CSE 331
Software Design & Implementation

James Wilcox & Kevin Zatloukal

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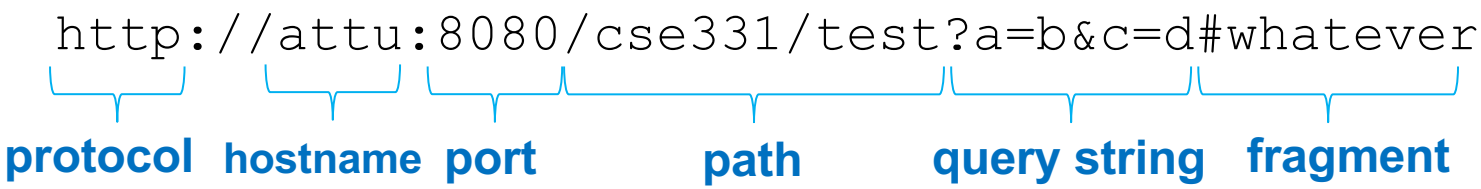
HTTP Servers

HTTP SERVERS

From last time: URLs



- **Port** is optional (default is 80 for HTTP)
- Optional "`?a=b&c=d`" part of path is called **query string**
  - "&"-separated key=value pairs
  - useful for passing arguments to the server-side code…
- **Fragment** is only kept in the browser
  - client can use this to record its place in the document
  - allows back/forward buttons to work on a single page

Server Frameworks

- How do we write a modular HTTP server?
  - need to split up the code into multiple classes

- Usual technique is to route requests using the **path**
  - use path to choose class that handles the request
  - used in Java, C++, Python, JavaScript, …
  - pass data to class using:
    - query string
    - POST body
    - (part of) path

Spark Java

- Simple library for writing HTTP servers in Java
  - not to be confused with “Apache Spark” — very different!

- Give Spark paths and corresponding classes
  - latter are called “routes” in this library
  - server will read the request path and invoke appropriate class
    - info about the request passed in request object
    - response can be written to response object or returned

- Library handles the event loop

Spark Java

```
Spark.get("/path", new MyRoute());
```

- `GET` request with this path are sent to this object

- Second argument must implement `Route` interface
  - single required method `handle(Request, Response)`
  - that means it can also be implemented with a **Lambda**

```
Spark.get("/ready", (request, response) -> {
  return "Nah, I'm busy";
});
```

Example: Hello Server

`HelloServer.java`

Example: To-Do Server

- Stores a To-Do list
- Clients can retrieve the current list
- Clients can update the list
  - check off an item
  - add a new item

Example: To-Do Server

`ToDoServer.java`

Spark Java

- Many more features
  - simple things are simple
  - complex things are possible
- Simple version is single threaded
  - makes life much easier
  - medium scale would use threads
  - high scale would not use them (see last lecture)
- Documentation at http://sparkjava.com/documentation

Example: To-Do Servers

Similar approaches work in other languages

- none of these ideas are specific to Java

Java	**`server-java`**
Python	**`server-py`**
Node.js	**`server-node`**

HTTP CLIENTS

Client / Server communication

- Original JavaScript API: `XmlHttpRequest`
- Create object call `open` to configure
  - pass in GET / POST, path, and async = true
- Listen for response event
  - `onload` invoked when done
    - `responseText` contains the response body string
- Call `send` to start the request
  - for a POST, pass in the request body
  - for GET, pass `null`

Example: To-Do Client

`client-xmlhttp/src/TodoApp.tsx`

Debugging

- Network tab in Chrome shows every request
  - full details of request
    - path, headers, etc.
  - full details of response
    - status code, response body, etc.
  - timing information

Client / Server communication

- Original JavaScript API: `XmlHttpRequest`

- Improved APIs:
  1. fetch (library)
  2. async / await (language)

Fetch

`fetch(url)` returns a **`Promise`**

`Promise` object

- **`.then(f)`** calls f after request completes
- **`.catch(f)`** calls f after request fails

```
fetch("localhost:4567/list")
.then((resp) => console.log(resp.status));
.catch((err) => console.error(err));
```

Promise Chaining

What is the point of **`Promise`**s?

- how is **`.then(f)`** different from **`.onload = f`**?

Key feature of the library is the ability to chain promises

- **`.then`** returns another **`Promise`**
- can use **`.then`** on it as well

```
fetch("localhost:4567/list")
.then((resp) => resp.text());
.then((text) => console.log(text));
```

`.then` called once status is known
`.text` called once body is known

Fetch: GET vs POST

`fetch` can be used to send either GET or POST

`fetch(url)`

- starts a GET request
- pass arguments by including a query string (”?a=b…”)

`fetch(url, {method: ”POST”, body: “…”})`

- starts a POST request

Example: To-Do Client

`client-fetch/…/TodoApp.tsx`

Await: Compiler Help for Promises

Syntax: **`await P`**

- where **`P`** is any expression producing a **`Promise`**

```
async function foo() {
  … code A …
  let v = await P;
  … code B …
}
```

- acts as if the code pauses at "await P"
- (but other events can continue being processed)

Await: Compiler Help for Promises

```
async function foo() {
  … code A …
  let v = await P;
  … code B …
}
```

becomes

```
function foo() {
  … code A …
  return P.then((v) => {
    … code B …
  });
}
```

Await Example

```
fetch("localhost:4567/list")
.then((resp) => resp.text());
.then((text) => console.log(text));
```

can be rewritten as

```
let resp = await fetch("localhost:4567/list");
let text = await resp.text();
console.log(text);
```

Second version is more readable for most people.

Await: Compiler Help for Promises

Syntax: **`await P`**

- where **`P`** is any expression producing a **`Promise`**

```
async function foo() {
  … code A …
  let v = await P;
  … code B …
}
```

- if **`.then`** is invoked, **`await`** returns that value
- if **`.catch`** is invoked, **`await`** throws that exception

Await: Compiler Help for Promises

```
async function foo() {
  … code A …
  try { await P; }
  catch (err) { … code B … }
}
```

becomes

```
function foo() {
  … code A …
  return P.catch((err) => {
    … code B …
  });
}
```

Async

- Functions that use **`await`** must be declared **`async`**
  - they no longer finish synchronously

- Compiler has them now return a **`Promise`**
  - only performs work up until the first **`await`**
  - Promise encapsulates the work after that

- You can chain code after them with **`await`**!

Example: To-Do Client

`client-async/…/TodoApp.tsx`