CSE 331

Software Design & Implementation

Section: HW9, JSON, and Fetch

Reminders

- React is new and very different! Start early and ask questions

Upcoming Deadlines

- HW8 due 11pm Thursday (8/11)

Last Time…

- HW8 Overview
- React Examples
- Using Leaflet for Maps in React

Today's Agenda

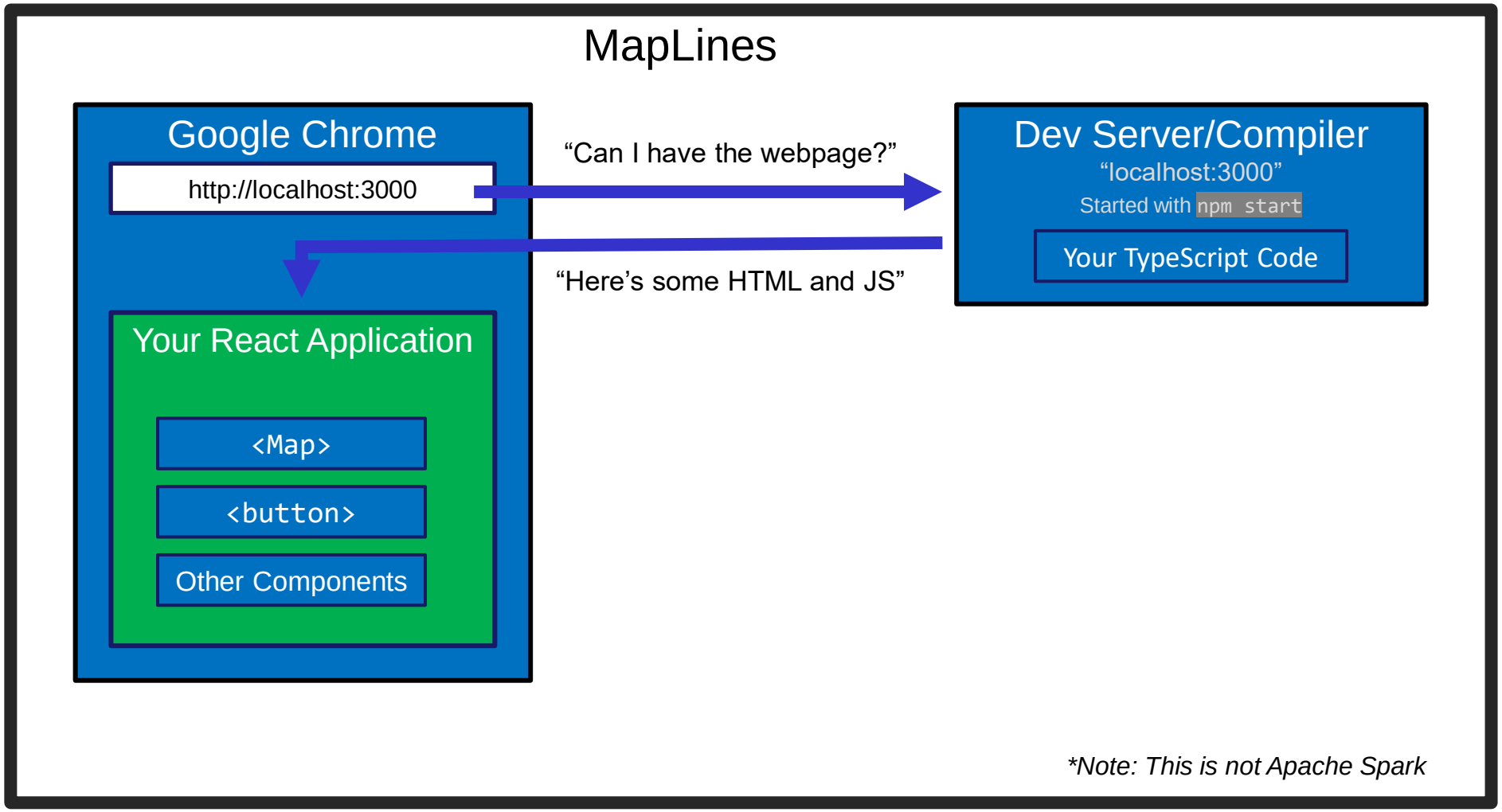
- HW9 Overview
- JSON
- Fetch

Homework 9 Overview

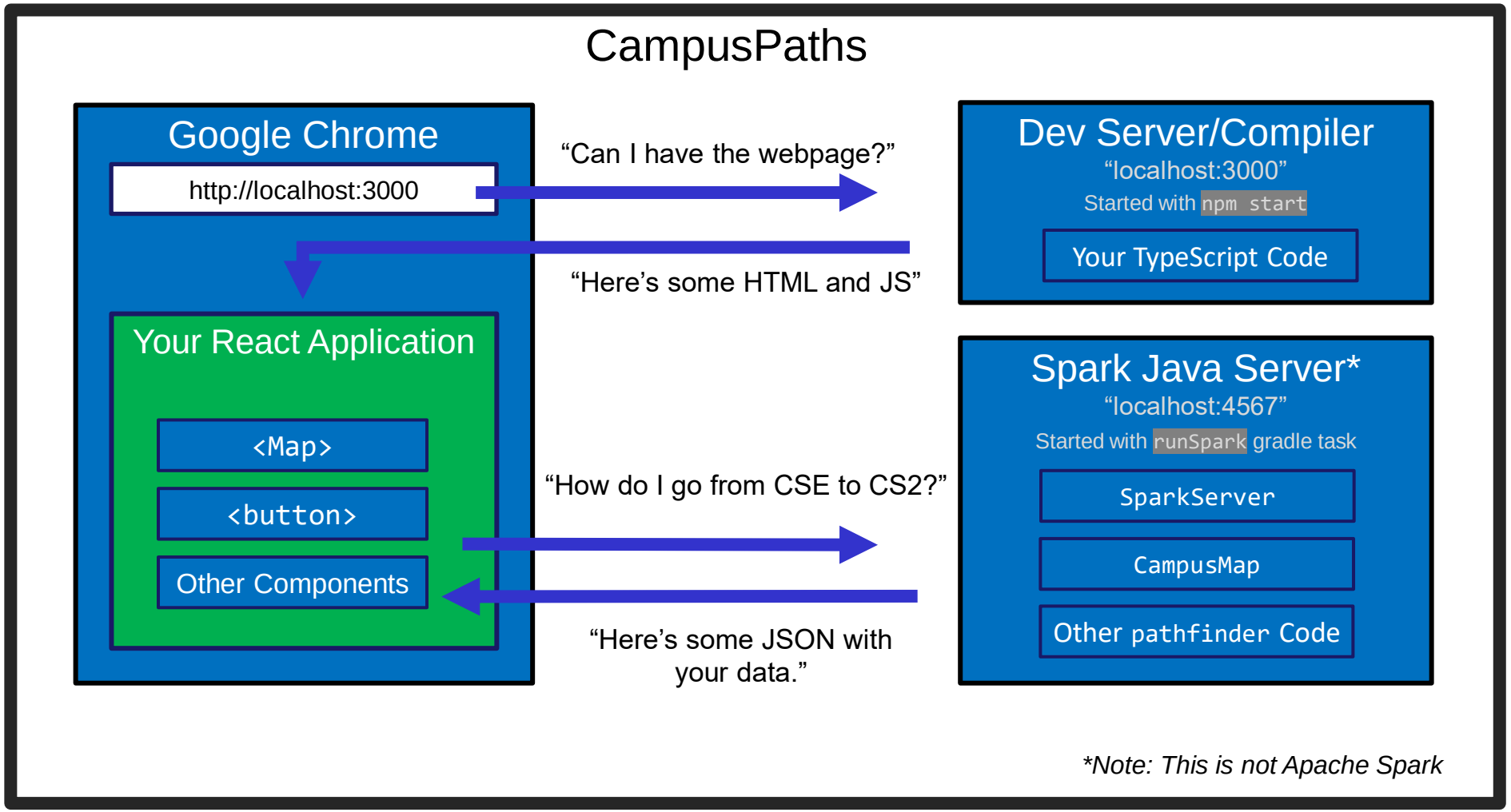
- Creating a new web GUI using React
  - Display a map and draw paths between two points on the map.
  - Similar to your React app in HW8 – but you may add more!
  - Send requests to your **Java server** (new) to request building and path info.

- Creating a **Java server** as part of your previous HW5-7 code
  - Receives **requests** from the React app to calculate paths/send data.
  - Not much code to write here thanks to **MVC**.
    - Reuse your **`CampusMap`** class from HW7.

The Map Lines Stack



The Campus Paths Stack



Any Questions?

- Done:
  - HW9 Basic Overview
- Up Next:
  - JSON
  - Fetch

JSON

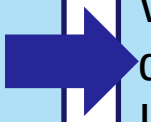
- We have a whole application written in Java (Pathfinder application)
- We're writing a whole application in JavaScript (React web application)
- Even if we get them to communicate (discussed later), we need to make sure they "speak the same language" since they store data *very* differently.

- JSON = JavaScript Object Notation
  - Can convert JS Object → String, and String → JS Object
  - Bonus: Strings are easy to send inside server requests/responses.

JSON ↔ Java

Java Object

```
public class SchoolInfo {

 String name = "U of Washington";
 String location = "Seattle";
 int founded = 1861;
 String mascot = "Dubs II";
 boolean isRainy = true;
 String website = "www.uw.edu";
 String[] colors = new String[]
                   {"Purple", "Gold"};

}
```



JSON String

{"name":"U of Washington","location":"Seattle","founded":1861,"mascot":"Dubs II","isRainy":true,"website":"www.uw.edu","colors":["Purple","Gold"]}

Use Gson (a library from Google) to convert between them.

- Tricky (but possible) to go from JSON String to Java Object, but we don't need that for this assignment.

```
Gson gson = new Gson();
SchoolInfo sInfo = new SchoolInfo();
String json = gson.toJson(sInfo);
```

JSON ↔ JS

Javascript Object

```
let schoolInfo = {

  name: "U of Washington",
  location: "Seattle",
  founded: 1861,
  mascot: "Dubs II",
  isRainy: true,
  website: "www.uw.edu",
  colors: ["Purple","Gold"]

}
```

JSON String

{"name":"U of Washington","location":"Seattle","founded":1861,"mascot":"Dubs II","isRainy":true,"website":"www.uw.edu","colors":["Purple","Gold"]}

- Can convert between the two easily (we'll see how later)
- This means: if the server sent back a JSON String, it'd be easy to use the data inside of it – just turn it into a JS Object and read its fields

JSON – Key Ideas

- Use Gson to turn Java objects containing the data into JSON before we send it back.
  - The Java objects don't have to be simple, like in the example, Gson can handle complicated structures.
- We can then turn the JSON string into a Javascript object so we can use the data (fetch can help us with that).

Any Questions?

- Done:
  - HW9 Basic Overview
  - JSON

- Up Next:
  - Fetch

What is a Request?

- Recall from lecture:
  - When you type a URL into your browser, it makes a GET request to that URL, the response to that request is the website itself (HTML, JS, etc..).
    - A GET request says "Hey server, can I get some info about _____?"
  - We're going to make a request from inside Javascript to ask for data about paths on campus.
  - There are other kinds of requests, but we're just using GET. (It's the default for **`fetch`**).
- Each "place" that a request can be sent is called an "endpoint."
  - Your Java server will provide multiple endpoints – one for each kind of request that your React app might want to make.
    - Find a path, get building info, etc…

Forming a Request

Server Address: `http://localhost:4567`

- Basic request with no extra data: **`"http://localhost:4567/getSomeData"`**
  - A request to the **`"/getSomeData"`** endpoint in the server at **`"localhost:4567"`**
  - **`"localhost"`** just means "on this same computer"
  - **`":4567"`** specifies a port number – every computer has multiple ports so multiple things can be running at a given time.
- Sending extra information in a request is done with a query string:
  - Add a **`"?"`**, then a list of **`"key=value"`** pairs. Each pair is separated by **`"&"`**.
  - Query string might look like: **`"?start=CSE&end=KNE"`**
- Complete request looks like:

  `http://localhost:4567/findPath?start=CSE&end=KNE`
- Sends a "/findPath" request to the server at "localhost:4567", and includes two pieces of extra information, named "start" and "end".

Forming a Request

Server Address: `http://localhost:4567`

`http://washington.edu/about`

`http://localhost:4567/getSomeData`

Hostname Port* Endpoint

Query Params*

`http://localhost:4567/findPath?start=CSE&end=KNE`

*Port and query params are technically optional

Servicing Requests

Recall from lecture:

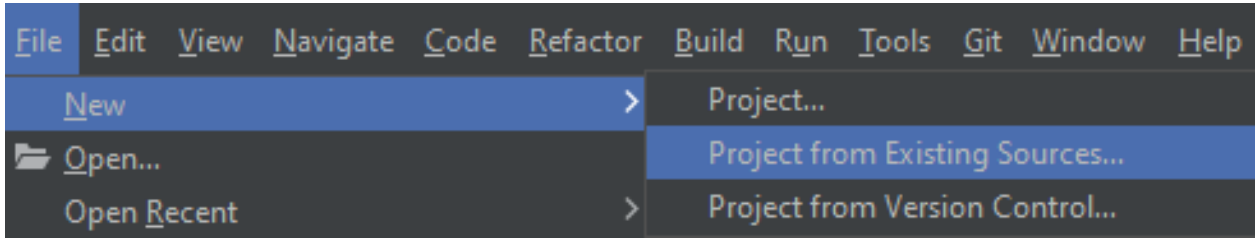
- We need some way to respond to these requests
- This is what we use our **`SparkServer`** for!
- For each "endpoint" we want, we need to define a route:

```
Spark.get("/hello-world", new Route() {
    @Override
    public Object handle(Request request, Response response)
            throws Exception {
        // we need to return our response
        return "Hello, Spark!";
    }
});
```

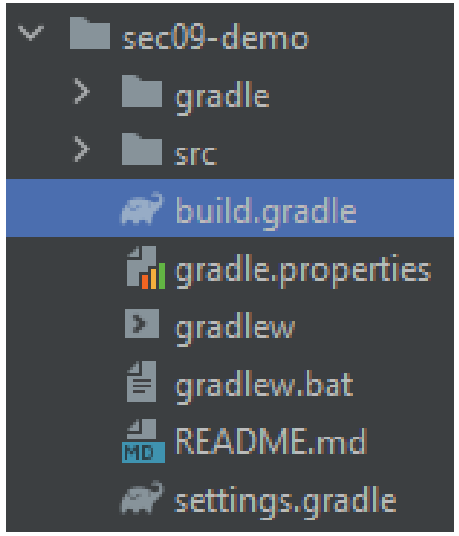
Requests and Spark Server Demo

Running the Section Demo

- Like last time, download and unzip the files from the website.



- New > Project from Existing Sources…
  - Choose the **build.gradle** file inside of the **sec09-demo** directory.



Running the Section Demo

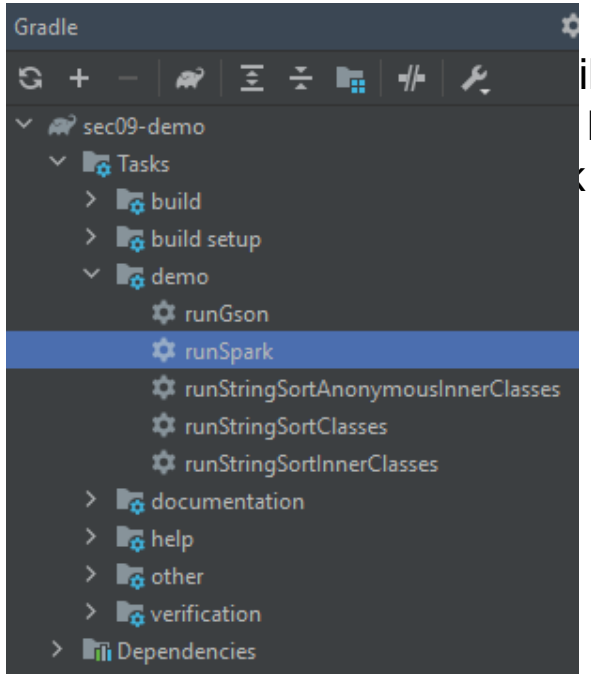
- Get the installation out of the way since it takes a while (have this install in the background while you check out the Spark demo!)
- In the IntelliJ terminal:
  - **`cd src/main/react`**
  - **`npm install`**

- Success! (Again, these warnings are **expected** and **normal**.)

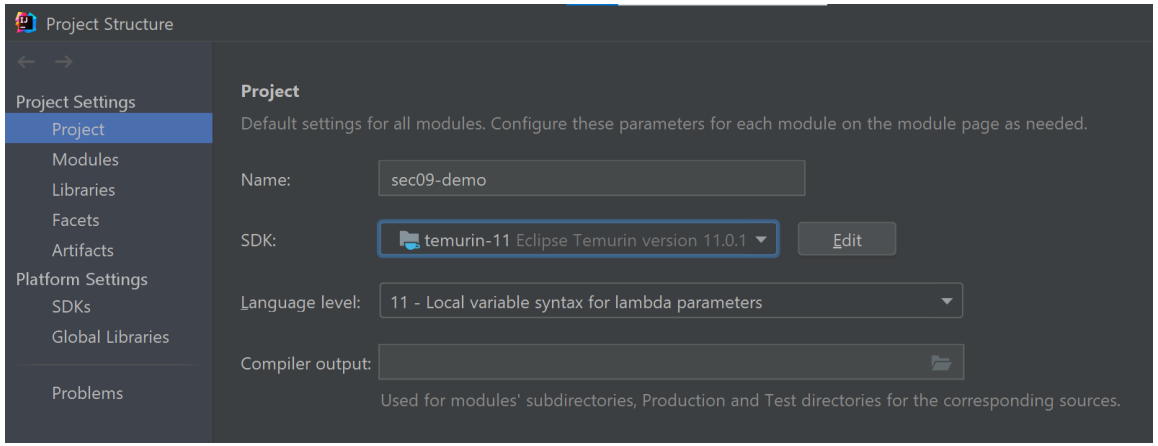
```
added 1914 packages from 751 contributors and audited 1920 packages in 284.332s

127 packages are looking for funding
  run `npm fund` for details

found 128 vulnerabilities (2 low, 65 moderate, 46 high, 15 critical)
  run `npm audit fix` to fix them, or `npm audit` for details
```

Starting up the Spark Server

- Start up the Spark Server by running the **runSpark** Gradle task.
- Alternatively, run the **main** method of `src/main/java/sparkDemo/SparkServer.java`



ile error? Make sure you're using Java 11!
Project Structure > Project
that the SDK is correct!



Starting up the Spark Server

- Your server is now running on **`http://localhost:4567`**

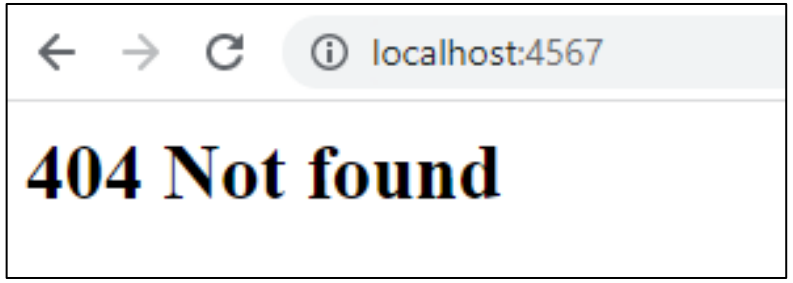
```
[main] INFO Spark Demo Server - Listening on: http://localhost:4567
[Thread-0] INFO org.eclipse.jetty.util.log - Logging initialized @299ms to org.eclipse.jetty.util.log.Slf4jLog
[Thread-0] WARN org.eclipse.jetty.server.AbstractConnector - Ignoring deprecated socket close linger time
[Thread-0] INFO spark.embeddedserver.jetty.EmbeddedJettyServer - == Spark has ignited ...
[Thread-0] INFO spark.embeddedserver.jetty.EmbeddedJettyServer - >> Listening on 0.0.0.0:4567
[Thread-0] INFO org.eclipse.jetty.server.Server - jetty-9.4.12.v20180830; built: 2018-08-30T13:59:14.071Z; git: 27208684755d94a9218
[Thread-0] INFO org.eclipse.jetty.server.session - DefaultSessionIdManager workerName=node0
[Thread-0] INFO org.eclipse.jetty.server.session - No SessionScavenger set, using defaults
[Thread-0] INFO org.eclipse.jetty.server.session - node0 Scavenging every 600000ms
[Thread-0] INFO org.eclipse.jetty.server.AbstractConnector - Started ServerConnector@30124862{HTTP/1.1,[http/1.1]}{0.0.0.0:4567}
[Thread-0] INFO org.eclipse.jetty.server.Server - Started @896ms
```

- These are **not** errors – the server just outputs info in red text.

- Let's try sending a request to the server…
  - Visit **`http://localhost:4567`** in a browser

Starting up the Spark Server

- We got a 404 Not Found Page.
  Why is this?



- INFO spark.http.matching.MatcherFilter - The requested route [/] has not been mapped in Spark for Accept

- Our server doesn't have an endpoint called "/"
- But our server does have other endpoints. Let's examine the code…
  - Open up **`src/main/java/sparkDemo/SparkServer.java`**

Example 1:

Hello, World

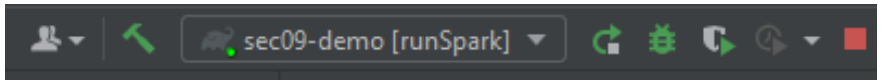
```
Spark.get("/hello-world", new Route() {
    @Override
    public Object handle(Request request,
                         Response response) throws Exception {
        // As a first example, let's just return
        // a static string.
        return "Hello, Spark!";
    }
});
```

Example 2:

Create Your Own Route!

- Create your own endpoint!

```
Spark.get("/your-endpoint-here", new Route() {
    @Override
    public Object handle(Request request,
                         Response response) throws Exception {
        return "Your message here!";
    }
});
```



- When you're done, you'll need to restart the server. Use the **stop** button and re-run the **runSpark** Gradle task.
  - Visit your newly-created endpoint!

Example 3:

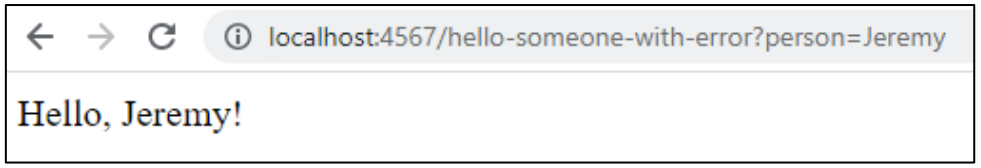
Query Parameters

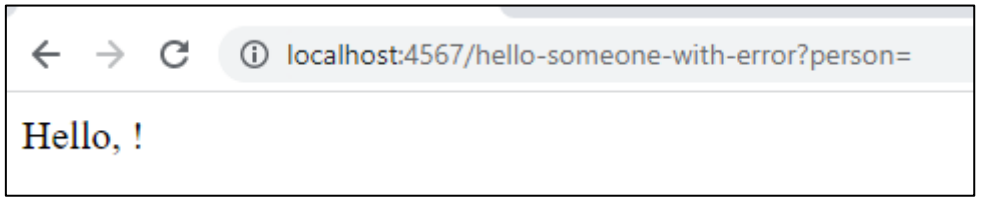
```
Spark.get("/hello-someone", new Route() {
    @Override
    public Object handle(Request request,
                         Response response) throws Exception {
        String personName = request.queryParams("person");
        return "Hello, " + personName + "!";
    }
});
```

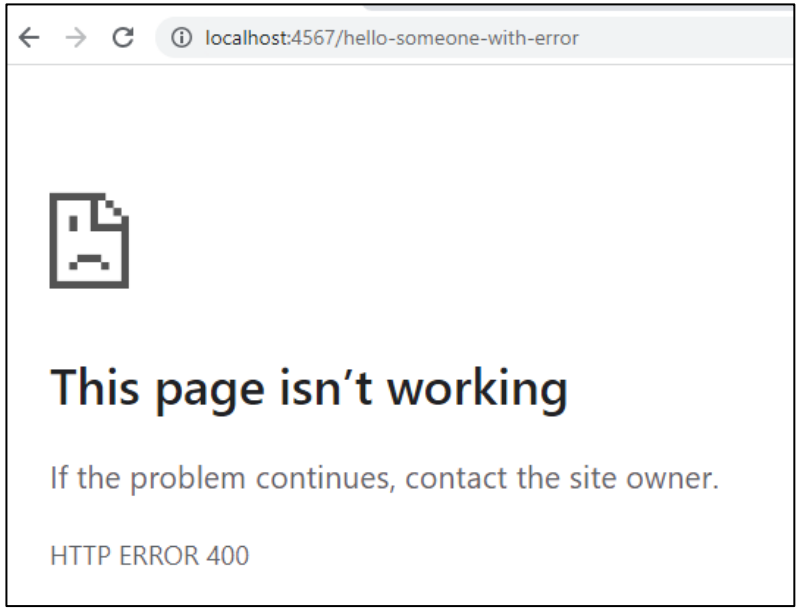
Example 4:

Parameter Error Handling

```
Spark.get("/hello-someone-with-error", new Route() {
        ...
        String personName = request.queryParams("person");
        if (personName == null) { Spark.halt(400); }
        return "Hello, " + personName + "!";
    }
});
```







Example 5:

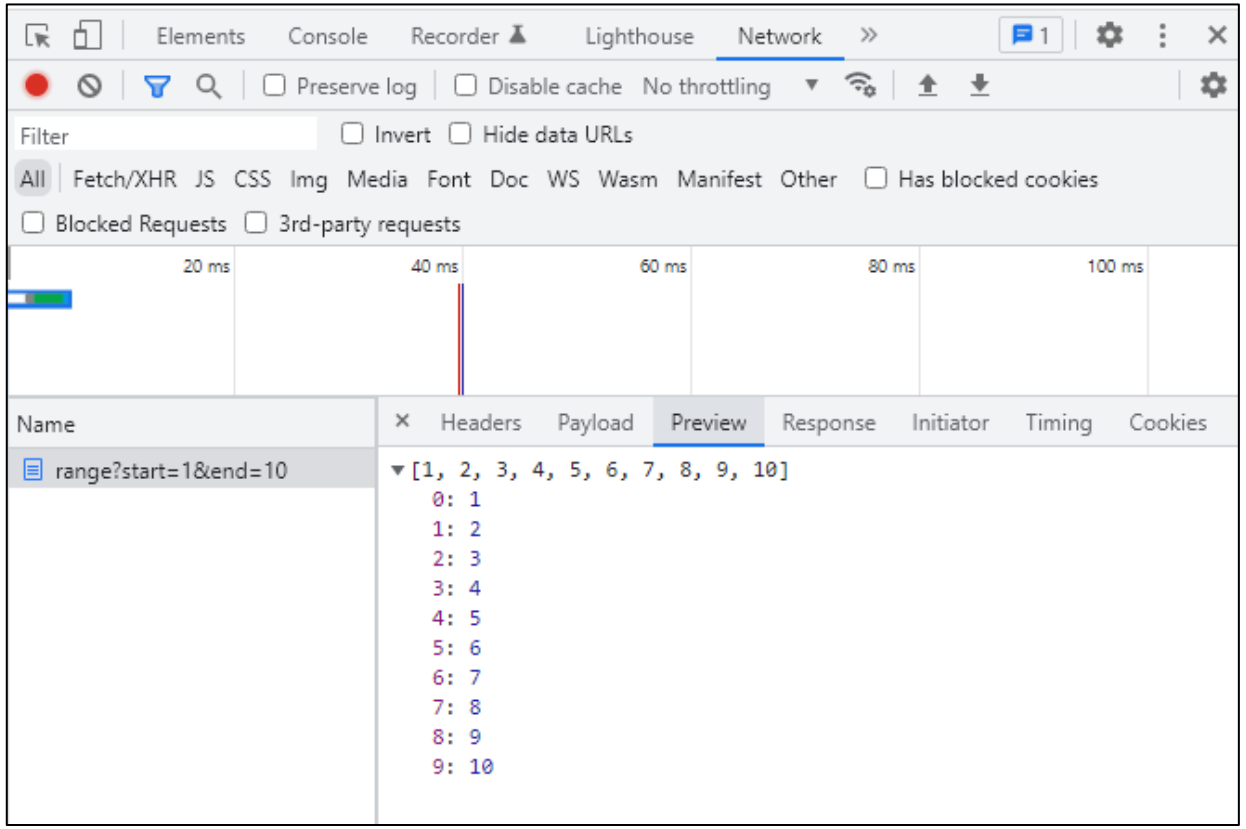
Sending Back a Simple Java Object

```
Spark.get("/range", new Route() {
        ...
        List<Integer> range = new ArrayList<>();
        for (int i = start; i <= end; i++) {
            range.add(i);
        }
        Gson gson = new Gson();
        String jsonResponse = gson.toJson(range);
        return jsonResponse;
    }
});
```

Example 5:

Sending Back a Simple Java Object

Tip: Use the network tab to view requests and responses!



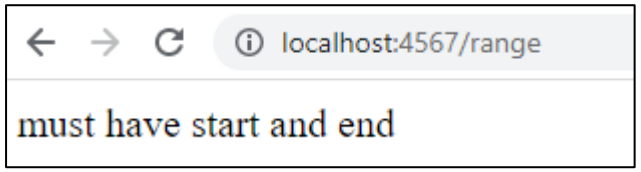
Example 5:

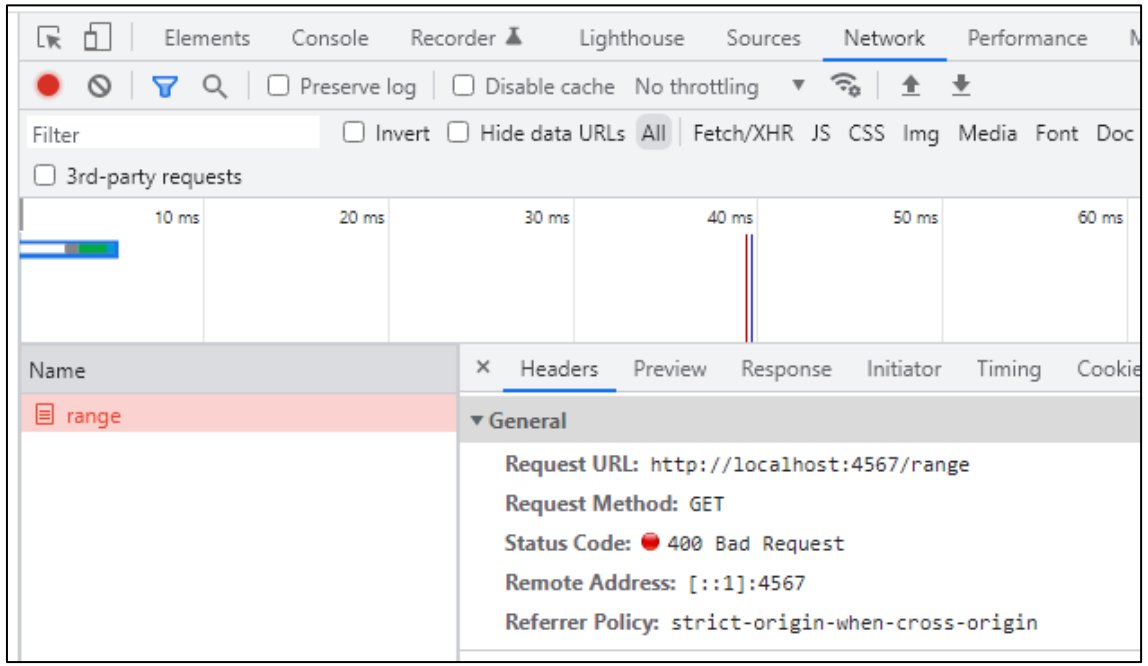
Sending Back a Simple Java Object

- Use descriptive and informative error messages!

```
Spark.halt(400, "must have start and end");
```

- Limited freedom to pick a status #!
  - See the docs

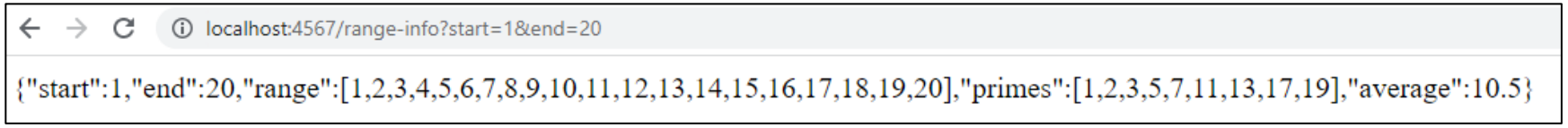




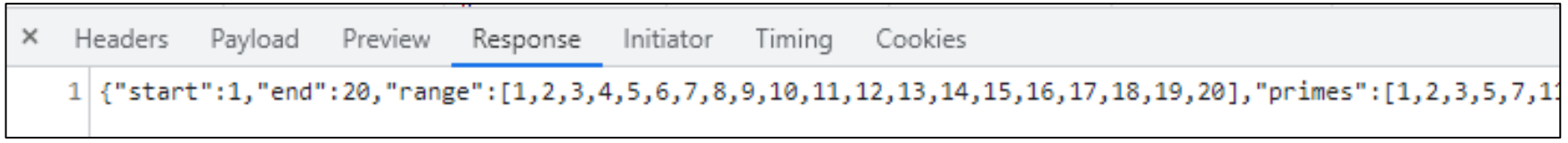
Example 6:

Sending Back a Complex Java Object

```
Spark.get("/range-info", new Route() {
        ...
        // RangeInfo is a class with fields:
        // start, end, range, primes, average
        RangeInfo rangeInfo = new RangeInfo(start, end);
        Gson gson = new Gson();
        return gson.toJson(rangeInfo);
    }
});
```



- The network tab also shows this!



Fetch

- Used by JS to send requests to servers to ask for info.
  - alternative to **`XmlHttpRequest`**

- Uses Promises:
  - Promises capture the idea of "it'll be finished later."
  - Asking a server for a response can be *slow*, so Promises allow the browser to keep working instead of stopping to wait.
  - Getting the data out is a little more complicated.
  - Java has Promises too – called **`CompletableFuture`**

- Can use **`async`**/**`await`** syntax to deal with promises.

Sending the Request in React

```
let responsePromise = fetch("http://localhost:4567/findPath?start=CSE&end=KNE");
```

- The URL you pass to **`fetch()`** can include a query string if you need to send extra data.
- **`responsePromise`** is a Promise object
  - Once the Promise "resolves," it'll hold whatever is sent back from the server.
- How do we get the data out of the Promise?
  - We can **`await`** the promise's resolution.
  - **`await`** tells the browser that it can pause the currently-executing function and go do other things. Once the promise resolves, it'll resume where we left off.
  - Prevents the browser from freezing while the request is happening (which can take some time to complete)

Getting Useful Data

"This function is pause-able"

Will eventually resolve to an actual JS object based on the JSON string.

Once we have the data, store it in a useful place.

```
async sendRequest() {
    let responsePromise = fetch("...");
    let response = await responsePromise;
    let parsingPromise = response.json();
    let parsedObject = await parsingPromise;
    this.setState({
        importantData: parsedObject
    });
}
```

Error Checking

Every response has a 'status code' (404 = Not Found). This checks for 200-299 = OK

On a complete failure (e.g. server isn't running) an error is thrown.

Make sure you create **informative** and **helpful** error messages!

```
async sendRequest() {
    try {
        let response = await fetch("...");
        if (!response.ok) {
            alert("Error message!");
            return;
        }
        let parsed = await response.json();
        this.setState({
            importantData: parsed
        });
    } catch (e) {
        alert("Error message!");
    }
}
```

Fetch Demo

Running the Fetch Demo

- Make sure your Spark Server is running (**runSpark** Gradle task)
- In the IntelliJ terminal:
  - Make sure you're in **`src/main/react`**
  - **`npm start`**

```
Compiled successfully!

You can now view sec09-demo in the browser.

  Local:            http://localhost:3000
  On Your Network:  http://192.168.1.9:3000

Note that the development build is not optimized.
To create a production build, use npm run build.
```

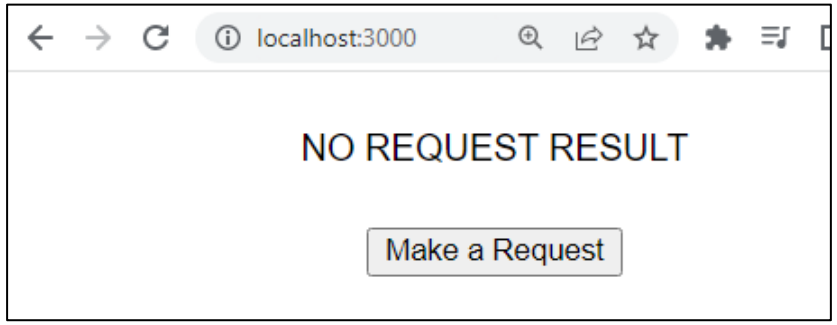
- A browser window should open up automatically
  - Issues: have you run **`npm install`** yet?
  - If so, run **`npm audit fix --force`** then run **`npm start`**

Example 7:

Fetch

App.tsx:

```
constructor(props: {}) {
  super(props);
  this.state = { requestResult: "NO REQUEST RESULT" };
}


render() {
  return (
    <div className="App">
      <p>{this.state.requestResult}</p>
      <button onClick={this.makeRequestLong}>
        Make a Request
      </button>
    </div>
  );
}
```



Example 7:

Fetch

```
makeRequestLong = async () => {
  try {
    let responsePromise = fetch("http://localhost:4567/
                                 hello-someone?person=React");
    let response = await responsePromise;
    if (!response.ok) {
      alert("Error! Expected: 200, Was: " + response.status);
      return;
    }
    let textPromise = response.text();
    let text = await textPromise;
    this.setState({ requestResult: text });
  } catch (e) {
    alert("There was an error contacting the server.");
    console.log(e);
  }
};
```

Example 7:

Fetch

```
makeRequestLong = async () => {
  try {
    let responsePromise = fetch("http://localhost:4567/
                                 hello-someone?person=React");
```

The type of this is **`Promise<Response>`**

Do **NOT** use **`https`**

```
    let response = await responsePromise;
    ...
};
```

await "resolves" a promise
(waits for the promise to be fulfilled)

The type of this is **`Response`**

Example 7:

Fetch

```
makeRequestLong = async () => {
    ...
    if (!response.ok) {
      alert("Error! Expected: 200, Was: " + response.status);
      return;
    }
    ...
};
```

Stop the execution of this function if the response is bad.

`Response` objects have other fields too, such as:

- **`.headers`**
- **`.statusText`**
- **`.url`**

Check out the docs for more info on **`Response`** objects!

Example 7:

Fetch

```
makeRequestLong = async () => {
    ...
    let textPromise = response.text();

    let text = await textPromise;

    ...
};
```

Since we used **`.text()`**, the type of this is **`Promise<string>`**

This endpoint returns a string (text). If your endpoint returns a JSON string, use **`response.json()`** instead.

`Promise<string>` resolves into **`string`**.
`text` is of type **`string`**.

Example 7:

Fetch

```
makeRequestLong = async () => {
    ...
    let text = await textPromise;
    this.setState({ requestResult: text });
  } catch (e) {
    alert("There was an error contacting the server.");
    console.log(e);
  }
};
```

We update the **state** with the response from the server!

Handle errors gracefully and inform the user of an error. Most common sources of errors:

- Fetch URL is wrong
- Server is offline
- Using `.json()` if the response doesn't contain valid JSON

Example 7:

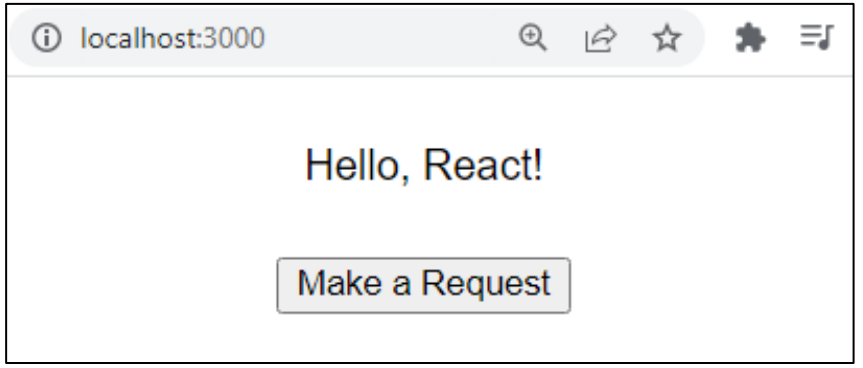
Fetch

Recap:

- When we click the button, its **`onClick`** listener will call the callback function we passed in: **`this.makeRequestLong`**
- **`this.makeRequestLong`** sends a **`fetch`** request to our **Spark Server**: **`http://localhost:4567/hello-someone?person=React`**
- **`this.makeRequestLong`** receives a response from the server and updates **`App`**'s **state**

- React notices the **state** update and queues a re-render
- The **`<p>`** element is re-rendered with the updated **state**!

Queue a re-render!



Example 8:

Fetch, but more compact

```
makeRequest = async () => {
  try {
    let response = await fetch("...");
    if (!response.ok) {
      alert("...");
      return;
    }
    let text = await response.text();
    this.setState({ requestResult: text });
  } catch (e) {
    alert("There was an error contacting the server.");
    console.log(e);
  }
};
```

Reduced the number of temporary variables!

Things to Know

- Can only use the **`await`** keyword inside a function declared with the **`async`** keyword.
  - **`async`** keyword means that a function can be "paused" while **`await`**-ing

- **`async`** functions automatically return a Promise that (will eventually) contain(s) their return value.
  - This means that if you need a return value from the function you declared as **`async`**, you'll need to **`await`** the function call.
  - But that means that the caller also needs to be **`async`**.
  - Therefore: best to **not** have useful return values from **`async`** functions
  - Instead of returning, call **`setState`** to store the result and trigger an update.

More Things to Know

- Error checking is **important**.
  - If you forget, the error most likely will disappear without actually causing your program to explode.
  - This is BAD! Silent errors can cause tricky bugs.
  - Happens because errors don't bubble outside of promises, and the **async** function you're inside is effectively "inside" a promise.
  - Means that if you don't catch an exception, it'll just disappear as soon as your function ends.

More More Things to Know

- The return value of **`await response.json()`** will be **`any`**
  - As we know, this is dangerous! (No TypeScript checks)
- To solve, we create an interface describing what the server will respond with (e.g. a **`Path`**) and ***`cast`*** the value to that type:

```
interface Path { ... }
const parsed: Path = await response.json() as Path;
```

- Note: This does not check that the value *actually has* this type
  - If the server sends back something different, could crash later
  - A true solution would check the object before casting
    - Can get pretty complicated – **not required** for HW9
    - If you're curious – libraries like **`io-ts`** can help with this

Any Questions?

- Done:
  - HW9 Overview
  - JSON
  - Fetch

Before next lecture…

1. Do HW8 by tonight!
   - No written portion
   - Coding portion (push and tag on GitLab)

2. Feel free to add additional JUnit tests or script tests!