Templates, Databinding and HTML

SWE 432, Fall 2019

Web Application Development

Today

- HTML
- Frontend JavaScript
- Intro to templating and React

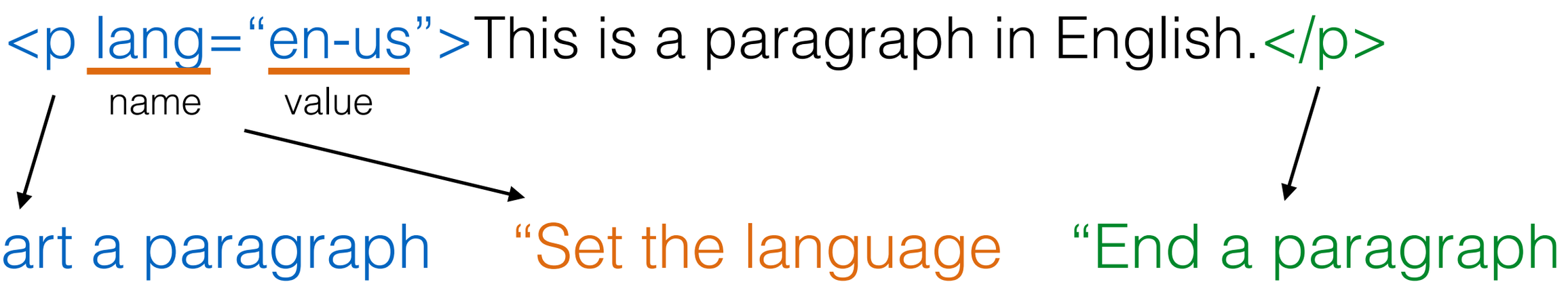
HTML: HyperText Markup Language

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

HTML History

- 1995: HTML 2.0. Published as standard with RFC 1866
- 1997: HTML 4.0 Standardized most modern HTML element w/ W3C recommendation
    - Encouraged use of CSS for styling elements over HTML attributes
- 2000: XHTML 1.0
    - Imposed stricter rules on HTML format
        - e.g., elements needed closing tag, attribute names in lowercase
- 2014: HTML5 published as W3C recommendation
    - New features for capturing more *semantic* information and *declarative* description of behavior
        - e.g., Input constraints
        - e.g., New tags that explain *purpose* of content
    - Important changes to DOM

HTML Elements



"Start a paragraph element"

Opening tag begins an HTML element. Opening tags must have a corresponding closing tag.

"Set the language to English"

HTML attributes are name / value pairs that provide additional information about the contents of an element.

"End a paragraph element"

Closing tag ends an HTML element. All content between the tags and the tags themselves compromise an HTML element.

HTML Elements

<input type="text" />

"Begin and end input element"

Some HTML tags can be self closing, including a built-in closing tag.

<!-- This is a comment. Comments can be multiline. -->

A starter HTML document

"Use HTML5 standards mode"

"HTML content"

"Header"

Information *about* the page

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="utf-8">
    <title>Hello World Site</title>
</head>
<body>
    Hello world!
</body>
</html>
```

Hello world!

"Interpret bytes as UTF-8 characters"

Includes both ASCII & international characters.

"Title"

Used by browser for title bar or tab.

"Document content"

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>
```

Use <h1>, <h2>, …, <h5> for headings

```
    <h2>Welcome, students!</h2>
        <p>
            <a href="https://www.youtube.com/watch?v=dQw4w9WgXcQ">See how to make
this page</a>
        </p>
    <h2>
        Some funny links
    </h2>
    <p>
        <ul>
            <li><a href="http://www.homestarrunner.com">Homestar Runner</a></li>
            <li><a
href="http://www.wb3w.net/The%20Original%20Hamsterdance.htm">Hamster Dance</a></li>
        </ul>
    </p>
    <h3>
        About Prof Bell
    </h3>
    <p>
        Prof Bell's office is at 4422 Engineering Building. His email address is <a
href="mailto:bellj@gmu.edu">bellj@gmu.edu</a>.
    </p>
    <p>
        Last updated: September 4th, 1999
    </p>
</div>
</body>
</html>
```

https://seecode.run/#-KQgR7vG9Ds7IUJS1kdq

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>
<div>
    <p>
        <img alt="My really cool laptop" src="http://www.wonder-
tonic.com/geocitiesizer/images/laptop-01.gif" /> <br />
        <div class="marquee">
            This is Prof Bell's ACTUAL homepage from 1999!
        </div>
    </p>
    <h2>Welcome, students!</h2>
        <p>
            <a href="https://www.youtube.com/watch?v=dQw4w9WgXcQ">See how to make
this page</a>
        </p>
    <h2>
        Some funny links
    </h2>
    <p>
        <ul>
            <li><a href="http://www.homestarrunner.com">Homestar Runner</a></li>
            <li><a
href="http://www.wb3w.net/The%20Original%20Hamsterdance.htm">Hamster Dance</a></li>
        </ul>
    </p>
    <h3>
        About Prof Bell
    </h3>
    <p>
        Prof Bell's office is at 4422 Engineering Building. His email address is <a
href="mailto:bellj@gmu.edu">bellj@gmu.edu</a>.
    </p>
```

Paragraphs (<p>) consist of related content. By default, each paragraph starts on a new line.

n/#-KQgR7vG9Ds7IUJS1kdq

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>
<div>
    <p>
        <img alt="My really cool laptop" src="http://www.wonder-
tonic.com/geocitiesizer/images/laptop-01.gif" /> <br />
        <div class="marquee">
            This is Prof Bell's ACTUAL homepage from 1999!
        </div>
    </p>
    <h2>Welcome, students!</h2>
        <p>
            <a href="https://www.youtube.com/watch?v=dQw4w9WgXcQ">See how to make
this page</a>
        </p>
    <h2>
        Some funny links
    </h2>
    <p>
        <ul>
            <li><a href="http://www.homestarrunner.com">Homestar Runner</a></li>
            <li><a
href="http://www.wb3w.net/The%20Original%20Hamsterdance.htm">Hamster Dance</a></li>
        </ul>
hr
    </p>
</div>
</body>
</html>
```

Unordered lists (<ul>) consist of list items (<li>) that each start on a new line. Lists can be nested arbitrarily deep.

https://seecode.run/#-KQgR7vG9Ds7IUJS1kdq

Text

```
 9      <h1>Level 1 Heading</h1>
10      <h2>Level 2 Heading</h2>
11      <h3>Level 3 Heading</h3>
12      <h4>Level 4 Heading</h4>
13      <h5>Level 5 Heading</h5>
14      <h6>Level 5 Heading</h6>
15      Text can be made <b>bold</b> and
16          <i>italic</i>, or <sup>super</sup>
17          and <sub>sub</sub>scripts. White
18          space collapsing removes all
19          sequences of two more more spaces
20          and line breaks, allowing
21          the markup to use tabs
22          and whitespace for
23          organization.
24          Spaces can be added with
25              &amp;nbsp;.
26      <br/>New lines can be added with &lt
            ;BR/&gt;.
27
28      <p>A paragraph conssists of one or
            more sentences that form a self
            -contained unit of discourse. By
            default, a browser will show each
            paragraph on a new line.</p>
29
30      <hr/>
31      Text can also be offest with
32      horizontal rules.
33
34
```

Level 1 Heading

Level 2 Heading

Level 3 Heading

Level 4 Heading

Level 5 Heading

Level 5 Heading

Text can be made **bold** and *italic*, or ^{super} and $_{sub}$scripts.
White space collapsing removes all sequences of two more more spaces and line breaks, allowing the markup to use tabs and whitespace for organization. Spaces can be added with .
New lines can be added with
.

A paragraph conssists of one or more sentences that form a self-contained unit of discourse. By default, a browser will show each paragraph on a new line.

Text can also be offest with horizontal rules.

Semantic markup

- Tags that can be used to denote the ***meaning*** of specific content
- Examples
  - An element that has importance.
  - <blockquote> An element that is a longer quote.
  - <q> A shorter quote inline in paragraph.
  - <abbr> Abbreviation
  - <cite> Reference to a work.
  - <dfn> The definition of a term.
  - <address> Contact information.
  - <ins><del> Content that was inserted or deleted.
  - <s> Something that is no longer accurate.

Links

```
<a href="http://www.google.com">Absolute link</a><br/>
<a href="movies.html">Relative URL</a><br/>
<a href="mailto:tlatoza@gmu.edu">Email Prof. LaToza</a><br/>
<a href="http://www.google.com" target="_blank">Opens in new
    window</a><br/>
<a href="#idName">Navigate to HTML element idName</a>
```

Absolute link
Relative URL
Email Prof. LaToza
Opens in new window
Navigate to HTML element idName

Controls

```
<p>Text Input: <input type="text" maxlength="5" /></p>
<p>Password Input: <input type="password" /></p>
<p>Search Input: <input type="search"></p>
<p>Text Area: <textarea>Initial text</textarea></p>
<p>Checkbox:
    <input type="checkbox" checked="checked" /> Checked
    <input type="checkbox" /> Unchecked
</p>
<p>Drop Down List Box:
    <select>
        <option>Option1</option>
        <option selected="selected">Option2</option>
    </select>
</p>
<p>Multiple Select Box:
    <select multiple="multiple">
        <option>Option1</option>
        <option selected="selected">Option2</option>
    </select>
</p>
<p>File Input Box: <input type="file" />
<p>Image Button: <input type="image" src="http://cs.gmu.edu/~tlatoza
    /images/reachabilityQuestion.jpg" width="50"></p>
<p>Button: <button>Button</button></p>
<p>Range Input: <input type="range" min="0" max="100" step="10"
    value="30" /></p>
```

Search input provides clear button

Text Input:

Password Input:

Search Input:

Text Area: Initial text

Checkbox: Checked Unchecked

Drop Down List Box: Option2

Multiple Select Box: Option1 Option2

File Input Box: Choose File No file chosen

Image Button:

Button: Button

Range Input:

Block vs. Inline Elements

Block elements

Block elements appear on a new line.
Examples: <h1><p>
<table><form>

```
<h1>Hiroshi Sugimoto</h1>
<p>The dates for the ORIGIN OF ART exhbibition are as
    follows:</p>
<ul>
    <li>Science: 21 Nov- 20 Feb 2010/2011</li>
    <li>Architecture: 6 Mar - 15 May 2011</li>
</ul>
```

Hiroshi Sugimoto

The dates for the ORIGIN OF ART exhbibition are as follows:

- Science: 21 Nov- 20 Feb 2010/2011
- Architecture: 6 Mar - 15 May 2011

Inline elements

Inline elements appear to continue on the same line.
Examples: <a><b><input><img>

```
Timed to a single revolution of the planet around the sun
at a 23.4 degrees tilt that plays out the rhythm of the
seasons, this <em>Origins of Art</em> cycle is organized
around four themes: <b>science, architecture, history</b>,
and <b>relgion</b>.
```

Timed to a single revolution of the planet around the sun at a 23.4 degrees tilt that plays out the rhythm of the seasons, this *Origins of Art* cycle is organized around four themes: **science, architecture, history**, and **relgion**.

Frontend JavaScript

- Static page
  - Completely described by HTML & CSS
- Dynamic page
  - Adds interactivity, updating HTML based on user interactions
  - Adding JS to frontend:

```
<script>
  console.log("Hello, world!");
</script>
```

  - We try to avoid doing this because:
    - Hard to organize
    - Different browsers support different things

DOM: Document Object Model

- API for interacting with HTML browser
- Contains objects corresponding to every HTML element
- Contains global objects for using other browser features

Reference and tutorials

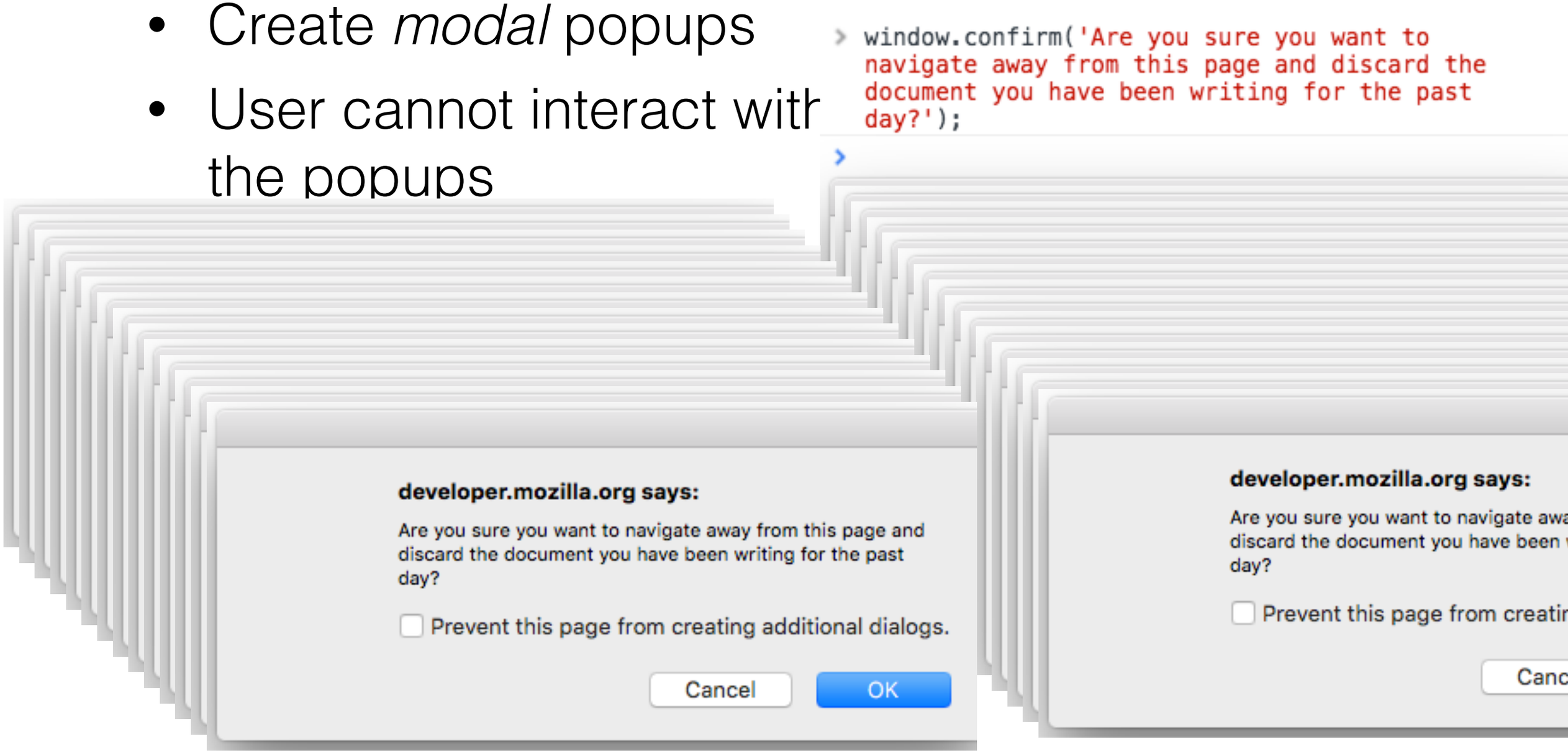
https://developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model

Global DOM objects

- window - the browser window
  - Has properties for following objects (e.g., window.document)
  - Or can refer to them directly (e.g., document)
- document - the current web page
- history - the list of pages the user has visited previously
- location - URL of current web page
- navigator - web browser being used
- screen - the area occupied by the browser & page

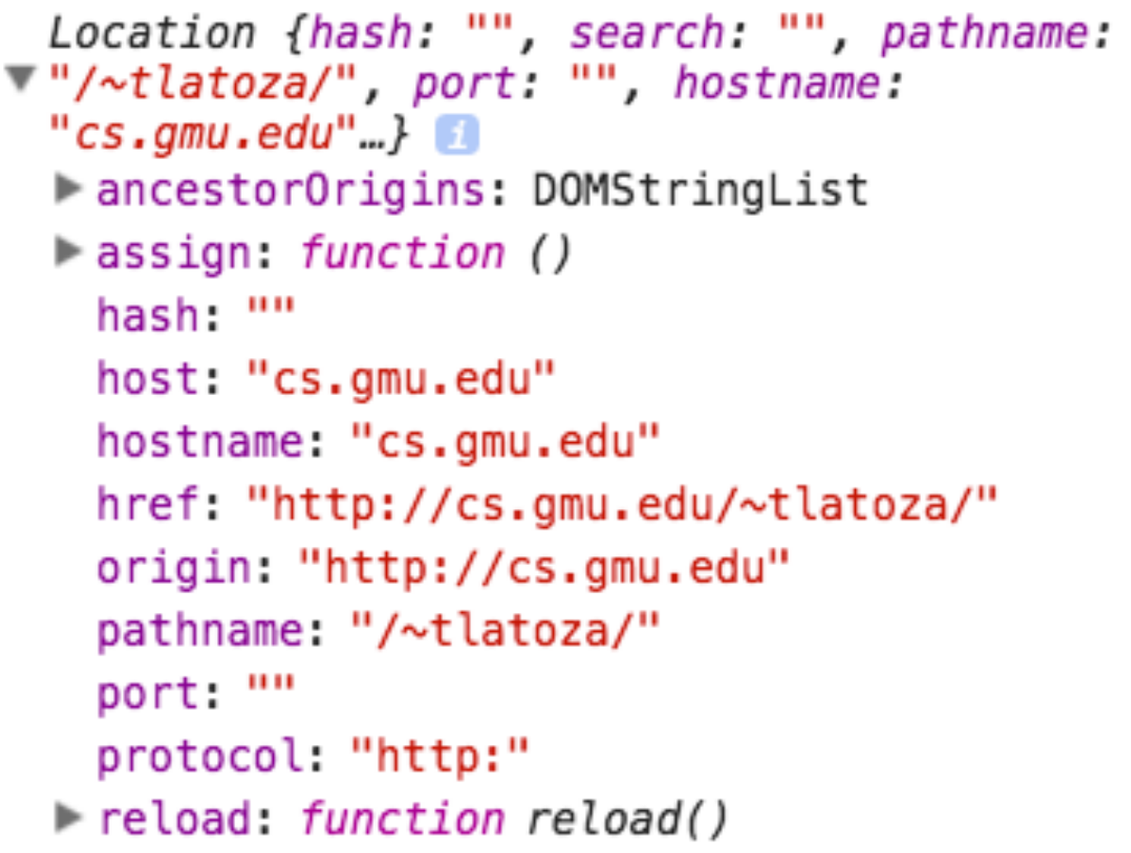
Working with popups

- alert, confirm, prompt
  - Create *modal* popups
  - User cannot interact with the popups



Working with location

- Some properties
  - location.href - full URL of c
  - location.protocol - protocc
  - location.host - hostname
  - location.port
  - location.pathname
- Can navigate to new page b location
  - location.href = '[new URL]';



Traveling through history

- history.back(), history.forward(), history.go(delta)
- What if you have an SPA & user navigates through different views?
  - Want to be able to jump between different views *within* a single URL
- Solution: manipulate history state
  - Add entries to history stack describing past views
  - Store and retrieve objec
    history.pushState() and

```
> history.pushState( { activePane: 'main' }, "");
<· undefined
> history.state
<· ▶Object {activePane: "main"}
> history.back();
<· undefined
> history.state
<· null
```

DOM Manipulation

- We can also manipulate the DOM directly
- For this class, we will *not* focus on doing this, but will use React instead
- This is how React works though - it manipulates the DOM

DOM Manipulation

Multiply two numbers

2 * 3 = 6

Multiply

- value

```
<h3>Multiply two numbers</h3>
<div>
    <input id="num1" type="number" /> *
    <input id="num2" type="number" /> =
    <span id="product"></span>
    <br/><br/>
    <button id="compute">Multiply</button>
</div>
```

```
document.getElementById('compute')
        .addEventListener("click", multiply);
function multiply()
{
    var x = document.getElementById('num1').value;
    var y = document.getElementById('num2').value;
    var productElem = document.getElementById('product');
    productElem.innerHTML = x * y;
}
```

"Get compute element"

"When compute is clicked, call multiply"

May choose any event that the compute element produces. May pass the name of a function or define an anonymous function inline.

DOM Manipulation

Multiply two numbers

3 * 4 = 12

Multiply

```
<h3>Multiply two numbers</h3>
<div>
    <input id="num1" type="number" /> *
    <input id="num2" type="number" /> =
    <span id="product"></span>
    <br/><br/>
    <button id="compute">Multiply</button>
</div>
```

```
document.getElementById('compute')
        .addEventListener("click", multiply);
function multiply()
{
    var x = document.getElementById('num1').value;
    var y = document.getElementById('num2').value;
    var productElem = document.getElementById('product');
    productElem.innerHTML = '<b>' + x * y + '</b>';
}
```

"Get the current value of the num1 element"

"Set the HTML between the tags of productElem to the value of x * y"

Manipulates the DOM by programmatically updating the value of the HTML content. DOM offers accessors for updating all of the DOM state.

DOM Manipulation Pattern

- Wait for some event
  - click, hover, focus, keypress, …
- Do some computation
  - Read data from event, controls, and/or previous application state
  - Update application state based on what happened
- Update the DOM
  - Generate HTML based on new application state
- Also: JQuery

Examples of events

- Form element events
  - change, focus, blur
- Network events
  - online, offline
- View events
  - resize, scroll
- Clipboard events
  - cut, copy, paste
- Keyboard events
  - keydown, keypress, keypup
- Mouse events
  - mouseenter, mouseleave, mousemove, mousedown, mouseup, click, dblclick, select

List of events: https://www.w3.org/TR/DOM-Level-3-Events/

DOM Manipulation Example

https://jsfiddle.net/Lbnhs8aa/1/

Loading pages

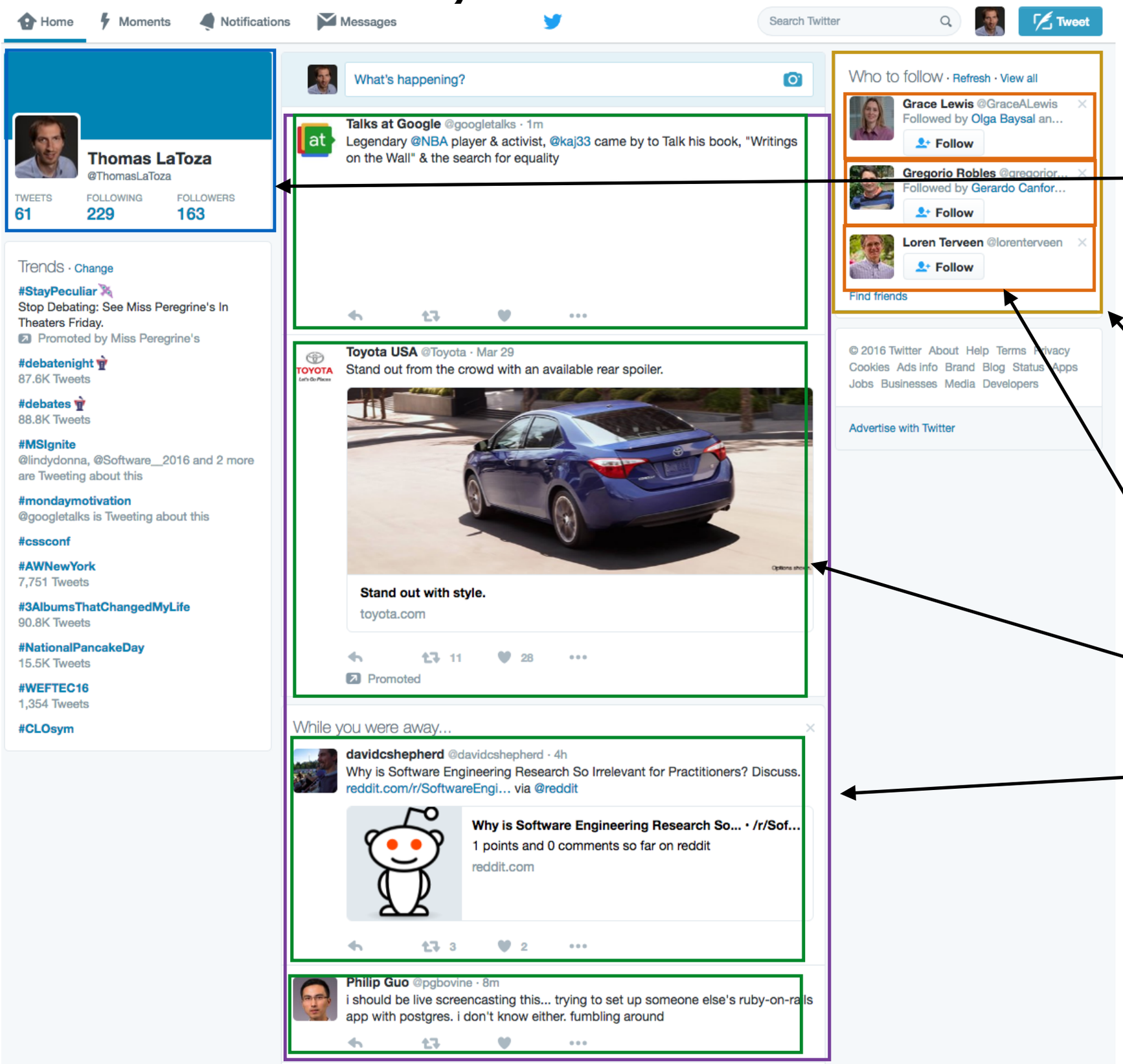
- What is the output of the following?

```
<script>
    document.getElementById('elem').innerHTML
= 'New content';
</script>
```

```
<div id="elem">Original content</div>
```

Answer: cannot set property innerHTML of undefined
Solution: Put your script in after the rest of the page is loaded
Or, perhaps better solution: don't do DOM manipulation

Anatomy of a Non-Trivial Web App



User profile widget

Who to follow widget

Follow widget

Feed widget

Feed item widget

Typical properties of web app UIs

- Each widget has both visual **presentation** & **logic**
    - e.g., clicking on follow button executes some logic related to the containing widget
    - Logic and presentation of individual widget strongly related, loosely related to other widgets
- Some widgets occur **more than once**
    - e.g., Follow widget occurs multiple times in Who to Follow Widget
    - Need to generate a copy of widget based on data
- Changes to **data** should cause changes to **widget**
    - e.g., following person should update UI to show that the person is followed. Should work even if person becomes followed through other UI
- Widgets are **hierarchical**, with parent and child
    - Seen this already with container elements in HTML…

Idea 1: Templates

```
 document.getElementById('todoItems').innerHTML +=
         '<div class="todoItem" data-index="' + key
         + '"><input type="text" onchange="itemChanged(this)" value="'
+ value + '"><button onclick="deleteItem(this.parentElement)">&#x2716;</button></div>';
```

- Templates describe **repeated** HTML through a single **common** representation
  - May have **variables** that describe variations in the template
  - May have **logic** that describes what values are used or when to instantiate template
  - Template may be **instantiated** by binding variables to values, creating HTML that can be used to update DOM

Templates with template literals

```
document.getElementById('todoItems').innerHTML +=
        `<div class="todoItem" data-index="${key}">
             <input type="text" onchange="itemChanged(this)" value="${value}">
             <button onclick="deleteItem(this.parentElement)">&#x2716;</button>
         </div>`;
```

- Template literals reduce confusion of nested strings

Server side vs. client side

- Where should template be instantiated?

- *Server-side* frameworks: Template instantiated on **server**
  - Examples: JSP, ColdFusion, PHP, ASP.NET
    - Logic executes on server, generating HTML that is served to browser

- *Front-end* framework: Template runs in web **browser**
  - Examples: React, Angular, Meteor, Ember, Aurelia, …
  - Server passes template to browser, browser generates HTML on demand

```
<html>
<head><title>First JSP</title></head>
<body>
  <%
    double num = Math.random();
    if (num > 0.95) {
  %>
      <h2>You'll have a luck day!</h2><p>(<%= num %>)</p>
  <%
    } else {
  %>
      <h2>Well, life goes on ... </h2><p>(<%= num %>)</p>
  <%
    }
  %>
```

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

ReactDOM.render(
  <HelloMessage name="John" />,
  mountNode
);
```

Server side vs. client side

- Server side
  - Oldest solution.
  - True when “real” code ran on server, Javascript
- Client side
  - Enables presentation logic to exist entirely in browser
  - e.g., can make call to remote web service, no need for server to be involved
  - (What we are looking at in this course).

Logic

- Templates require combining logic with HTML
  - Conditionals - only display presentation if some expression is true
  - Loops - repeat this template once for every item in collection
- How should this be expressed?
  - Embed code in HTML (ColdFusion, JSP, Angular)
  - Embed HTML in code (React)

Embed code in HTML

```
<cfcomponent name = "PersonalChef">
    <cffunction name = "makeToast" returnType = "component">
        <cfargument name = "color" required="yes">

        <cfset this.makeToast = "Making your toast #arguments.color#!" />
        <cfreturn this />
    </cffunction>
</cfcomponent>
```

```
<html>
<head><title>First JSP</title></head>
<body>
  <%
    double num = Math.random();
    if (num > 0.95) {
  %>
      <h2>You'll have a luck day!</h2><p>(<%= num %>)</p>
  <%
    } else {
  %>
      <h2>Well, life goes on ... </h2><p>(<%= num %>)</p>
  <%
    }
  %>
```

- Template takes the form of an HTML file, with extensions
  - Custom tags (e.g., <% %>) enable logic to be embedded in HTML
  - Uses another language (e.g., Java, C) or custom language to express logic
  - Found in frameworks such as PHP, Angular, ColdFusion, ASP, ...

Embed HTML in code

- Template takes the form of an HTML fragment, embedded in a code file

  - HTML instantiated as part of an expression, becomes a value that can be stored to variables

  - Uses another language (e.g., Javascript) to express logic

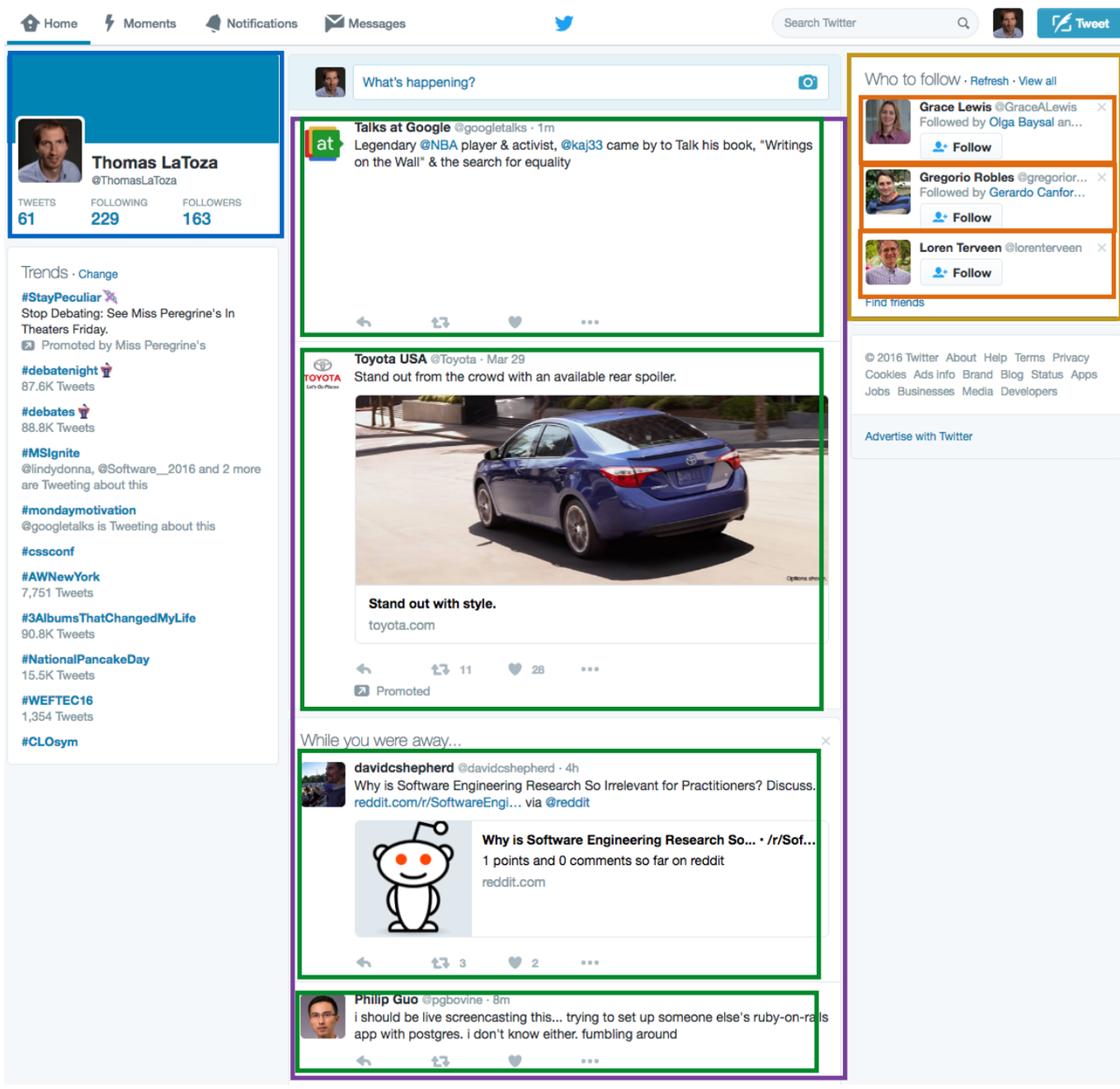
  - This course: **React**

Templates enable HTML to be rendered multiple times

- Rendering takes a template, instantiates the template, outputs HTML
- Logic determines which part(s) of templates are rendered
- Expressions are evaluated to instantiate values
    - e.g., { this.props.name }
    - Different variable values ==> different HTML output

Idea 2: Components

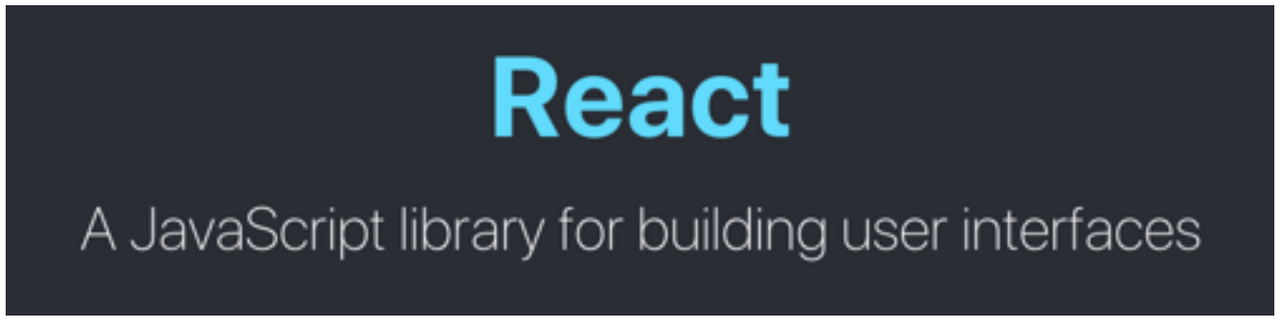
- Web pages are complex, with lots of logic and presentation
- How can we organize web page to maximize modularity?
- Solution: Components
  - Templates that correspond to a specific widget
  - Encapsulates related logic & presentation using language construct (e.g., class)



Components

- Organize related logic and presentation into a single unit
  - Includes necessary *state* and the logic for updating this state
  - Includes presentation for *rendering* this state into HTML
  - Outside world *must* interact with state through accessors, enabling access to be controlled
- Synchronizes state and visual presentation
  - Whenever state changes, HTML should be rendered again
- Components instantiated through custom HTML tag

React: Front End Framework for Components



- Originally build by Facebook
- Opensource frontend framework
- Powerful abstractions for describing frontend UI components
- Official documentation & tutorials
  - https://reactjs.org/

Example

```
class HelloMessage extends React.Component {
  render() {
    return (
      <div>
        Hello world!
      </div>
    );
  }
}

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

"Declare a HelloMessage component"

Declares a new component with the provided functions.

"Return the following HTML whenever the component is rendered"

Render generates the HTML for the component. The HTML is dynamically generated by the library.

"Render HelloMessage and insert in mountNode"

Instantiates component, replaces mountNode innerHTML with rendered HTML. Second parameter should always be a DOM element.

Example - Properties

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

ReactDOM.render(
  <HelloMessage name="John" />,
  mountNode
);
```

“Read this.props.name and output the value”

Evaluates the expression to a value.

“Set the name property of HelloMessage to John”

Components have a this.props collection that contains a set of properties instantiated for each component.

Embedding HTML in Javascript

- HTML embedded in JavaScript

```
return <div>Hello {this.props.name}</div>;
```

  - HTML can be used as an expression

  - HTML is checked for correct syntax

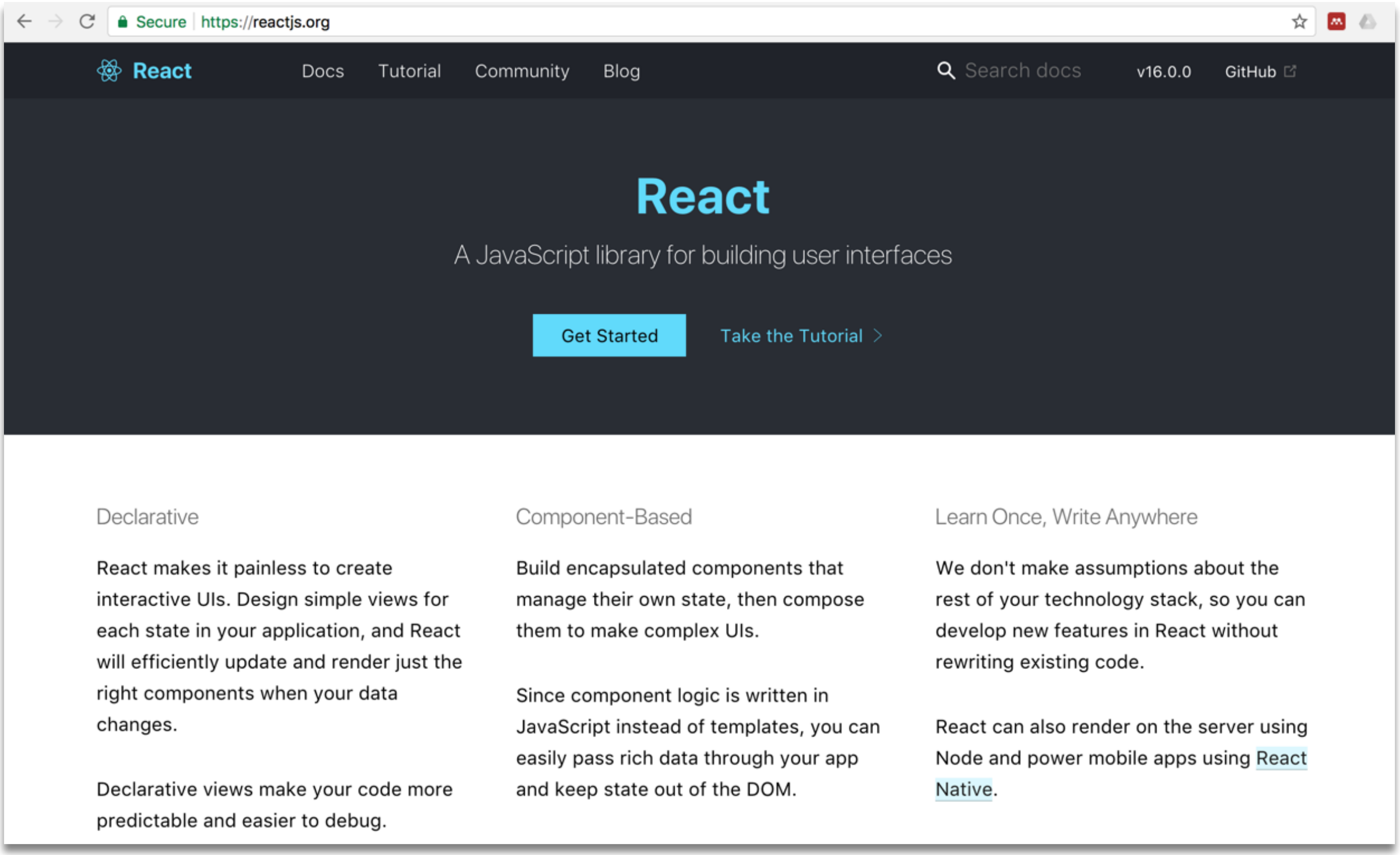
    - Can use { expr } to evaluate an expression and return a value

      - e.g., { 5 + 2 }, { foo() }

    - Output of expression is HTML

JSX

- How do you embed HTML in JavaScript and get syntax checking??
- Idea: extend the language: JSX
  - Javascript language, with additional feature that expressions may be HTML
  - Can be used with ES6 or traditional JS (ES5)
- It's a new language
  - Browsers *do not* natively run JSX
  - If you include a JSX file as source, you will get an error


Secure https://reactjs.org
React
Docs
Tutorial
Community
Blog
Search docs
v16.0.0
GitHub
React
A JavaScript library for building user interfaces
Get Started
Take the Tutorial
Declarative
React makes it painless to create interactive UIs. Design simple views for each state in your application, and React will efficiently update and render just the right components when your data changes.
Declarative views make your code more predictable and easier to debug.
Component-Based
Build encapsulated components that manage their own state, then compose them to make complex UIs.
Since component logic is written in JavaScript instead of templates, you can easily pass rich data through your app and keep state out of the DOM.
Learn Once, Write Anywhere
We don't make assumptions about the rest of your technology stack, so you can develop new features in React without rewriting existing code.
React can also render on the server using Node and power mobile apps using React Native.

Secure | https://codepen.io/gaearon/pen/gWWZgR?editors=1010

Tic Tac Toe

A PEN BY Dan Abramov PRO

Fork | Settings | Change View

HTML

```
<div id="errors" style="
  background: #c00;
  color: #fff;
  display: none;
  margin: -20px -20px 20px;
  padding: 20px;
  white-space: pre-wrap;
"></div>
<div id="root"></div>
<script>
window.addEventListener('mousedown',
function(e) {
  document.body.classList.add('mouse-
navigation');
  document.body.classList.remove('kbd-
navigation');
});
window.addEventListener('keydown',
function(e) {
  if (e.keyCode === 9) {
    document.body.classList.add('kbd-
```

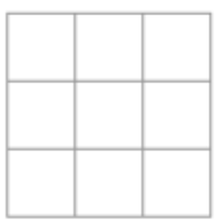
CSS

JS (Babel)

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

class Board extends React.Component {
  renderSquare(i) {
    return (
      <Square
        value={this.props.squares[i]}
        onClick={() => this.props.onClick(i)}
      />
    );
  }

  render() {
    return (
      <div>
```



Next player: X

1. Go to game start

- Pastebin sites such as JSFiddle and codepen.io work with React
- Just need to include React first

Create React App

```
npx create-react-app my-app
cd my-app
npm start
```

(npx comes with npm 5.2+ and higher, see instructions for older npm versions)

Then open http://localhost:3000/ to see your app.
When you're ready to deploy to production, create a minified bundle with `npm run build`.

```
cd my-app
yarn start

Happy hacking!
λ cd my-app
λ npm start

> my-app@0.1.0 start ~/my-app
> react-scripts start

Starting the development server...

Compiled successfully!

You can now view my-app in the browser.

  Local:            http://localhost:3000/
  On Your Network:  http://192.168.37.106:3000/
```

https://github.com/facebook/create-react-app