Making HTTP Requests

SWE 432, Fall 2017

Design and Implementation of Software for the Web

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Today

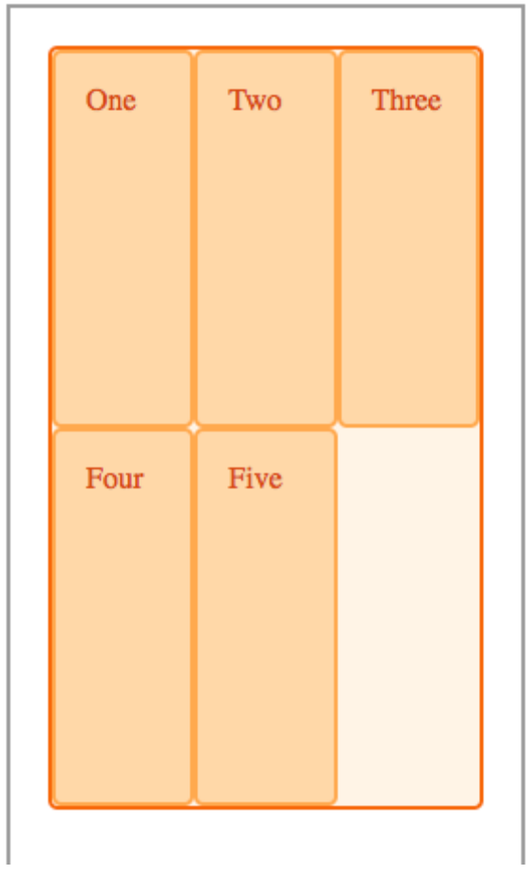
- Building responsive layouts with CSS grids
- Making HTTP requests
- Events in frontend JavaScript

- Next time: making and responding to HTTP requests

CSS Grids

```html
<div class="wrapper">
  <div>One</div>
  <div>Two</div>
  <div>Three</div>
  <div>Four</div>
  <div>Five</div>
</div>
```

```css
.wrapper {
  display: grid;
  grid-template-columns: repeat(3, 1fr);
  grid-auto-rows: 200px;
}
```



https://developer.mozilla.org/en-US/docs/Web/CSS/CSS_Grid_Layout/Basic_Concepts_of_Grid_Layout

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.

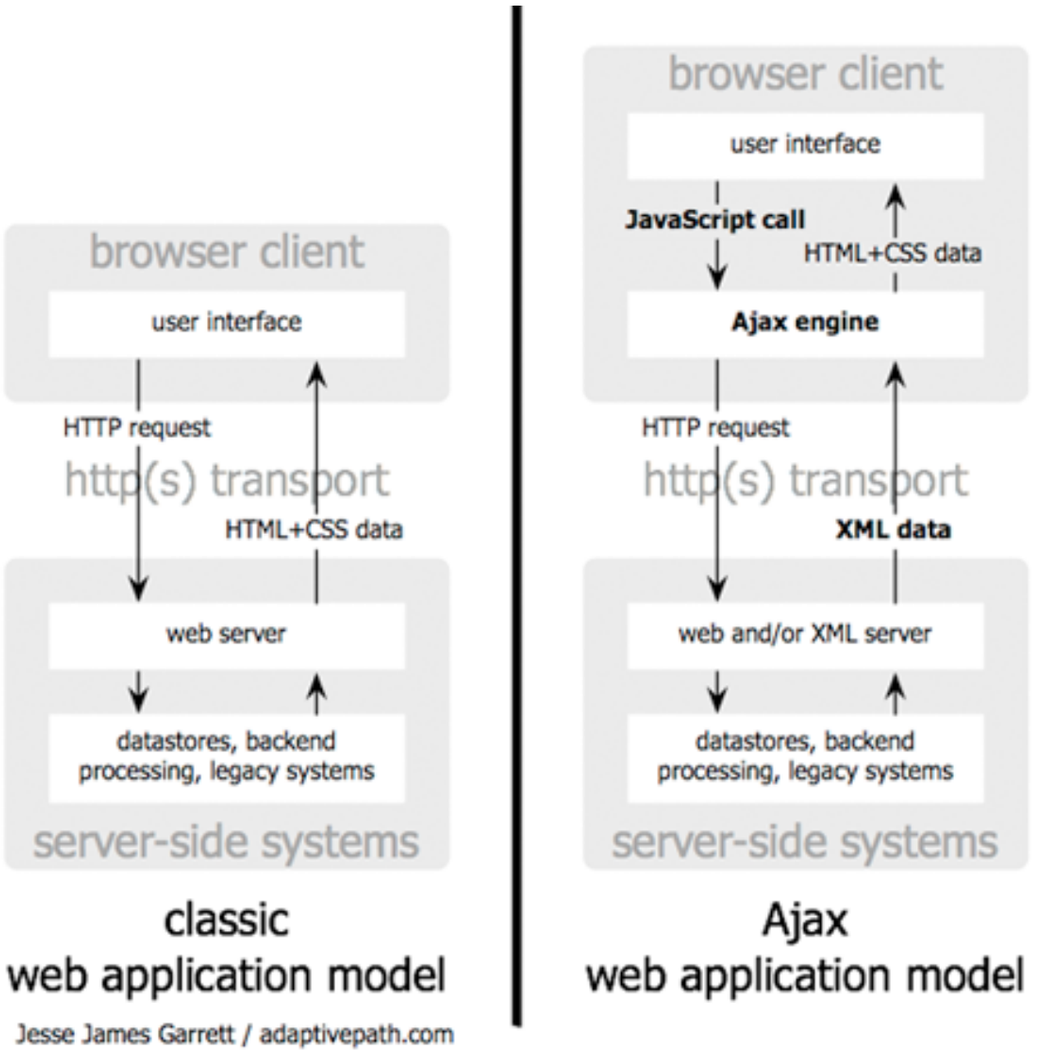
Activity: Build an interactive page

- In groups of 2 or 3
  - Build a 4 function calculator page that lets users add, delete, multiply, and divide

- Key code snippets
  - document.getElementById(**'compute'**)
  - elem.addEventListener(**"click"**, *handler*);
  - inputElem.value
  - elem.innerHTML

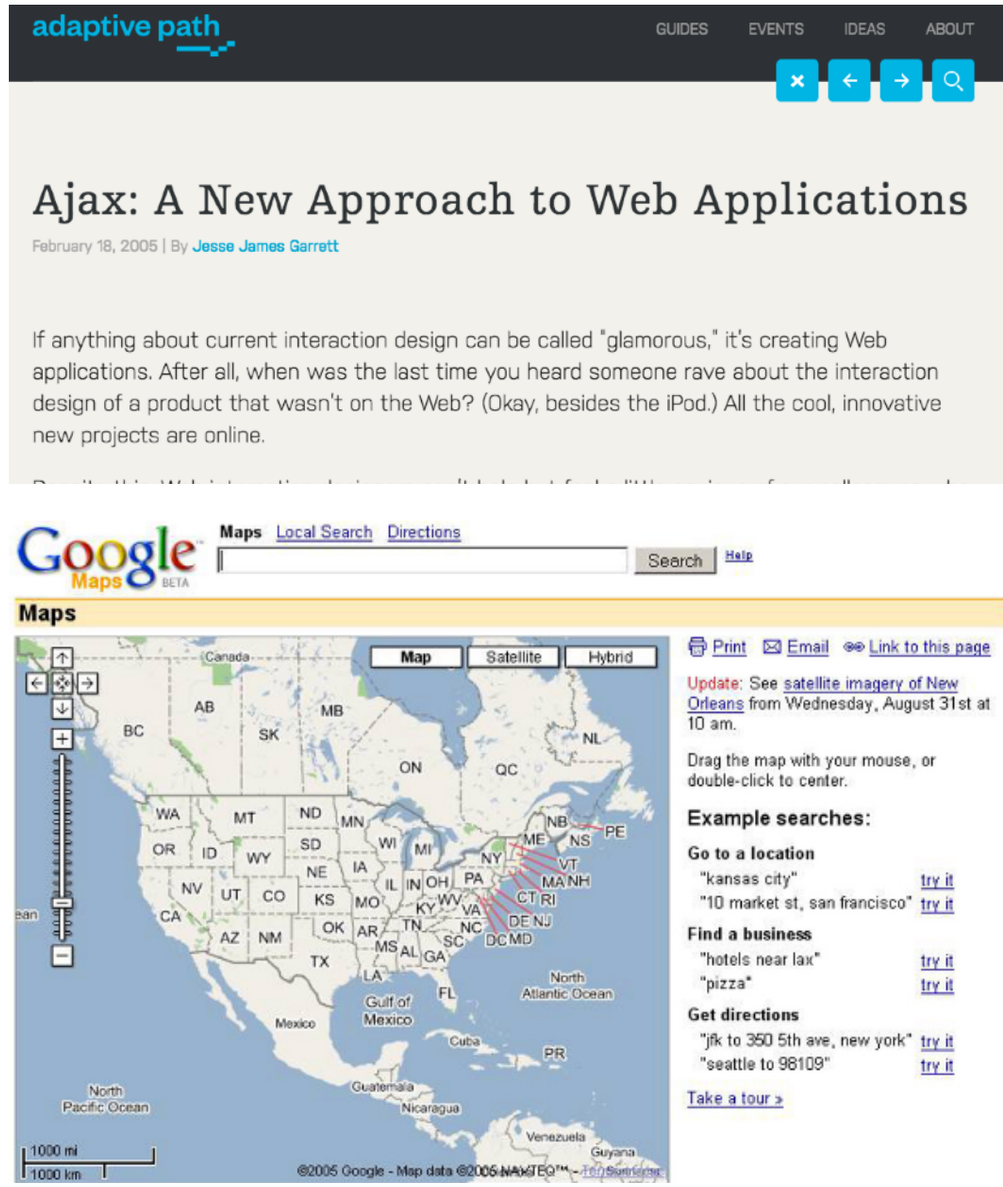
AJAX: Asynchronous JavaScript and XML

- Set of technologies to send and receive data from server asynchronously without interfering with behavior of page
  - HTML & CSS
  - DOM Manipulation
  - JSON or XML for data interchange
  - XMLHttpRequest for asynchronous communication
  - JavaScript
- Originally defined for XML. But representation independent, and now used mostly for JSON.



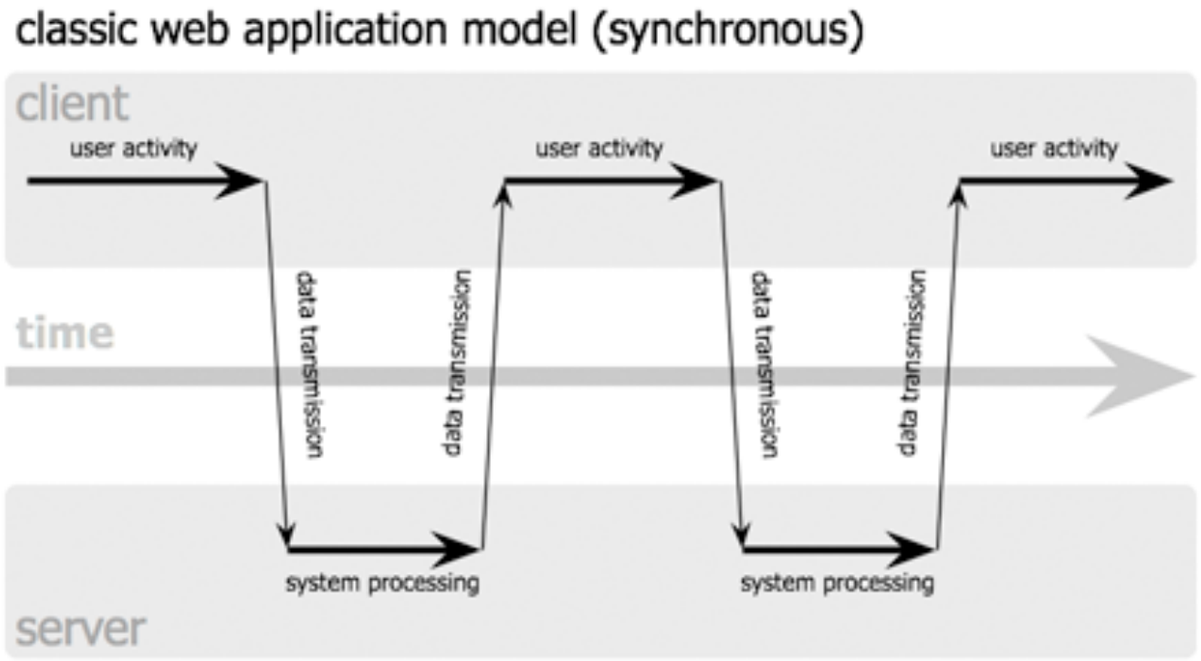
History

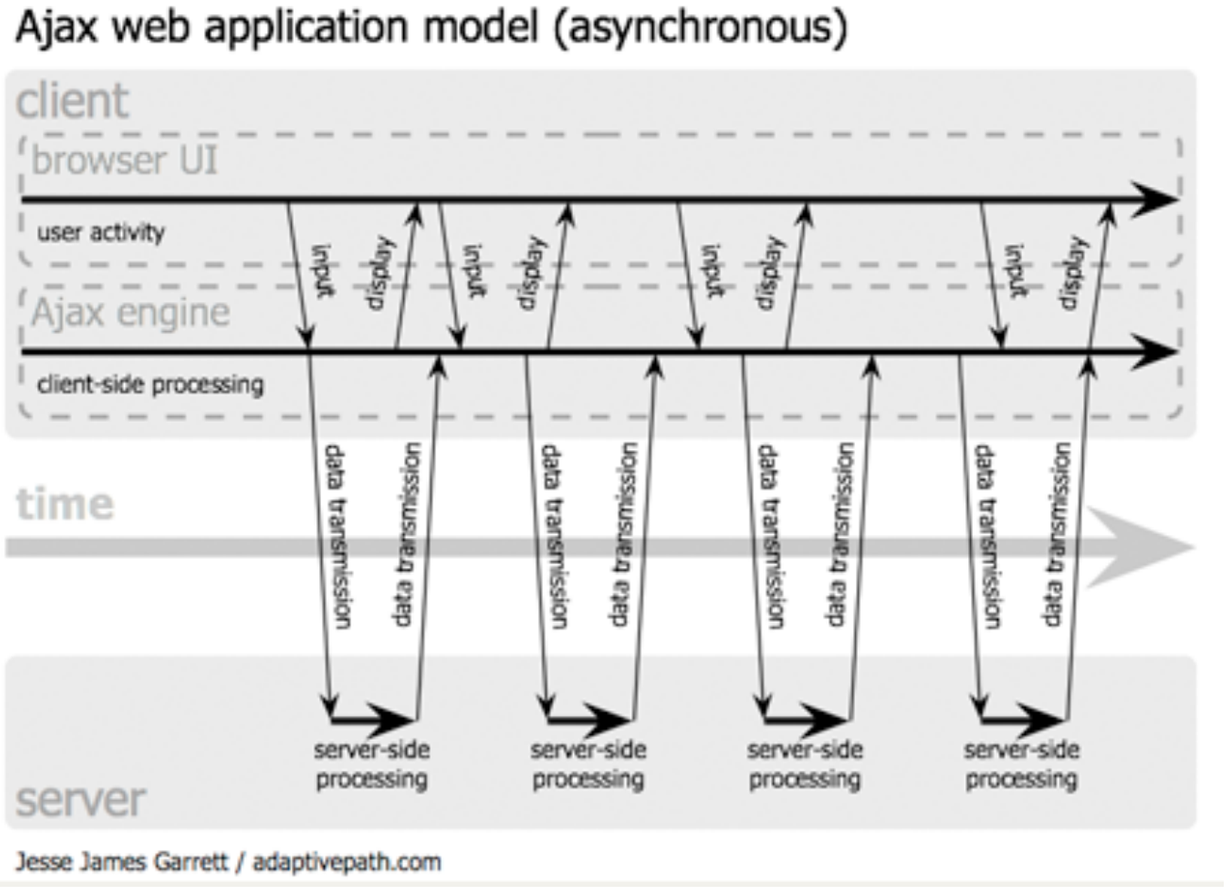
- 1998: Microsoft Outlook Web App implements first XMLHttp script
- 2004: Google releases Gmail with AJAX
- 2005: “AJAX: A New Approach to Web Applications” by Jesse James Garrett [1]
- 2005: Google Maps with AJAX
- 2006: W3C releases draft of XMLHttpRequest standard



[1] http://adaptivepath.org/ideas/ajax-new-approach-web-applications/

Synchronous vs. Asynchronous Requests

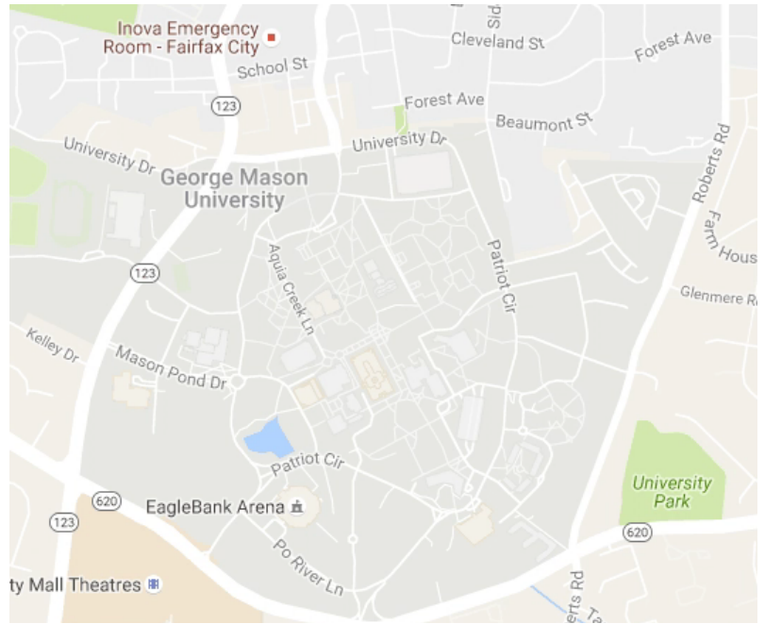




- Classic web apps require user to wait for response to server
- Asynchronous requests enable user to continue to interact with app

Example - Lazy Content Loading

- User changes visible viewport
  - JS code renders new area of map based on updated viewport
  - Check tile cache
    - If in cache, load tile from cache
    - If not in cache,
      - request tile from Google Maps Server



Lazy Content Loading

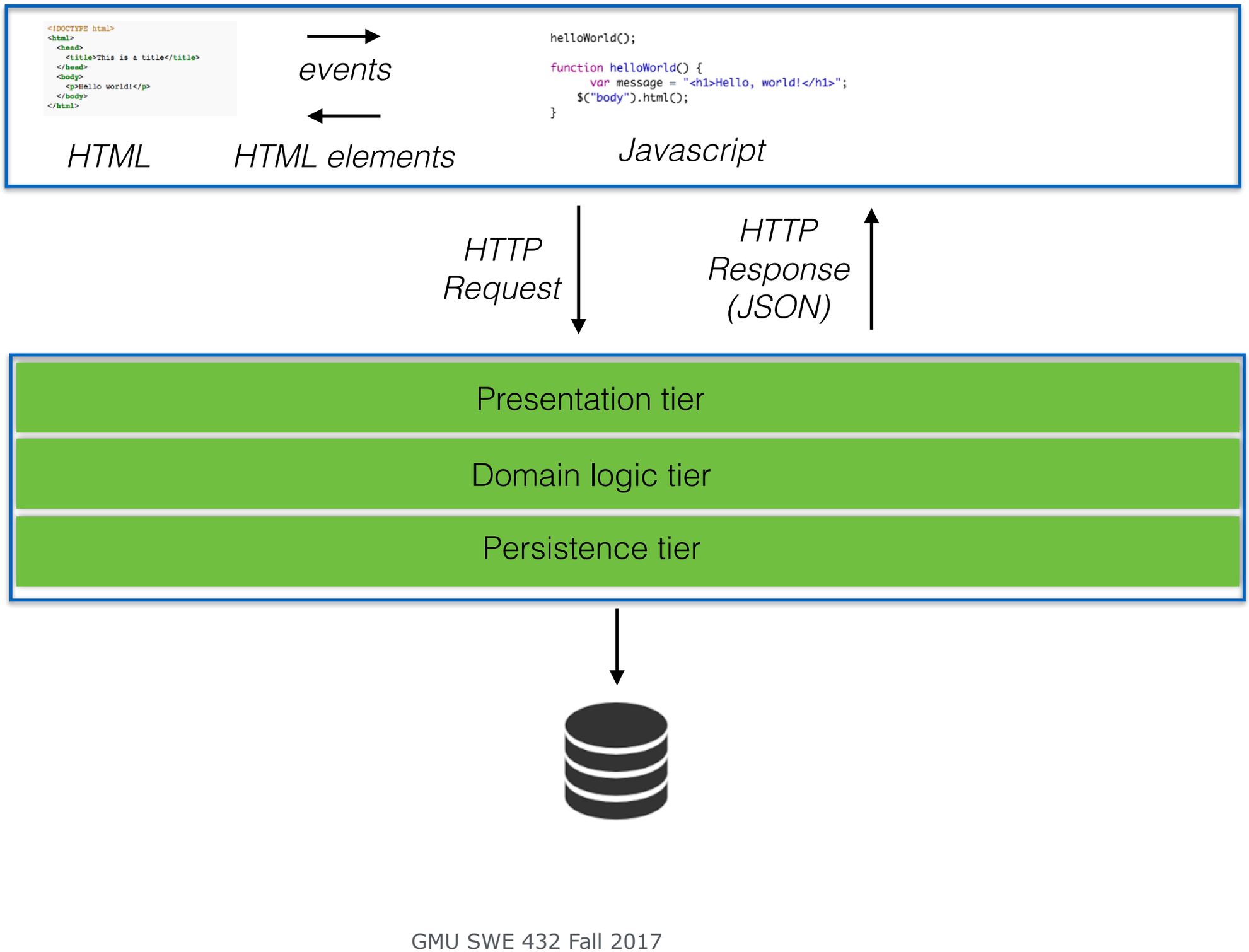
- Advantages:
  - Can have *vast* dataset that the user feels as if they are interacting with in real time
  - Only need to download content that user actually needs
  - Can (sometimes) do computation on client with really simple server that just fetches appropriate part of large data set

Some Uses for AJAX

- Lazily load content only when requested
  - e.g., FB newsfeed, Google Maps tile loading
- Load parts of web page from different hosts
  - e.g., advertisements, embedded Twitter widget, …
- Persist user data
  - In some cases, can do all computation client side
  - Enables building web app *without dedicated backend*
- Submit form data to server

Single Page Application Site

Browser



Web Server

Database

Single Page Application (SPA)

- Client-side logic sends messages to server, receives response
- Logic is associated with a single HTML pages, written in Javascript
- HTML elements dynamically added and removed through DOM manipulation
- Processing that does not require server may occur entirely client side, dramatically increasing responsiveness & reducing needed server resources
- Classic example: Gmail

Making HTTP Requests

- Fetch works on the frontend
- Part of browser API, no need to install
- Some minor differences

```
var myImage = document.querySelector('img');
```

```
fetch('flowers.jpg').then(function(response) {
  return response.blob();
}).then(function(myBlob) {
  var objectURL = URL.createObjectURL(myBlob);
  myImage.src = objectURL;
});
```

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

Posting user data

```
// Retrieve data from controls on page
var userInput = document.getElementById('userInput').value;

// Send data to remote service
fetch("/apiEndpoint",
{
    headers: {
     'Content-Type': 'application/json'
    },
    method: "POST",
    body: JSON.stringify({ "dataProp": userInput })
})
.then(function(res){ console.log(res) })
.catch(function(res){ console.log(res) });
```

Demo: Simple todo app

Loading pages

- What is the output of the following?

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

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

Loading pages

- Code in script tags will run in the order in which it is contained in the page
- Solution: should put script tags at the bottom of the body after elements in the document.

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <title>Title</title>
</head>
<body>
    <div id="container"></div>

    <script src="client.js"></script>
</body>
</html>
```

The Event Loop

```
fetch('https://api.wmata.com/Incidents.svc/json/
ElevatorIncidents',
    { headers: { api_key:
"e1eee2b5677f408da40af8480a5fd5a8"} })
    .then(function(res) {
        return res.json();
    }).then(function(json) {
    global = json;
});
```

- Event loop is responsible for dispatching events when they occur
- Simplified main thread for event loop:

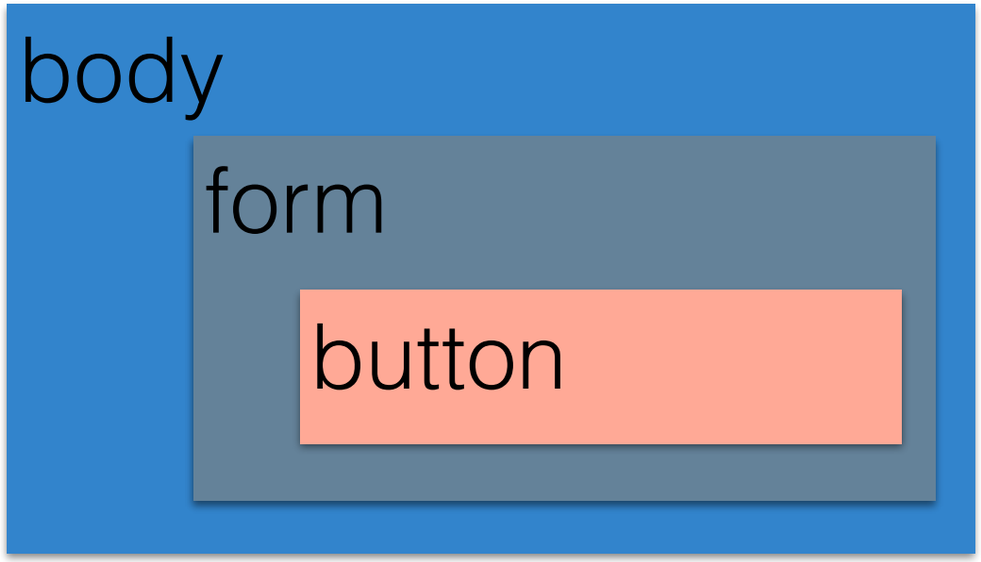
```
while(queue.waitForMessage()){
  queue.processNextMessage();
}
```

How do you write a "good" event handler?

- Run-to-completion
  - The JS engine will not handle the next event until your event handler finishes
- Good news: no other code will run until you finish (no worries about other threads overwriting your data)
- Bad/OK news: Event handlers must not block
  - Blocking -> Stall/wait for input (e.g. alert(), non-async network requests)
  - If you *must* do something that takes a long time (e.g. computation), split it up into multiple events using Promises (just like on backend)

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?

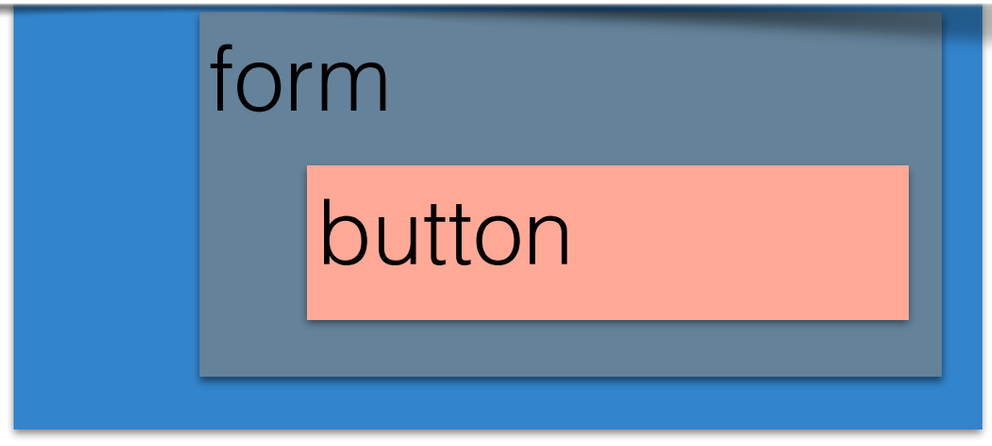



```
Listener1: body onClick
Listener2: form onClick
Listener3: button onClick
```

What happens when we click `button`?

Event Bubbling

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



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

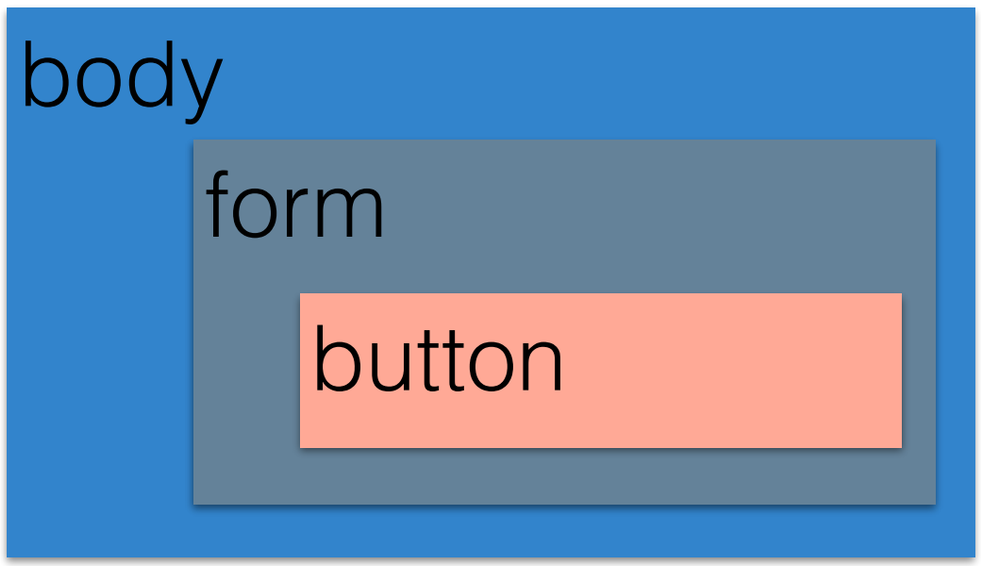
Called →

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

This is the default behavior

Event Bubbling

- An individual listener can stop bubbling by calling
- `event.stopPropagation();`
  - Assuming that `event` is the name of your handler's parameter




```
Listener1: body onClick
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```
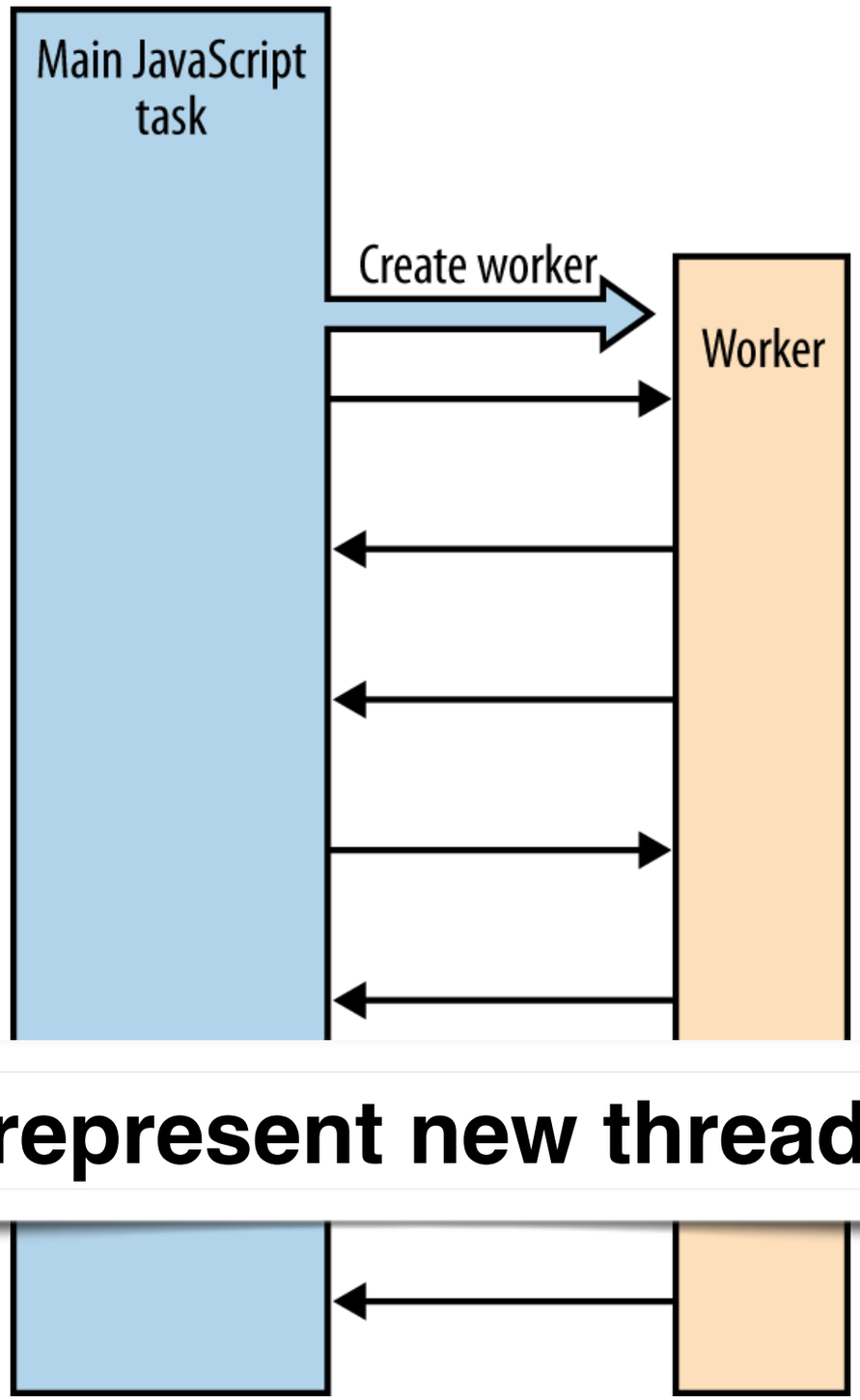

Web Workers



Web Workers represent new threads of execution

Web Workers

- Web Workers allow you to run arbitrary code in the background, without affecting the performance of your page
- Web Workers:
  - Must be defined in separate files
  - Can not access `document`, `window`, or `parent` objects (so no DOM manipulation)
  - **Can** use fetch
  - Should mainly be used for performing long, intensive computation (text parsing, image processing, big data)
  - Communicate with the rest of your app with messages

Web Worker API

- Defining a new worker

```
var worker = new Worker('worker.js');
```

- Registering a listener to hear results from the worker

```
worker.addEventListener("message", function(e){
    console.log("Message from worker: <" + e.data + ">");
});
worker.addEventListener("error", function(e){
    console.log(“Uh oh");
});
```

- Sending data to the worker

```
worker.postMessage("Hello");
```

- In the worker: registering for messages from the main thread, sending responses

```
self.addEventListener('message', function(e) { doSomething(); });
self.postMessage(“Greetings from the Worker");
```

- Including additional scripts:

```
importScripts('script2.js');
```

- Kill a worker:

```
worker.terminate();
```

Passing Messages with Web Workers

- Can pass string or object
- Objects are *passed by value*
  - Good news: reduces concurrency programming errors
  - Bad news: passing a big (10's of MB's) object will be *slow*
- Alternative: *transfer* an object
  - No longer exists in the original thread
  - Syntax:

```
worker.postMessage(myObject, [myObject]);
```

Web Workers: Example

Defining a web worker in worker.js

```
self.addEventListener('message', function(e) {
    self.postMessage("Worker is sending back the text:" + e.data);
}, false);
```

Using a web worker in our web app

```
<script language="javascript">
    "use strict";
    var worker = new Worker('worker.js');
    worker.addEventListener("message", function(e){
        console.log("Message from worker: <" + e.data + ">");
    });
    worker.postMessage("Hello");
    worker.postMessage("How's it going over there, worker?");
    worker.terminate();
</script>
```

When should you use web workers?

- Mainly for computational stuff:
  - Image manipulation
  - Map routing (without going off to server)
  - Numerical methods
  - Remember: can *not* interact with DOM in web worker

Web Workers Demo

Calculating Pi iteratively

```
function CalculatePi(loop)
{
    var n=1;
    var c = parseInt(loop);
    console.log(loop);
    for (var i=0,Pi=0;i<=c;i++) {
        Pi=Pi+(4/n)-(4/(n+2));
        n=n+4;
    }
    return Pi;
}
```

https://gmu-swe432.github.io/lecture8demos/public/WebWorkerDemoFinished.html

https://github.com/gmu-swe432/lecture8demos/tree/master/public

Readings for next time

- React Quick Start:
  - https://reactjs.org/docs/hello-world.html
  - https://reactjs.org/docs/introducing-jsx.html
  - https://reactjs.org/docs/rendering-elements.html
  - https://reactjs.org/docs/components-and-props.html
  - https://reactjs.org/docs/handling-events.html