JavaScript Basics

Mendel Rosenblum

What is JavaScript?

From Wikipedia:

> ... **high-level**, **dynamic**, **untyped**, and **interpreted** programming language
>
> ... is **prototype-based** with **first-class functions**, …
>
> ... supporting **object-oriented**, **imperative**, and **functional programming**
>
> ... has an API for working with **text**, **arrays**, **dates** and **regular expressions**

- Not particularly similar to Java: More like C crossed with Self/Scheme
  - C-like statements with everything objects, closures, garbage collection, etc.
- Also known as ECMAScript

Some thoughts about JavaScript

- Example of a **scripting language**
  - Interpreted, less declaring of things, just use them
- Seems like it was designed in a rush
  - Some “Good Parts”, some not so good
  - Got bad reputation

- Many programmers use a subset that avoids some common problems
  - `"use strict";` tweaks language to avoid some problematic parts
- Language being extended to enhance things: New ECMAScript every year!
  - Transpiling common so new features used: e.g ECMAScript Version N, **TypeScript**
- Code quality checkers (e.g. `jslint`, `jshint`, `eslint`) widely used

Good news if you know C - JavaScript is similar

```
i = 3;

i = i * 10 + 3 + (i / 10);

while (i >= 0) {
    sum += i*i;   // Comment
    i--;
}

for (i = 0; i < 10; i++)  {

}
/* this is a comment */
```

```
if (i < 3) {
    i = foobar(i);
} else {
    i = i * .02;
}
```

Most C operators work:

```
* / % + - ! >= <= > < && || ?:

function foobar(i) { return i;}

continue/break/return
```

JavaScript has **dynamic** typing

```
var i;   // Need to define variable ('use strict';), note: untyped

typeof i == 'undefined'  // It does have a type of ‘undefined’

i = 32;         // Now: typeof i == typeof 32 == 'number'

i = "foobar"; // Now: typeof i == typeof 'foobar' == 'string'

i = true;     // Now typeof i == 'boolean'
```

- Variables have the type of the last thing assigned to it
- Primitive types: undefined, number, string, boolean, function, object

Variable scoping with `var`: Lexical/static scoping

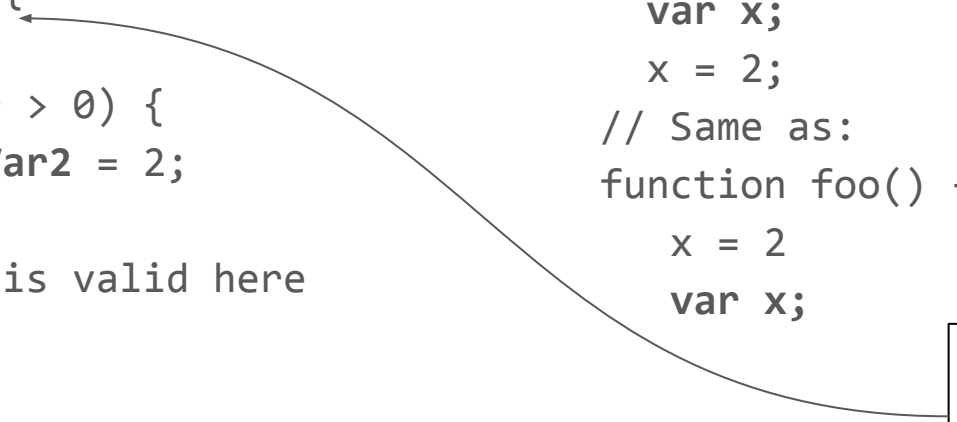
Two scopes: Global and function local

```
var globalVar;

function foo() {
  var localVar;
  if (globalVar > 0) {
     var localVar2 = 2;
  }
  // localVar2 is valid here
}
```

All `var` statements **hoisted** to top of scope:

```
function foo() {
  var x;
  x = 2;
// Same as:
function foo() {
   x = 2
   var x;
```



`localVar2` is hoisted here but has value undefined

Var scope problems

- Global variables are bad in browsers - Easy to get conflicts between modules
- Hoisting can cause confusion in local scopes (e.g. access before value set)

```
function() {
  console.log('Val is:', val);
  ...
  for(var i = 0; i < 10; i++) {
       var val = "different string"; // Hoisted to func start
```

- Some JavaScript guides suggest always declaring all `var` at function start
- ES6 introduced non-hoisting, scoped **`let`** and **`const`** with explicit scopes
  Some coding environments ban **`var`** and use **`let`** or **`const`** instead

Var scope problems

- Global variables are bad in browsers - Easy to get conflicts between modules
- Hoisting can cause confusion in local scopes (e.g. access before value set)

```
function() {
  console.log('Val is:', val);  // Syntax error
  ...
  for(let i = 0; i < 10; i++) {
       let val = "different string"; // Works
```

- Some JavaScript guides suggest always declaring all var at function start
- ES6 introduced non-hoisting, scoped **`let`** and explicit scopes

  Some coding environments ban **`var`** and use **`let`** or **`const`** instead

`number` type

`number` type is stored in floating point (i.e. double in C)

$$\texttt{MAX\_INT} = (2^{53} - 1) = 9007199254740991$$

Some oddities: `NaN, Infinity` are numbers

```
1/0 == Infinity
Math.sqrt(-1) == NaN
```

Nerd joke: `typeof NaN` returns `'number'`

Watch out:

`(0.1 + 0.2) == 0.3` is `false` `// 0.30000000000000004`

bitwise operators (e.g. `~, &, |, ^, >>, <<, >>>`) are 32bit!

`string` type

`string` type is variable length (no `char` type)

```
let foo = 'This is a test';  // can use "This is a test"
foo.length  // 14
```

+ is string concat operator

```
foo = foo + 'XXX'; // This is a testXXX
```

Lots of useful methods: `indexOf()`, `charAt()`, `match()`, `search()`, `replace()`, `toUpperCase()`, `toLowerCase()`, `slice()`, `substr()`, …

```
'foo'.toUpperCase() // 'FOO'
```

`boolean` type

- Either **`true`** or **`false`**
- Language classifies values as either **truthy** or **falsy**
  - Used when a value is converted to a `boolean` e.g. `if (foo) { … }`
- Falsy:

  `false`, `0`, `""`, `null`, `undefined`, and `NaN`

- Truthy:

  Not falsy (`all objects, non-empty strings, non-zero numbers, functions, etc.`)

`undefined` and `null`

- **`undefined`** - does not have a value assign

```
let x;   //  x has a value of undefined
x = undefined;  // It can be explicitly store
typeof x == 'undefined'
```

- **`null`** - a value that represents whatever the user wants it to

  Use to return special condition (e.g. no value)
  typeof null == ‘object’

- Both are falsy but not equal (`null == undefined; null !== undefined`)

`function` type

```
var foobar = function foobar(x) {   // Same as function foobar(x)
    if (x <= 1) {
        return 1;
    }
    return x*foobar(x-1);
}
typeof foobar == ‘function’;  foobar.name == 'foobar'
```

- Function definitions are hoisted (i.e. can use before definition)
- Can be called with a different number arguments than definition
  - `Array arguments` variable (e.g. `arguments[0]` is first argument)
  - Unspecified arguments have value `undefined`
- All functions return a value (default is `undefined`)

First class function example

```
let aFuncVar = function (x) {
                  console.log('Func called with', x);
                  return x+1;
               };
myFunc(aFuncVar);
function myFunc(routine) {                    // passed as a param
   console.log('Called with', routine.toString());
   let retVal = routine(10);
   console.log('retVal', retVal);
   return retVal;
}
```

Output

```
Called with function (x) {
                  console.log('Called with', x);
                  return x+1;
               }
Func called with 10
retVal 11
```

object type

- Object is an unordered collection of name-value pairs called **properties**

```
let foo = {};
let bar = {name: "Alice", age: 23, state: "California"};
```

- Name can be any string: `let x = { "": "empty", "---": "dashes"}`
- Referenced either like a structure or like a hash table with string keys:

```
bar.name or bar["name"]
x["---"]   // have to use hash format for illegal names
foo.nonExistent == undefined
```

- Global scope is an object in browser (i.e. `window[prop]`)

Properties can be added, removed, enumerated

- To add, just assign to the property:

```
let foo = {};
foo.name = "Fred";      // foo.name returns "Fred"
```

- To remove use `delete`:

```
let foo = {name: "Fred"};
delete foo.name; // foo is now an empty object
```

- To enumerate use `Object.keys()`:

```
Object.keys({name: "Alice", age: 23}) = ["name", "age"]
```

Arrays

```
let anArr = [1,2,3];
```

Are special objects: `typeof anArr == 'object'`

Indexed by non-negative integers: (anArr[0] == 1)

Can be **sparse** and **polymorphic**: `anArr[5]='FooBar'; //[1,2,3,,,'FooBar']`

Like strings, have many methods: `anArr.length == 3`

`push, pop, shift, unshift, sort, reverse, splice, …`

Oddity: can store properties like objects (e.g. `anArr.name = 'Foo'`)

Some properties have implications: (e.g. `anArr.length = 0;`)

Dates

```
let date = new Date();
```

Are special objects: `typeof date == 'object'`

The number of milliseconds since midnight January 1, 1970 UTC

Timezone needed to convert. Not good for fixed dates (e.g. birthdays)

Many methods for returning and setting the data object. For example:

```
date.valueOf() = 1452359316314
date.toISOString() = '2016-01-09T17:08:36.314Z'
date.toLocaleString() = '1/9/2016, 9:08:36 AM'
```

Regular Expressions

```
let re = /ab+c/;   or   let re2 = new RegExp("ab+c");
```

Defines a pattern that can be searched for in a string

- String: `search()`, `match()`, `replace()`, and `split()`
- RegExp: `exec()` and `test()`

Cool combination of CS Theory and Practice: CS143

Uses:

- Searching: Does this string have a pattern I'm interested in?
- Parsing: Interpret this string as a program and return its components

Regular Expressions by example - search/test

```
/HALT/.test(str);    // Returns true if string str has the substr HALT
/halt/i.test(str);   // Same but ignore case
/[Hh]alt [A-Z]/.test(str); // Returns true if str either “Halt L” or “halt L”

'XXX abbbbbbc'.search(/ab+c/);   // Returns 4 (position of ‘a’)
'XXX ac'.search(/ab+c/);         // Returns -1, no match
'XXX ac'.search(/ab*c/);         // Returns 4

'12e34'.search(/[^\d]/);         // Returns 2
'foo: bar;'.search(/...\s*:\s*...\s*;/);    // Returns 0
```

Regular Expressions - exec/match/replace

```
let str = "This has 'quoted' words like 'this'";
let re = /'[^']*'/g;

re.exec(str);  // Returns ["'quoted'", index: 9,  input: …
re.exec(str);  // Returns ["'this'", index: 29,  input: …
re.exec(str);  // Returns null

str.match(/'[^']*'/g);  // Returns ["'quoted'", "'this'"]

str.replace(/'[^']*'/g, 'XXX'); // Returns:
                                'This has XXX words with XXX.'
```

Exceptions - `try/catch`

- Error reporting frequently done with exceptions
  Example:
  ```
  nonExistentFunction();
  ```
  Terminates execution with error:
  ```
  Uncaught ReferenceError: nonExistentFunction is not defined
  ```
- Exception go up stack: Catch exceptions with `try/catch`
  ```
  try {
    nonExistentFunction();
  } catch (err) {   // typeof err 'object'
    console.log("Error call func", err.name, err.message);
  }
  ```

Exceptions - `throw/finally`

- Raise exceptions with `throw` statement

```
try {
   throw "Help!";
} catch (errstr) {  // errstr === "Help!"
   console.log('Got exception', errstr);
} finally {
    // This block is executed after try/catch
}
```

- Conventions are to `throw` sub-classes of `Error` object

```
console.log("Got Error:", err.stack || err.message || err);
```

Getting JavaScript into a web page

- By including a separate file:

```
<script type="text/javascript" src="code.js"></script>
```

- Inline in the HTML:

```
<script type="text/javascript">
//<![CDATA[
Javascript goes here...
//]]>
</script>
```