CS 142 Discussion Session

JavaScript

Agenda

(1) Review of JavaScript

(2) Getting Started with Project 2

*Most focus on (1) because if you're comfortable with JavaScript, the project is simple; but only talking about the project doesn't cover everything there is to know about JavaScript.

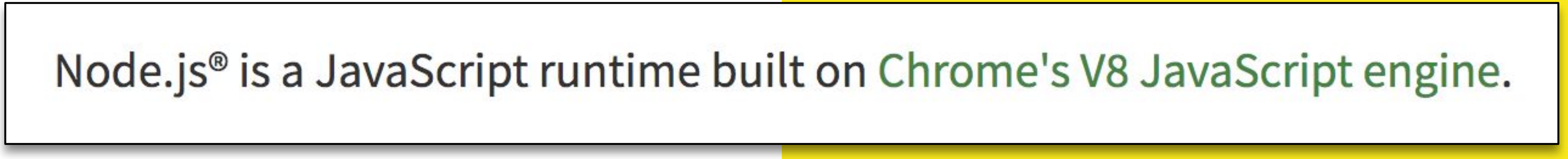
JavaScript

See also: "JavaScript: The Good Parts" by Douglas Crockford

Why JavaScript?

It's the language of the web:
Take it or leave it!

- Web browsers are based on JavaScript.
- We run some programs in Node.js, but Node.js is basically just the guts of Google Chrome running in the Terminal!
- JavaScript is used to interact with the documents shown by web browsers.
  - **Demo?**



Node.js® is a JavaScript runtime built on Chrome's V8 JavaScript engine.

The Good, the Bad, and the Bizarre

(What makes JS programming special?)

- ❏ Loose / Dynamic Typing
- ❏ Dynamic Objects
- ❏ Prototype Inheritance
- ❏ First-Class Functions
- ❏ Function Scoping / Global Variables
- ❏ Callback Functions
- ❏ `"this"`

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Basics

- **Primitive Types:** number *(yup, just the one)*, string, boolean, null, undefined.
  - Everything else (including functions!) is an Object.
- **Variables:** Dynamically typed. Hoisted.
  - `var x = 10;`
  - `x = "hello"`
- **Control Flow & Operators:** Similar to C / C++ / most other languages.
- **No block scoping!**

```
for (var i = 1; i < 11; i++) {
     var j = i * 2;
}
console.log(j);
```

- **This means "global namespace" gets clogged real fast.** (Bad thing about JS.)

Basics

- **"Falsy" values:** Evaluate to `false` if treated as boolean.
    - `undefined, '', 0, NaN, false, null`
- Everything else evaluates to true.

    ```
    if (0) {console.log("Bummer");}           // Nope.
    if (10) {console.log("Hooray");}          >> Hooray
    ```

- **Comparisons:** Use `===` unless you want JS to do type conversion for you. This is generally not recommended because it can have behavior you might not anticipate; if you want type conversion you should do it yourself.
    - Similar for `!=` vs. `!==`

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Objects

- **What is an object?**
  - Anything that's not a primitive. (Gee, thanks!)
  - *Mutable, keyed collection.* (Think Python dictionary!)
- **Using objects**
  - `var student = {};`
  - `student.name = "Miguel";`
  - `student.grade = "A";`
    - `{name: "Miguel", grade: "A"}`
  - `delete student.grade;`
    - `{name: "Miguel}`
  - `student["grade"] = "S";`
    - `{name: "Miguel", grade: "S"}`

Prototypes and Inheritance

- **Prototypes:** Every object has a "prototype." *What does it do?*
    - *When you attempt to access a property that does not exist in the object, JavaScript looks in the prototype.*
    - Relationship is **one-way**. *Editing an object doesn't change its prototype.*
    - Relationship is **dynamic**. *Updated prototype will immediately be reflected by all of its "children".*
- By default, all objects have Object as their prototype. You can change it:
    - `obj.__proto__ = my_prototype; OR Object.setPrototypeOf(obj, my_prototype);`
- Check if an object has its *own* property (not in the prototype) with:
    - `obj.hasOwnProperty("property");`

Time for some live-coding… please be kind.

The Good, the Bad, and the Bizarre

(What makes JS programming special?)

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- □ Prototype Inheritance
- □ First-Class Functions
- □ Function Scoping / Global Variables
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- □ `"this"`

Functions

- **Defining a function…**

```
function add(x, y) {    // give it a name
    return x + y;
}
```

OR

```
var add = function(x, y) {  // store it in a variable -- "first class"
    return x + y;
}
```

OR

```
(function(x, y) {       // anonymous boi 😎
    return x + y;
})(2, 3);               // what will this return?
```

Functions

- **Function scoping:** Variables don't die when they see curly braces! Instead, each *function* has its own scope. Things not inside of functions are in the global scope.

  Inner functions can see things from outer functions, but outer functions cannot see things from inner functions, unless they are returned or stored in an outer variable.

```
(function hello() {
     var i = "greetings";
     function world () {
          var j = "planetoid";
          console.log(i);
     }
     world();                    >> "greetings"
     console.log(j);             >> undefined
})();
```

Functions

- **Closures:** Because of function scoping, variables can "persist" inside the scope (closure) of a function that was invoked long ago... this can be nice for making "private" variables.

```
var bank_account = (function() {
     balance = 100;
     return {check_balance: function() {return balance;} };
}(); // wtf just happened…

// The 'balance' variable is stuck inside the scope of this anonymous function.
// We can't change it or even look directly at it from out here. :( But…
bank_account.check_balance();
>> 100  // nice...
```

Functions

- **Callback Functions:** Everything we do in JavaScript is "blocking"... that is, we don't go on to line 2 until line 1 is finished. But some "asynchronous" processes (network operations, reading a file, etc.) take a long time...
    - **Solution:** Start the process, give it a function to call when it is done, and move on with our lives! This function is called a "callback."

```
function cb() {
    console.log("What if we moved on to the next line?");
}
do_async_thing_that_takes_a_long_time(cb);
console.log("Haha… just kidding… unless? 😳");
```

```
>> Haha… just kidding… unless? 😳
>> What if we moved on to the next line?
```

Functions

Invocation Patterns: How a function works depends on how it is invoked.

- *Method invocation:* Function is invoked as a method (a property of an object). In this case, the keyword `this` refers to the object that owns the method!

```
cat.num_meows = 10;
cat.meow = function() {
     for (i = 0; i < this.num_meows; i++) {
          console.log("meow");
     }
}
cat.meow()         // Will print 'meow' ten times.
```

- *Function invocation:* Function isn't property of an object, it's just invoked with ( ), the normal way you're used to. `this` is undefined.
- *'Apply' or 'Call':* Function is invoked using one of these methods, which allows you to set `this` to be whatever you want. (See documentation for details.)

Functions

- *Constructor invocation:* Function is invoked with `new` keyword, in which case, it acts as a template (or "constructor") to create an object with the fields specified in the body of the function! (Essentially a "class".)
    - Functions written for this purpose are written differently than functions meant to be invoked normally; and it's customary to name them with a capital letter.

```
function Cat(name) {
     this.name = name;
     this.meow = function () {                 // Bad practice, methods
         console.log("meow " + this.name);     // shared by all members of a
     }                                         // class should be in the
}                                              // prototype.
var my_cat = new Cat("Archie");
my_cat.meow();                            >> meow Archie
```

Functions

- *If I want all Cats to share a single "meow" method, add it to the prototype... (this is the proper way to do it; each Cat doesn't need its very own copy of "meow.")*

```
function Cat(name) {
     this.name = name;
}

Cat.prototype.meow = function () {
     console.log("meow " + this.name);
}

Var my_cat = new Cat("Hannibal");
my_cat.meow();                            >> meow Hannibal
```

Newer Features

- Arrow Functions
  - (parameters) => result
  - `var add = (a, b) => {a + b};`
  - Keeps the value of '`this`' whatever it was outside the function (can be convenient).
- `let`
  - Use instead of `var` to get block-scoping; can help avoid polluting the global namespace.
- ES6 "Classes"
  - Instead of using a function with constructor invocation, this allows you to write an honest-to-goodness class! (See the documentation for more details.)

Getting Started with Project 2

Getting Started

(i.e. what do I need to write JavaScript?)

- ➔ Install Node.js.
- ➔ Download and unzip the starter code.
- ➔ `npm install`
- ➔ Fire up your favorite text editor. (I like Sublime!)
- ➔ Use `npm run jshint` to check your syntax.
  - 🙅 If you don't, you'll lose style points, 100% guaranteed :)
- ➔ Use `npm test` or open the included HTML file to sanity check your functionality!

`~Warning: Included sanity checks are NOT exhaustive!~`

What's in the box? (Your newly unzipped directory)

IMPORTANT FOR THE ASSIGNMENT

- `cs142-test-project2.html` — Open this to test your code!
- `cs142-test-project2.js` — Code that runs to test your code!

IN CASE YOU'RE CURIOUS

- `node_modules` 📂
  - Created *after* running `npm install`
  - Has useful packages, like the syntax checker!
- `package.json` — Specifies what packages to install with `npm install`.
- `run-tests-using-node.js` — Used to test your code with Node locally.
- `.jshintrc` (hidden) — Config for JSHint.

Problem 1:
MultiFilter

Objective

- Write a **function** (`cs142MakeMultiFilter`) that:
  - (1) Accepts an array (e.g. [1, 2, 3]) as input.
  - (2) Creates a copy of that array in its scope, so it persists (think about closures here)...
  - (3) **Returns a function** (`arrayFilterer`) that allows the user to apply a filter (or multiple filters) to this array.
- Usage:

```
>   var myFilter = cs142MakeMultiFilter([1, 2, 3, 4]);
>   var odd = function(x) {return x % 2 == 1};
>   var even = function(x) {return x % 2 == 0};
>   myFilter();            // [1, 2, 3, 4]
>   myFilter(odd)(even)(); // []
```

Whoa, wait a sec...

- What's up with the "chaining"? (`myFilter(odd)(even)();`)
    - Our parent function returns a child function, `arrayFilterer`, which is stored in `myFilter`.
    - Because `arrayFilterer` is supposed to return itself, when we call `myFilter()`, the resulting value is *also* `arrayFilterer`, which we can immediately invoke with another `();`
    - This is why it's perfectly okay to do `myFilter(f)(g)(h)();`
    - And, when it's called with no function, `arrayFilterer` just returns the current array (rather than filtering it). This is what the last empty pair of parentheses does.
    - After filtering out all the odd and even numbers, `currentArray` is empty!

Tips

- The built-in `filter` method of the Array class will come in handy!
- Check if something is a function with `typeof / instanceof.`
- Set the value of `this` with `.call` or `.bind.`
- Pay attention to the different "cases":
    - **Function?** If a filtering function (like `odd` or `even`) is provided, then filter the array by it, and return `arrayFilterer`. If it's not provided, just immediately return `currentArray`.
    - **Callback?** If a callback is provided, call the callback after filtering, and before returning `arrayFilterer`. If it's not provided, then ignore it.

Problem 2:
Template Processor

Objective

- Write a **class** (using the old-fashioned "function" paradigm) that:
  - (1) Accepts a template string (e.g. `"{{greeting}}, my name is {{name}}"`) as parameter.
  - (2) Has a method `fillIn` which, when given a "dictionary" (Object of key value pairs), returns a "filled-in" version of the template string where each `{{key}}` is replaced with the corresponding value from the dictionary, and any `{{key}}` not in the dictionary is deleted.
- Usage:

```
> var myTP = new Cs142TemplateProcessor("{{greeting}}, my name is {{name}}");
> var result = myTP.fillIn({"greeting":"hello", "name":"ben"});
> console.log(result);
    ■ "hello, my name is ben."
```

Tips

- Spend some time getting familiar with **regular expressions**. They'll definitely be useful for this problem!
- There are lots of ways to comb through a string.
    - `.exec`, `.replace`, `.find`, `.match` come to mind.
- Remember, if all Template Processors are going to share a function, it's proper to add that function to the prototype, rather than each instance of the class having its own copy.

Problem 3: Global Variables

😷

Objective

Remove variables from the global namespace, without ruining the functionality of the code in the file!

Toy Example:

```
var x = 10;           // This toy example has x and y in the
var y = 5;            // global namespace. How can we remove them?
console.log(x + y);
```

Approach

Could we shove them all into an object?

(Sometimes this is done to keep code clean, since the global namespace in the web browser becomes *incredibly* polluted.) **Will this work?**

```
var VARS = {x:10, y:5};
console.log(VARS.x + VARS.y);
```

Approach

Could we shove them all into an object?

(Sometimes this is done to keep code clean, since the global namespace in the web browser becomes *incredibly* polluted.) **Will this work?**

```
var VARS = {x:10, y:5};             // VARS is now in the global
console.log(VARS.x + VARS.y);       // namespace. :(
```

Approach

What about using a function? Functions have their own private scope!

Will this address our problem?

```
function secret() {
    var x = 10;
    var y = 5;
    console.log(x + y);
}

secret();
```

Approach

What about using a function? Functions have their own private scope!

Will this address our problem?

```
function secret() {
    var x = 10;
    var y = 5;
    console.log(x + y);
}

secret();      // secret is now in the global namespace :(
```

Tips

- The spec says:

Change cs142-test-project2.js [...] using an **anonymous function** to hide symbols in the global namespace yet keep the same checking functionality.

(This should be enough to get you thinking!)

Debugging!

Ways to debug

- Insert `console.log()` statements to test expected values.
    - You can get surprisingly far with plain old print debugging!
    - These things will print to the browser console (the thing you see when you right-click and hit inspect) if your code is running in the browser, and will print to the terminal if your code is running in Node.js.
- You can also type lines of code into the console in the browser!
- Finally, if you're failing some tests, try looking at the code for the tests, and see what kinds of inputs are being given to the functions you're writing.

Thank you!