Interactive Web Programming

1st semester of 2021

Murilo Camargos
(**murilo.filho@fgv.br**)

Heavily based on **Victoria Kirst** slides

Schedule

Today:

- Functional JavaScript
    - Anonymous functions
    - Currying
    - Closures
- Loading data from files
    - Fetch API
    - Promises - High-level!
    - JSON

A quick note on HW2

General stuff:

- I sent a feedback for each one of you on **sunday** at **19h30**.
- If you **didn't receive anything** from me yesterday, please, send me an email **ASAP (murilo.filho@fgv.br)**.

ATTENTION:

- If you take all feedback from yesterday and fix everything by **April 16**, you can still earn a **10**!!!
- For that you **MUST** fix everything you can, answer the google forms and send me an email confirming you want a new evaluation.

Practical Functional JavaScript

Example: `findIndex`

list*.[`findIndex(`callback*, *thisArg***`)`]:**

Returns the index of an element.

callback is a function with the following parameters:

- **element:** The current element being processed.
- **index:** The index of the current element being processed in the array.
- **array**: the array `findIndex` was called upon.

callback is called for every element in the array, and returns true if found, false otherwise.

thisArg is the value of `this` in ***callback***

`findIndex`

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

Q: How can we use `findIndex` to see whether or not `'strawberry'` is in the `flavors` list?

`findIndex`

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

1. Define a **testing function**, to be called on each element in the list. (Returns `true` if it passes the test.)

```
function isStrawberry(element) {
  return element === 'strawberry';
}
```

The **testing function** can take `element`, `index`, and `array` as parameters, but we are only using `element`.

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

2. Pass the testing function into `findIndex`.

```
function isStrawberry(element) {
  return element === 'strawberry';
}

const idxOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];


function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

The `isStrawberry` function will fire for each element in the array.

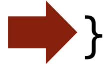
findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];

function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}
```



Returns **false**, so keep searching.

```
const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}
```

Returns **false**, so keep searching.

```
const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

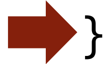
```
function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}
```

Returns **true**, so stop searching.



```
const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

findIndex returns 2, since the first element to pass the **testing function** was found at index 2. (CodePen)

findIndex

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];
```

```
function isStrawberry(element) {
  return element === 'strawberry';
}

const indexOfStrawberry = flavors.findIndex(isStrawberry);
```

Let's clean this up a little bit...

Anonymous functions

Anonymous functions

We do not need to give an identifier to functions.

When we define a function without an identifier, we call it an **anonymous function**

- Also known as a **function literal**, or a **lambda function**

We can define our test function directly in `findIndex`:

```
function isStrawberry(element) {
  return element === 'strawberry';
}

const index = flavors.findIndex(isStrawberry);
```

Anonymous functions

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When we define a function without an identifier, we call it an **anonymous function**

- Also known as a **function literal**, or a **lambda function**

We can define our test function directly in `findIndex`:

```
const index = flavors.findIndex(
  function(element) { return element === 'strawberry'; });
```

Arrow functions

We can use the **arrow function** syntax for defining functions:

```
const index = flavors.findIndex(
  function(element) { return element === 'strawberry'; });
```

Arrow functions

We can use the **arrow function** syntax for defining functions:

```
const index = flavors.findIndex(
 (element) => { return element === 'strawberry'; });
```

Concise arrow functions

We can use the **concise version** of the arrow function:

- You can omit the parentheses if there is only one parameter
- You can omit the curly braces if there's only one statement in the function, and it's a return statement

```
const index = flavors.findIndex(
  (element) => { return element === 'strawberry'; });
```

Concise arrow functions

We can use the **concise version** of the arrow function:

- You can omit the parentheses if there is only one parameter
- You can omit the curly braces if there's only one statement in the function, and it's a return statement

```
const index = flavors.findIndex(
   element => element === 'strawberry');
```

Case-insensitive search

If we wanted to make this case insensitive, we could do:

```
const index = flavors.findIndex(
   element => element.toLowerCase() === 'strawberry');
```

Case-insensitive search

If we wanted to make this case insensitive, we could do:

```
const index = flavors.findIndex(
   element => element.toLowerCase() === 'strawberry');
```

This is a lot more elegant than the for-loop approach!

```
for (let i = 0; i < flavors.length; i++) {
  if (flavors[i].toLowerCase() === 'strawberry') {
    break;
  }
}
const index = i;
```

Currying

isFlavor

What if instead of checking specifically for `strawberry`…

```
function isStrawberry(element) {
  return element === 'strawberry';
}
```

isFlavor

…we wanted to create a generic `isFlavor` checker?

```
function isFlavor(flavor, element) {
  return element === flavor;
}
```

isFlavor

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];


function isFlavor(element) {
  // ERROR: flavor is undefined!
  return element === flavor;
}

const indexOfFlavor = flavors.findIndex(isFlavor);
```

The problem is there's no way to pass in the `flavor` parameter in the callback for `findIndex`...

Currying

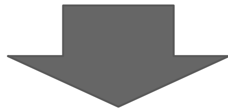
```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];

function createFlavorTest(flavor) {
  function isFlavor(element) {
    return element === flavor;
  }
  return isFlavor;
}
const isStrawberry = createFlavorTest('strawberry');
const indexOfFlavor = flavors.findIndex(isStrawberry);
```

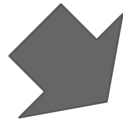
Solution: Create a function that takes a `flavor` parameter and creates a testing function for that parameter. (CodePen)

Currying

```
function isFlavor(flavor, element) {
  return element === flavor;
}
```



```
function createFlavorTest(flavor) {
  function isFlavor(element) {
    return element === flavor;
  }
  return isFlavor;
}
```



```
flavors.findIndex(isFlavor);
```

This idea is called **currying**: breaking down a function with multiple arguments by applying one at a time in a sequence of created functions.

Aside: closure

```
const flavors =
    ['vanilla', 'chocolate', 'strawberry', 'green tea'];

function createFlavorTest(flavor) {
  function isFlavor(element) {
    return element === flavor;
  }
  return isFlavor;
}
const isStrawberry = createFlavorTest('strawberry');
const indexOfFlavor = flavors.findIndex(isStrawberry);
```

Aside: Any function that is declared within another function is called a **closure**. Closures can refer to variables in the outer function (`flavor` in this case).

Review: Functional JavaScript

- Functions in JavaScript are **first-class citizens**:
  - Objects that can be passed as parameters
  - Can be created within functions:
    - Inner functions are called **closures**
  - Can be created without being saved to a variable
    - These are called **anonymous functions**, or function literals, or lambdas
  - Can be created and returned from functions
    - Constructing a new function that references part of the outer function's parameters is called **currying**

Loading data from files

Loading data from a file

What if you had a list of images in a text file that you wanted to load in your web page?

```
1  https://media1.giphy.com/media/xNT2CcLjhbI0U/200.gif
2  https://media2.giphy.com/media/3o7btM3VVVNtssGReo/200.gif
3  https://media1.giphy.com/media/l3q2uxEzLIE8cWMq4/200.gif
4  https://media2.giphy.com/media/LDwL3ao61wfHa/200.gif
5  https://media1.giphy.com/media/3o7TKMt1VVNkHV2PaE/200.gif
6  https://media3.giphy.com/media/DNQFjMJbbsNmU/200.gif
7  https://media1.giphy.com/media/26FKTsKMKtUSomuNq/200.gif
8  https://media1.giphy.com/media/xThuW5Hf2N8idJHFVS/200.gif
9  https://media1.giphy.com/media/XlFfSD0CiyGLC/200.gif
10 https://media3.giphy.com/media/ZaBHSbiLQTmFi/200.gif
11 https://media3.giphy.com/media/JPbZwjMcxJYic/200.gif
12 https://media1.giphy.com/media/FArgGzk7KO14k/200.gif
13 https://media1.giphy.com/media/UFoLN1EyKjLbi/200.gif
14 https://media1.giphy.com/media/11zXBCAb9soCQM/200.gif
15 https://media4.giphy.com/media/xUPGcHeIeZMmTcDQJy/200.gif
16 https://media2.giphy.com/media/apZwWJInOBvos/200.gif
17 https://media2.giphy.com/media/sB4nvt5xIiNig/200.gif
18 https://media0.giphy.com/media/Y8Bi9lCOzXRkY/200.gif
19 https://media1.giphy.com/media/12wUXjm6f8Hhcc/200.gif
20 https://media4.giphy.com/media/26gsuVyk5fKB1YAAE/200.gif
21 https://media3.giphy.com/media/l2SpMU9sWIvT2nrCo/200.gif
22 https://media2.giphy.com/media/kR1vWazNc7972/200.gif
23 https://media4.giphy.com/media/Tv3m2GAAl2Re8/200.gif
24 https://media2.giphy.com/media/9nujydsBLz2dq/200.gif
25 https://media3.giphy.com/media/AG39l0rHgkRLa/200.gif
```

Intuition: `loadFromFile`

If we wanted to have an API to load external files in JavaScript, it might look something like this:

```
// FAKE HYPOTHETICAL API.
// This is not real a JavaScript function!
const contents = loadFromFile('images.txt');
```

Intuition: `loadFromFile`

```
// FAKE HYPOTHETICAL API.
// This is not real a JavaScript function!
const contents = loadFromFile('images.txt');
```

A few problems with this hypothetical fake API:

- We want to load the file **asynchronously**: the JavaScript should not block while we're loading the file
- There's no way to check the status of the request. What if the resource didn't exist? What if we're not allowed to access the resource?

Intuition: `loadFromFile`

An asynchronous version of this API might look like this:

```
// FAKE HYPOTHETICAL API.
// This is not real a JavaScript function!
function onSuccess(response) {
  const body = response.text;
  ...
}
loadFromFile('images.txt', onSuccess, onFail);
```

Where `onSuccess` and `onFail` are callback functions that should fire if the request succeeded or failed, respectively.

Fetch API

Fetch API: `fetch()`

The Fetch API is the API to use to load external resources (text, JSON, etc) in the browser.

The Fetch API is made up of one function, and its syntax is is concise and easy to use:

```
fetch('images.txt');
```

Note: `XMLHttpRequest` ("XHR") is the old API for loading resources from the browser. XHR still works, but is clunky and harder to use.

Fetch API: `fetch()`

The Fetch API is the API to use to load external resources (text, JSON, etc) in the browser.

The Fetch API is made up of one function, and its syntax is is concise and easy to use:

```
fetch('images.txt');
```

- The `fetch()` method takes the string path to the resource you want to fetch as a parameter
- It returns a `Promise`

Fetch API: `fetch()`

The Fetch API is the API to use to load external resources (text, JSON, etc) in the browser.

The Fetch API is made up of one function, and its syntax is is concise and easy to use:

```
fetch('images.txt');
```

- The `fetch()` method takes the string path to the resource you want to fetch as a parameter
- It returns a `Promise`
  - **What the heck is a `Promise`?**

`Promises`: Another conceptual odyssey

`Promises` and `.then()`

A `Promise`:

- An object used to manage asynchronous results
- Has a `then()` method that lets you attach functions to execute onSuccess or onError
- Allows you to build **chains** of asynchronous results.

`Promises` are easier to **use** than to **define**...

Simple example: getUserMedia

There is an API called `getUserMedia` that allows you get the media stream from your webcam.

There are two versions of getUserMedia:

- `navigator.getUserMedia` **(deprecated)**
  - Uses callbacks

- `navigator.mediaDevices.getUserMedia`
  - Returns a `Promise`

getUserMedia with callbacks

```
const video = document.querySelector('video');

function onCameraOpen(stream) {
  video.srcObject = stream;
}
function onError(error) {
  console.log(error);
}

navigator.getUserMedia({ video: true },
  onCameraOpen, onError);
```

CodePen

getUserMedia with Promise

```
const video = document.querySelector('video');

function onCameraOpen(stream) {
  video.srcObject = stream;
}
function onError(error) {
  console.log(error);
}

navigator.mediaDevices.getUserMedia({ video: true })
  .then(onCameraOpen, onError);
```

CodePen

Hypothetical Fetch API

```
// FAKE HYPOTHETICAL API.
// This is not how fetch is called!
function onSuccess(response) {
  ...
}
function onFail(response) {
  ...
}
fetch('images.txt', onSuccess, onFail);
```

Real Fetch API

```
function onSuccess(response) {
  ...
}
function onFail(response) {
  ...
}
fetch('images.txt').then(onSuccess, onFail);
```

Promise syntax

Q: How does this syntax work?

```
fetch('images.txt').then(onSuccess, onFail);
```

Promise syntax

Q: How does this syntax work?

```
fetch('images.txt').then(onSuccess, onFail);
```

The syntax above is the same as:

```
const promise = fetch('images.txt');
promise.then(onSuccess, onFail);
```

Promise syntax

```
const promise = fetch('images.txt');
promise.then(onSuccess, onFail);
```

The object `fetch` returns is of type [`Promise`].

A promise is in one of three states:

- **pending**: initial state, not fulfilled or rejected.
- **fulfilled**: the operation completed successfully.
- **rejected**: the operation failed.

You attach handlers to the promise via `.then()`

Promise syntax

```
const promise = fetch('images.txt');
promise.t
```

The objec

A promis

- **pendi**
- **fulfill**
- **reject**

(We'll think about this more deeply in a later lecture.)

(Right now we will just use Promises.)

You attach handlers to the promise via `.then()`

Using Fetch

```
function onSuccess(response) {
  console.log(response.status);
}
fetch('images.txt').then(onSuccess);
```

The success function for Fetch gets a response parameter:

- `response.status`: Contains the status code for the request, e.g. 200 for HTTP success
    - HTTP status codes

Fetch attempt

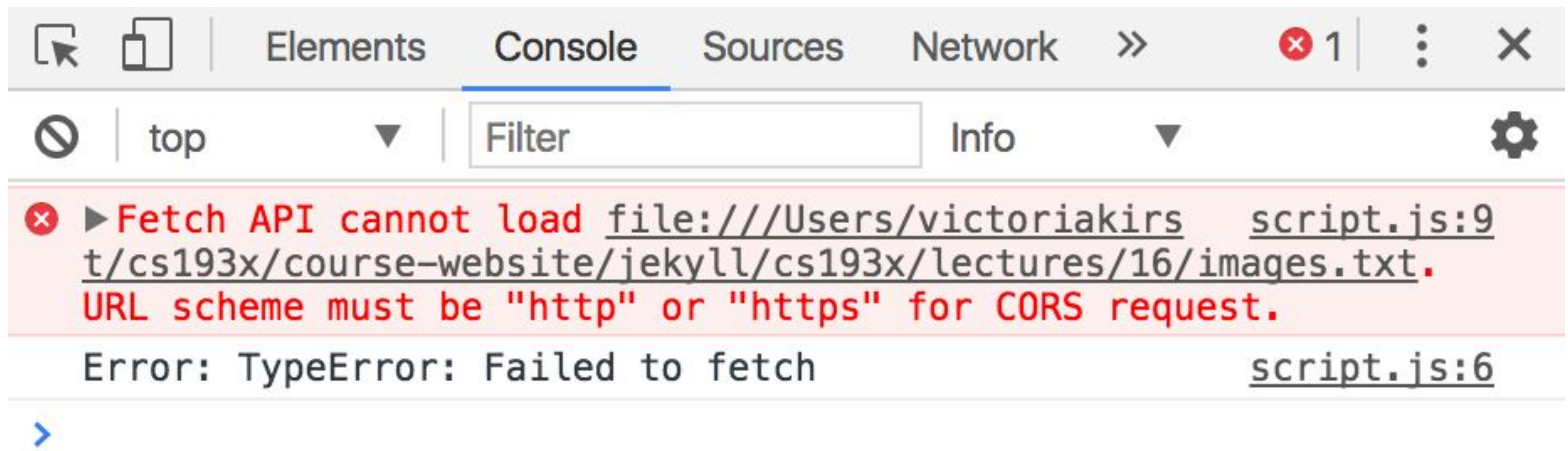
```
function onSuccess(response) {
  console.log(response.status);
}

function onError(error) {
  console.log('Error: ' + error);
}

fetch('images.txt')
    .then(onSuccess, onError);
```

Fetch error

If we try to load this in the browser, we get the following JavaScript error:



Notice that our onError function was also called.

Local files

When we load a web page in the browser that is saved on our computer, it is served via `file://` protocol:

We are **not allowed** to load files in JavaScript from the `file://` protocol, which is why we got the error.

Serve over HTTP

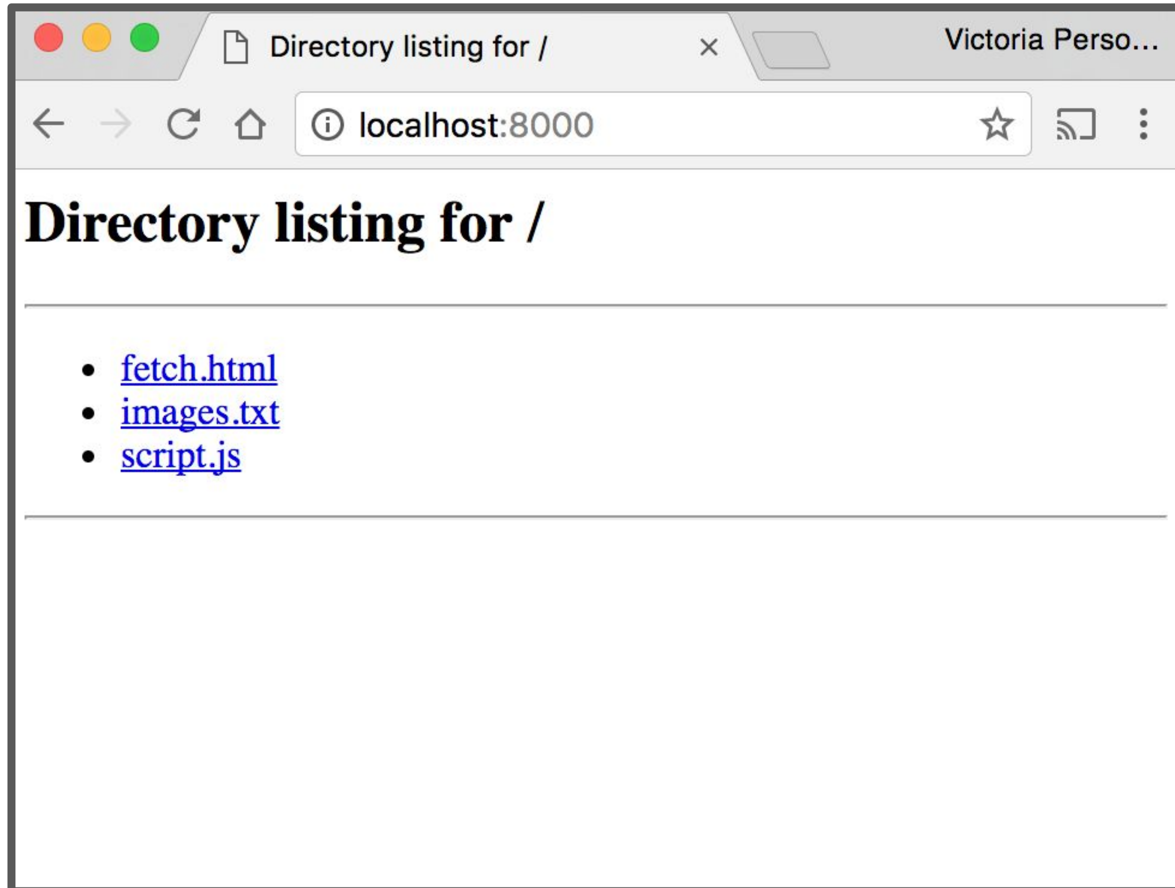
We can run a program to serve our local files over HTTP:

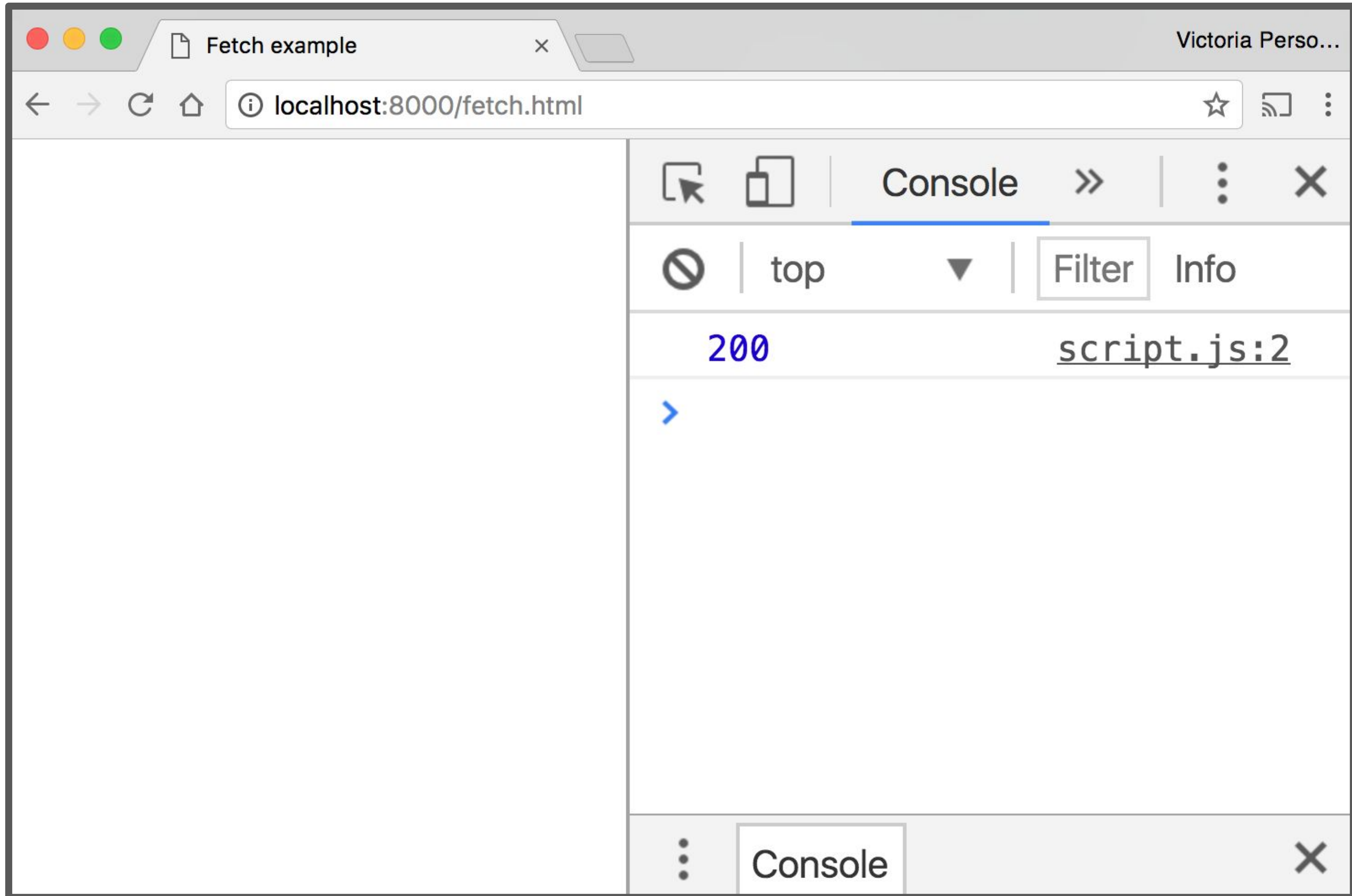
```
$ python -m http.server
Serving HTTP on 0.0.0.0 port 8000 ...
```

This now starts up a **server** that can load the files in the current directory over HTTP.

- We can access this server by navigating to: `http://localhost:8000/`

```
$ python -m http.server
Serving HTTP on 0.0.0.0 port 8000 ...
```





We got HTTP response 200, which is success! (codes)

How do we get the data from `fetch()`?

Using Fetch

```
function onSuccess(response) {
  ..
}
fetch('images.txt').then(onSuccess);
```

- `response.status`: Status code for the request
- `response.text()`:
  - Asynchronously reads the response stream
  - **Returns a `Promise`** that resolves with the string containing the response stream data.

text() Promise

Q: How do we change the following code to print out the response body?

```
function onSuccess(response) {
  console.log(response.status);
}

function onError(error) {
  console.log('Error: ' + error);
}

fetch('images.txt')
    .then(onSuccess, onError);
```

```
function onStreamProcessed(text) {
  console.log(text);
}

function onResponse(response) {
  console.log(response.status);
  response.text().then(onStreamProcessed);
}

function onError(error) {
  console.log('Error: ' + error);
}

fetch('images.txt').then(onResponse, onError);
```

Chaining Promises

We want the following asynchronous actions to be completed in this order:

1. When the `fetch` completes, run `onResponse`
2. When `response.text()` completes, run `onStreamProcessed`

```
function onStreamProcessed(text) { ... }
function onResponse(response) {
  response.text().then(onStreamProcessed);
}
fetch('images.txt').then(onResponse, onError);
```

We can rewrite this:

```
function onStreamProcessed(text) {
  console.log(text);
}

function onResponse(response) {
  response.text().then(onStreamProcessed);
}

function onError(error) {
  console.log('Error: ' + error);
}

fetch('images.txt').then(onResponse, onError);
```

We can rewrite this:

```
function onStreamProcessed(text) {
  console.log(text);
}

function onResponse(response) {
  return response.text();
}

function onError(error) {
  console.log('Error: ' + error);
}

fetch('images.txt')
    .then(onResponse, onError)
    .then(onStreamProcessed);
```

Chaining Promises

```
function onStreamProcessed(text) {
  console.log(text);
}

function onResponse(response) {
  return response.text();
}

fetch('images.txt')
    .then(onResponse, onError)
    .then(onStreamProcessed);
```

If we don't think about it too hard, the syntax is fairly intuitive.

We'll think about this more deeply later!

JSON

JavaScript Object Notation

JSON: Stands for **J**ava**S**cript **O**bject **N**otation

- Created by Douglas Crockford
- Defines a way of **serializing** JavaScript objects
    - **to serialize**: to turn an object into a string that can be deserialized
    - **to deserialize**: to turn a serialized string into an object
- `JSON.stringify(`***object***`)` returns a string representing ***object*** serialized in JSON format
- `JSON.parse(`***jsonString***`)` returns a JS object from the ***jsonString*** serialized in JSON format

JSON.stringify()

We can use the `JSON.stringify()` function to seralize a JavaScript object:

```
const bear = {
  name: 'Ice Bear',
  hobbies: ['knitting', 'cooking', 'dancing']
};

const serializedBear = JSON.stringify(bear);
console.log(serializedBear);
```

[CodePen]

JSON.parse()

We can use the `JSON.parse()` function to deseralize a JavaScript object:

```
const bearString = '{"name":"Ice Bear","hobbies":["knitting","cooking","dancing"]}';

const bear = JSON.parse(bearString);
console.log(bear);
```

CodePen

Why JSON?

JSON is a useful format for storing data that we can load into a JavaScript API via fetch().

Let's say we had a list of Songs and Titles.

- If we stored it as a text file, we would have to know how we are separating song name vs title, etc
- If we stored it as a JSON file, we can just deserialize the object.

JSON

songs.json

```
{
  "cranes": {
    "fileName": "solange-cranes-kaytranada.mp3",
    "artist": "Solange",
    "title": "Cranes in the Sky [KAYTRANADA Remix]"
  },
  "timeless": {
    "fileName": "james-blake-timeless.mp3",
    "artist": "James Blake",
    "title": "Timeless"
  },
  "knock": {
    "fileName": "knockknock.mp4",
    "artist": "Twice",
    "title": "Knock Knock"
  },
  "deep": {
    "fileName": "janet-jackson-go-deep.mp3",
    "artist": "Janet Jackson",
    "title": "Go Deep [Alesia Remix]"
  },
  "discretion": {
    "fileName": "mitis-innocent-discretion.mp3",
    "artist": "MitiS",
    "title": "Innocent Discretion"
  },
  "spear": {
    "fileName": "toby-fox-spear-of-justice.mp3",
    "artist": "Toby Fox",
    "title": "Spear of Justice"
  }
}
```

Fetch API and JSON

The Fetch API also has built-in support for json:

```
function onStreamProcessed(json) {
  console.log(json);
}

function onResponse(response) {
  return response.json();
}

fetch('songs.json')
    .then(onResponse, onError)
    .then(onStreamProcessed);
```