CS 152: *Programming Language Paradigms*

Taming the Dark, Scary Corners of JavaScript

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JavaScript has first-class functions.

```
function makeAdder(x) {
  return function (y) {
    return x + y;
} }
var addOne = makeAdder(1);
console.log(addOne(10));
```

Warm up exercise: Create a `makeListOfAdders` function.

Use anonymous functions where possible.

input: a list of numbers
returns: a list of adders

```
a = makeListOfAdders([1,5]);
a[0](42); // 43
a[1](42); // 47
```

```
function makeListOfAdders(lst) {
  var arr = [];
  for (var i=0; i<lst.length; i++) {
    var n = lst[i];
    arr[i] = function(x) { return x + n; }
  }
  return arr;
}

var adders =
     makeListOfAdders([1,3,99,21]);
adders.forEach(function(adder) {
  console.log(adder(100));
});
```

Prints:

```
121
121
121
121
```

```
function makeListOfAdders(lst) {
  var arr = [];
  for (var i=0; i<lst.length; i++) {
    arr[i]=function(x) {return x + lst[i];}
  }
  return arr;
}

var adders =
     makeListOfAdders([1,3,99,21]);
adders.forEach(function(adder) {
  console.log(adder(100));
});
```

Prints:

```
NaN
NaN
NaN
NaN
```

What is going on in this wacky language???!!!

JavaScript does *not* have block scope.

So while you see:

```
for (var i=0; i<lst.length; i++)
  var n = lst[i];
```

the interpreter sees:

```
var i, n;
for (i=0; i<lst.length; i++)
  n = lst[i];
```

In JavaScript, this is known as *variable hoisting*.

Faking block scope

```
function makeListOfAdders(lst) {
  var i, arr = [];
  for (i=0; i<lst.length; i++) {
   (function() {
    var n = lst[i];
    arr[i] = function(x) {
      return x + n;
    }
   })();
  }
  return arr;
}
```

Function creates new scope

A JavaScript constructor

```
name = "Monty";
function Rabbit(name) {
  this.name = name;
}
var r = Rabbit("Python");

console.log(r.name);
                  // ERROR!!!
console.log(name);
                  // Prints "Python"
```

Forgot `new`

A JavaScript constructor

```
function Rabbit(name, favFoods) {
  this.name = name;
  this.myFoods = [];
  favFoods.forEach(function(food) {
    this.myFoods.push(food);
  });
}
var bugs = new Rabbit("Bugs",
      ["carrots", "lettuce", "souls"]);
console.log(bugs.myFoods);
```

`this` refers to the global scope

Execution Contexts

Comprised of:

- A variable object
  - Container for variables & functions
- A scope chain
  - The variable object plus parent scopes
- A context object (`this`)

Global context

- Top level context.
- Variable object is known as the *global object*.
- `this` refers to global object

Function contexts

- Variable objects (aka *activation objects*) include
  - Arguments passed to the function
  - A special `arguments` object
  - Local variables
- What is `this`? It's complicated…

What does `this` refer to?

- Normal function calls: the global object
- Object methods: the object
- Constructers (functions called w/ `new`):
  - the new object being created.
- Special cases:
  - `call`, `apply`, `bind`
  - in-line event handlers on DOM elements

apply, call, and bind

```
x = 3;

function foo(y) {
  console.log(this.x + y);
}
foo(100);

foo.apply(null, [100]);  // Array passed for args
foo.apply({x:4}, [100]);
foo.call({x:4}, 100);    // No array needed

var bf = foo.bind({x:5});// Create a new function
bf(100);
```

Additional challenges …

Forget `var`, variables are global

```
function swap(arr,i,j) {
  tmp = arr[i]; arr[i] = arr[j]; arr[j] = tmp;
}
function sortAndGetLargest (arr) {
  tmp = arr[0]; // largest elem
  for (i=0; i<arr.length; i++) {
    if (arr[i] > tmp) tmp = arr[i];
    for (j=i+1; j<arr.length; j++)
      if (arr[i] < arr[j]) swap(arr,i,j);
  }
  return tmp;
}
var largest = sortAndGetLargest([99,2,43,8,0,21,12]);
console.log(largest); // should be 99, but prints 0
```

Semicolon insertion does strange things

```
function makeObject () {
  return
  {
    madeBy: 'Austin Tech. Sys.'
  }
}
var o = makeObject();
console.log(o.madeBy); // error
```

parseInt won't warn you of problems

```
console.log(parseInt("42"));


console.log("what do you get? "
          + parseInt("16 tons"));


console.log(parseInt("1O1"));
```

I put in an "oh" just
to mess with you

`NaN` does not help matters

```
function productOf(arr) {
  var prod = 1;
  for (var i in arr) {
    var n = parseInt(arr[i])
    prod = prod * n;
  }
  return prod;
}
console.log(
  productOf(["9","42","1"])); // 378
console.log(productOf(
  ["9","forty-two","1"])); // NaN
```

We might try to fix our code …

```
function productOf(arr) {
  var prod = 1;
  for (var i in arr) {
    var n = parseInt(arr[i])
    if (typeof n === "number")
       prod = prod * n;
  }
  return prod;
}
```

… but typeof does not help us.

```
> typeof NaN
'number'
```

Nor does it help us check for null.

```
> typeof null
'object'
```

The == operator is not transitive

```
'' == '0'           // false
0 == ''             // true
0 == '0'            // true

false == 'false'    // false
false == '0'        // true

false == undefined  // false
false == null       // true
null == undefined   // true

' \t\r\n ' == 0     // true
```

```
function typeOfChar(ch) {
  var sType = 'Other character';
  switch (ch) {
    case 'A':
    case 'B':
    ...
      sType = "Capital letter"
    case 'a':
    ...
      sType = "Lowercase letter"
    case '0':
    ...
      sType = "Digit"
  }
  return sType;
}
```

```
var str = "Hello 42";
for (var i=0; i<str.length; i++) {
  console.log(
    typeOfChar(str.charAt(i)));
}
```

Output:

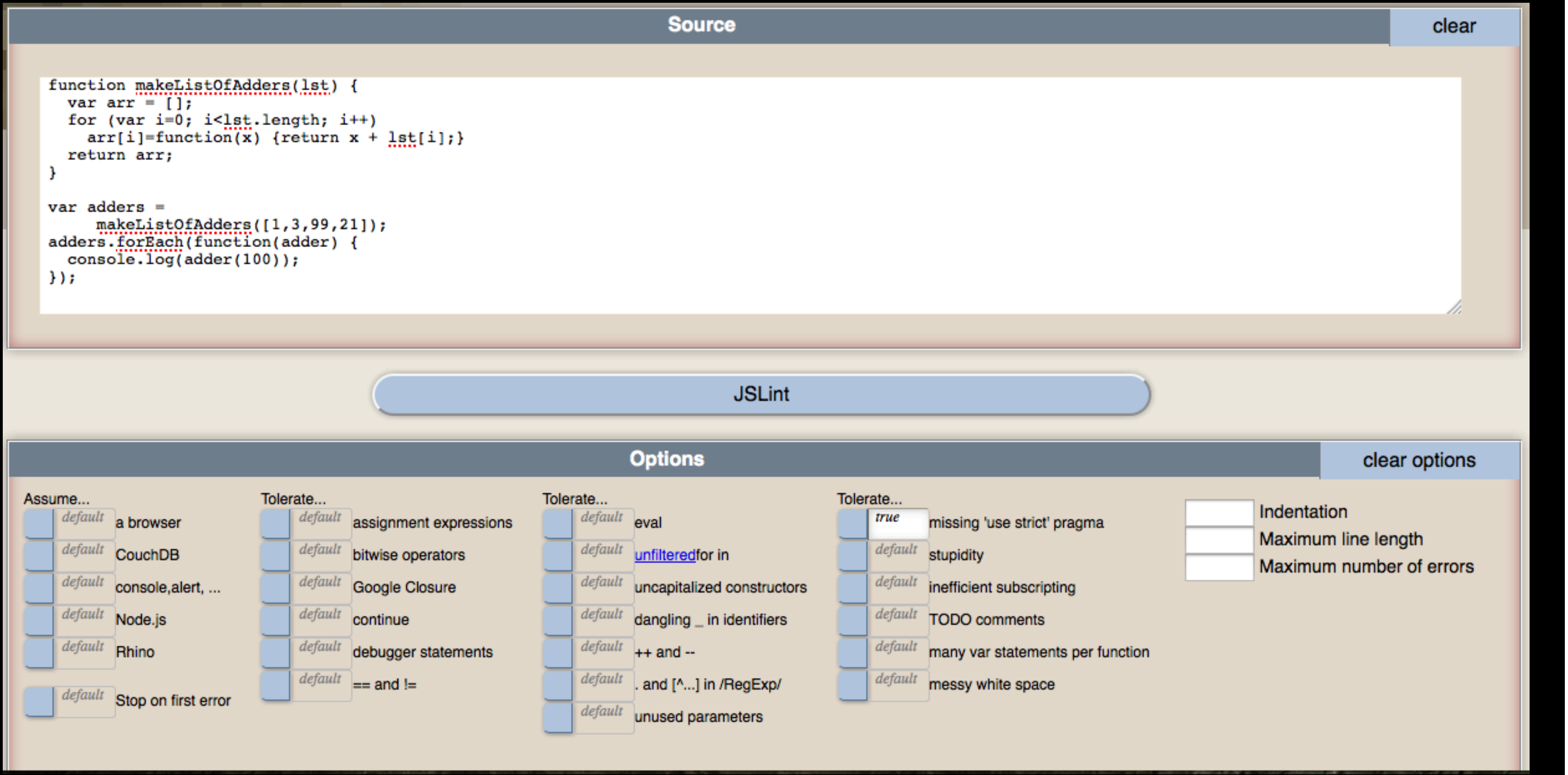
```
Digit
Digit
Digit
Digit
Digit
Other character
Digit
Digit
```

How can we tame the ugliness?

Tools to write cleaner/safer JavaScript:

- JSLint (http://www.jslint.com/)
- TypeScript– Static typechecker for JS

JSLint: *The JavaScript Code Quality Tool*



```
function makeListOfAdders(lst) {
  var arr = [];
  for (var i=0; i<lst.length; i++)
    arr[i]=function(x) {return x + lst[i];}
  return arr;
}

var adders =
     makeListOfAdders([1,3,99,21]);
adders.forEach(function(adder) {
  console.log(adder(100));
});
```

Assume...

- default a browser
- default CouchDB
- default console,alert, ...
- default Node.js
- default Rhino

- default Stop on first error

Tolerate...

- default assignment expressions
- default bitwise operators
- default Google Closure
- default continue
- default debugger statements
- default == and !=

Tolerate...

- default eval
- default unfilteredfor in
- default uncapitalized constructors
- default dangling _ in identifiers
- default ++ and --
- default . and [^...] in /RegExp/
- default unused parameters

Tolerate...

- true missing 'use strict' pragma
- default stupidity
- default inefficient subscripting
- default TODO comments
- default many var statements per function
- default messy white space

Indentation

Maximum line length

Maximum number of errors

JSLint

- Static code analysis tool
- Developed by Douglas Crockford.
- Inspired by lint tool
  - catch common programming errors.

JSLint Expectations

- Variables declared before use
- Semicolons required
- Double equals not used
- (And getting more opinionated)

makeListOfAdders source

```
function makeListOfAdders(lst) {
  var arr = [];
  for (var i=0; i<lst.length; i++)
    arr[i]=function(x) {return x + lst[i];}
  return arr;
}

var adders =
     makeListOfAdders([1,3,99,21]);
adders.forEach(function(adder) {
  console.log(adder(100));
});
```

Debug `makeListOfAdders`
(in class)

TypeScript

What do type systems give us?

- Tips for compilers
- Hints for IDEs
- Enforced documentation
- But most importantly…

Type systems prevent us from running code with errors.

TypeScript

- Developed by Microsoft
- A new language (sort-of)
  - Type annotations
  - Classes
  - A superset of JavaScript
    - or it tries to be
- Compiles to JavaScript

TypeScript file

greeter.ts

```
function greeter(person) {
  return "Hello, " + person;
}
var user = "Vlad the Impaler";
console.log(greeter(user));
```

Compiled TypeScript

greeter.js

```
function greeter(person) {
  return "Hello, " + person;
}
var user = "Vlad the Impaler";
console.log(greeter(user));
```

TypeScript file, with annotations

greeter.ts

```
function greeter(person: string){
  return "Hello, " + person;
}
var user = "Vlad the Impaler";
console.log(greeter(user));
```

Basic Types

- **number** (`var pi: number = 3.14`)
- **boolean** (`var b: boolean = true`)
- **string** (`var greet: string = "hi"`)
- **array** (`var lst: number[] = [1,3]`)
- **enum**
- **any** (`var a: any = 3;`
  `var b: any = "hi";`)
- **void**

Functions

```
function add(x: number,
             y: number): number {
  return x + y;
}

add(3,4)
```

Classes

```
class Employee {
  name: string;
  salary: number;
  constructor(name: string, salary: number) {
    this.name = name;
    this.salary = salary;
  }
  display() { console.log(this.name); }
}

var emp = new Employee("Jon", 87321);
console.log(emp.salary);
```

Translated code

```
var Employee = (function () {
  function Employee(name, salary) {
    this.name = name;
    this.salary = salary;
  }
  Employee.prototype.display =
    function (){console.log(this.name);};
  return Employee;
})();
var emp = new Employee("Jon", 87321);
console.log(emp.salary);
```

Lab

Today's lab will contrast JSLint and TypeScript.

Details are available in Canvas.