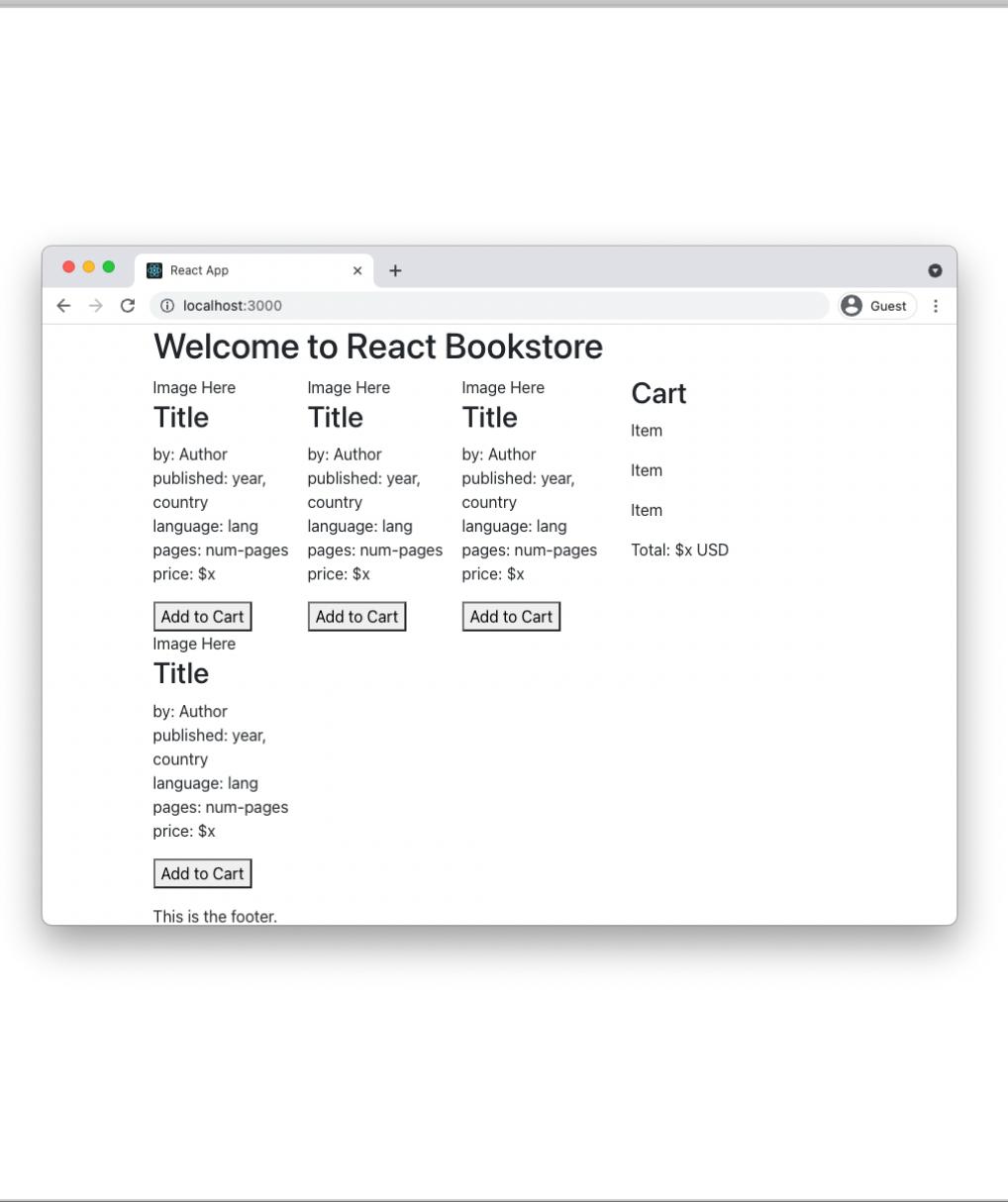
---

1. import styled from 'styled-components';
2. Call styled.[object] function, passing in style info using Tagged Template Literal Notation.

```
const Title = styled.h1`  
  font-size: 1.5em;  
  text-align: center;  
  color: palevioletred;  
`;
```

```
<Title>This is a styled component</Title>
```

# Lab 06: Styling React



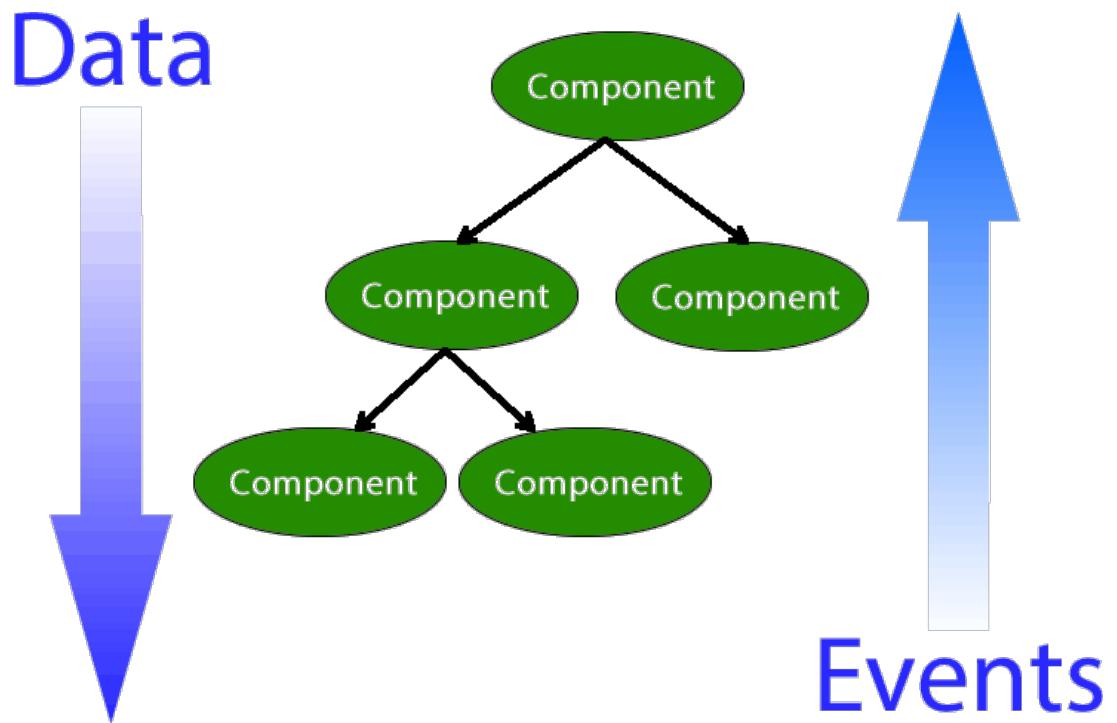
# Data Flow



# One-way Data Flow

---

- Each UI element represents one component
- All data flows from owner to child



# props

---

- Props are passed from the parent component to its children
- JSX attributes become a single object in the child.
- Parent:

```
<Hello name="Chris" />
```

- Child:

```
class Hello extends React.Component {  
  render() {  
    return (<h1>Hello, {this.props.name}</h1>);  
  }  
}
```

# props.children

---

- Returns the child elements of a React element.
- Makes composition of elements possible.

```
<BorderBox>
  <p>The first paragraph.</p>
  <p>The second paragraph.</p>
</BorderBox>
```

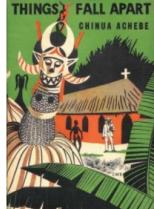
```
function BorderBox(props) {
  return(<div style={{border:"1px solid black"}}>
    {props.children}
  </div>);
}
```

# Lab 07: Props and Containers

React App

localhost:3000 Guest

## Welcome to React Bookstore



**Things Fall Apart**  
by: Chinua Achebe  
published: 1958, Nigeria  
language: English  
pages: 209  
price: \$5

**Add to Cart**



**Fairy tales**  
by: Hans Christian Andersen  
published: 1835-37, Denmark  
language: Danish  
pages: 784  
price: \$5

**Add to Cart**



**The Divine Comedy**  
by: Dante Alighieri  
published: 1308-1321, Italy  
language: Italian  
pages: 928  
price: \$5

**Add to Cart**

**Cart**

Item

Item

Item

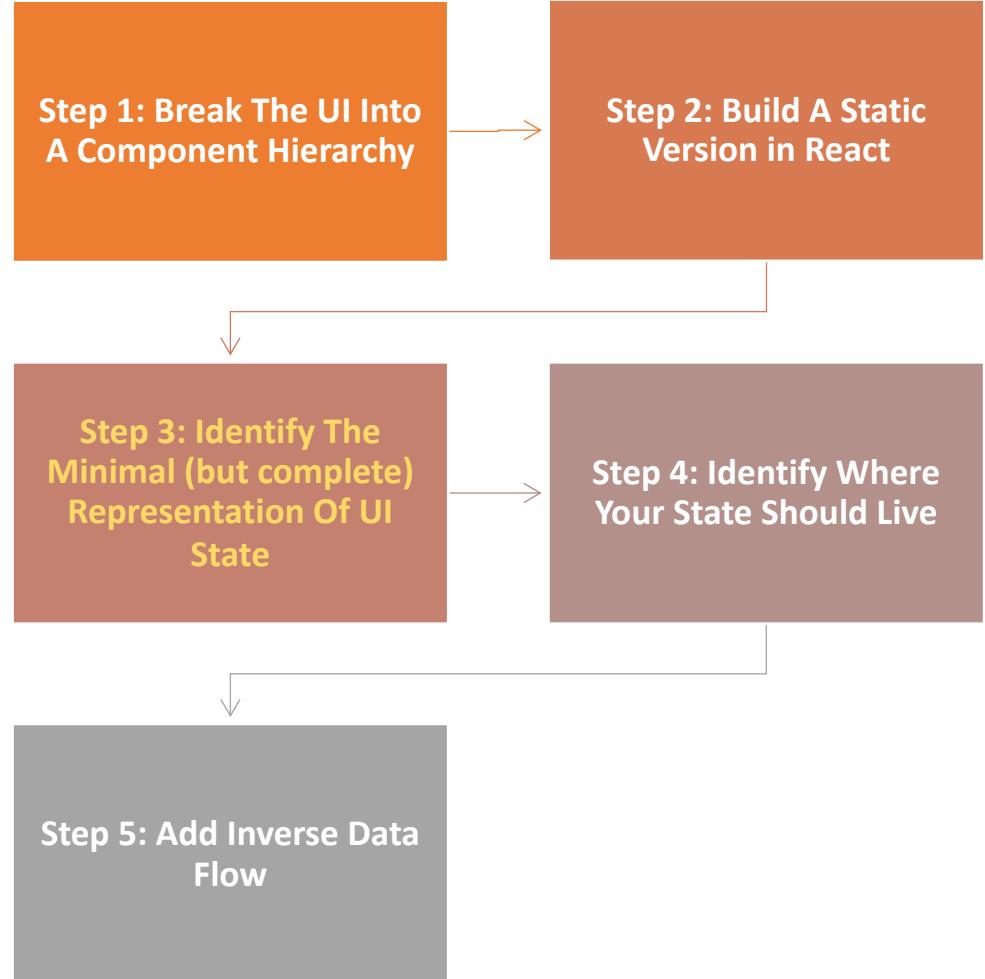
Total: \$x USD

State



# React Development Process

**Step 3:**  
**Identify The Minimal  
(but complete)  
Representation Of UI  
State**



# What is State?

---

- A JavaScript object used to hold INTERNAL data that influences the output of the render method.

# How State Affects render()

---

- The state object can only be changed using the `setState()` method. This method modifies the state object and then causes the component to render.

# How to Know if it Should Be State

---

- Is it state?
  - Is it passed from the parent via props?
    - Probably not state
  - Does it change over time?
    - Might be state
  - Can you compute it based on any other state or props in your application?
    - Probably not state

# Props vs. State

---

## Props

- Passed to the child within the render method of the parent
- Immutable
- Better performance

## State

- State of the parent becomes prop of child
- Mutable

# Setting Initial State

---

- In Class Components:

```
class MyComponent extends React.Component {  
  constructor() {  
    this.state = { /* some initial state */ }  
  }  
}
```

- In Function Components:

- useState Hook returns a stateful variable and a function for setting it.
- Argument passed to useState is the initial value of the variable.

```
function MyComponent () {  
  const [myState, setmyState] = useState("hi!");  
}  
}
```

# Updating State

in Class Components

- `setState()`
  - Takes an object and merges the object into the state object.

in Function Components

- setter function returned by `useState`
  - replaces current value with argument

# setState

---

- Function for updating a class component's state outside of the constructor.
- Takes an object or a function as its argument and uses the argument to schedule an update to the state.
- `setState` is asynchronous

# setState with an Object

---

- The object will be merged with the current state.

# setState with a Function

---

- The function receives the state and props of the component and returns an object.
- The object will be merged with the current state.
- Use a function when the new state depends on the current state.

# useState setter function

---

- The 2<sup>nd</sup> element of the array returned by the useState hook is a function for updating the state variable (the first element returned by the hook).
- Unlike setState in class components, the updater function returned by useState does not merge the new state, it replaces the old state with the new state.

# Valid arguments

---

- You can pass any value or a function to a setter function.
- If the new state depends on the old state, pass a function to the setter function.

# What to Put in State

---

- Properties of a component that can change over time.

# What Not to Put in State

---

- Anything that can be calculated.
- Anything passed down from a parent component.

# JavaScript Lesson: Shallow Copy

---

- JavaScript arrays and objects are reference values
- If you use the assignment operator to copy an array, the new array still references the old.

```
let arr = ['red', 'green', 'blue'];
```

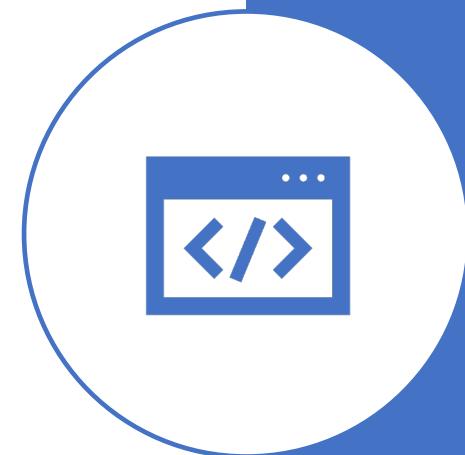
```
let newArr = arr;
```

```
newArr.push('orange');
```

```
arr
```

```
> ['red','green','blue','orange']
```

- To copy an array or object without referencing the old one, you need to make a shallow copy



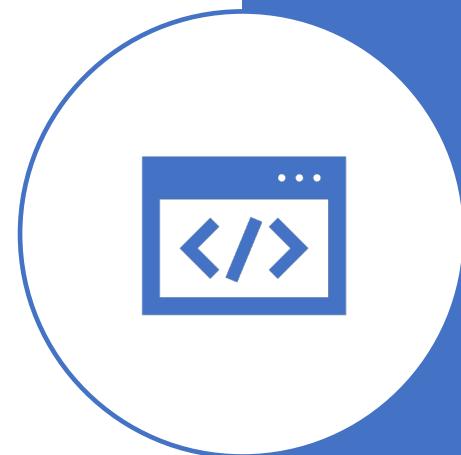
# Shallow Copy an Array

- A shallow copy is an array created by copying each element of the original array to the new array.
- Can be done in several ways:
  - **Using a loop**

```
for (i = 0; i < numbers.length; i++) {  
    numbersCopy[i] = numbers[i];  
}
```
  - **Using the slice method**

```
numbersCopy = numbers.slice();
```
  - **Using the spread operator**

```
numbersCopy = [...numbers];
```



# Shallow Copy an Object

- A shallow copy is an array created by copying each property of the original object to the new object.
- Can be done using spread operator:

```
let person = { foo: 'bar', x: 0 };
```

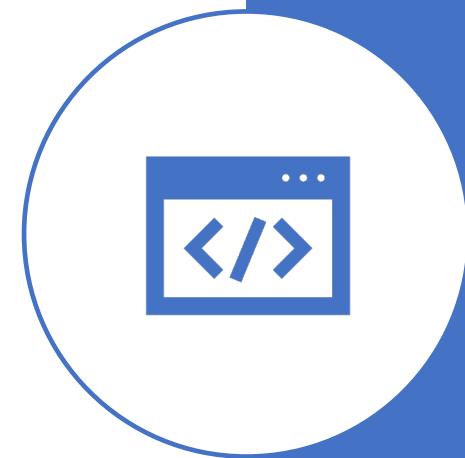
```
let p1 = { ...person };
```

- Or by using `Object.assign`:

```
let p2 = Object.assign( {}, person );
```

- Or using JSON:

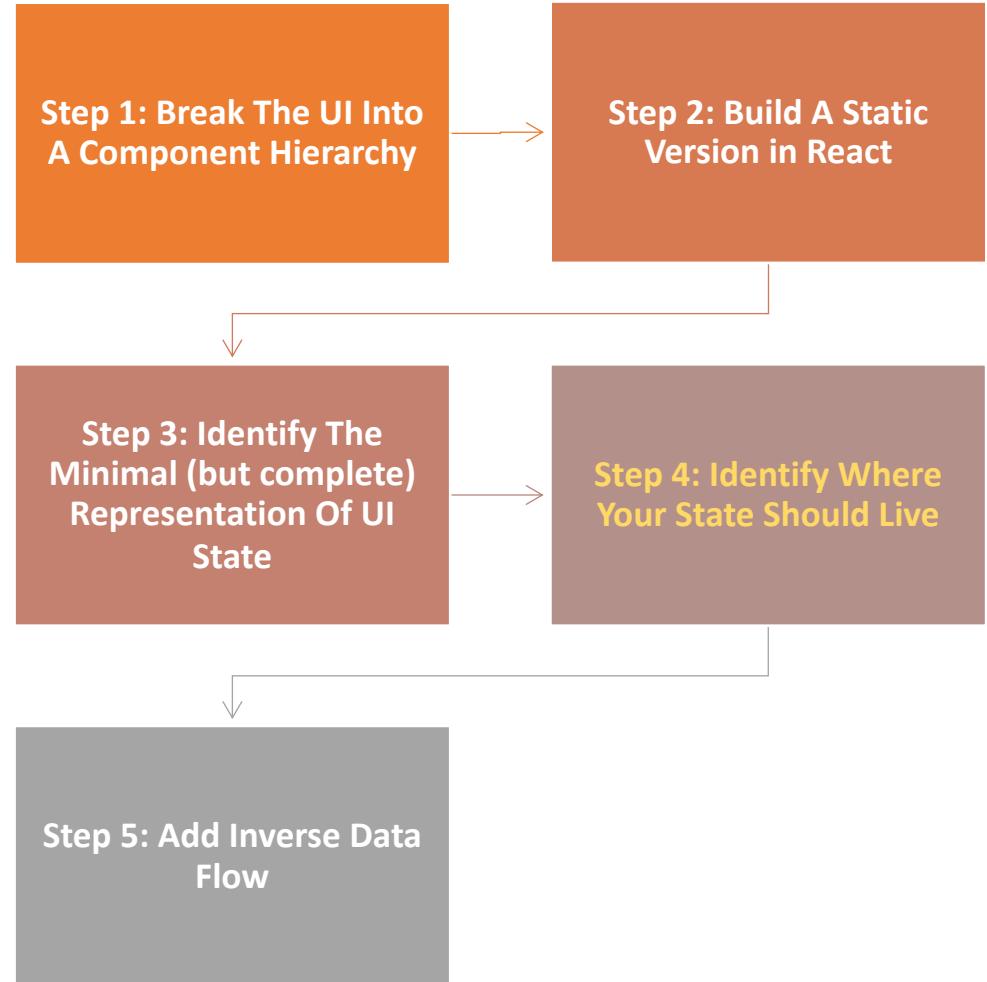
```
let p3 =  
JSON.parse( JSON.stringify(person) );
```



# React Development Process

## Step 4:

### Identify Where Your State Should Live



# Where Should Your State Live?

---

- For each piece of state:
  - Identify every component that renders something based on that state.
    - Find a common owner component
    - The common owner or a component higher in the hierarchy should own the state.
  - If you can't find a common owner, create a new component higher up in the hierarchy just for holding the state.

# Lab 08: Adding State

React App

localhost:3000

Guest

## Welcome to React Bookstore



**Things Fall Apart**  
by Chinua Achebe  
published: 1958, Nigeria  
language: English  
pages: 209  
price: \$5

**In Cart**



**Fairy tales**  
by: Hans Christian Andersen  
published: 1835-37, Denmark  
language: Danish  
pages: 784  
price: \$5

**In Cart**



**The Divine Comedy**  
by: Dante Alighieri  
published: 1308-1321, Italy  
language: Italian  
pages: 928  
price: \$5

**In Cart**



**Yalkut Shimoni**



### Cart

Things Fall Apart - 5  
Fairy tales - 5  
The Divine Comedy - 5  
Total: \$15 USD

# Events



# SyntheticEvent



- A cross-browser wrapper around the browser's native event
- Hides the implementation details of how React events translate to DOM events
- Contains the same properties as native events, along with some React-specific ones.

# Event Listener Attributes

---

- React's built-in components support HTML-style event listener attributes.
- There are some differences between how to use these in React and how they're used in HTML
- React event listener attributes use camelCase
  - onSubmit
  - onClick
  - onChange

# The Event Object

---

- React events create a `SytheticBaseEvent` object
- `SyntheticBaseEvent` has a property called `NativeEvent`, which contains the properties of the native DOM event.
- You can use `SyntheticBaseEvent` the same as you the native `Event` object in JavaScript without React.
- `SyntheticBaseEvent` is passed to the callback function when an event happens.

# Event Handler Functions

---

- Unlike HTML event listeners, which take a function call, React event handlers take a function name or a function.
- HTML
  - `<button onclick="handleChange()">Click Me</button>`
- React (JSX)
  - `<button onClick={handlechange}>Click Me</button>`
- The function will be called, and the Synthetic Event will be passed to it, when the event happens.

# Binding Event Handlers

---

- When you pass a function from a class component to another component, you need to bind the function to the parent class to provide the correct context for the `this` keyword.
- Only necessary when using method notation or the `function` keyword in class components.
- Arrow functions are automatically bound to the object where they're created.
- Function components don't have an instance (no `this`), so no binding inner functions.

# Passing Data to Event Handlers

---

- Many times, the event object contains all the data you need for the event handler function, so there's no need to explicitly pass arguments.

```
handleEvent (e) {  
  this.setState ({firstName:e.target.value}) ;  
}
```

```
<input type="text" onChange={handleEvent} />
```

- If you want to pass data to an event handler, one way is to use an arrow function as the value of the listener.

```
<input type="text"  
  onChange={ (e)=>updateName (e.target.value) } />
```

# Important Event Properties

---

- `Event.cancelable` indicates whether an event can be canceled.
- `Event.target` references the object onto which the event was originally dispatched (such as an element that was clicked or a form input that was typed into).
- `Event.type` contains the name of the event, such as `click`, `change`, `load`, `mouseover`, and so forth.
- `Event.preventDefault` cancels an event if it's cancelable.

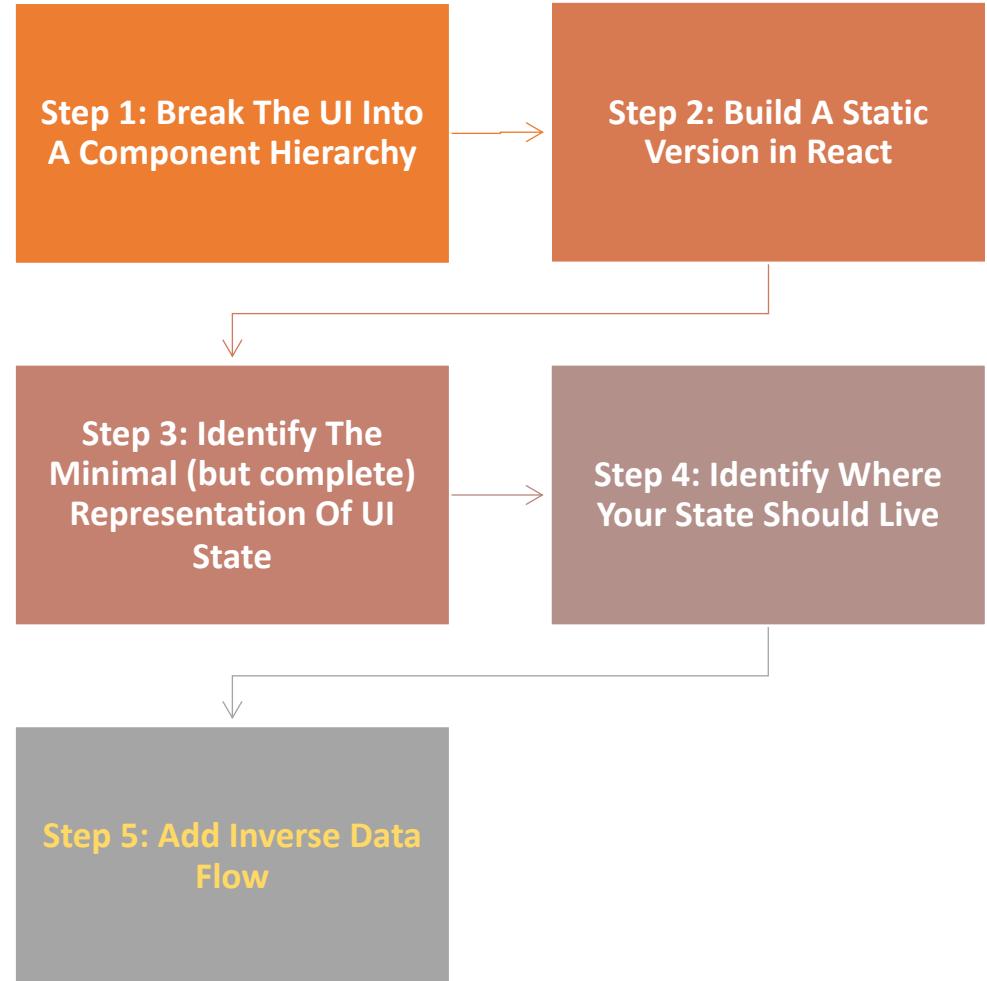
# Forms

---

- Objectives
- Use Controlled Components
- Use Uncontrolled Components

# React Development Process

## Step 5: Add Inverse Data Flow



# What is "Inverse Data Flow"?

---

- Use a function to update state in components higher up in the hierarchy.

# Forms Have State

---

- They are different from other native components because they can be mutated based on user interactions.
- Properties of Form components
  - value
    - supported by <input> and <textarea>
  - checked
    - supported by <input type="checkbox | radio" />
  - selected
    - supported by <option>
- <textarea> should be set with value attribute, rather than children in React

# Form Events

---

- Form components allow listening for changes using `onChange`
- The `onChange` prop fires when:
  - The value of `<input>` or `<textarea>` changes.
  - The checked state of `<input>` changes.
  - The selected state of `<option>` changes.

# Controlled Components

---

- A controlled <input> is one with a value prop.
- User input has no effect on the rendered element.
- To update the value in response to user input, you can use the onChange event.
- Controlled vs. Uncontrolled Demo:
  - <https://goo.gl/wMMbVc>

# Uncontrolled Components

---

- An `<input>` without a `value` property is an uncontrolled component.

```
render() {  
  return <input type="text" />;  
}
```

- User input will be reflected immediately by the rendered element.
- Maintains its own internal state

# Preventing Default Actions

---

- Use Event.preventDefault to prevent an element's default action from happening.
- Commonly used with forms to prevent submitting from trying to load a separate page.

```
handleSubmit (e) {  
  e.preventDefault ();  
  // do something here  
}
```

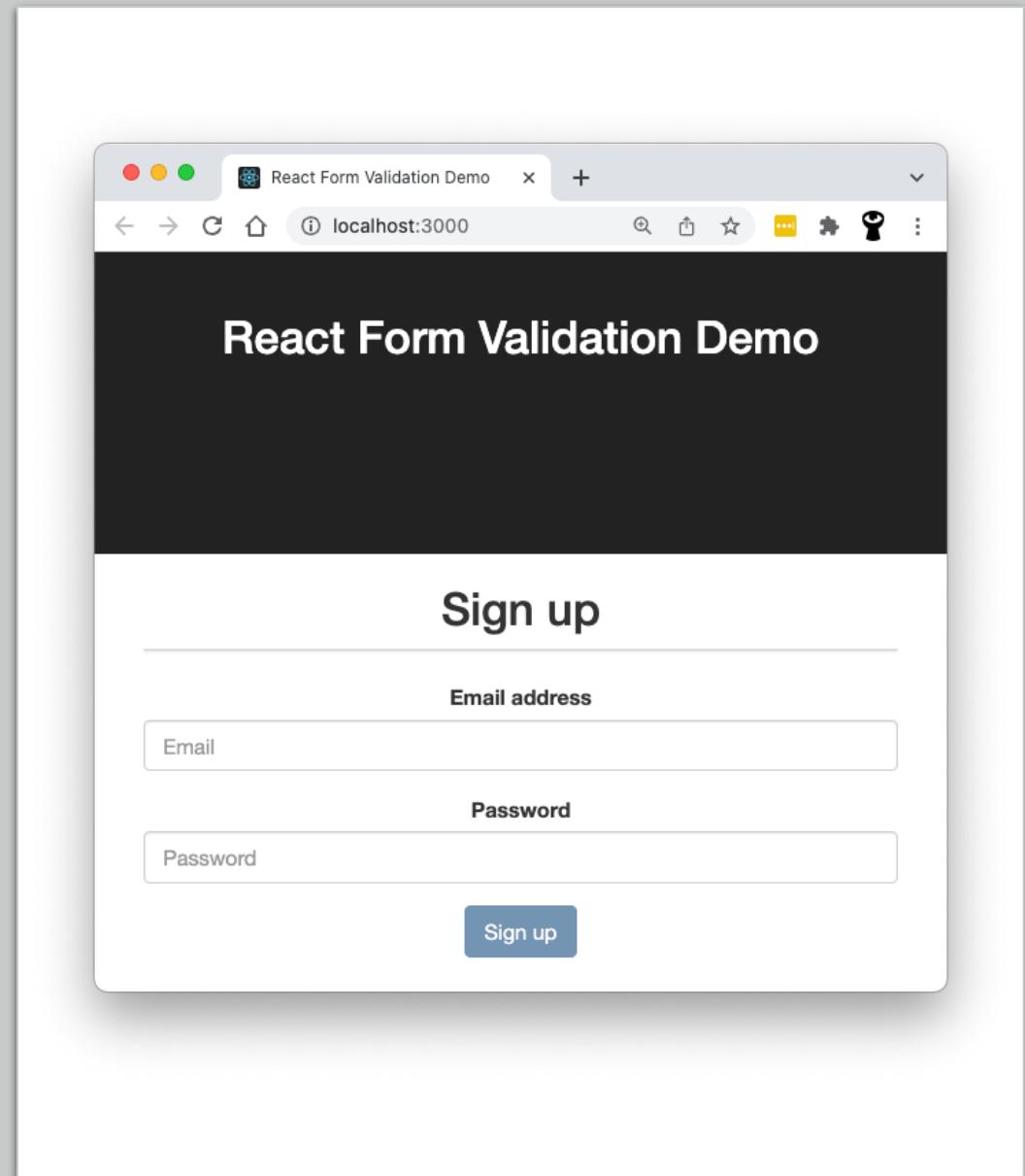
# Complex Forms and Validation

---

- Two methods:
  1. Write your own
    - benefits
      - write only the validators you need
      - more customizable
      - no need to upgrade third-party component
    - disadvantages
      - may not be as robust or efficient as a library
      - will take longer
      - requires writing regular expressions
  2. Use a library
    - react-hook-form
    - formik
    - redux-form

# Basic Form Validation

- Demo



# Refs

---

- Gives React access to a DOM node or an instance of a component.

# Creating a ref in a Class Component

```
class TextReader extends Component {  
  constructor(props) {  
    super(props);  
    this.textView = React.createRef();  
  }  
  render() {  
    return (  
      <textarea ref={this.textView}  
        value={this.props.bookText} />  
    );  
  }  
}  
export default TextReader;
```

# Creating a ref in a Function Component

```
import {useRef} from 'react';

function TextReader(props) {
  const textView = useRef(null);

  return (
    <textarea ref={textView}
              value={props.bookText} />
  );
}

export default TextReader;
```

# Using refs

```
class TextReader extends Component {  
  
  constructor(props) {  
    super(props);  
    this.textView = React.createRef();  
  }  
  
  componentDidMount() {  
    this.textView.current.focus();  
  }  
  
  render() {  
    return (  
      <textarea style={{width:'380px',height:'400px'}}  
        ref={this.textView}  
        value={this.props.bookText} />  
    );  
  }  
}  
  
export default TextReader;
```

# Callback Ref

---

- To use, pass a function into the ref attribute.
- Doesn't use createRef or useRef.
- The function receives the React component.
- The function will be called when the component mounts and called again with null with the component unmounts.
- Useful when the child you're attaching the ref to is dynamic.

# Callback ref Example

```
class TextReaderCallback extends Component {
  constructor(props) {
    super(props);
    this.textView = null;
    this.focusTextView = () => {
      if (this.textView) this.textView.focus();
    };
  }
  componentDidMount() {
    this.focusTextView();
  }
  render() {
    return (
      <textarea style={{width:'380px',height:'400px'}} 
        ref={(e)=>this.textView = e}
        value={this.props.bookText} />
    );
  }
}
export default TextReaderCallback;
```

# When to Use Refs

---

- Managing focus, text selection, or media playback.
- Triggering imperative animations.
- Integrating with third-party DOM libraries.

**Avoid using refs for anything that can be done declaratively.**

# Lab 09:

## Interactions, Events, Callbacks

React App

localhost:3000

### Welcome to React Bookstore

Fairy tales

**Things Fall Apart**

by: Chinua Achebe  
Published: 1958,  
Nigeria  
Language: English  
Pages: 209  
Price: \$5

In Cart

**The Divine Comedy**

by: Dante Alighieri  
Published: 1308-  
1321, Italy  
Language: Italian  
Pages: 928  
Price: \$5

Add to Cart

**The Book Of Job**

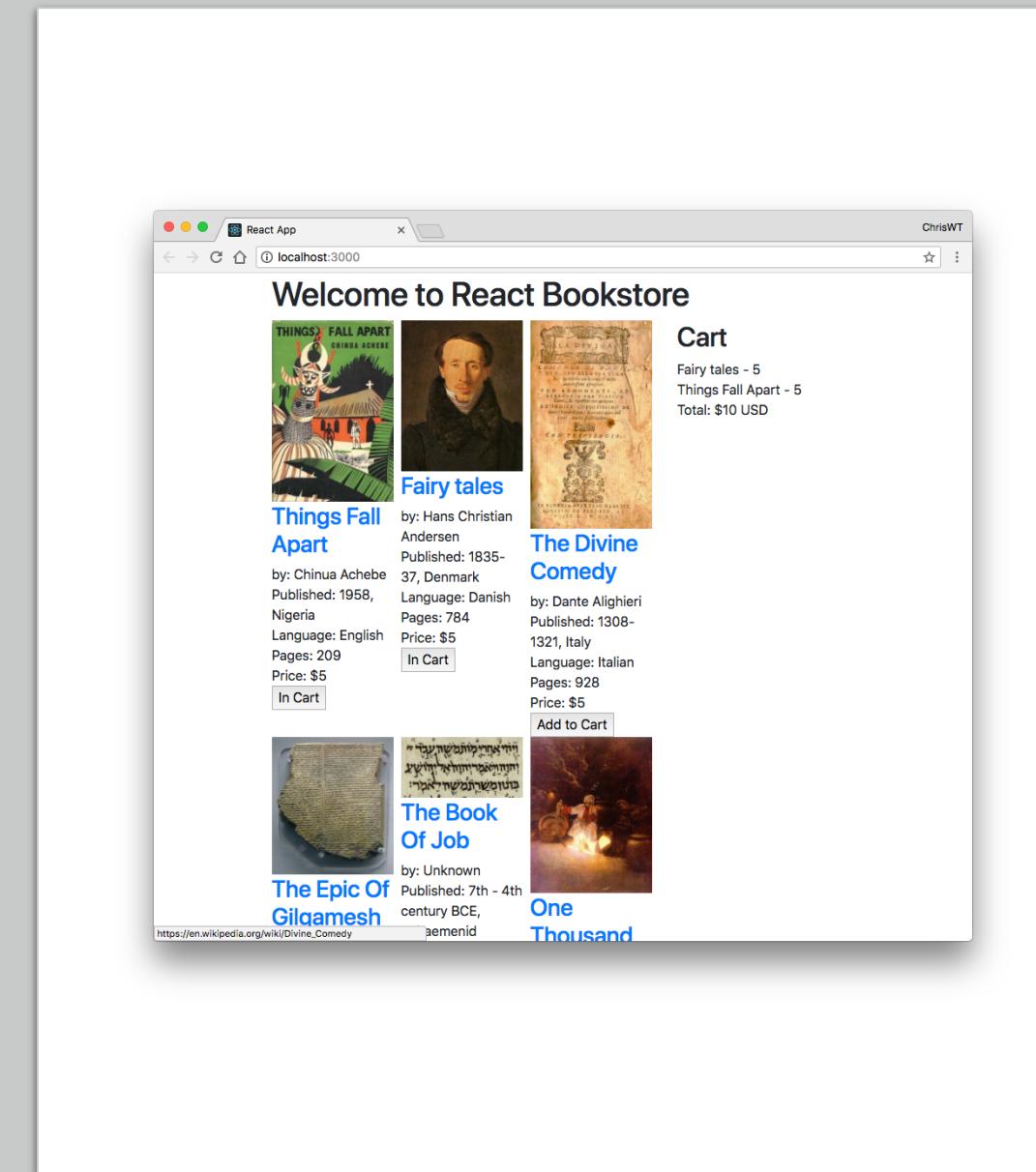
by: Unknown  
Published: 7th - 4th  
century BCE,  
æmenid

**The Epic Of Gilgamesh**

[https://en.wikipedia.org/wiki/Divine\\_Comedy](https://en.wikipedia.org/wiki/Divine_Comedy)

Cart

Fairy tales - 5  
Things Fall Apart - 5  
Total: \$10 USD



# Component Life-Cycle Events

---

- Categories
  - Mount
  - Updating
  - Unmounting
  - Error handling

# Life-Cycle Methods

---

- Methods of components that allow you to hook into views when specific conditions happen.

# Mount/Unmount

---

- Mount and unmount methods are called when components are added to the DOM (Mount) and removed from the DOM (Unmount).
- Each is invoked only once in the lifecycle of the component
- Used for:
  - establish default props
  - set initial state
  - make AJAX request to fetch data for component
  - set up listeners
  - remove listeners

# Mount/Unmount Lifecycle Methods

---

- constructor
- static getDerivedStateFromProps
  - checks whether props have changed and uses new props to update state
- render
- componentDidMount
- componentWillUnmount

# Updating Lifecycle Methods

---

- static `getDerivedStateFromProps`
- `shouldComponentUpdate`
  - returns a Boolean, which determines whether updating will happen.
- `getSnapshotBeforeUpdate`
  - use for capturing information about the state before updating
- `render`
- `componentDidUpdate`

# Error Handling Methods

---

- `getDerivedStateFromError`
  - Runs when an error happens in a descendant component.
  - Receives the error that occurred and can return an object for updating the state.
- `componentDidCatch`
  - Runs after a descendant component throws an error.
  - Useful for logging errors.

## ReactDOM.unmountComponentAtNode

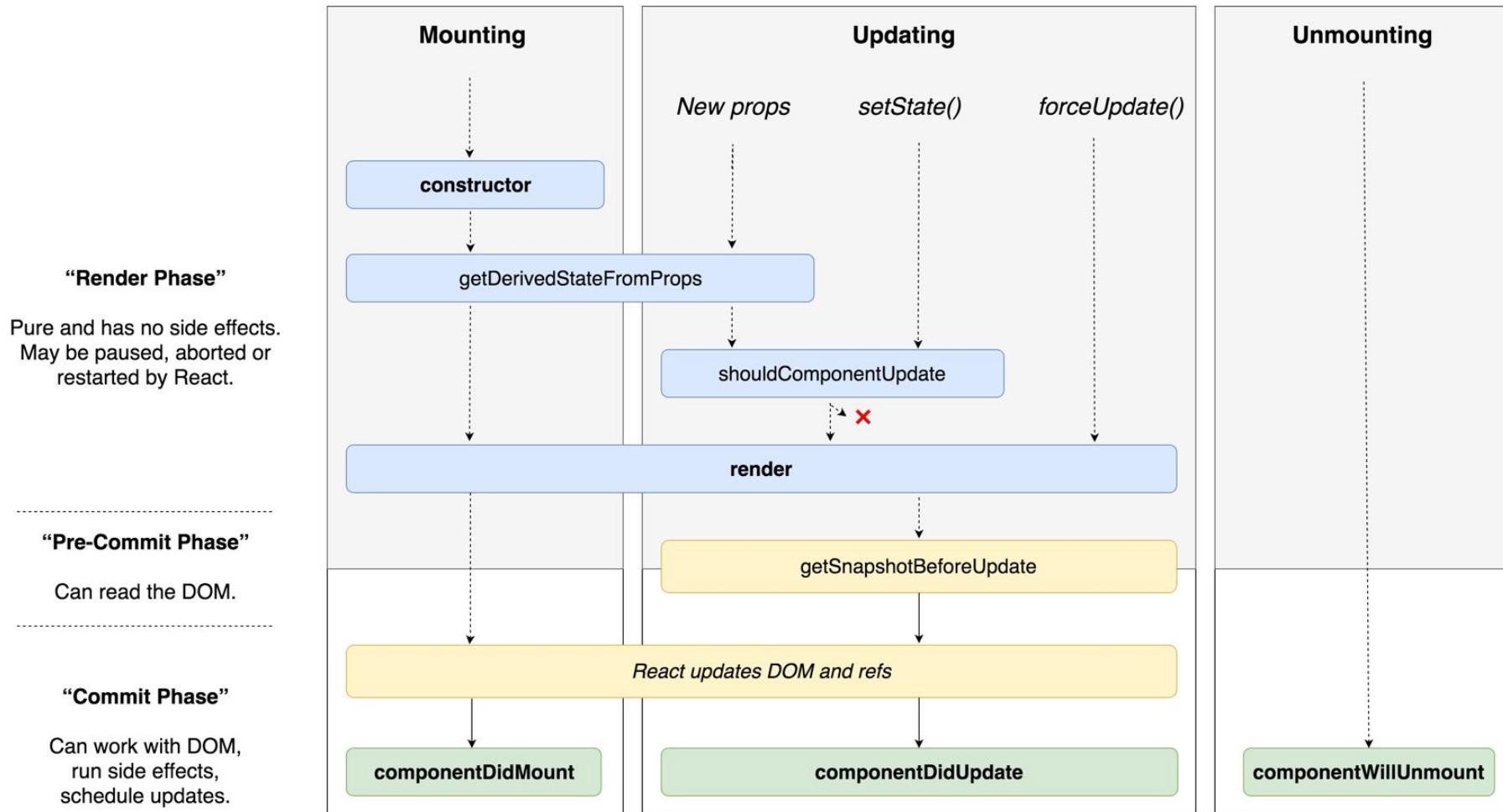
---

- Removes a mounted component from the DOM and cleans up its event handlers and state

ReactDOM.unmountComponentAtNode

```
(document.getElementById('container'));
```

# Component Life Cycle



# AJAX and Browser Storage

---



# Promises



# What Are Promises?

---

- An abstraction for asynchronous programming
- Alternative to callbacks
- A promise represents the result of an async operation
- Is in one of three states
  - pending – the initial state of a promise
  - fulfilled – represents a successful operation
  - rejected – represents a failed operation

# Promises vs. Event Listeners

---

- Event listeners are useful for things that can happen multiple times to a single object.
- A promise can only succeed or fail once.
- If a promise has succeeded or failed, you can react to it at any time.

```
readJSON(filename).then(success, failure);
```

# Why Use Promises?

---

- Chain them together to transform values or run additional async actions
- Cleaner code
  - Avoid problems associated with multiple callbacks
    - Callback Hell
    - Christmas Tree
    - Tower of Babel
    - Etc.

# Demo: Callback vs. Promise

---

- **Callback**

- ```
fs.readFile('text.txt', function(err,
  file) {
  if (err) {
    //handle error
  } else {
    console.log(file.toString());
  }
});
```

- **Promise**

- ```
readText('text.txt')
  .then(function(data) {
    console.log(data.toString());
  }, console.error
);
```

# Using Promises

---

```
const fs = require('fs');

function readFileAsync (file, encoding) {
    return new Promise(function (resolve, reject) {
        fs.readFile(file, encoding, function (err, data) {
            if (err) return reject(err);
            resolve(data);
        })
    })
}

readFileAsync('myfile.txt')
    .then(console.log, console.error);
```

# Async / Await

---

- Simplifies using promises.

```
async function f() {  
    return 1;  
}
```

- An `async` function always returns a promise.

```
f().then(alert);
```

- You can use the `await` keyword inside an `async` function to wait until the promise resolves.

```
async function getUser() {  
    let resp = await fetch('http://url.com/users/');  
    return resp;  
}
```

# AJAX

---

- Fetch vs. Axios
- AJAX in class components
- AJAX in function components
- Four Ways
  - Root Component
    - *Best for small apps and prototypes.*
  - Container Components
    - *Create a container component for every presentational component that needs data from the server.*
  - Redux Thunk
    - *Lab: Thunk*
  - Redux Saga
  - Suspense & Async Rendering
- Demo: Authentication with React and JWT

# AJAX in Class Components

---

- Use `componentDidMount` lifecycle method

```
componentDidMount() {  
  axios.get(`http://www.reddit.com/r/${this.props.subreddit}.json`)  
    .then(res => { const posts =  
      res.data.data.children.map(obj =>  
        obj.data);  
  
      this.setState({ posts });  
    } );  
}
```

# AJAX in Function Components

---

- use useEffect hook

```
useEffect(() => {
  async function fetchData() {
    const response = await fetch(url);
    const json = await response.json();
    setData(json);
  }
  fetchData();
}, [url]);
```

# Fetch vs. Axios

---

- Fetch is built-in to browsers
- Axios is a separate library
- Axios converts JSON data automatically
- The response from Fetch must be converted to an object using `response.json()`

# Suspense

---

- Lets your components wait for something (such as data fetching).

```
<Suspense fallback={<h1>Loading profile...</h1>}>  
  <ProfileDetails />  
</Suspense>
```

- New in React 18

# Cross-origin Resource Sharing (CORS)

---

- Browsers block JavaScript from accessing data from API endpoints on different domains.
- Specifically, CORS is triggered for HTTP requests from JavaScript to:
  - different domain (example.com calling api.com)
  - different subdomain (example.com calling api.example.com)
  - different port (example.com calling example.com:3000)
  - different protocol (https://example.com calling http://example.com)

# CORS: Simple Request

---

- Simple request
  - GET or POST
- Non-simple request:
  - Content-Type other than application/x-www-form-urlencoded, multipart/form-data, or text-plain or a request with cookies.
  - Server returns Access-Control-Allow-Origin header, which is checked by the browser.

# Access-Control-Allow-Origin

---

- Header returned by HTTP server
- Can allow any origin:
  - Access-Control-Allow-Origin: \*
- Or specific origins:
  - Access-Control-Allow-Origin: <https://example.com>
- Example (using Node / express):

```
const cors = require('cors');
app.use(cors({
    origin: 'https://www.example.com'
}));
```

# CORS: Non-simple request

---

- If the request is non-simple, the browser will make a preflight request.
- Preflight request uses the OPTIONS method to determine if the non-simple request can be made.
- Example:

```
curl -i -X OPTIONS localhost:3001/api/ping  
\\ -H 'Access-Control-Request-Method: GET'  
\\ -H 'Access-Control-Request-Headers:  
Content-Type, Accept'  
\\ -H 'Origin: http://localhost:3000'
```

# Preflight Response

---

- Server responds to Preflight request with headers.
- Example:

HTTP/1.1 204 No Content

Access-Control-Allow-Origin: \*

Access-Control-Allow-Methods:  
GET, HEAD, PUT, PATCH, POST, DELETE

Vary: Access-Control-Request-Headers

Access-Control-Allow-Headers: Content-Type,  
Accept

Content-Length: 0

Date: Fri, 05 Apr 2019 11:41:08 GMT

Connection: keep-alive

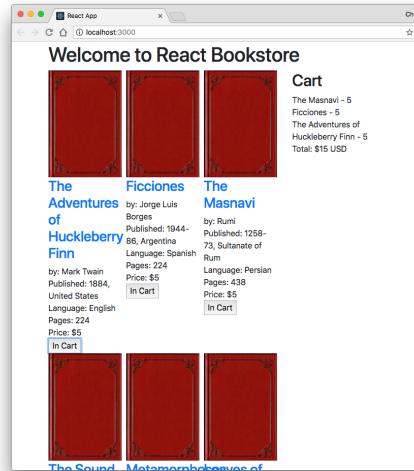
# Preflight (cont.)

---

- Browser examines headers returned by server to determine whether to make the non-simple request.

# Lab 10:

## Component Life-Cycle and AJAX



# Hooks



# The Problem: Functions Aren't Classes

---

Functional Components:

- can't have state.
- can't use lifecycle methods.
- can't update state

# The Solution



- Hooks!

# What are Hooks?

---

- Hooks provide access to imperative ways of working in React
- Completely opt-in
- Backwards compatible
- Reduces complexity
- Provides a more direct API to props, state, context, refs, and lifecycle
- Provides a standard way to reuse behavior between components
- Hooks let you use more of React's features without Classes

# But What are Hooks?

---

- Hooks are functions that let you hook into React state and lifecycle features from function components.
- Hooks allow you to reuse stateful logic without changing your component hierarchy.

# Built-in Hooks

---

- React has several “built-in” hooks.
- useState
  - Takes an initial value and returns a state variable and a method for updating that variable.
- useEffect
  - Adds the ability to perform side effects from a function.
  - Serves the same purpose as componentDidMount, componentDidUpdate, and componentWillUnmount.
  - Lets you call a function when any of these lifecycle events happen.

# Rules of Hooks

---

- Must be called at the top level
  - Not inside loops, conditions, or nested functions.
- Can only be called from function components.
- Hooks start with “use” by convention.

# useState

---

```
import React, { useState } from 'react';
function Example() {
  const [count, setCount] = useState(0);
  return (
    <div>
      <p>You clicked {count} times</p>
      <button onClick={() => setCount(count + 1)}>
        Click me
      </button>
    </div>
  );
}
```

# useState can be used multiple times

---

```
function ManyStates() {  
  const [animal, setAnimal] = useState('monkey');  
  const [name, setName] = useState('Chris');  
  const [todos, setTodos] = useState([{ text: 'eat  
lunch' }]);  
  // ..  
}
```

# useEffect

---

- Adds the ability to perform side effects from a function component.
- Serves the same purpose as `componentDidMount`, `componentDidUpdate`, and `componentWillUnmount`
- By default, React runs effects after every render, including the first.

# useEffect example

---

```
function LifecycleDemo() {  
  useEffect(()=> {  
    console.log('render!');  
    //optional "cleanup" return statement  
    to run before render or unmount  
    return () =>  
      console.log('unmounting');  
  })  
  
  return "This is a lifecycle demo";  
}
```

# When does useEffect run?

---

- By default: before every render.
- Want to run it less often?
  - Provide a 2nd argument
    - Array
    - If one of them has changed, the effect will run again.
    - Will still run after the initial render.
  - To run only on Mount and Unmount, pass an empty array `[]`
    - Simulates componentDidMount lifecycle method

# Uses for useEffect

---

- Fetch initial data
- focus inputs on first render
- Re-fetching when data changes

# More Built-in Hooks

---

- useContext
- useReducer
- useCallback
- useMemo
- useRef
- useImperativeHandle
- useLayoutEffect
- useDebugValue

# Custom Hooks

---

- A JavaScript function whose name starts with "use" and that may call other Hooks.
- Lets you extract component logic into reusable functions.
- Isn't a feature of React, but is enabled by Hooks.

# Why Use Custom Hooks

---

- Share logic between components.
- Hide complex logic behind a simple interface.

# Custom Hook Examples – React Spring

---

- React Spring
  - Animation library
    - useSpring
    - useTransition
    - useChain
  - Examples: <https://www.react-spring.io/docs/hooks/examples>

# Custom Hooks Examples - useFetch

---

- data fetching Hook
- Several different versions currently exist

```
const { data, loading, setUrl } =  
useFetch('https://your.api.url/search/');
```

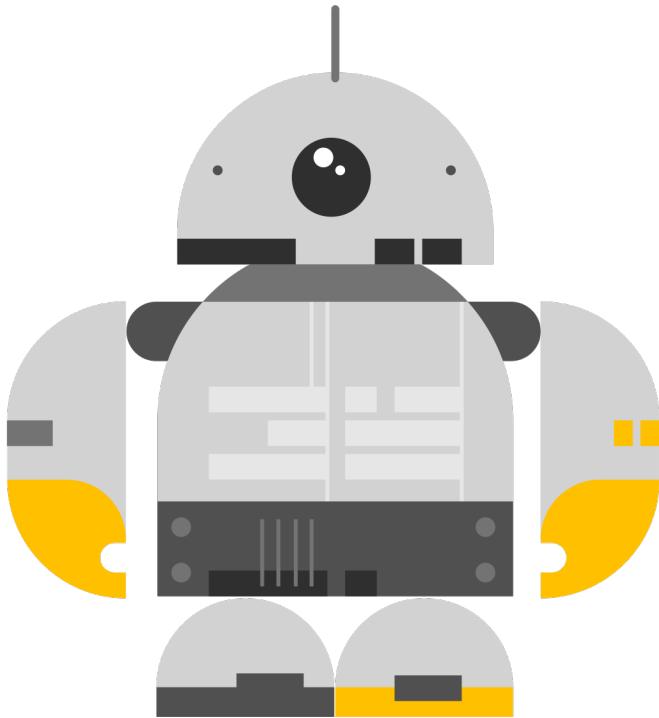
# Making Custom Hooks

---

- Make a function with a name starting with 'use'
- Use other hooks inside it
- Custom hooks can be reused in multiple components and each instance will have its own isolated state.

# Lab 11:

## Converting a Class Component to a Function Component



# PropType

---

- Allows you to add type to props
- Useful for debugging, documentation
- Types:
  - array
  - object
  - string
  - number
  - bool (not boolean)
  - func (not function)
  - node
  - element

# Using PropTypes

---

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

class Component extends React.Component {
  ...
}

Component.propTypes = {
  name: PropTypes.string.isRequired,
  size: PropTypes.number.isRequired,
  color: PropTypes.string.isRequired,
  style: PropTypes.object
};
```

# propTypes on Function Components

---

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

function MyComponent(props) {
  return (
    ...
  );
}

MyComponent.propTypes = {
  name: PropTypes.string.isRequired
}
export default MyComponent;
```

# defaultProps

---

- A class property (like Component.propTypes) that specifies defaults for props.

```
class Greeting extends React.Component {  
  render() {  
    return (  
      <h1>Hello, {this.props.name}</h1>  
    );  
  }  
}
```

```
Greeting.defaultProps = { name: 'Stranger' };
```

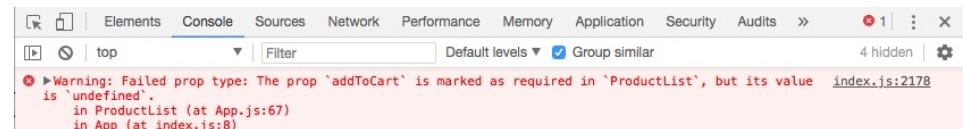
# defaultProps / propTypes using Static Property Syntax

---

```
class Greeting extends React.Component {  
  static defaultProps = { name: 'Stranger' };  
  render() {  
    return (  
      <h1>Hello, {this.props.name}</h1>  
    );  
  }  
}
```

# Lab 12:

## PropTypes and Default Props



# React with TypeScript



# TypeScript Basics

---

- JavaScript with Syntax for Types
- Strongly typed language
- Converts to JavaScript

# Why TypeScript?

---

- Static type checking
- Better tooling
- Better documentation
- More confidence in code
- Can be applied gradually

# JS vs. TS

## JS

```
function greet(name) {  
    return `Hello, ${name}!`;  
}
```

```
greet(17);
```

```
"Hello 17!"
```

## TS

```
function greet(name:string) {  
    return `Hello, ${name}!`;  
}
```

```
greet(17);
```

Argument of type 'number' is not assignable to parameter of type 'string'.

# Type inference

---

- When you declare a variable using var, let, or const, you can optionally add a type annotation
  - `let myName: string = "Chris";`
- However, this isn't necessary most times. TypeScript will infer the type from the type of the initial value.
  - `let myName = "Chris"; // myName is inferred as 'string'`

# Type annotations in functions

---

- Parameters with type annotations will be checked.
- Return values can be annotated too, but it's not usually necessary because TypeScript can infer it.

# Annotating Objects

---

- List properties and their types.

```
function doSomething(options: {speed: number,  
priority: number, comments?: string})
```

- The ? indicates that a property is optional.
- If you don't specify a type, it will be assumed to be 'any',

# Union Types

---

- Types formed from two or more types.

```
function (loginId: number | string)  
{
```

```
    ...
```

```
}
```

- loginID can be either a number or a string

# Type aliases

---

- A name for a type
- Allows reuse of types

```
type Coords = {  
    x: number,  
    y: number  
}
```

# Interfaces

---

- Another way to name a type.

```
interface Coords = {  
    x: number,  
    y: number  
}
```

- Interfaces can be extended, unlike aliases.

# Extending Interfaces

---

```
Interface Person {  
    name: string  
}
```

```
Interface Customer extends Person {  
    creditLimit: number  
}
```

# Type Assertions

---

- Specifies a more specific type than TS can know about.

```
const myCanvas =  
document.getElementById("main_canvas") as  
HTMLCanvasElement;
```

# Literal Types

---

- Sets a type to a specific value.
  - `let x: "hello" = "hello";`
- Is useful when used with unions to specify possible values for a variable.
  - `function printText(s: string, alignment: "left" | "right" | "center") {`

# React TypeScript Cheatsheet

---

- <https://github.com/typescript-cheatsheets/react#reacttypescript-cheatsheets>
- Really handy copy / paste examples

# Getting Started with TypeScript in React

---

- Create-React-App includes typescript support
- Start a new project with:

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

# or

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

# File Naming

---

- For files containing JSX:

`filename.tsx`

- For other TS files:

`filename.ts`

# Lab 13:

## Converting to TypeScript

1. Make a new CRA project, using the typescript template
2. Copy code from your existing React Bookstore project and start converting it to TypeScript.
3. Run npm start to see TypeScript errors and fix them.

# React Patterns and Best Practices

---



## F.I.R.S.T.

---

- React Components should be:
  - Focused
  - Independent
  - Reusable
  - Small
  - Testable

# Single Responsibility

---

- A component should only do one thing.
- If it ends up growing, it should be decomposed into smaller subcomponents.
- A responsibility is a "reason to change."
- Single responsibility makes components more robust.

"A class should have only one reason to change."

*-Robert C. Martin*

# Pure Functions

Pure functions always return the same result given the same arguments.

Pure function's execution doesn't depend on the state of the application.

Pure functions don't modify the variables outside of their scope (no side effects).

# Benefits of Pure Functions

Easy to test

Easy to reason about

Easy to reuse

Easy to reproduce the results

# Function Comparison

## **slice()**

```
var toppings =  
['cheese', 'pepperoni', 'mushrooms'];  
  
toppings.slice(0,2);  
// ["cheese", "pepperoni"]  
toppings.slice(0,2);  
// ["cheese", "pepperoni"]  
toppings.slice(0,2);  
// ["cheese", "pepperoni"]
```

- Always returns the same result given the same arguments
- Doesn't depend on the state of the application
- Doesn't modify variables outside its scope
- **It's a Pure Function!**

## **splice()**

```
var toppings =  
['cheese', 'pepperoni', 'mushrooms'];  
  
toppings.splice(0,2);  
// ["cheese", "pepperoni"]  
toppings.splice(0,2);  
// ["mushrooms"]  
toppings.splice(0,2);  
// []
```

- **Not Pure!**

# React.PureComponent

---

- If your Component returns the same result given the same props and state, use React.PureComponent
- PureComponent does a shallow state and prop comparison and doesn't update if the component is unchanged.
- May give a performance boost

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

# React.memo

---

- Works the same as React.PureComponent, but for functional components.

```
const MyComponent = React.memo(  
  function MyComponent(props) {  
    ...  
  } );
```

# Composition

---

- Composition is combining smaller components to form a larger whole.

# Container Components

---

- Wrap presentational components
- Contain the logic and state

# Presentational Components

---

- Components that just output presentation
- Contain no logic

# Higher Order Functions

---

- A **function** that can take another **function** as an argument and/or that returns a **function** as a result.

```
const multiplyBy = (multiplier) => (number) => number *  
multiplier
```

```
const double = multiplyBy(2); // returns (number) => number * 2
```

```
double(10) // returns 20
```

# Higher Order Components

---

- A **function** that takes (wraps) a component and returns a new component.
- Allow us to abstract over actions, not just values.

```
const EnhancedComponent =  
higherOrderComponent(WrappedComponent);
```

# Reusable Components

---

- Break down the common design elements (buttons, form fields, layout components, etc.) into reusable components with well-defined interfaces.
- The next time you need to build some UI, you can write much less code.
- This means faster development time, fewer bugs, and fewer bytes down the wire.

# Test-Driven Development

- Objectives
- Learn the TDD Steps
- Write Assertions
- Understand exception handling in JS
- Create tests with Jest
- Automate cross-browser testing

# Goal of TDD



- Clean code that works.

# The TDD Cycle

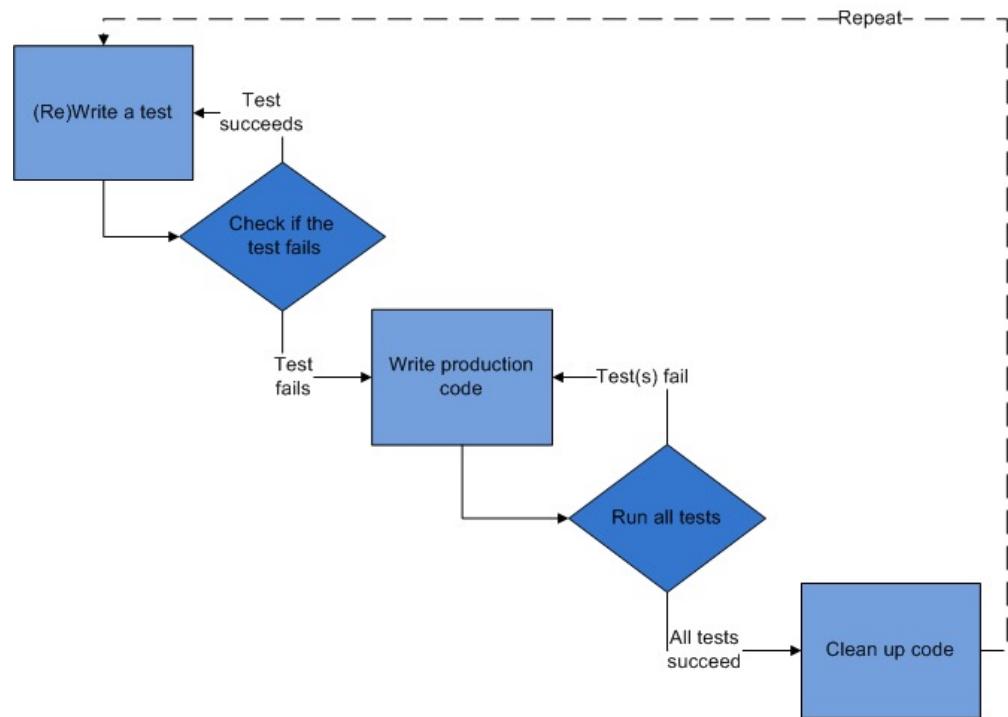
---

- Red
  - write a little test that doesn't work.
- Green
  - make the test work, as quickly as possible.
  - don't worry about doing it right.
- Refactor
  - eliminate duplication created in making the test work.

# TDD Steps

---

- Write a test
- Check that test fails
- Write code
- Run test - passes!
- Refactor
- Repeat



# Red

---

- Write the story.
- Invent the interface you wish you had.
- Characteristics of a good tests:
  - Each test should be independent of the others.
  - Any behavior should be specified in only one test.
  - No unnecessary assertions
  - Test only one code unit at a time
  - Avoid unnecessary preconditions

# Green

---

- Get the test to pass as quickly as possible.
- Three strategies:
  - Fake it
    - Do something, no matter how bad, to get the test to pass.
  - Use an obvious clean solution.
    - But don't try too hard!
  - Triangulation
    - only generalize code when you have two examples or more.
    - When the 2<sup>nd</sup> example demands a more general solution, then and only then do you generalize.

# Refactor

---

- Make it right.
- Remove duplication.
- Improve the test.
- Repeat.
- Add ideas or things that aren't immediately needed to a todo list.

# Assertions

---

- Expression that encapsulates testable logic
- Assertion Libraries
  - Chai, should.js, expect.js, better.assert
- Examples
  - `expect(buttonText).toEqual('Go!'); // jasmine`
  - `result.body.should.be.a('array'); // chai`
  - `equal($('h1').text(), "hello"); // QUnit`
  - `assert.deepEqual(obj1, obj2); // Assert`

# JavaScript Testing Frameworks

---

- Jasmine
- Mocha
  - doesn't include its own assertion library
- QUnit
  - from JQuery
- js-test-driver
- YUI Test
- Sinon.JS
- Jest

# JS Exception Handling

---

```
function hello(name) {  
    return "Hello, " + name;  
}  
  
let result = hello("World");  
let expected = "Hello, World!";  
try {  
    if (result !== expected) throw new Error  
        ("Expected " + expected + " but got " +  
            result);  
} catch (err) {  
    console.log(err);  
}
```

# Jest Overview

## Objectives

- Write test suites
- Create specs
- Set expectations
- Use matchers

JEST



# How Jest Works

---

- Suites describe your tests
- Specs contain assertions

```
describe("This is a suite", function() {  
  var a;  
  
  test("A spec test assertions", function() {  
    a = true;  
  
    expect(a).toBe(true);  
  });  
});
```

# Test Suites

---

- Created using the `describe` function
- Contain one or more specs
- 2 params
  - Text description
  - Function

```
describe("Hello", function() {  
  ...  
})
```

# Specs

---

- Created using the `it` or `test` function
  - they're the same thing
- Contains one or more expectations
- **expectations === assertions**

```
describe("Hello", function() {  
  
    it("Concats Hello and a name", function() {  
        var expected = "Hello, World!";  
        var actual = hello("World");  
        expect(actual).toEqual(expected);  
    });  
});
```

# Expectations

---

- AKA assertions
- Made using `expect` function,
  - Takes a value
- Chained to a Matcher
  - Takes the expected value

```
expect(actual).toEqual(expected);
```

# Matchers

---

- expect(fn).toThrow(e);
- expect(instance).toBe(instance);
- expect(mixed).toBeDefined();
- expect(mixed).toBeFalsy();
- expect(number).toBeGreaterThanOrEqual(number);
- expect(number).toBeLessThan(number);
- expect(mixed).toBeNull();
- expect(mixed).toBeTruthy();
- expect(mixed).toBeUndefined();
- expect(array).toContain(member);
- expect(string).toContain(substring);
- expect(mixed).toEqual(mixed);
- expect(mixed).toMatch(pattern);

# Testing React Components

---

- Objectives
- Learn about different rendering modes
- Learn about Jest
- Write Unit Tests with Jest

# What to Test in a React Component

---

- Does it render?
- Does it render correctly?
- Test every possible state / condition
- Test the events
- Test the edge cases

# ReactDOM.findDOMNode

---

- `findDOMNode(component)`
- **If the component has been mounted, returns the corresponding native browser DOM element**

# Jest

---

- Facebook's Testing Framework
- Runs any tests in `_tests_` directories, or named `.spec.js`, or named `.test.js`
- Simulates browser environment with jsdom

# Mocking

---

- Mock Function - erase the implementation of a function
- Manual Mocking - stub out functionality with mock data
- Timer Mocking - swap out native timer functions

# Mock Function

---

- `const mockCallback = jest.fn();`
- `forEach([0, 1], mockCallback);`
- `// The mock function is called twice`
- `expect(mockCallback.mock.calls.length).toBe(2);`
- `// The first argument of the first call to the function was 0`
- `expect(mockCallback.mock.calls[0][0]).toBe(0);`
- `// The first argument of the second call to the function was 1`
- `expect(mockCallback.mock.calls[1][0]).toBe(1);`

# Manual Mock

---

- Ensures tests will be fast and reliable by mocking external data and core modules.
- Define in a `__mocks__` subdirectory adjacent to the module

```
.  
├── config  
├── __mocks__  
│   └── fs.js  
├── models  
│   ├── __mocks__  
│   │   └── user.js  
│   └── user.js  
└── node_modules  
└── views
```

# Manual Mocks (cont.)

---

- Recommended practice is to create an automatic mock and then override it.
- See  
[https://github.com/facebook/jest/tree/master/examples/manual\\_mocks](https://github.com/facebook/jest/tree/master/examples/manual_mocks) for examples of manual mocks and tests that use them.

# Automocking

---

- Disabled by default, but can be used on a per-module basis
  - `jest.mock(moduleName)`
- Enable automock by default in `jest.config`
  - `automock: true`

# Snapshot Testing

---

1. Renders a components
2. Creates a "snapshot file" on first run
3. Compares subsequent runs with first and fails test if different.

# Sample Snapshot Test

---

```
import React from 'react';
import Link from '../Link.react';
import renderer from 'react-test-renderer';

it('renders correctly', () => {

  const tree = renderer.create(
    <Link page="http://www.facebook.com">
      Facebook
    </Link>).toJSON();

  expect(tree).toMatchSnapshot();
});
```

# TestUtils

---

- renderIntoDocument()
- mockComponent()
- isElement()
- isElementOfType()
- isDomComponent()
- isCompositeComponent()
- isCompositeComponentWithType()
- findAllInRenderedTree()
- more...
- **NOTE:** TestUtils has been moved into react-dom as of v15.5.0

# TestUtils Example

---

- Old (pre-15.5.0):
- import TestUtils from 'react-addons-test-utils';
  
- New (15.5.0):
- import TestUtils from 'react-dom/test-utils';

# Enzyme

---

- Testing utility for React, created by Airbnb
- 3 render modes
  - shallow
    - render just the component
  - mount (Full Rendering)
    - For testing where you have components that require the full lifecycle in order to test.
    - Need to run in a browser environment.
  - render
    - renders react components to static HTML
- To use, pass a React component into a mode method.
  - `const wrapper = shallow(<PollSubmitButton />);`

# Shallow Rendering

---

- Renders just a single component, regardless of where it is in the hierarchy.
- Allows you to isolate components for testing.
  - Ensure that your tests are indirectly asserting on behavior of child components.

# Lab 14: Testing with Jest and Enzyme

```
lab12 — node - npm MANPATH=/opt/local/man: TERM_PROGRAM=HyperTerm  
src/containers/App.test.js  
src/components/Cart.test.js  
src/components/Product.test.js  
src/components/CartItem.test.js  
src/components/ProductList.test.js  
  
 Suites: 5 passed, 5 total  
 :      5 passed, 5 total  
hots:  0 total  
       1.106s  
11 test suites.  
  
Usage: Press w to show more.
```

# Flux and Redux

- Objectives
  - Understand the Flux pattern
  - Explain Redux's architecture
  - Create Redux actions
  - Write pure functions
  - Use Reducers
  - Use Redux with AJAX

# Flux

---

- Flux isn't a library or module.
- It's a design pattern.
- npm install flux installs Facebook's dispatcher.
- It's possible to use Flux design principles without Facebook's module.

# Flux Flow

---

1. Some sort of interaction happens in the view.
2. This creates an action, which the dispatcher dispatches.
3. Stores react to the dispatched action if they're interested, updating their internal state.
4. Stateful view component(s) hear the change event of stores they're listening to.
5. Stateful view component(s) ask the stores for new data, calling `setState` with the new data.

# Flux Action

---

- An action in flux is what's made when something happens.
- In other words, when you click on something, that's not an action
  - it creates an action. Your click is an interaction.
- Actions should have (but aren't required to have) a type and a payload. Most of the time they will have both, occasionally they'll just have a type.

# Flux Dispatcher

---

- Broadcasts actions when they happen and it lets things tune in to those broadcasts
- Instead of an onClick function using a callback passed to it to set the state of your application, you have it (onClick) use the dispatcher to dispatch a specific action for anyone who's interested to listen for.

# Flux Stores

---

- Represents the ideal state of your application
- If a user enters something into a form, it dispatches an action. If the store is listening for this action, it will update its internal state accordingly.
- Stores don't contain any public setters, just public getters. The only ones who can change the data in a store is the store itself when it hears an action from the dispatcher that it's interested in.

# EventEmitter

---

- Stores emit change events that don't contain data.
- If the view is listening for the particular store's change event, the view should ask the store for the new data that will bring the view back into sync, call `setState`, and re-render.

# Redux

---

- An implementation of Flux
- Stores state of the app in an object tree in a single store
- The state tree can only be changed by emitting an action
- Specify how the actions transform the state tree using pure reducers

# Stores & Immutable State Tree

---

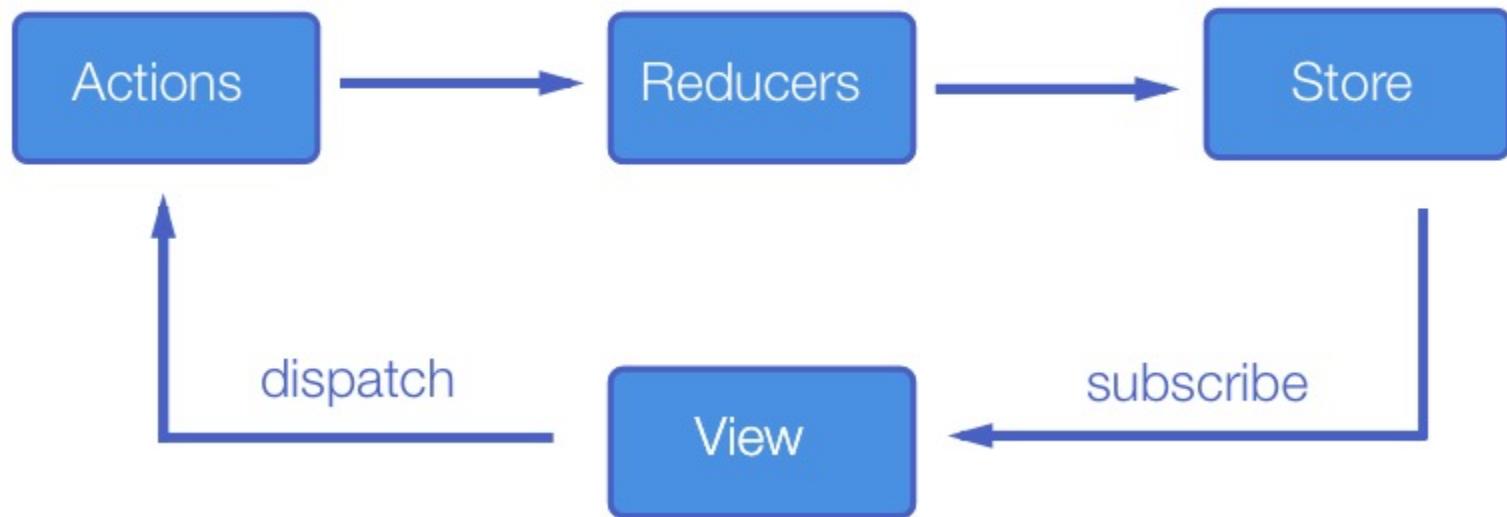
- The biggest difference between Flux and Redux is that Redux has a single store.
- Redux has a single store with a single root reducing function.
- Split the root reducer into smaller reducers to grow the app.
- Trace mutations by replaying actions that cause them.

# Redux Actions

---

- Payloads of information that send data from the application to the store.
- Actions are the only way to mutate the internal state.
- Use `store.dispatch()` to send them to the store.

```
const ADD_TODO = 'ADD_TODO'  
{  
  type: ADD_TODO,  
  text: 'Build my first Redux app'  
}
```



# Reducers

---

- Specifies how the application's state changes in response to something happening (an action).
- A pure function that takes the previous state and an action, and returns the next state.
- `(previousState, action) => newState`

# Things You Should Never do in a Reducer

---

- Mutate its arguments
- Perform side effects like API calls and routing transitions
- Call non-pure functions

# Reducer Composition

---

- The fundamental pattern of building Redux apps
- Split up reducer functions using child reducers.
- Workflow
  - Write top-level reducer to handle a particular function.
  - Break up the top-level reducer into a master reducer that calls smaller reducers to separate concerns.

# Reducer Composition Example

---

```
function checkedValue(state = [], action) {  
  switch (action.type) {  
    case 'SELECT_ANSWER':  
      return state  
        .slice(0,action.index)  
        .concat([action.value])  
        .concat(state.slice(action.index+1));  
    default:  
      return state;  
  }  
}  
export default checkedValue;  
  
function question(state = [], action) {  
  return state;  
}  
export default questions;
```

# Reducer Composition Example (cont.)

---

## Combine reducers

```
const rootReducer = combineReducers({  
  questions,  
  checkedValue  
});
```

```
Export default rootReducer;
```

# Higher Order Reducer

---

- `combineReducers()` is a higher order reducer
- A higher order reducer is a higher order function that returns a new reducer.

# Redux Store

---

- Holds the application state
- Allows access to state via `getState()`
- Allows state to be updated via `dispatch(action)`
- Registers listeners via `subscribe(listener)`
- Handles unregistering of listeners via the function returned by `subscribe(listener)`

# Redux Store Design

---

- Many applications use data that is relational or "nested"

```
let orders = [
  {
    id:1,
    customer:{id:20,name:"Wilma",address:""},
    items:[{id:10,name:"Toaster",price:20}]
  }
]
```

- Relational data mapped to objects can be complex and cause repetition.

# Redux Store Design

---

- Solution: Normalize part of your store, and treat it like a database.
- **Data normalization:**
- Each type of data gets its own "table" in the state.
- Each "data table" should store the individual items in an object, with the IDs of the items as keys and the items themselves as the values.
- Any references to individual items should be done by storing the item's ID.
- Arrays of IDs should be used to indicate ordering.

# Normalized Redux Store Example

---

```
{  
  orders : {  
    byId : {  
      "order1" : {id : "order1", customer : "customer1",  
                  items: ["item1","item2"]},  
      "order2" : {id : "order2", customer : "customer1",  
                  items: ["item1","item6"]}  
    },  
    allIds : [ "order1", "order2" ] ,  
  customers : {  
    byId : {  
      "customer1" : { ... }  
      ...  
    }  
  }  
}
```

# Benefits of Normalizing Store

---

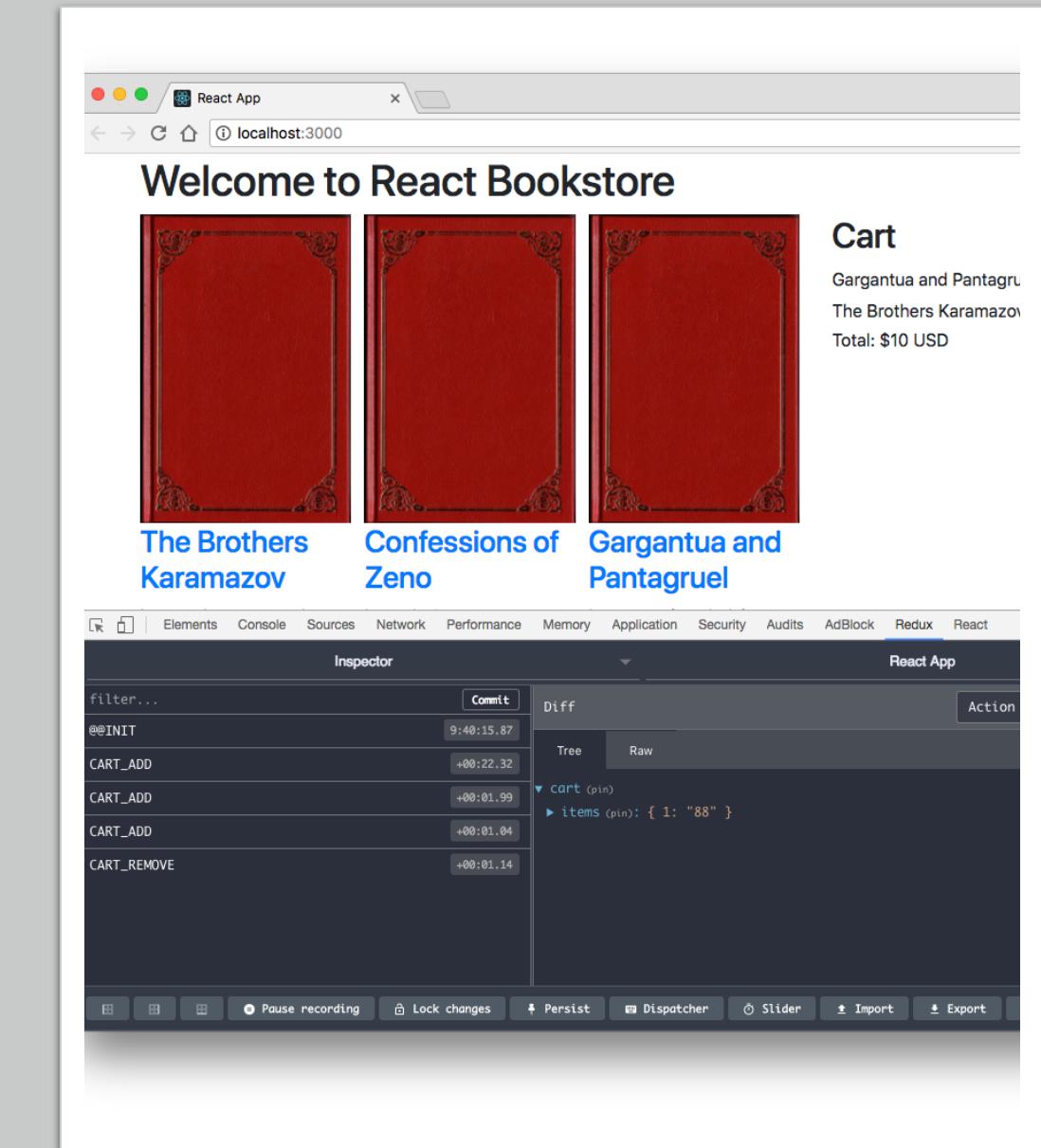
- Each item is defined in only one place
- Simplifies Reducer logic (flatter structure)
- Simplifies logic for retrieving and updating items
- Because each data type is separated, updates to a single type of data require fewer components to be re-rendered

# Redux Pros and Cons

---

- Redux Pros
  - Declarative
  - Immutable state
  - Mutation logic separate from views
  - Great for testing
- Redux Cons
  - More complicated than just using plain react components

# Lab 15: Implementing Redux



# What is Redux Middleware?

---

- a higher-order function that composes a dispatch function to return a new dispatch function.
- a third-party extension point between dispatching an action and the reducer.



# What is Middleware Good For?

---

- Logging actions
- Reporting errors
- Dispatching new actions
- Asynchronous requests

# React AJAX Best Practices

---

- Four Ways
  - Root Component
    - Best for small apps and prototypes.
  - Container Components
    - Create a container component for every presentational component that needs data from the server.
  - Redux Middleware
    - Thunk Middleware
    - Saga
  - Relay
    - Good for large applications
    - Declare data needs of components with GraphQL
    - Relay automatically downloads data and fills out the props

# Using React with Other Libraries

---

- Use the lifecycle events to attach logic from other libraries.
- `componentDidMount`
  - Attach code that will run when the component is loaded.
  - Can be used similarly to jQuery's `$(document).ready()`
- `componentDidUpdate`
  - Attach code that will run when a component updates.

# Redux Thunk

---

- Allows you to write action creators that return a function instead of an object.

# How is Thunk Useful?

---

- delay the dispatch of an action
- dispatch only if a certain condition is met
- perform async network operation
  - database
  - AJAX

# How does Thunk work?

---

1. Redux Thunk middleware is added to the store
2. When an action creator returns a function, that inner function will get executed by the Thunk middleware.
3. The inner function receives the store methods `dispatch` and `getState()` as parameters.
4. On success, the Thunk action calls a standard action.

# Redux Saga

---

- Useful for complex async operations.
- Uses generator functions to complete actions in series.
- [redux-saga.js.org/docs/introduction/BeginnerTutorial.html](https://redux-saga.js.org/docs/introduction/BeginnerTutorial.html)  
!

# Using Sagas

```
//install redux-saga
npm install --save redux-saga

//dispatch an action
class UserComponent extends React.Component {
...
onSomeButtonClicked() {
    const { userId, dispatch } = this.props;
    dispatch({
        type: 'USER_FETCH_REQUESTED',
        payload: {userId} });
}
...
}
```

# Using Sagas (cont.)

```
// create a "worker" saga to do the async action

import { call, put, takeEvery, takeLatest } from 'redux-saga/effects';
import Api from '...';

// worker Saga: will be fired on USER_FETCH_REQUESTED actions

function* fetchUser(action) {
  try {
    const user = yield call(Api.fetchUser, action.payload.userId);
    yield put({type: "USER_FETCH_SUCCEEDED", user: user});
  } catch (e) {
    yield put({type: "USER_FETCH_FAILED", message: e.message});
  }
}
```

# Using Saga (cont.)

```
// create a listener saga to listen for the event

function* mySaga() {
    yield takeEvery("USER_FETCH_REQUESTED", fetchUser);
}

/* Alternatively you may use takeLatest.

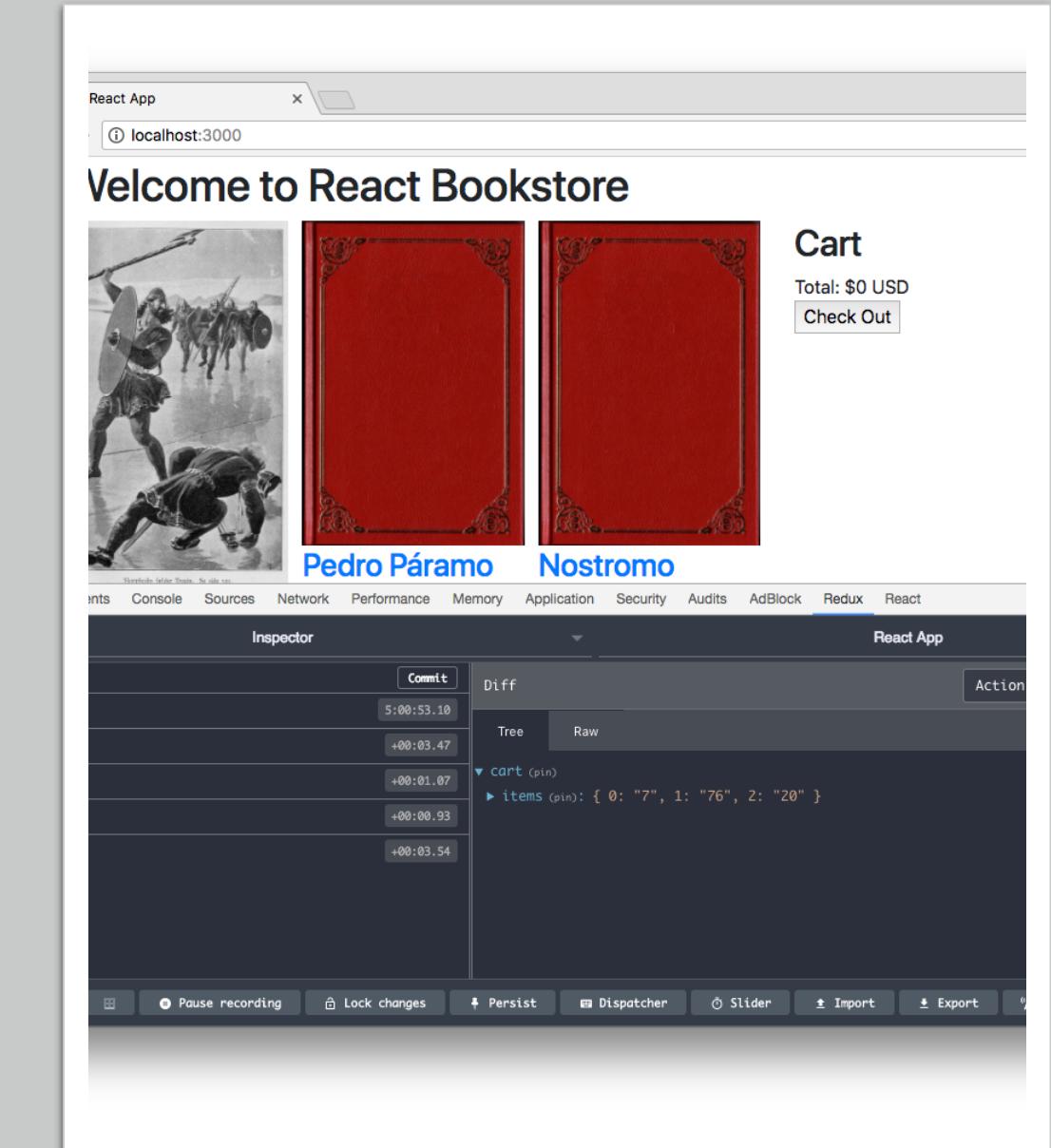
function* mySaga() {
    yield takeLatest("USER_FETCH_REQUESTED", fetchUser);
}
*/
// export mySaga
export default mySaga;
```

# Using Saga (cont.)

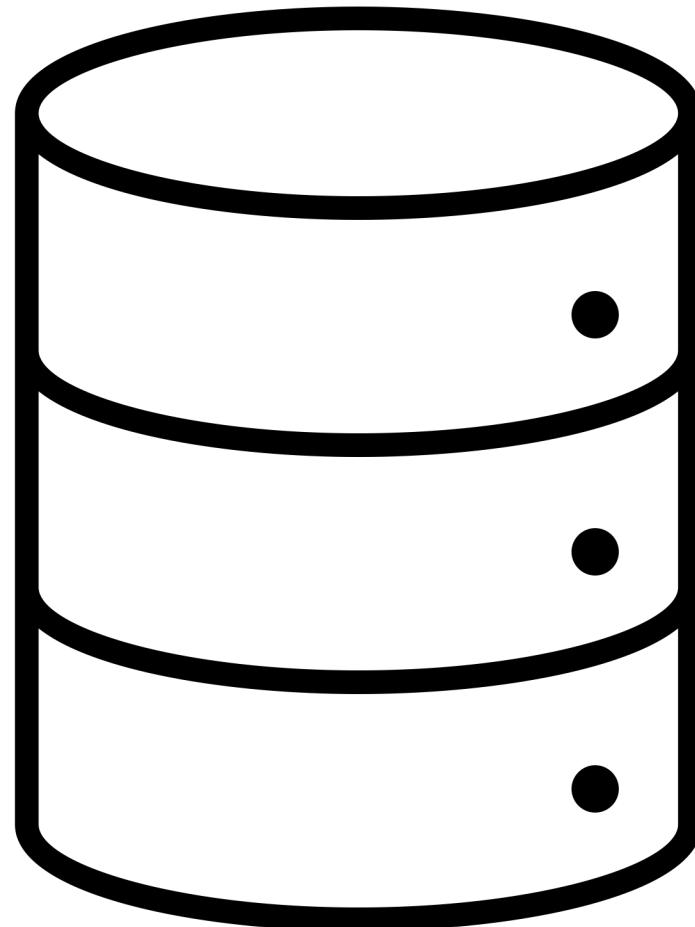
```
// Connect Saga to the store, using middleware
import { createStore, applyMiddleware } from 'redux';
import createSagaMiddleware from 'redux-saga';
import reducer from './reducers';
import mySaga from './sagas';

// create the saga middleware
const sagaMiddleware = createSagaMiddleware();
// mount it on the Store
const store = createStore( reducer,
applyMiddleware(sagaMiddleware) );
// then run the saga
sagaMiddleware.run(mySaga);
// render the application
```

# Lab 16: Redux Thunk

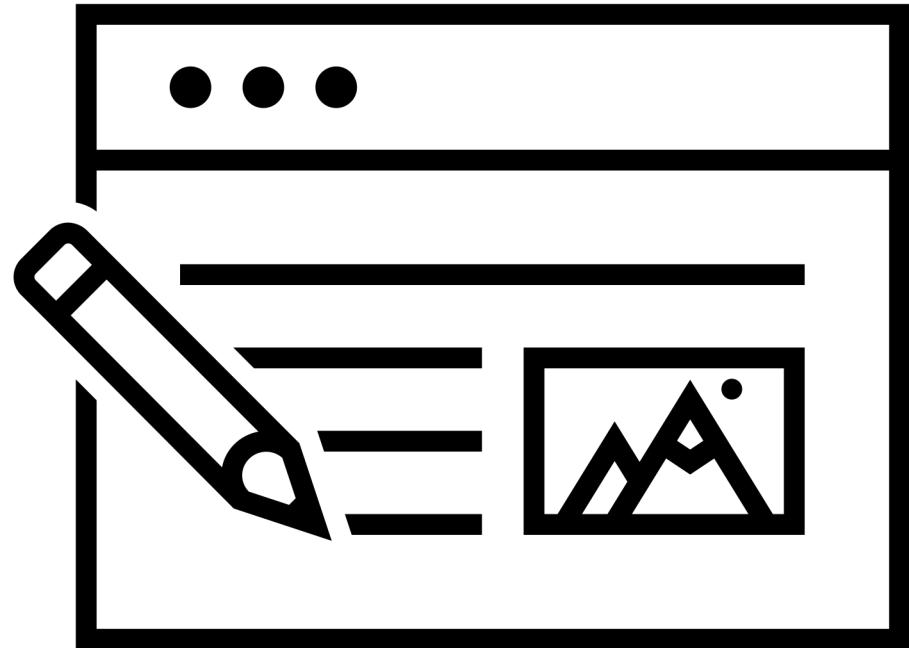


# Lab 17: Persisting Data in localStorage with Redux



# Lab 18:

## Refactoring



# Routing

# React Router

---

- Declarative way to do routing
- Maps components to URLs
- Dynamic routing
  - Routing takes place as the component is rendering
  - Not in a configuration
  - Almost everything in React Router is a component

# Using React Router

---

- Import the version of React Router for your target environment (i.e. DOM or Native), plus other components

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

- Render the Router

```
ReactDOM.render( (
```

```
<BrowserRouter> <App/> </BrowserRouter> ), holder)
```

- Use <Link> to link to a new location (in <App> in this case)

```
<Link to="/dashboard">Dashboard</Link>
```

- Render a Route (also in <App>)

```
<Route path="/dashboard" component={Dashboard} />
```

# Router Rendering Example

index.js

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

```
ReactDOM.render(()  
  <BrowserRouter>  
    <App/>  
  </BrowserRouter>  
) , holder)
```

- Use BrowserRouter when you have a server
- Use HashRouter if you're using a static file server.

# Route Matching

- Route
  - Compares the value of the path prop to the current location's pathname.
  - Renders the component specified by the component prop.
  - Can be used anywhere you want to render based on location.
- Switch
  - Can be (optionally) used for grouping Routes. Will iterate through a group and stop when a match is found.

# The match Object

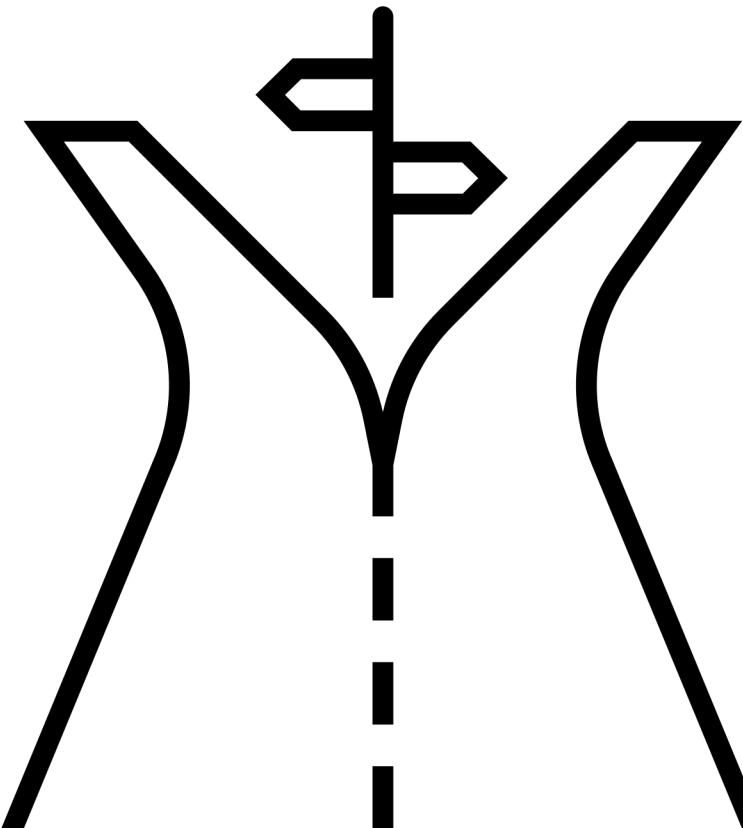
- The Route component passes an object named match to components.
- The match object contains information about the match.
- One imported property of match is match.params
- Params are passed in the URL
  - <Link to="/users/:uid">View User Details</Link>
- You can access them using this.match.params or with React Router's useParams hook.

# Navigation

- <Link>
  - Creates links in your application.
  - Inserts an <a> in your HTML
- <NavLink>
  - Can be styled as "active" when it matches the current location.
- <Redirect>
  - Forces navigation

# Lab 19:

## React Router



# Deploying React

---



# Development vs. Production

---

- Development build
  - Uncompressed.
  - Displays additional warnings that are helpful for debugging.
  - Contains helpers not necessary in production
  - ~669kb
- Production build
  - Compressed.
  - Contains additional performance optimizations.
  - ~147kb

# Optimization Techniques

---

- Use `shouldComponentUpdate` hook to add optimization hints to React's diff algorithm

```
shouldComponentUpdate: function() {  
    // Let's just never update this component again.  
    return false;  
},
```

- Use **keys**
  - Unique identifier created with `key` attribute.

# Code Splitting

---

- Improves the performance of your app by lazy loading only the components that are currently needed.
- Two ways

- dynamic import

```
import("./math").then(math => {
  console.log(math.add(43, 32));
})
```

- React.lazy

```
const MyComponent =
  React.lazy(()=>import('./Header'));
```

# Using Lazy Loaded Component

---

```
import React, { Suspense } from 'react';

const OtherComponent = React.lazy(() =>
    import('./OtherComponent'));

function MyComponent() {
    return (
        <div>
            <Suspense fallback={<div>Loading...</div>}>
                <OtherComponent />
            </Suspense>
        </div>
    );
}
```

# Building Your Project

---

- In create-react-app, run the build script
- `npm run build`
- Build makes a build directory, which contains:
  - `index.html`
  - static assets (js and css)
  - sourcemap files
  - `asset-manifest.json`

# Deploying React

---

- React apps can be served using plain old HTTP servers, node servers, or cloud hosting.
- Popular hosting options include:
  - Netlify
  - Firebase
  - Heroku
  - AWS
- To deploy/host for free, you can use Github Pages

# Server-side React

---

- Allows you to pre-render components' initial state on the server
- Methods:
  - `renderToString`
    - Returns an HTML string
    - Send the markup down on the initial request for faster page loads and to allow search engines to crawl your pages for SEO purposes.
  - `renderToStaticMarkup`
    - Works the same as `renderToString`, but doesn't add in the extra React DOM elements
    - Good for using React as a static page generator

# Render Caching

---

- A technique for making web pages load faster on subsequent visits.
1. Encapsulate load state so that no server call is required to render the initial view
  2. Make all API calls before render()
  3. Cache locally in the unload handler
  4. Restore the last known state on load
  5. Render the last known state in react using ReactDOM.hydrate

# ReactDOM.hydrate

---

- import {render, hydrate} from "react-dom"
- if (window.hasRestoredState) {
  - hydrate(<MyPage />, renderTarget);
  - } else {
    - render(<MyPage />, renderTarget);
  - }

# Advanced Topics



# What is an error boundary?

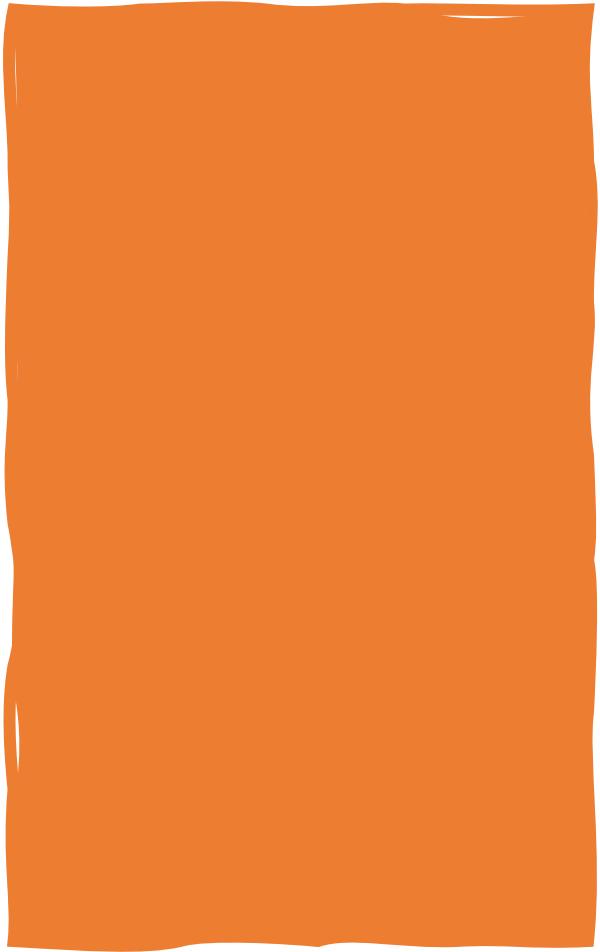
---

- Error boundaries use the `getDerivedStateFromError` and/or `componentDidCatch` lifecycle methods to catch and handle errors in component.
- Can be used to keep an error in a child component from crashing the entire UI
- Can also be used for logging the error

# Implementing Error Boundaries

```
class ErrorBoundary extends React.Component {  
  constructor(props) {  
    super(props);  
    this.state = { hasError: false };  
  
    static getDerivedStateFromError(error) {  
      return { hasError: true };  
    }  
  
    componentDidCatch(error, errorInfo) {  
      logErrorToMyService(error, errorInfo);  
    }  
  
    render() {  
      if (this.state.hasError) {  
        return <h1>Something went wrong.</h1>;  
      }  
  
      return this.props.children; }  
}
```

# Context API



# Context API

---

- Context allows parents to pass data implicitly to children, no matter how deep the component tree is.

# Using Context with Provider

```
const ColorContext = React.createContext('color');
class ColorProvider extends React.Component {
  render(){
    return (
      <ColorContext.Provider value={'red'}>
        { this.props.children }
      </ColorContext.Provider>
    )
  }
}
class Parent extends React.Component {
  render(){
    return (
      <ColorProvider><Child /></ColorProvider>
    );
  }
}
```

# Micro Frontends

---

- Micro Frontends decompose frontend applications into independent units in the same way that microservices decompose the back end.
- Gives teams the ability to independently develop, test, and deploy each micro frontend.

# React Micro Frontends

---

- Challenges:
  - Overhead: Each micro frontend needs to access the same libraries, CSS, routes
    - Can create massive problem of duplication of code and poor performance
  - Cross-cutting concerns: Each frontend needs to share authentication, for example.
  - Communication between micro frontends is more complex than between components in an app.

# Common strategies for React Micro frontends

---

- Use a container application to handle rendering and routing between the micro frontends.
- Use a CDN to host shared frontend libraries and resources.
- Make use of React Portals to render components from an application outside of its root DOM node.

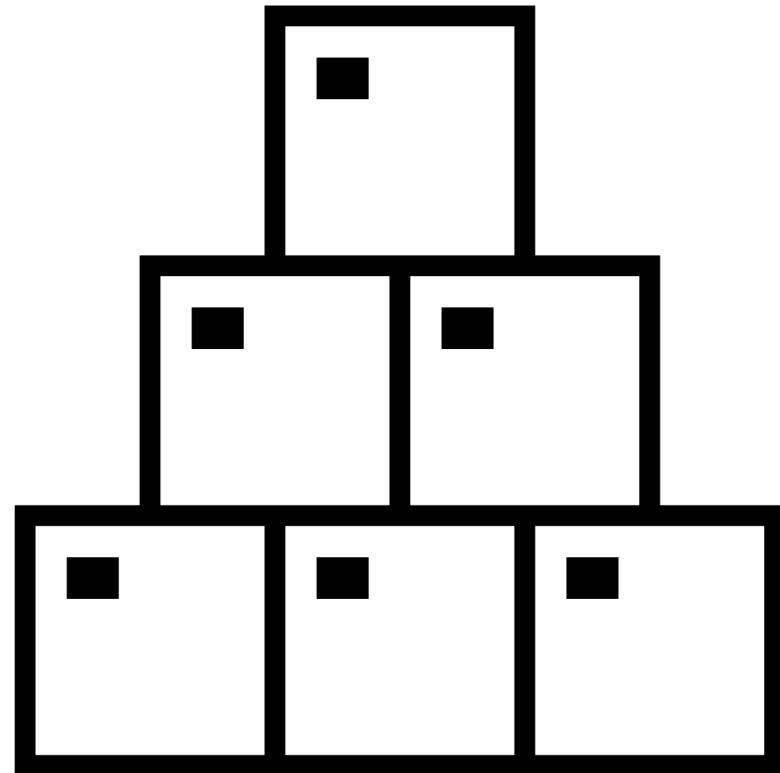
# Shared State in React Micro Frontends

---

- Four strategies
  - Web workers
  - Props and callbacks
  - Custom events
  - Pub Sub library

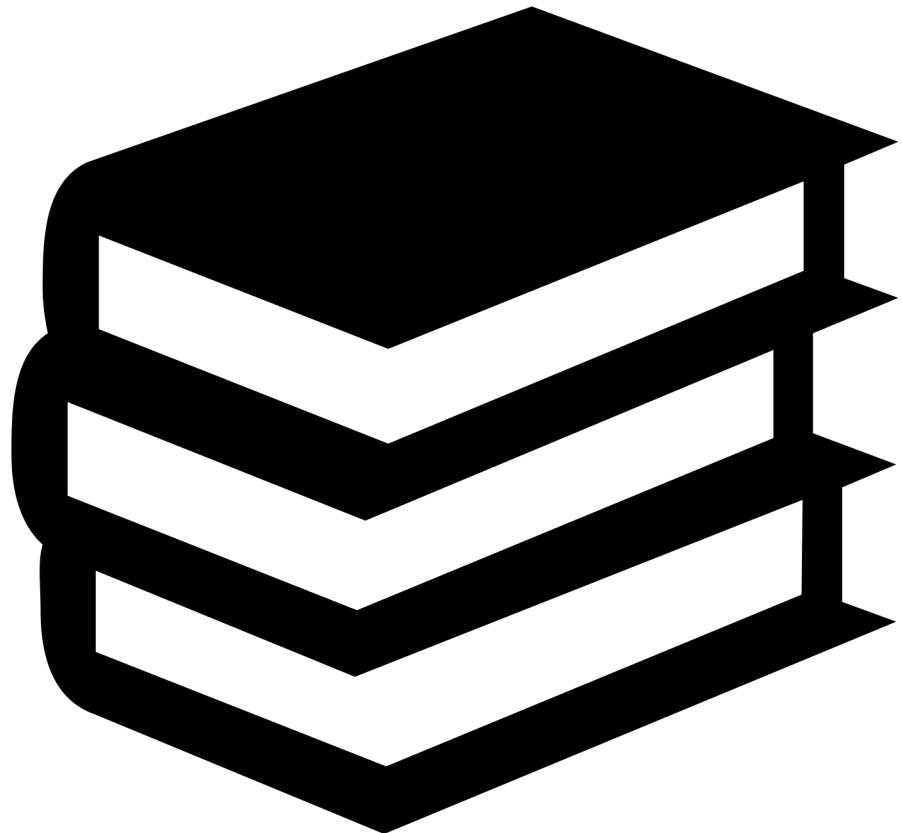
# Lab 20:

## Creating Micro Frontends



# Lab 21:

## Converting the Bookstore to a Micro Frontend



## Bonus Lab: Implement Shared State

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.

# JavaScript Development Ecosystem and Tools

---

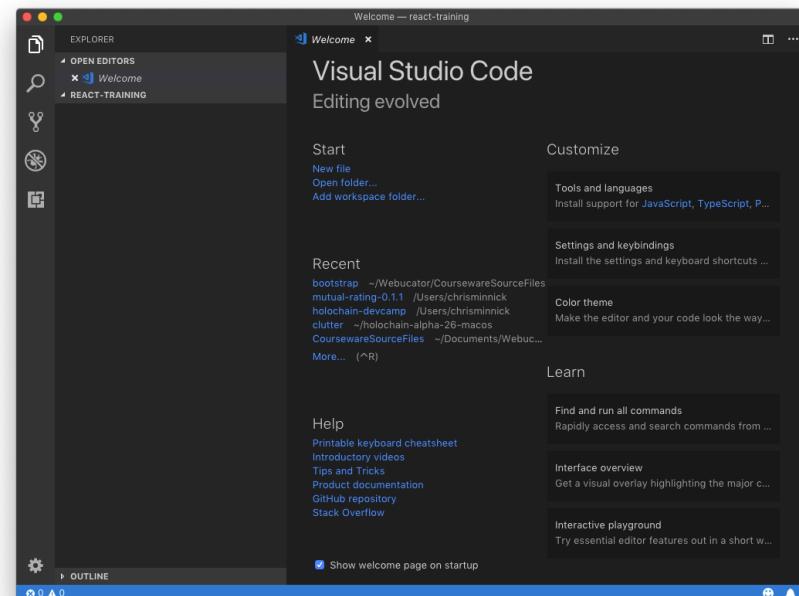
- Objectives:
- Configure your IDE
- Use Node.js as a development tool
- Use NPM to install and manage packages
- Use Git for version control
- Use command line dev tools

# Code Editors and IDEs

---

- MS Visual Studio Code
- JetBrains WebStorm
- Atom ([atom.io](http://atom.io))
- Adobe Brackets
- Eclipse
- Emacs
- IntelliJ IDEA
- Netbeans
- Sublime Text
- vi/Vim

# Lab: Visual Studio Code



# Node.js



- Objectives
- Install Node
- Test node and get started using npm

# What is Node.js?

---

- JavaScript runtime
- Built on Google Chrome's V8 JavaScript engine
- Open-source
- Event-driven
- Non-blocking
  - Never waits
- Single-threaded
  - Can handle thousands of concurrent connections with minimal overhead
- No buffering
- Used on the server as well as for development automation

# How is Node.js Different?

---

- JavaScript is single-threaded
- A Node application has one event loop, and gives you the benefit of multithreading with `async` operations
  - Can handle thousands of concurrent connections with minimal overhead
- No buffering
  - Node applications never buffer data.
  - Data is output in chunks.
- Non-blocking
  - Node doesn't wait for data to be returned from APIs.
  - While it's possible to write blocking code in Node.js, it's discouraged.

# A Simple Node.js Example

---

```
const http = require('http');

const hostname = '127.0.0.1';
const port = 3000;

const server = http.createServer((req, res) => {
  res.statusCode = 200;
  res.setHeader('Content-Type', 'text/plain');
  res.end('Hello World\n');
}) ;

server.listen(port, hostname, () => {
  console.log(`Server running at http://${hostname}:${port}/`);
}) ;
```

# EventEmitter

---

- Node is event driven.
- EventEmitter is a class that lets you listen for events and assign actions when those events occur.
- Very loose way of coupling different parts of your application together.

```
var EventEmitter = require("events").EventEmitter;
```

```
var ee = new EventEmitter();
ee.on("someEvent", function () {
    console.log("event has occurred");
});
```

```
ee.emit("someEvent");
```

# Modules Overview

---

- Node uses CommonJS for loading modules
- Original name was ServerJS
- Provides a way to import dependencies in JavaScript when used outside the browser (such as server side or in desktop applications)
- `module.exports`
  - Encapsulates code into a module
- `require`
  - Imports a module into JavaScript code

# CommonJS Example

---

- foo.js
- var circle = require('./circle.js');
- console.log('Area of circle: ' + circle.area(4));
- circle.js
- exports.area = function(r){
- return Math.PI \* r \* r;
- }

# Front-end Node

---

- Node has become an essential part of front end development.
- It's used by:
  - Package installers
  - Task runners
  - Testing frameworks
  - CSS compilers
  - JS Transpilers
  - Web servers
  - Web browsers (PhantomJS)
  - and more!

# Git

- Objectives
- Learn about how Git works
- Learn a typical Git workflow
- Install Git
- Use the most common Git commands

# What is Version Control?

---

- Essential component of any development workflow
- Records changes to files over time
- Allows recalling of specific versions
- Makes collaboration possible
- Makes software development safer

# History of Git

---

- From 2002 - 2005, the Linux Kernel used the proprietary BitKeeper VCS.
- In 2005, after a falling out with BitKeeper's developer, they decided to create their own VCS.
- Goals
  - Speed
  - Simple design
  - Strong support for non-linear development
  - Fully distributed
  - Able to handle large projects

# What is Git?

---

- Version Control System (VCS)
- Different from SVN, CVS, etc
  - Other VCS: store list of changes
  - Git: store a snapshot of files at time of commit
- Doesn't restore unchanged files
- Nearly every operation is local
- Generally only adds data
  - It's difficult to do something that can't be un-done.

# 3 States of Git

---

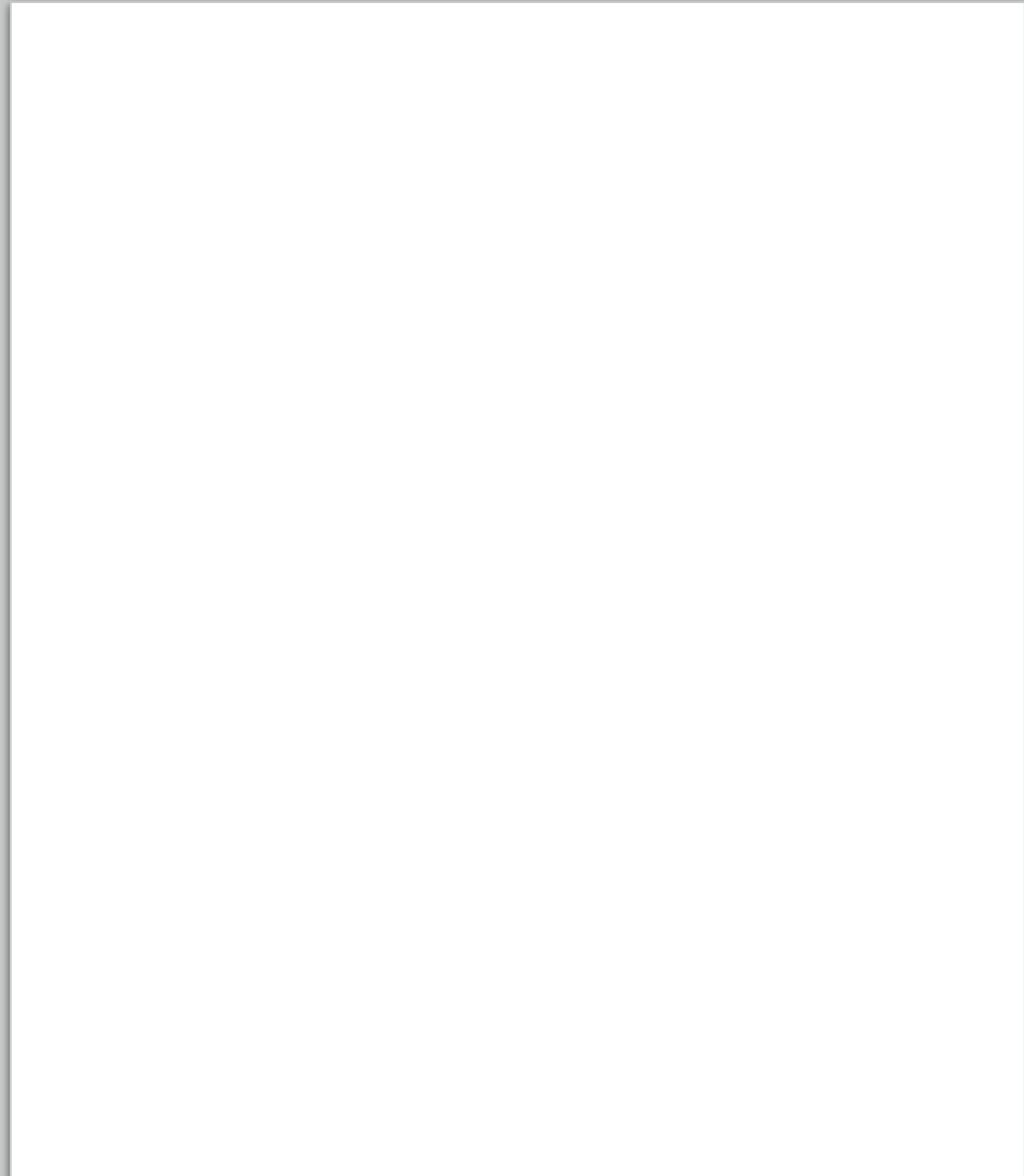
- Git has three states that your files can reside in:
  - Modified
    - Data changed but not committed
  - Staged
    - File is marked to go into your next snapshot
  - Committed
    - Data stored in your local repo

# Git Workflow

---

1. Modify files
2. Stage the files
  - Adds snapshots to the staging area
  - Git add
  - Git add is dual-purpose: it tells git to track new files and it stages changes to existing files.
3. Commit
  - Stores a snapshot permanently in your Git directory
  - Git commit- You can also skip the staging area by using the -a option with git commit. This will automatically stage all tracked files before doing the commit.

# Lab - Version Control With Git



# Command Prompt

- Objectives
- Use a Unix-style command prompt
- Get familiar with basic commands

# Know Your Shell

- Bash shell
- Terminal (Mac)
- Git bash (Windows)

You can use the windows command prompt, but it has its own non-standard commands, so using a bash emulator is recommended.

- `cd` = change directory
- `./` = current directory
- `../` = up one directory
- `ls` = list files
- `ls -la` = long list format and don't hide files starting with `.`
- `pwd` = print working directory
- `mkdir` = create a new directory
- `cp [source] [dest]` = copy
- `mv [source] [dest]` = move, or rename
- `rm` = remove files or directories
- `help` = get bash commands
- `-help` = get help with a command

# Chapter 2:

## Reproducible Builds

- Objectives
- Understand the role of build tools
- Learn about build automation
- Configure and use npm

# Why Automate Your Build?

---

- First step in creating culture of Continuous Delivery and DevOps
  - Continuous Delivery
    - Teams produce software in short cycles, ensuring that software can be reliably released at any time.
  - DevOps
    - Emphasizes communication and collaboration of developers and IT and creates culture of rapid and reliable releases.

# Task Runners

---

- Grunt
  - emphasizes configuration over code
- Gulp
  - emphasizes code over configuration
- npm as build tool
  - write shell scripts to automate tasks

# npm

---

- Installs, publishes, and manages node programs
- Is bundled and installed with Node
- Allows you to install Node.js applications from the npm registry
- Written in JavaScript

# Lab – Initialize npm

```
chrismini:test-npm chrisjminnick$ npm init
This utility will walk you through creating a package.json file.
It only covers the most common items, and tries to guess sensible defaults.

See `npm help json` for definitive documentation on these fields
and exactly what they do.

Use `npm install <pkg> --save` afterwards to install a package and
save it as a dependency in the package.json file.

Press ^C at any time to quit.
name: (test-npm)
version: (1.0.0)
description:
entry point: (index.js)
test command:
git repository: |
```

# node\_modules

---

- Two ways to install npm packages
  - Locally
  - Globally
- When you install packages locally, they're put into the **node\_modules** directory in your current directory.
- You should always run npm install from the same directory as your **package.json** file, which should be at the root of your project.
- Run `npm update` to update local packages
- Run `npm outdated` to find out which packages are outdated.

# package.json

---

- Manages locally installed npm packages
- Documents packages your project depends on
- Specifies the versions of each package your project can use
- Makes your build reproducible
- Package versions are specified using Semantic versioning (semver)
- Semver ranges:
  - ~ : patch release - 1.0.x
  - ^ : minor release - 1.x
  - \* : major release - x

# npm Install

---

- Is used to download and install a package
- `-g`: install globally
- `--save`: Package will appear in your dependencies
- `--save-dev`: Package will appear in your `devDependencies`
- `--save-optional`: Package will appear in your `optionalDependencies`
- `--save-exact`: Saved dependency will be configured with an exact version rather than the default range operator.

# Lab – Using npm as a Build Tool

---



# Static Code Analysis

---

- Objectives
- Learn about Lint tools
- Use ESLint
- Configure ESLint
- Manual testing with a local web server

# Lint tools

---

- JSLint
  - Created by Douglas Crockford
  - Highly opinionated (like Mr. Crockford)
  - Flags style that conflicts with "The Good Parts" according to D.C.
- JSHint
  - More control
  - Doesn't flag style issues by default
- ESLint
  - Allows developers to create their own rules ("Pluggable")
  - "Agenda free" - doesn't promote any particular style

# Configuring ESLint

---

- Two ways
  - Configuration comments
    - embed configuration info in JS files with comments
    - `/* eslint eqeqeq: "off", curly: "error" */`
  - Configuration files
    - `.eslintrc` file

# ESLint: What Can Be Configured?

---

- Environments
  - Where is the code running?
  - Includes predefined global variables for each environment.
- Globals
  - Specify additional globals your scripts use.
- Rules
  - Enable rules at different levels.

# ESLint Rules

---

- 3 Levels
  - "off" or 0
    - Rule not applied.
  - "warn" or 1
    - Warn but don't exit.
  - "error" or 2
    - Error and exit.
- Example rules

```
{  
  "rules": {  
    "eqeqeq": "off",  
    "curly": "error",  
    "quotes": ["error", "double"]  
  }  
}
```

# Lab 7 - Automate Linting

---

- Install ESLint into project
- Test it
- Create an npm script called "lint"
- Make lint task a dependency of default build task

# Lab - Managing External Dependencies

---

1. Create a script called `version-check` to check the node version
2. Compare node version against version listed in `package.json`
3. Fail with helpful message if wrong version is installed
4. Make the default task dependent on version

# Chapter 6:

## Building and

## Refactoring

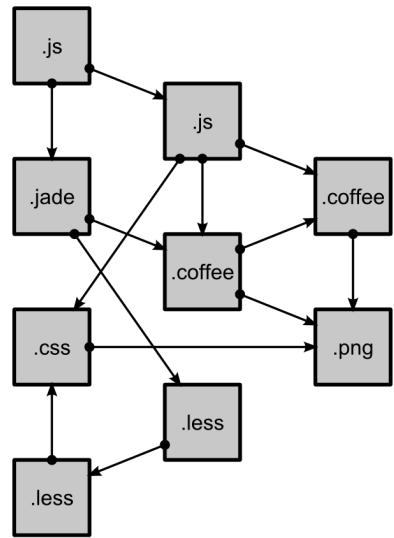
- Objectives
- Use Webpack to build your production files
- Integrate Webpack into the automated build

# Building the dist directory

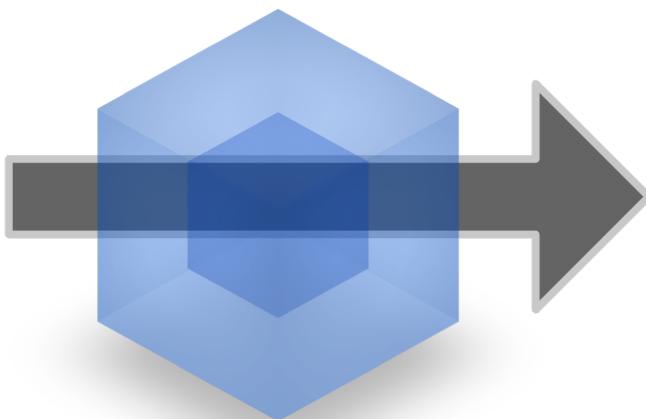
---

- Use webpack to bundle everything
- Use babel to convert ES6 code to ES5
- Use run webpack and create the dist directory.

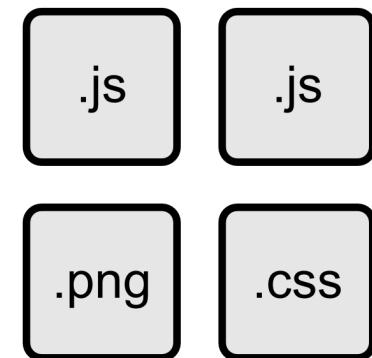
# webpack



modules  
with dependencies



**webpack**  
MODULE BUNDLER



static  
assets

# How webpack Works

---

- Treats all assets as modules.
- Loads modules using most module styles (CommonJs, AMD, ES6) and creates a 'bundle'.
- Uses loaders to transform non-JS resources into JS
  - Loaders transform individual files
- Plugins extend webpack's capabilities
  - Plugins work on the entire bundle

# Lab: Deploying with Webpack

---



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