React, Part 1
SWE 432, Fall 2019
Web Application Development
Logistics

• Midterm graded, returned at end of class
• HW3 due 1 week from today
• Lecture last Wed cancelled
• No class meeting this Wed, video lecture posted online
Review: HTML: HyperText Markup Language

- Language for describing *structure* of a document
- Denotes hierarchy of elements
- What might be elements in this document?
Review: HTML Example

<!DOCTYPE html>
<html>
<head>
  <link rel="stylesheet" type="text/css" href="main.css">
  <title>Prof Bell's Webpage</title>
</head>
<body>

<h1>Prof Jonathan Bell</h1>

Welcome, students! <a href="https://www.youtube.com/watch?v=dOw4w9WgXcQ">See how to make this page</a>

<h2>Some funny links</h2>
<ul>
  <li><a href="http://www.homestarunner.com">Homestar Runner</a></li>
  <li><a href="http://www.wb3w.net/The%20Original%20Hamsterdance.htm">Hamster Dance</a></li>
</ul>

About Prof Bell

Prof Bell’s office is at 4422 Engineering Building. His email address is <a href="mailto:bellj@gmu.edu">bellj@gmu.edu</a>.

Last updated: September 4th, 1999

https://seecode.run/#-KQgR7vG9Ds7IUJS1kdq
Review: Components

• Web pages are complex, with lots of logic and presentation
• How can we organize web page to maximize modularity?
• Solution: Components
  • Templates that correspond to a specific widget
  • Encapsulates related logic & presentation using language construct (e.g., class)
Today

• REACT’ing to change
• Big demo of React

• If time
  • Extend demo in small groups
Reacting to change

- What happens when state of component changes?
  - e.g., user adds a new item to list

Idea

1. Your code updates this.state of component when event(s) occur (e.g., user enters data, get data from network) using this.setState(newState)
2. Calls to this.setState automatically cause render to be invoked by framework
3. Reconciliation: Framework diffs output of render with previous call to render, updating only part of DOM that changed
What is state?

- All internal component data that, when changed, should trigger UI update
  - Stored as single JSON object this.state
- What isn’t state?
  - Anything that could be computed from state (redundant)
  - Other components - should build them in render
  - Data duplicated from properties.
Properties vs. State

- Properties should be **immutable**.
  - Created through attributes when component is instantiated.
  - Should *never* update within component.
  - Parent may create a new instance of component with new properties.

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

- State **changes** to reflect the current state of the component.
  - Can (and should) change based on the current internal data of your component.
Working with state

• Constructor should initialize state of object

    constructor(props) {
      super(props);
      this.state = {date: new Date()};
    }

• Use this.setState to update state

    this.setState({
      date: new Date()
    });

• Doing this will (asynchronously) eventually result in render being invoked
  • Multiple state updates may be batched together and result in a single render call
Partial state updates

- State is an object, may contain whatever properties you add
- Can use `setState` to update only parts of state you'd like to update

```javascript
fetchPosts().then(response => {
  this.setState({
    posts: response.posts
  });
});

fetchComments().then(response => {
  this.setState({
    comments: response.comments
  });
});
```
class Toggle extends React.Component {
  constructor(props) {
    super(props);
    this.state = {isToggleOn: true};

    // This binding is necessary to make `this` work in the callback
    this.handleClick = this.handleClick.bind(this);
  }

  handleClick() {
    this.setState(prevState => ({ isToggleOn: !prevState.isToggleOn }));
  }

  render() {
    return (
      <button onClick={this.handleClick}>
        {this.state.isToggleOn ? 'ON' : 'OFF'}
      </button>
    );
  }
}

ReactDOM.render(<Toggle />, document.getElementById('root'))

https://reactjs.org/docs/handling-events.html
Event Dispatching

- Each event target can have (0…n) listeners registered for any given event type, called in arbitrary order.
- What happens with nested elements?

What happens when we click in button?
What happens when we click in **button**?

**Listener1**: body onClick
**Listener2**: form onClick
**Listener3**: button onClick

This is the default behavior
Event Capturing

What happens when we click in `button`?

Called

- `Listener1: body onClick`
- `Listener2: form onClick`
- `Listener3: button onClick`

Enable event capturing when you register your listener:

```
element.addEventListener('click', myListener, true);
```
Event Dispatching

- An individual listener can stop bubbling/capturing by calling
  
  `event.stopPropagation();`

- Assuming that `event` is the name of your handler’s parameter

- Diagram showing:
  - `body`
  - `form`
  - `button`

- Listeners:
  - `Listener1: body onClick`
  - `Listener2: form onClick`
  - `Listener3: button onClick`
Functional components

- What happens if you have a simple component that only has properties and no state.
- Can use the function syntax to create a component.
- Component that is only a render method.

```javascript
function Square(props) {
  return (
    <button className="square" onClick={props.onClick}>
      {props.value}
    </button>
  );
}
```
Nesting components

• UI is often composed of nested components
  • Like containers in HTML, corresponds to hierarchy of HTML elements
  • But…now each element is a React component that is generated
• Parent *owns* instance of child
  • Occurs whenever component instantiates other component in render function
  • Parent configures child by passing in properties through attributes
Nesting components

```javascript
render() {
  return (
    <div>
      <PagePic pagename={this.props.pagename} />
      <PageLink pagename={this.props.pagename} />
    </div>
  );
}
```

Establishes ownership by creating in render function.

Sets pagename property of child to value of pagename property of parent.
The data flows down

- State that is common to multiple components should be owned by a common ancestor
- State can be passed into descendants as properties
- When this state can manipulated by descendants (e.g., a control), change events should invoke a handler on common ancestor
- Handler function should be passed to descendents

https://reactjs.org/docs/state-and-lifecycle.html#the-data-flows-down
The data flows down

class Calculator extends React.Component {
    constructor(props) {
        super(props);
        this.handleCelsiusChange = this.handleCelsiusChange.bind(this);
        this.state = {temperature: '', scale: 'c'};
    }

    handleCelsiusChange(temperature) {
        this.setState({scale: 'c', temperature});
    }

    render() {
        const scale = this.state.scale;
        const temperature = this.state.temperature;
        const celsius = scale === 'f' ? tryConvert(temperature, toCelsius) : temperature;

        return (  
            <div>
                <TemperatureInput  
                    scale="c"  
                    temperature={{celsius}}  
                    onTemperatureChange={this.handleCelsiusChange} />
            </div>
        );
    }
}
Single page app

• In a single page app, there is only one single HTML page loaded by browser.

• When new views are opened by user or data arrives from server, client side JavaScript code generates new views.

• How could you build a single page app using React?
What's wrong with this code?

class Timer extends React.Component {
    constructor(props) {
        super(props);
        this.state = { seconds: 0 };
        this.interval = setInterval(() => this.tick(), 1000);
    }

    tick() {
        this.setState(prevState => ({
            seconds: prevState.seconds + 1
        }));
    }

    render() {
        return (
            <div> Seconds: {this.state.seconds} </div>
        );
    }
}

ReactDOM.render(<Timer />, mountNode);
Component lifecycle

```javascript
class Timer extends React.Component {
  constructor(props) {
    super(props);
    this.state = { seconds: 0 };  
  }

  tick() {
    this.setState(prevState => ({
      seconds: prevState.seconds + 1
    }));
  }

  componentDidMount() {
    this.interval = setInterval(() => this.tick(), 1000);
  }

  componentWillUnmount() {
    clearInterval(this.interval);
  }

  render() {
    return (  
      <div>
        Seconds: {this.state.seconds}
      </div>
    );
  }

  ReactDOM.render(<Timer />, mountNode);
```
Component lifecycle

```javascript
class Timer extends React.Component {
  constructor(props) {
    super(props);
    this.state = { seconds: 0 };
  }

  tick() {
    this.setState(prevState => ({
      seconds: prevState.seconds + 1
    }));
  }

  componentDidMount() {
    this.interval = setInterval(() => this.tick(), 1000);
  }

  componentWillUnmount() {
    clearInterval(this.interval);
  }

  render() {
    return (<div>
      Seconds: {this.state.seconds}
    </div>);
  }
}

ReactDOM.render(<Timer />, mountNode);
```

ReactDOM.render(...)  
[component created]  
constructor(...)  
render()  
componentDidMount()  
tick()  
render()  
...

[component rendered again by parent]  
componentWillUnmount()  
[component created]  
...
class EssayForm extends React.Component {
    constructor(props) {
        super(props);
        this.state = {
            value: 'Please write an essay about your favorite DOM element.'
        };
        this.handleChange = this.handleChange.bind(this);
        this.handleSubmit = this.handleSubmit.bind(this);
    }
    handleChange(event) {
        this.setState({value: event.target.value});
    }
    handleSubmit(event) {
        alert('An essay was submitted: ' + this.state.value);
        event.preventDefault();
    }
    render() {
        return (
            <form onSubmit={this.handleSubmit}>
                <label>
                    Name: <textarea value={this.state.value} onChange={this.handleChange} />
                </label>
                <input type="submit" value="Submit" />
            </form>
        );
    }
}

https://reactjs.org/docs/forms.html
Controlled Components

- Single source of truth
- Whenever a control changes its value
  - React is notified
  - State is updated
- Whenever state is updated
  - If necessary, render function executes and generates control with new value
Reconciliation

- Process by which React updates the DOM with each new render pass
- Occurs based on order of components
  - Second child of Card is destroyed.
  - First child of Card has text mutated.

https://reactjs.org/docs/reconciliation.html
Reconciliation with Keys

- Problem: what if children are dynamically generated and have their own state that must be persisted across render passes?
  - Don’t want children to be randomly transformed into other child with different state
- Solution: give children identity using keys
  - Children with keys will always keep identity, as updates will reorder them or destroy them if gone
function NumberList(props) {
    const numbers = props.numbers;
    const listItems = numbers.map((number) =>
        <li key={number.toString()}>
            {number}
        </li>
    );
    return (  
        <ul>{listItems}</ul>
    );
}

const numbers = [1, 2, 3, 4, 5];
ReactDOM.render(  
    <NumberList numbers={numbers} />,  
    document.getElementById('root')
);
class App extends Component {
    constructor(props) {
        super(props);
        this.state = { items: [], text: '' }; 
        this.handleChange = this.handleChange.bind(this);
        this.handleSubmit = this.handleSubmit.bind(this);
    }
    render() {
        return ( 
            <div>
                <h3>TODO</h3>
                <form onSubmit={this.handleSubmit}>
                    <input onChange={this.handleChange} value={this.state.text} />
                    <button>Add #{this.state.items.length + 1}</button>
                </form>
            </div>
        );
    }
}

class TodoList extends Component {
    render() {
        return ( 
            <ul>{this.props.items.map(item => ( 
                <li key={item.id}>{item.text}</li>
            ))}</ul>
        );
    }
}
In Class Activity

• Start with React todo demo app:

• Add a “delete item” button
• Add an “edit” button that converts an item into a text field, then lets you save changes to it