CSE 331
Software Design & Implementation

Bryan Lim / Ardi Madadi
based on slides and code by
Kevin Zatloukal and Andrew Gies

Winter 2022

Modern Web UIs

The Road So Far…

Done:

- First, look at basic HTML on its own
  - No scripting, no dynamic content
  - Just how content/structure is communicated to the browser

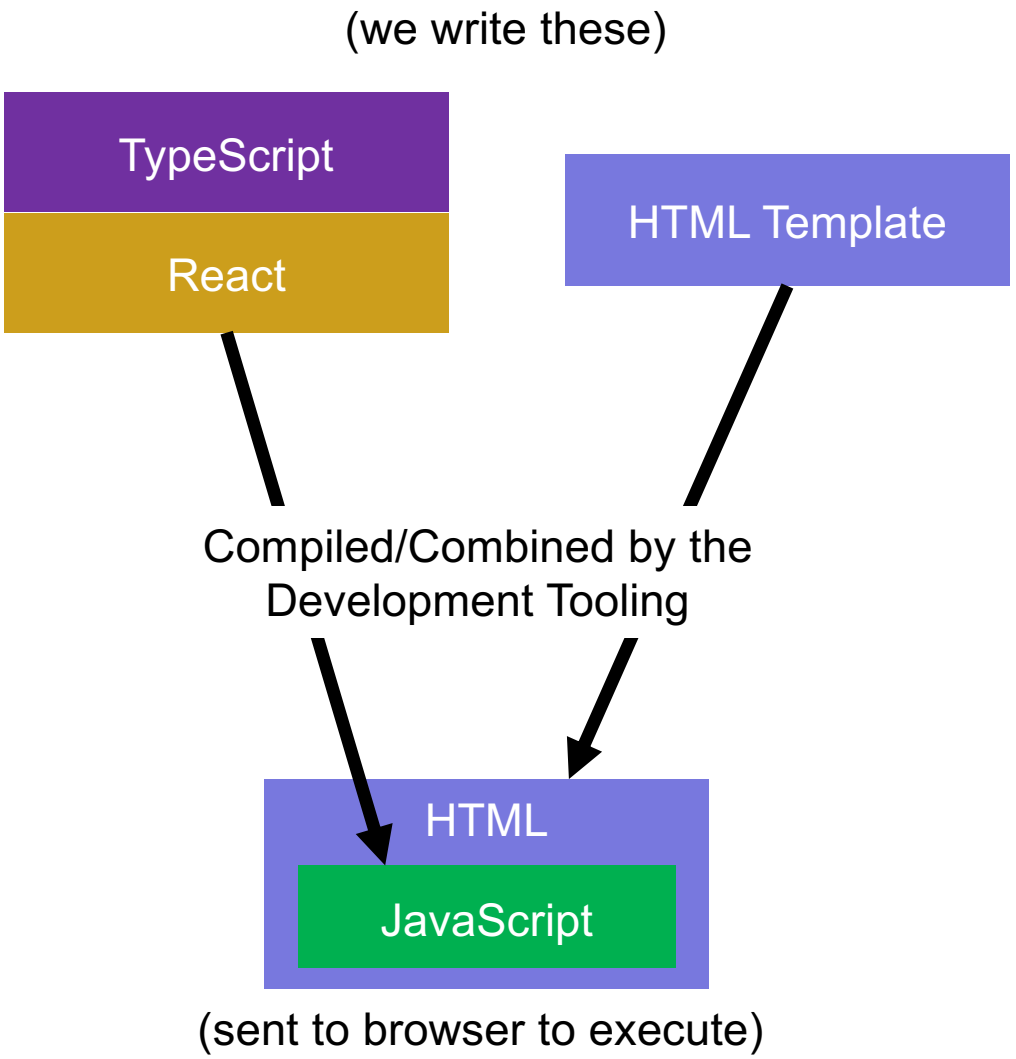
- Second, look at basic TypeScript (& JavaScript) on its own
  - No browser, no HTML, just the language
  - Get a feel for what's different from Java

- Third, a quick look at very basic user interactions
  - Events, event listeners, and callbacks (more depth later)

Now:

- Fourth, use TypeScript with React with HTML
  - Write TypeScript code, using the React library
  - Generates the page content using HTML-like syntax

Reminder: Our Stack



Making the Jump to React

- Write mostly TS, which is responsible for dynamically generating the HTML on-the-fly.
  - Fundamentally different way of thinking about websites.
  - Allows code reuse (more or less impossible in HTML)
  - Improves modularity.
  - Designed to reduce coupling, increase cohesion. (Yay!)

- The webpage is made up of *Components*
  - Component = a class that extends the `Component` class
  - Components contain each other & form a tree structure
    - Just like HTML tags

The Contract

- React is "in charge" of the creation of the webpage.
  - It calls methods in your components to do that
  - You override those methods to control the behavior

- React can understand the data used to display the website
  - When data changes, it updates the page

- You can create multiple components
  - Can reuse a single component multiple times
  - Each component is a single "part" of the webpage

Example 1

- The simplest source code to create a React website is these 3 files:
  - `index.html`
    - A very small amount of "necessary" HTML
    - Most of the actual web content will be generated by the TS/React code
  - `index.tsx`
    - Starting point of code – runs when the page loads
    - Starts React
  - `App.tsx`
    - Our first component – the App component

- When we build the React app, all these files will be incorporated into what is sent to the browser

React

- Regain modularity by allowing custom tags

```
let app = (
    <div>
      <TitleBar name="My App"/>
      <EditPane rows="80" />
    </div>);
```

- `TitleBar` and `EditPane` can be separate modules
  - their HTML gets substituted in these positions

React

- Custom tags implemented using classes (like TS)

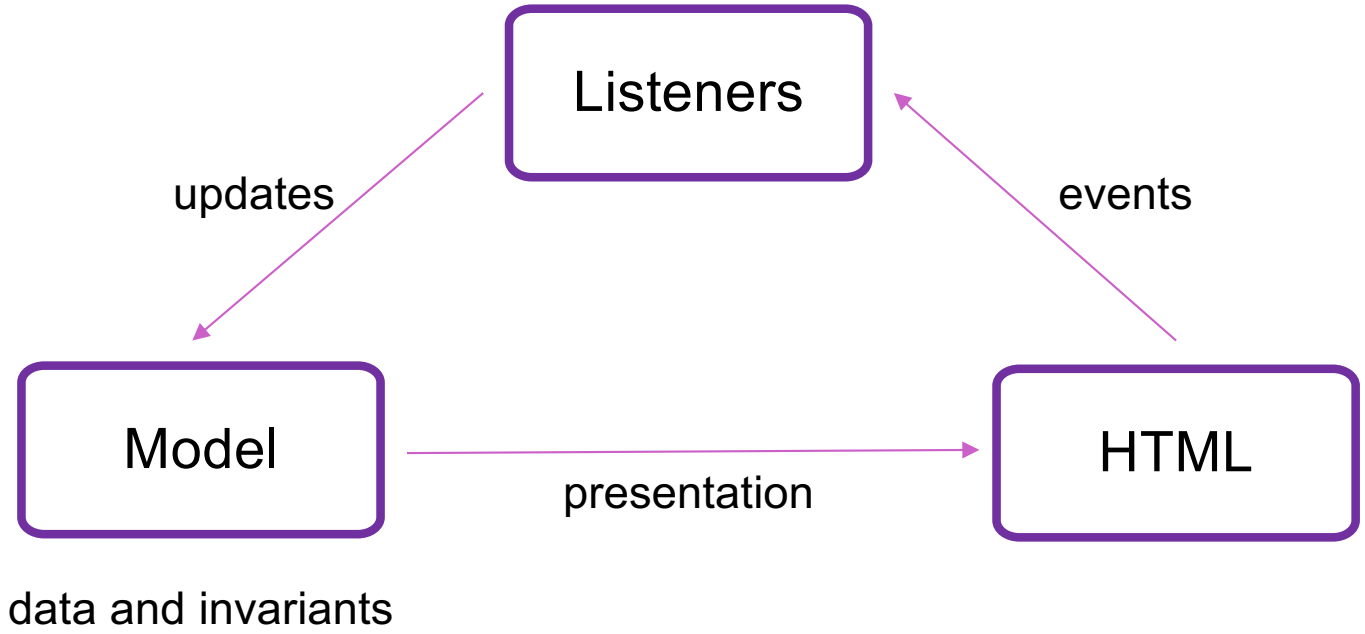
```
class TitleBar extends React.Component {
```

- Attributes (`name="My App"`) passed in `props` arg
- Method `render` produces the HTML for component
- Framework joins all the HTML into one blob
  - can update in a single call to `innerHTML = …`

Example 2

register-react/…

Structure of a React Application

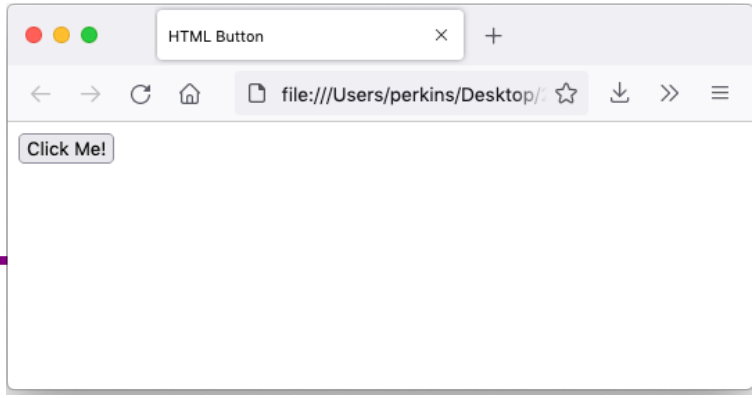


React State

- Components become dynamic by maintaining state
  - stored in fields of `this.state`
  - call `this.setState({field: value})` to update

- React will respond by calling `render` again
  - will automatically update the HTML to match the HTML produced by this call

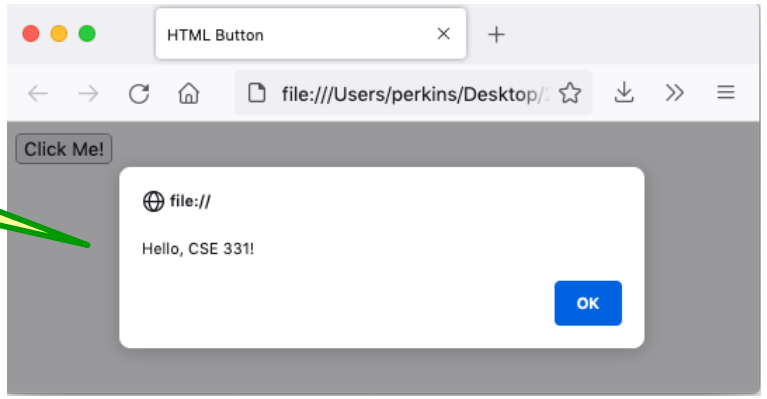
Callbacks in JS



0 – web page is loaded into browser

```
<html lang="en">
  <head>
    <title>HTML Button</title>
  </head>
  <body>
    <script type="text/javascript">
        function sayHello() {
            alert("Hello, CSE 331!");
        }
    </script>
    <button onclick="sayHello()">Click Me!</button>
  </body>
</html>
```

3 – when button is clicked function sayHello() is called and alert box is displayed



1 – JS sayHello function embedded in web page inside <script> tag

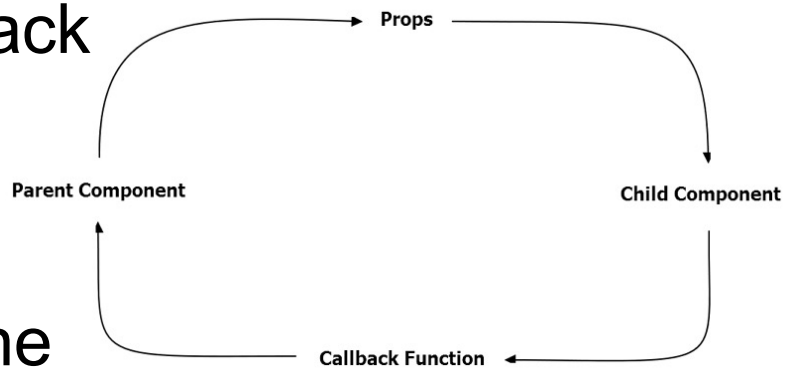
2 – Button created on page load; sayHello() function *registered* to be called on click event

Callbacks in JS

- This is the *callback pattern*
- The webpage is loaded into the web browser, and it contains a JavaScript function and a button
- When the button is created, the JS function to be called on a button click is *registered* with the button
  - The function is not called at this time
- When the user clicks the button, it causes a user-interface *event* to happen
  - In response, the button calls the function that was registered to be executed on a click event
    - This is a *callback*

Callbacks in React

- React terminology uses the term passing in (instead of registering) a callback function when we supply such a function as a prop to a child component.
- We can propagate information upwards from child component.
  - We can pass down a callback function from a parent component as a prop.
  - When called, the callback function can then update the fields (state) of the parent component from the child component.



Source: www.dotnettricks.com

Example 3

register-react2/…

Event Listeners

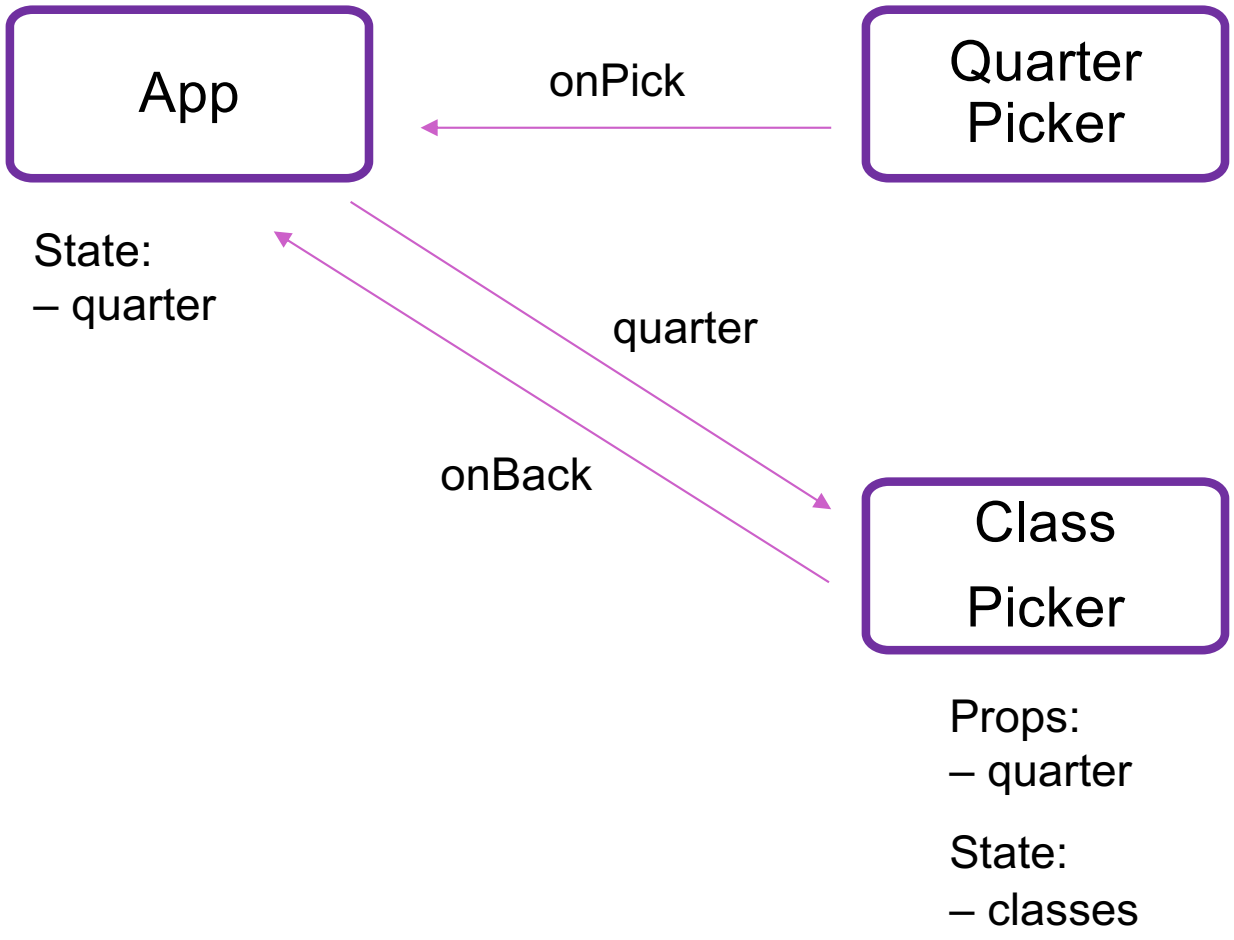
Three ways to do this properly:

1. `onClick={this.handleClick.bind(this)}`
2. `onClick={(e) => this.handleClick(e)}`
3. Make `handleClick` a prop rather than a method:

   ```
   handleClick: (e) => { … };
   ```

   Then `this.handleClick` is okay. (The homework assignment does this instead.)

Structure of Example React App



React State

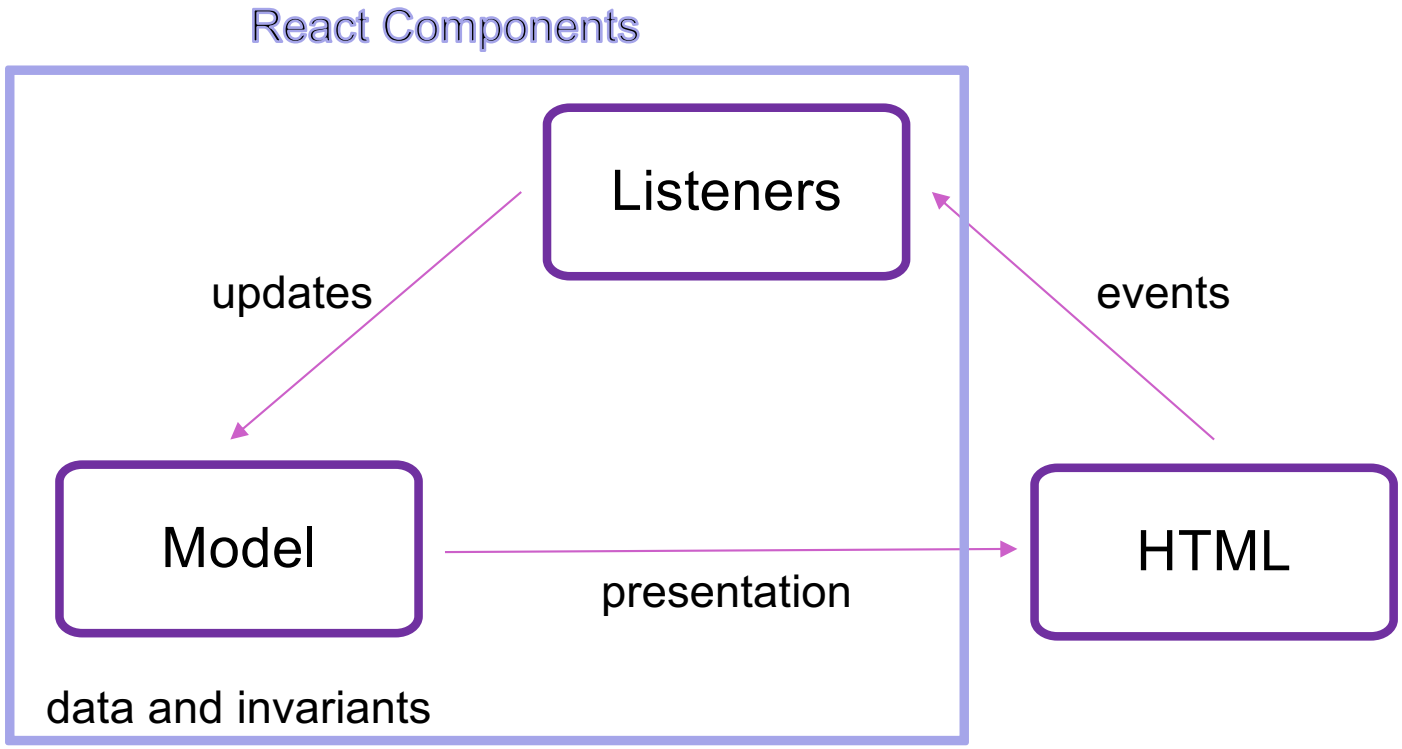
- Custom tag also has its own events

- Updating data in a parent:
  - sends parent component new data via event
  - parent updates state with `setState`
  - React calls parent's `render` to get new HTML
    - result can include new children
    - result can include changes to child props

Splitting the Model

- State should exist in the **lowest common parent** of all the components that need it
  - sent down to children via *props*
- Children change it via *events*
  - sent up to the parent so it can change its state
- Parent's render creates new children with new props

Structure of a React Application



Structure of a React Application

- Model must store all data necessary to generate the exact UI on the screen
  - react may call `render` at any time
  - must produce identical UI

- Any state in the HTML components must be mirrored in the model
  - e.g., every text field's `value` must be part of some React component's state
  - render produces

```
<input type="text" value={…}>
```

React setState

- `setState` does not update state instantly:

```
// this.state.x is 2
this.setState({x: 3});
console.log(this.state.x); // still 2!
```

- Update occurs after the event finishes processing
  - `setState` adds a new event to the queue
  - work is performed when that event is processed

- React can batch together multiple updates

React Gotchas

- `render` should not have side-effects
  - only *read* `this.state` in render
- Never modify `this.state`
  - use `this.setState` instead
- Never modify `this.props`
  - read-only information about parent's state
- Not following these rules may introduce bugs that will be hard to catch!

React Performance

- React re-computes the tree of HTML on state change
  - can compute a "diff" vs last version to get changes

- Surprisingly, this is not slow!
  - slow part is calls into browser methods
  - pure-JS parts are very fast in modern browsers
  - processing HTML strings is also incredibly fast

React Tools

- Use of compilers etc. means new tool set

- `npm` does much of the work for us
  - installs third-party libraries
  - runs the compiler(s)

- Much more in sections tomorrow…