CSE 341
Lecture 23

Introduction to JavaScript

slides created by Marty Stepp

http://www.cs.washington.edu/341/

Language timeline

category	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**
scientific	Fortran			Matlab	
business	Cobol	DBMSes	SQL	VB	
functional	Lisp	ML, Scheme	Erlang	Haskell	F#
imperative/procedural	Algol	Pascal, C, Smalltalk	Ada, C++	Java	C#
scripting	BASIC		Perl	Python, Ruby, PHP, **JavaScript**	
logical		Prolog	CLP(R)		

What is JavaScript?

- created in 1995 by Brandon Eich of Netscape/Mozilla
  - *"JS had to "look like Java" only less so, be Java's dumb kid brother or boy-hostage sidekick. Plus, I had to be done in ten days or something worse than JS would have happened."* - Brandon Eich
  - originally called "LiveScript" to match Netscape branding
  - renamed to JavaScript to capitalize on popularity of Java
  - submitted as a standard to ECMA in 1997 as "ECMAScript"

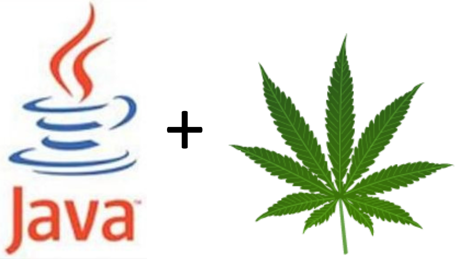
- not directly related to Java
  - Eich claims he was most influenced by Self and Scheme
  - some JS syntax, libraries, etc. are ripped off by Java, C
  - D. Crockford: *"JavaScript is Lisp in C's clothing."*

JavaScript today

- possibly the most used programming language today (!!)
  - mostly used for client-side web page scripting, but increasingly used to build server apps, other programs
  - current standardized version: ECMAScript 5 (2009)

- Is JavaScript a bad programming language??
  - had bad browser behavior, slow, poor web coders, etc.
  - recent implementations are faster, better, more stable
  - JS in browser works with "DOM" (Document Object Model)
  - related JS+web technologies: Ajax, JSON, jQuery, etc.
  - spin-off languages: JScript (MS), ActionScript (Adobe), etc.

JavaScript vs. Java



= JavaScript

- *interpreted*, not compiled
  - dynamic typing
  - first-class functions; nested functions; closures
  - a structured, imperative object-oriented, scripting lang.
  - prototype-based object and inheritance system
  - sophisticated first-class resizable array type
  - first-class regular expression support
- more relaxed syntax and rules
  - fewer and "looser" data types
  - variables don't always need to be declared
  - key construct is first-class *function* rather than the class

Running JS code in a browser

```
<html>
  <head>
    <script src="myfile.js"
            type="text/javascript"></script>
  </head>
  <body>
    <p>My web page</p> ...
  </body>
</html>
```

- We won't be doing this!
  - aside: Firebug extension

```
<div class="contentTop1">
<div class="contentInner1">
  <div class="contentInner2">
    <div class="contentInner3">
      <div class="contentInner">
        <h1 class="siteTitle">
          <a href="/" style="">
        </h1>
        <div class="subTitle">Thoughts
        on software and life.</div>
        <div class="pageHead">
        <div id="post000170" class="blogPost"
```

```
.siteTitle {                sheet.css (line 103)
  font-size: 1.5em;
}

h1 {                         sheet.css (line 10)
  ~~font-size: 1.3em;~~
  letter-spacing: -1px;
}
```

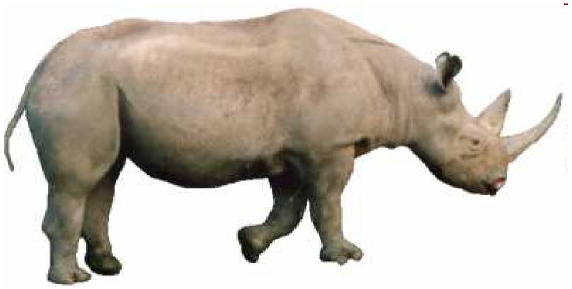
Inherited from div#content

```
#content {                  sheet.css (line 122)
  text-align: left;
}
```

Inherited from body

Running JS without a browser

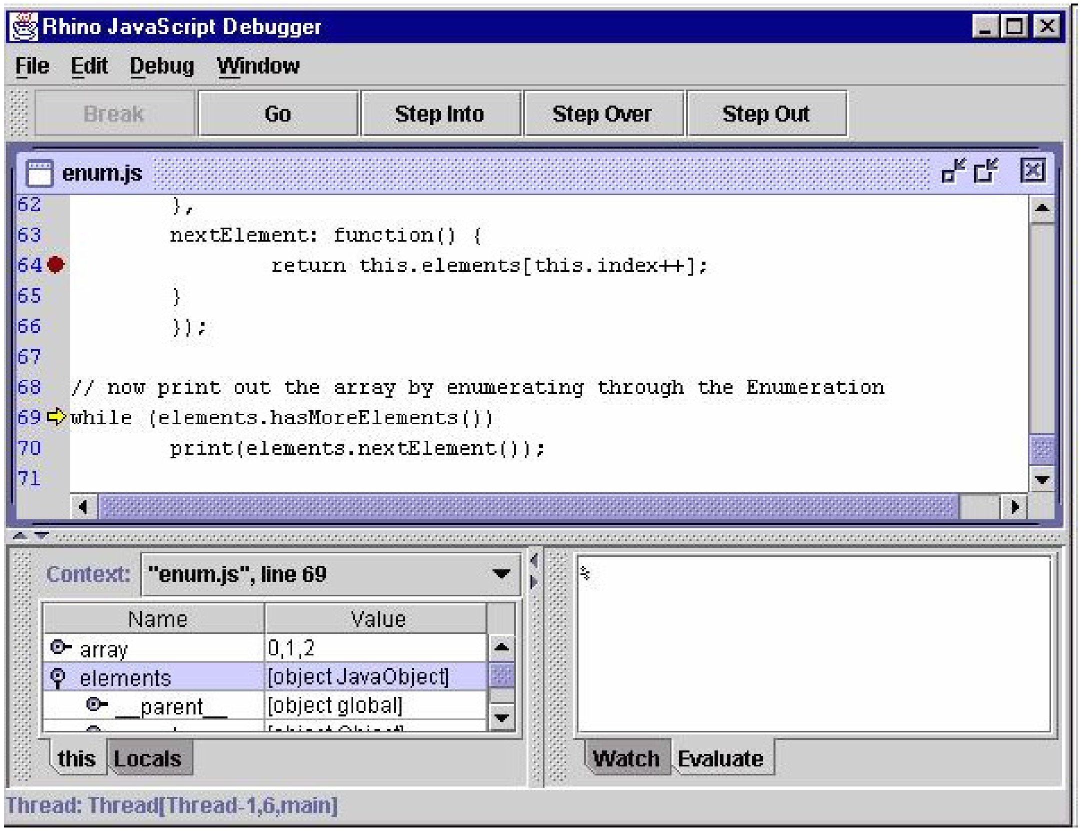
- **CommonJS**: project started in 2009 to create a standard library of JS types and functions for all non-web apps
  - **Rhino** (Mozilla)
  - V8 (Google / Chrome)
  - Narwhal
  - others: Ringo, Joyent, Sprout, Persevere



- We support the **Rhino** runtime for this course.
  - http://www.mozilla.org/rhino/
  - `java -jar rhino.jar` ***`JSFileName`***

The Rhino debugger

```
java -classpath rhino.jar
  org.mozilla.javascript.tools.debugger.Main filename.js
```



```
        },
        nextElement: function() {
                return this.elements[this.index++];
        }
        });

// now print out the array by enumerating through the Enumeration
while (elements.hasMoreElements())
        print(elements.nextElement());
```

Context: "enum.js", line 69

Name	Value
array	0,1,2
elements	[object JavaObject]
__parent__	[object global]

Thread: Thread[Thread-1,6,main]

- http://www.mozilla.org/rhino/debugger.html

JavaScript syntax

print (CommonJS)

print(***expr***, ***expr***, ..., ***expr***);

- provided by Rhino as part of CommonJS
  - `print("Hello, world!\n");`
  - `print(1+1, 4, 3*2);          // 2 4 6`
  - other shell variables/functions:
    - arguments, environment, help, defineClass, deserialize, load(***filename***), loadClass, readFile(***name***), readURL, runCommand, seal, serialize, spawn, sync, quit, version
  - doesn't work in web browsers (use alert instead)

Variables

`var` ***`name`*** `=` ***`expression`***`;`

- Examples:
  - `var age = 32;`
  - `var weight = 127.4;`
  - `var clientName = "Connie Client";`

- variables are declared with `var` keyword (case sensitive)
- types not specified, but JS does have types
  - `Number`, `Boolean`, `String`, `Array`, `Object`, `Function`, `Null`, `Undefined`
  - can find out a variable's type by calling `typeof`

Numbers

```
var enrollment = 99;
var medianGrade = 2.8;
var credits = 5 + 4 + (2 * 3);
```

- integers and real numbers are the same type
  - (no `int` vs. `double`)
- same operators: `+ - * / % ++ -- = += -= *= /= %=`
  - similar precedence to Java
  - many operators auto-convert types: `"2" * 3` is 6

Number properties/methods

Number object "static" properties

Number.MAX_VALUE	largest possible number, roughly 10^{308}
Number.MIN_VALUE	smallest *positive* number, roughly 10^{-324}
Number.NaN	Not-a-Number; result of invalid computations
Number.POSITIVE_INFINITY	infinity; result of 1/0
Number.NEGATIVE_INFINITY	negative infinity; result of -1/0

Number instance methods

.toString(***[base]***)	convert a number to a string with optional base
.toFixed(***digits***)	fixed-point real with given # digits past decimal
.toExponential(***digits***)	convert a number to scientific notation
.toPrecision(***digits***)	floating-point real, given # digits past decimal

global methods related to numbers

isNaN(***expr***)	true if the expression evaluates to NaN
isFinite(***expr***)	true if ***expr*** is neither NaN nor an infinity

The Math object

```
var rand1to10 = Math.floor(Math.random() * 10 + 1);
var three = Math.floor(Math.PI);
```

- `Math` methods: `abs`, `ceil`, `cos`, `floor`, `log`, `max`, `min`, `pow`, `random`, `round`, `sin`, `sqrt`, `tan`
- properties: `E`, `PI`

Math properties/methods

Math.E	*e*, base of natural logarithms: 2.718...
Math.LN10, Math.LN2, Math.LOG2E, Math.LOG10E	natural logarithm of 10 and 2; logarithm of *e* in base 2 and base 10
Math.PI	π, circle's circumference/diameter: 3.14159...
Math.SQRT1_2, Math.SQRT2	square roots of $^1/_2$ and 2
Math.abs(***n***)	absolute value
Math.acos/asin/atan(***n***)	arc-sin/cosine/tangent of angle in radians
Math.ceil(***n***)	ceiling (rounds a real number up)
Math.cos/sin/tan(***n***)	sin/cosine/tangent of angle in radians
Math.exp(***n***)	e^n, *e* raised to the *n*th power
Math.floor(***n***)	floor (rounds a real number down)
Math.log(***n***)	natural logarithm (base *e*)
Math.max/min(***a***, ***b***...)	largest/smallest of 2 or more numbers
Math.pow(***x***, ***y***)	x^y, *x* raised to the *y*th power
Math.random()	random real number *k* in range $0 \le k < 1$
Math.round(***n***)	round number to nearest whole number
Math.sqrt(***n***)	square root

Comments (same as Java)

```
// single-line comment

/*
multi-line comment
multi-line comment
*/
```

- (identical to Java's comment syntax)

Strings

```
var s = "Connie Client";
var firstName = s.substring(0, s.indexOf(" "));
var len = s.length;           // 13
var s2 = 'Melvin Merchant';   // can use "" or ''
```

- String **methods**: `charAt`, `charCodeAt`, `fromCharCode`, `indexOf`, `lastIndexOf`, `replace`, `split`, `substring`, `toLowerCase`, `toUpperCase`
  - `charAt` returns a one-letter string (there is no `char` type)
  - `length` is a property (not a method as in Java)
- **concatenation** with `+` : `1 + 1` is 2, but `"1" + 1` is `"11"`
- strings can be **compared** with `<`, `<=`, `==`, `!=`, `>`, `>=`

String methods

String.fromCharCode(***expr***)	converts ASCII integer → String
.charAt(***index***)	returns character at index, as a String
.charCodeAt(***index***)	returns ASCII value at a given index
.concat(***str...***)	returns concatenation of string(s) to this one

.indexOf(***str[,start]***)
.lastIndexOf(***str[,start]***)
	first/last index at which given string begins in this string, *optionally* starting from given index

.match(***regexp***)	returns any matches for this string against the given string or regular expression ("regex")
.replace(***old, new***)	replaces first occurrence of old string or regular expr. with new string (use regex to replace all)
.search(***regexp***)	first index where given regex occurs

.slice(***start, end***)
.substring(***start, end***)
	substr. from start (inclusive) to end (exclusive)

.split(***delimiter[,limit]***)	break apart a string into an array of strings

.toLowerCase()
.toUpperCase()
	return new string in all upper/lowercase

More about Strings and numbers

- escape sequences behave as in Java: `\' \" \& \n \t \\`

- convert string to number with `parseInt`, `parseFloat`:

```
var count = 10;
var s1 = "" + count;                     // "10"
var s2 = count + " bananas, ah ah ah!";
var n1 = parseInt("42 is the answer");   // 42
var n2 = parseInt("0x2A", 16);           // 42
var n3 = parseFloat("3.1415");           // 3.1415
var bad = parseInt("booyah");            // NaN
```

- access the letters of a String with `[]` or `charAt`:

```
var firstLetter = s[0];
var firstLetter = s.charAt(0);
var lastLetter  = s.charAt(s.length - 1);
```

The for loop (same as Java)

```
for (initialization; test; update) {
    statements;
}
```

```
for (var i = 0; i < 10; i++) {
    print(i + "\n");
}
```

```
var s1 = "hi, there!!!",  s2 = "";
for (var i = 0; i < s1.length; i++) {
    var c = s1.charAt(i);
    if (c >= "a" && c <= "z") {
        s2 += c + c;
    }
```

Logical operators

`> < >= <= && || ! == != === !==`

- most logical operators automatically convert types:
  - `5 < "7"` is `true`
  - `42 == 42.0` is `true`
  - `"5.0" == 5` is `true`
- `===` , `!==` are strict equality tests; checks type *and* value
  - `"5.0" === 5` is `false`

The if/else statement

```
if (test) {
    statements;
} else if (test) {
    statements;
} else {
    statements;
}
```

- identical structure to Java's `if/else` statement...
  - but JavaScript allows almost any value as a test!

Boolean type

```
var iLike341 = true;
var ieIsGood = "IE6" > 0;          // false
if ("JS is great") { ... }         // true
if (0 || "") { ... }               // false
```

- any value can be used as a test
  - "falsey" values: `0`, `0.0`, NaN, `""`, `null`, and `undefined`
  - "truthy" values: anything else

- converting a value into a boolean explicitly:

```
var boolValue = Boolean(otherValue);
var boolValue = !!(otherValue);
```

&& and || in depth

- a && b is a binary operator that returns:
  - if a is truthy, then b, else a
  - *(this turns out to be a truthy/falsey value in the right cases)*

- a || b is a binary operator that returns:
  - if a is truthy, then a, else b
  - *(this turns out to be a truthy/falsey value in the right cases)*

- Examples:

`0 || 42 || 12 || -1`	returns 42	(truthy)
`NaN || null || ""`	returns `""`	(falsey)
`1 + 1 && 6 && 9`	returns 9	(truthy)
`3 && 4 && null && 5 && 6`	returns `null`	(falsey)

null vs. undefined

```
var ned = null;
var benson = 9;
var caroline;
```

- at this point in the code:
  - ned is null
  - benson is 9
  - caroline is undefined
- undefined: has not been declared, does not exist
- null: exists, but specifically assigned an empty value
  - Why does JavaScript have both of these?

The while loop (same as Java)

```
while (test) {
    statements;
}

do {
    statements;
} while (test);
```

- `break` and `continue` keywords also behave as in Java

Functions

```
function name(paramName, ..., paramName) {
    statements;
}

function myFunction(name) {
    print("Hello, " + name + "!\n");
    print("How are you?\n");
}
```

- unlike in Java, functions are *first-class* (can be stored as variables, passed as parameters, returned, ...)

JavaScript keywords

```
break   case     catch  continue debugger
default delete   do     else     finally
for     function if     in       instanceof
new     return   switch this     throw
try     typeof   var    void     while
with
```

- Reserved words (these don't do anything yet):

```
class   const    enum   export   extends
import  implements interface let package
private protected public static super yield
```