CSE 331
Software Design & Implementation

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Winter 2021

HW9, Spark Java, Fetch

Administrivia

- HW8 due this week (Thur. 3/4 @ 11:00pm)

- Section this week is Question Time
  - No planned material – come hang out and ask questions

- HW 9 Due a week later (Thur. 3/11 @ 11:00pm)
  - Spec released later today. ☺
  - Plan ahead - this assignment can take a little longer than others.
  - Get creative! Lots of cool opportunities.

- Any questions?

Agenda

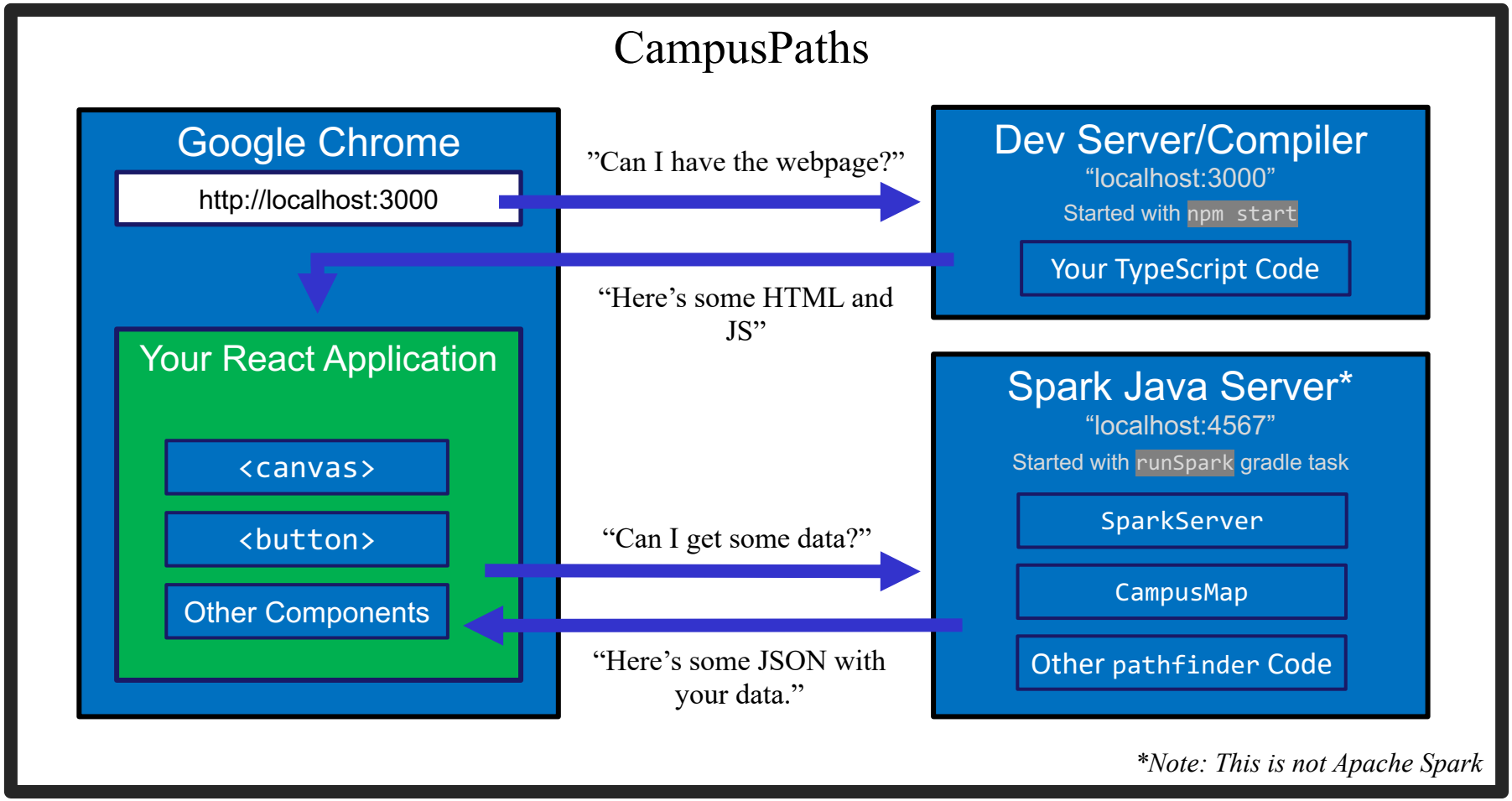
- HW9 Overview
- Anonymous Inner Classes
  - Common Java idiom – can make code easier to write.
  - Come in handy when writing the Java server.
- JSON
  - Brief overview
  - Helps share data between Java and JS.
- Fetch
  - How your JS sends requests to the Java server.
- Spark Java
  - How to turn your `hw-pathfinder` code into a Java server.

Homework 9 Overview

- Creating a new web GUI using React
  - Display a map and draw paths between two points on the map.
  - Works just like your React app in HW8 – but you get to design it!
  - 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 Campus Paths Stack



Any Questions?

- Done:
  - HW9 Basic Overview
- Up Next:
  - Anonymous Inner Classes
  - JSON
  - Fetch
  - Spark Java

Anonymous Inner Classes

- Helps put code closer to where it's used.
- Makes sense when you aren't re-using classes.

- The Example: sorting Strings by length instead of alphabetically.
  - We need to make a Comparator – but how best to organize our code?
  - Start with what we're used to, then refine.

~~Anonymous Inner~~ Classes (Attempt 1)

```
public class StringSorter {

    public static void main(String[] args) {
        String[] strings = new String[]{"CSE331", "UW", "React", "Java"};
        Arrays.sort(strings, new LengthComparator());
        System.out.println(Arrays.toString(strings));
    }
}
```

StringSorter.java

```
public class LengthComparator implements Comparator<String> {

    @Override
    public int compare(String s1, String s2) {
        return Integer.compare(s1.length(), s2.length());
    }
}
```

LengthComparator.java

Attempt 1 – Pros/Cons

- Pros:
  - Easy to reuse (assuming we want to).
- Cons:
  - Polluting the namespace with a whole extra top-level class.
  - Understanding the main method requires viewing two separate Java files.

~~Anonymous~~ Inner Classes (Attempt 2)

```
public class InnerStringSorter {

    public static void main(String[] args) {
        String[] strings = new String[]{"CSE331", "UW", "React", "Java"};
        Arrays.sort(strings, new InnerLengthComparator());
        System.out.println(Arrays.toString(strings));
    }

    public static class InnerLengthComparator implements Comparator<String> {

        @Override
        public int compare(String s1, String s2) {
            return Integer.compare(s1.length(), s2.length());
        }
    }
}
```

InnerStringSorter.java

Attempt 2 – Pros/Cons

- Pros:
  - In a single Java file now – easier to read/understand.
  - Still reusable outside this file, but more annoying syntax to do so:
    - `new InnerStringSorter.InnerLengthComparator()`
- Cons:
  - If we're not reusing it, this is unnecessary indirection.
    - Reader has to find and read a new class to understand what the code in main means, even if we only ever do this sorting in one place.

Anonymous Inner Classes (Attempt 3)

```
public class AnonymousStringSorter {

    public static void main(String[] args) {
        String[] strings = new String[]{"CSE331", "UW", "React", "Java"};
        Arrays.sort(strings, new Comparator<String>() {

            @Override
            public int compare(String s1, String s2) {
                return Integer.compare(s1.length(), s2.length());
            }
        });
        System.out.println(Arrays.toString(strings));
    }
}
```

AnonymousStringSorter.java

Anonymous Inner Classes (Attempt 3)

```
public class AnonymousStringSorter {

    public static void main(String[] args) {
        String[] strings = new String[]{"CSE331", "UW", "React", "
        Arrays.sort(strings, new Comparator<String>() {

            @Override
            public int compare(String s1, String s2) {
                return Integer.compare(s1.length(), s2.length());
            }
        });
        System.out.println(Arrays.toString(strings));
    }
}
```

AnonymousStringSorter.java

Creating and using the class, all at once! No need to give it a name.

Attempt 3 – Pros/Cons

- Pros:
  - Still in a single Java file
  - Puts the meaning of the code right where it's being executed - easy to see exactly what the `Arrays.sort` is going to do.
  - Super useful if you need to make a whole bunch of different Comparators (or objects that extend other classes). Doing something similar to this in HW9.
- Cons:
  - Not reusable (there's no name!)
    - Anonymous inner classes only make sense in certain circumstances, like when you need to make an object for one specific situation.
  - Can be harder to read if overused.

- Note: Java 8 adds a whole bunch of additional ways to write these sorts of things.
  - Not going to discuss them, but you're welcome to learn and use them if you'd like!

Any Questions?

- Done:
  - HW9 Basic Overview
  - Anonymous Inner Classes

- Up Next:
  - JSON
  - Fetch
  - Spark Java

JSON

- We have a whole application written in Java so far:
  - Reads TSV data, manages a Graph data structure, manages building information, uses Dijkstra's algorithm to find paths.
- We're writing a whole application in Javascript:
  - React web app to create a GUI for your users to interact with.
- Even if we get them to communicate (discussed later), we need to make sure they "speak the same language".
  - Javascript and Java 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 ↔ 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 the fields out of the object.

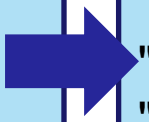
JSON ↔ JS

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 – 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.
- Easy to turn a JSON string into a Javascript object so we can use the data (fetch can help us with that).

Any Questions?

- Done:
  - HW9 Basic Overview
  - Anonymous Inner Classes
  - JSON

- Up Next:
  - Fetch
  - Spark Java

Fetch

- Used by JS to send requests to servers to ask for info.

- Uses Promises:
  - Promises capture the idea of “it’ll be finished later.”
  - We can "pause" the currently executing function while we wait for the promise to complete
  - 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.

- We’re using async/await syntax to deal with promises.

Creating a Request

- Basically just a URL:
  - 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 (i.e., the 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...

Creating 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.
    - ("4567" is the port we're using in this example – no further significance beyond that)
- 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".
- You don't need to name your endpoints or query string parameters anything specific, the above is just an example.

Sending the Request

```
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

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’ (e.g. 404 = Not Found) This checks for 200 = OK

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

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

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 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: generally best to not have useful return values from `async` functions (for 331 that is; there are lots of use cases outside of this course, but can get complicated fast).
  - Instead of returning, consider calling `setState` to store the result and trigger an update (like in the example).

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.
  - This 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 Basic Overview
  - Anonymous Inner Classes
  - JSON
  - Fetch

- Up Next:
  - Spark Java

Spark Java

- Using the Spark Java framework – designed to make this short & easy.
  - *Note: there's also something called Apache Spark. Completely different, careful what you Google.*
- Create the server by creating "routes" in the main method of your program.
  - A route is an instruction that tells the server what to do when it gets a particular request.
  - Create Route objects and override their `abstract handle()` method
    - Remember anonymous inner classes? ☺
  - The handle method gets information about the request, can set information about the response, then return something that should be sent back to the client.

Our First Spark Route

```
public static void main(String[] args) {
     Spark.get("/hello-world", new Route() {
          @Override
          public Object handle(Request request, Response response) throws Exception {
                    return "Hello, Spark!";
          }
     });
}
```

- Creating a new anonymous subclass of `Route`
  - Probably not going to have a whole bunch of different endpoints that all send back "Hello, Spark!" – so this makes sense.
- Telling Spark to use that Route whenever it receives a GET request (`Spark.get`) to the "`/hello-world`" endpoint.
  - Responds to the request: "`http://localhost:4567/hello-world`"

Demo Time!

- See that simple Spark route in action
- See a Spark route that can get info from a query parameter and use it
- See the node-fetch code that sends a request to the Spark endpoint that we just went over and displays it on the page.

- There are more demos than we can go over in section – get the code from the website to see everything.
  - LOTS of useful info in there.

Wrap-Up

- Don't forget:
  - HW8 Due This Week (Thurs 3/4 @ 11:00pm)
  - HW9 Due Next Week (Thurs 3/11 @ 11:00pm)

- Use your resources!
  - Office Hours
  - Section Q&A this week
  - Links from HW specs
  - React Tips & Tricks Handout (See "Resources" page on web)
  - Other students (remember academic honesty policies: can't share/show/copy code, but discussion is great!)
  - Google (carefully, always fully understand code you use)