

The JavaScript Language (Part 1)

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Objectives

- We will cover:
 - A subset of JavaScript...
 - That is appropriate for COS 333...
 - Through example programs

Agenda

- **Overview**
- Setup
- Simple programs
- Functions
- Standard library
- Data types and operators
- Terminal I/O
- Exceptions
- Statements

Overview



Brendan
Eich

Overview: Motivation

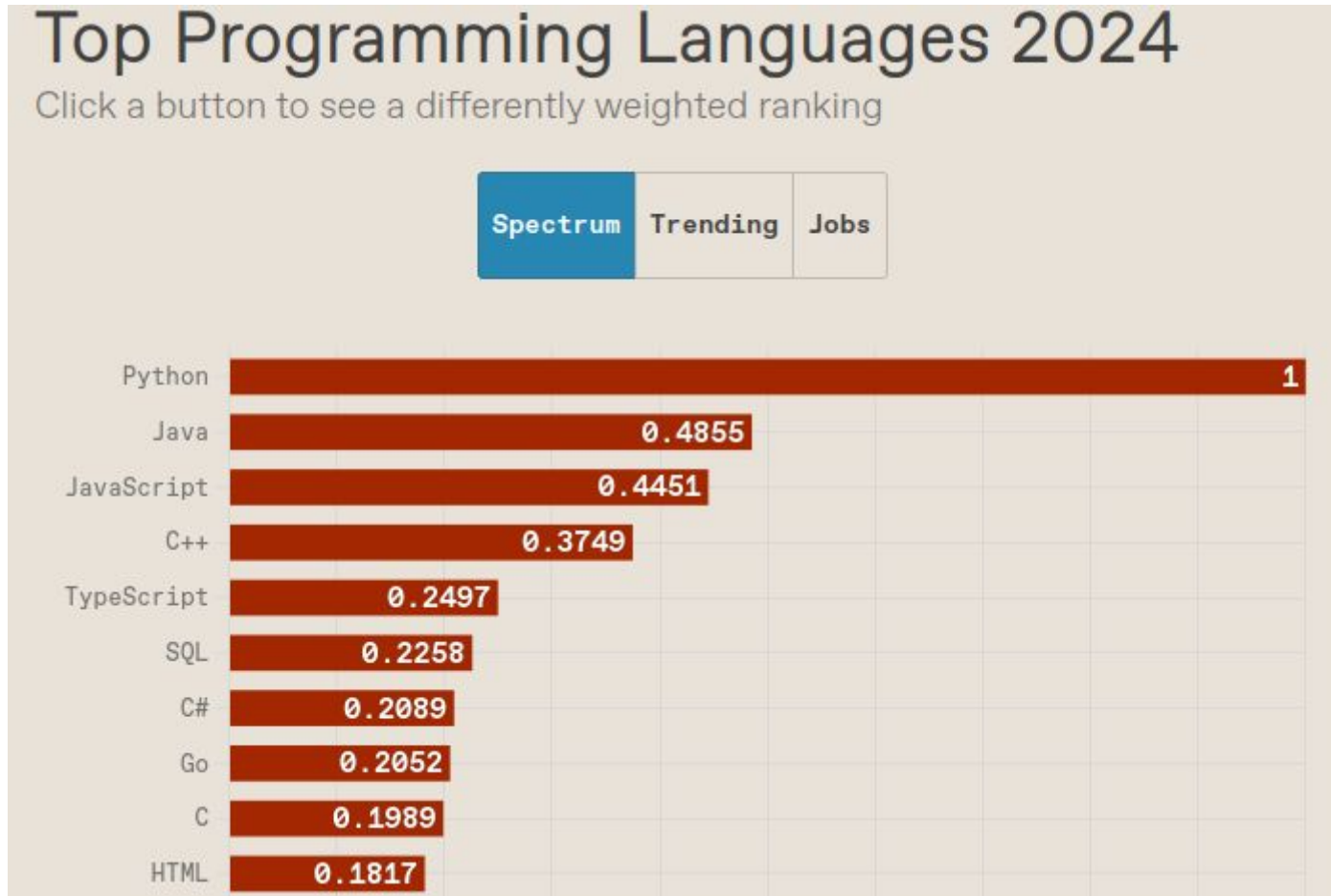
- **Question:**
 - Why study JavaScript?
- **Answer: ...**

Overview: Motivation

| Rank | Language | Ratings |
|------|----------------------|---------|
| 1 | Python | 21.9% |
| 2 | C++ | 11.6% |
| 3 | Java | 10.5% |
| 4 | C | 8.4% |
| 5 | C# | 5.6% |
| 6 | JavaScript | 3.5% |
| 7 | Visual Basic | 2.4% |
| 8 | Go | 2.0% |
| 9 | FORTRAN | 1.8% |
| 10 | Delphi/Object Pascal | 1.7% |
| 11 | SQL | 1.6 |

<https://www.tiobe.com/tiobe-index/> on 10/20/24

Overview: Motivation



<https://spectrum.ieee.org/the-top-programming-languages-2024>

Overview: Motivation



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Overview: Motivation



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Overview: Motivation

| Website | Front End | Back End |
|-----------|------------------------|---|
| Google | JavaScript, TypeScript | C, C++, Go, Java, Python, Node |
| Facebook | JavaScript, TypeScript | Hack, Python, C++, Java, Erlang, D, Haskell |
| YouTube | JavaScript, TypeScript | Python, C, C++, Java, Go |
| Yahoo | JavaScript | PHP |
| Etsy | JavaScript | PHP |
| Amazon | JavaScript | Java, C++, Perl |
| Wikipedia | JavaScript | PHP |
| Fandom | JavaScript | PHP |
| X | JavaScript | C++, Java, Scala, Ruby |
| Bing | JavaScript | C++, C# |
| eBay | JavaScript | Java, JavaScript, Scala |

<https://en.wikipedia.org/wiki/>

Programming_languages_used_in_most_popular_websites (10/20/24)

Overview: ECMAScript

- JavaScript is an implementation of...
- ***ECMAScript***
 - By **E**uropean **C**omputer **M**anufacturer's **A**ssociation
 - Latest specification:
 - <https://tc39.es/ecma262/>

Overview: ECMAScript

| Year | Name | Description |
|------|----------------------------------|---|
| 1997 | <i>ECMAScript1</i> <i>ES1</i> | First edition |
| 1998 | <i>ECMAScript2</i> <i>ES2</i> | Editorial changes only |
| 1999 | <i>ECMAScript3</i> <i>ES3</i> | Added regular expressions Added try/catch |
| | <i>ECMAScript4</i> <i>ES4</i> | Never released |

https://www.w3schools.com/js/js_versions.asp

Overview: ECMAScript

| Year | Name | Description |
|------|--|---|
| 2009 | <i>ECMAScript5</i> <i>ES5</i> | Added "strict mode" Added JSON support Added String.trim() Added Array.isArray() Added Array Iteration Methods |
| 2011 | <i>ECMAScript5.1</i> <i>ES5.1</i> | Editorial changes |
| 2015 | <i>ECMAScript6</i> <i>ECMAScript2015</i> <i>ES6</i> | Added let and const Added default parameter values Added Array.find() Added Array.findIndex() Added classes Added promises |

https://www.w3schools.com/js/js_versions.asp

Overview: ECMAScript

| Year | Name | Description |
|------|---|--|
| 2016 | <i>ECMAScript7</i> <i>ECMAScript2016</i> <i>ES7</i> | Added exponential operator (**) Added Array.prototype.includes |
| 2017 | <i>ECMAScript8</i> <i>ECMAScript2017</i> <i>ES8</i> | Added string padding Added new Object properties Added Async functions Added Shared Memory |
| 2018 | <i>ECMAScript9</i> <i>ECMAScript2018</i> <i>ES9</i> | Added rest / spread properties Added Asynchronous iteration Added Promise.finally() Additions to RegExp |

https://www.w3schools.com/js/js_versions.asp

Overview: ECMAScript

| Year | Name | Description |
|------|--|---|
| 2019 | <i>ECMAScript10</i> <i>ECMAScript 2019</i> <i>ES10</i> | Added Array.prototype.flat Added Array.prototype.flatMap Changed Array.sort and Object.fromEntries |
| 2020 | <i>ECMAScript11</i> <i>ECMAScript2020</i> <i>ES11</i> | Added BigInt Added null coalescing syntax |
| 2021 | <i>ECMAScript12</i> <i>ECMAScript2021</i> <i>ES12</i> | Added replaceAll for strings Added Promise.any Added AggregateError |

https://www.w3schools.com/js/js_versions.asp

Overview: ECMAScript

| Year | Name | Description |
|------|--|--|
| 2022 | <i>ECMAScript13</i> <i>ECMAScript2022</i> <i>ES13</i> | Added top-level await Added private class fields |
| 2023 | <i>ECMAScript14</i> <i>ECMAScript2023</i> <i>ES14</i> | Added functions to Array.prototype Added #! support |
| 2024 | <i>ECMAScript15</i> <i>ECMAScript2024</i> <i>ES15</i> | |

https://www.w3schools.com/js/js_versions.asp

Overview: Transpiling

- **Problem:**
 - You create JavaScript code that uses some ES6 syntax
 - You want your code to be runnable on all browsers
 - Some old-but-still-widely-used browsers can interpret only ES5 syntax

Overview: Transpiling

- **Solution:** *Transpile*
 - You transpile your code from ES6 to ES5
 - You provide your code to browsers as ES5
 - Example transpiler: *Babel*

Overview: Polyfilling

- **Problem:**
 - You create some JavaScript code that uses ES5 syntax, but also uses some new modules – modules that are available only on new (post-ES5) browsers
 - You want your code to be runnable on ES5 browsers

Overview: Polyfilling

- **Solution: *Polyfill***
 - You polyfill those new modules
 - You compose your own versions of those new modules and include them in your code
 - Or better...
 - You include in your code an already vetted set of polyfills

Overview: Learning JavaScript

- **Commentary**

- To learn ES_n , you must also learn ES_{n-1} , ES_{n-2} , ..., ES_1
- JavaScript is a particularly difficult language to master

Overview: Running JavaScript

- Options for running JavaScript:
 - In browser (soon)
 - Via **Node.js** (now)

Overview: Node.js



Ryan
Dahl

Agenda

- Overview
- **Setup**
- Simple programs
- Functions
- Standard library
- Data types and operators
- Terminal I/O
- Exceptions
- Statements

Setup

- **Step 1: Install Node.js and npm**
 - Linux
 - Use your package manager to install the node and npm packages
 - Mac
 - Use Homebrew to install Node.js by issuing this command:
 - `brew install node`
 - MS Windows
 - Browse to <https://nodejs.org/en/download>
 - Download an appropriate .msi file
 - In Windows Explorer, double click on the .msi file
 - Use the installation defaults

Setup

- **Step 2: Install Node.js modules**
 - At shell prompt
 - cd to the directory that contains JavaScript code
 - **Install the `readline-sync` module**
 - `npm install readline-sync`

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Simple Programs

- See **hello1.js**

```
$ node hello1.js  
hello, world  
$
```

Simple Programs

- See **hello2.js**

```
$ node hello2.js  
hello, world  
$
```

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Functions

- See **square.js**

```
$ node square.js  
25  
25  
25  
25  
25  
$
```

Aside: “Never Fail” Design

- “Never fail”
 - Pervasive JavaScript design philosophy

```
function square1(i) {  
    return i * i;  
}  
...  
n = square1(5);      // What happens?  
n = square1(5, 6);  // What happens?  
n = square1();       // What happens?
```


Aside: The Arguments Array

- The arguments array

```
function sumall() {  
    let sum = 0;  
    for (let i = 0; i < arguments.length; i++)  
        sum += arguments[i];  
    return sum;  
}  
...  
n = sumall();           // 0  
n = sumall(5);         // 5  
n = sumall(5, 6, 7);   // 18
```

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Standard Library

- See **squareroot.js**

```
$ node squareroot.js  
1.4142135623730951  
$
```

Full list of built-in objects in ES15:

<https://tc39.es/ecma262/>

Full list of built-in objects in Mozilla:

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects

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- Overview
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- **Data types and operators**
- **Terminal I/O**
- Exceptions
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Data Types and Operators

- See **circle1.js**

```
$ node circle1.js
Enter the circle's radius:
5
A circle with radius 5 has diameter 10
and circumference 31.41592653589793.
$ node circle1.js
Enter the circle's radius:
1
A circle with radius 1 has diameter 2
and circumference 6.283185307179586.
$
```

Data Types and Operators

| Data Type | Size | Example Literals |
|-----------|----------|------------------------------|
| Boolean | 1 byte | false, true |
| String | (varies) | "hi", 'hi' |
| Number | 8 bytes | 123, -123, 0.0, 1.23, 1.23e4 |

All numbers are stored as IEEE 754 floating point

Data Types and Operators

- Type conversion functions
 - `Number(x)`
 - `Boolean(x)`
 - `String(x)`

Data Types and Operators

- Strong suggestion
 - **Use the type conversion functions** to avoid mixed-type expressions!

Recommended viewing:

<https://www.destroyallsoftware.com/talks/wat>

Data Types and Operators

| Operators | (Priority) Meaning |
|----------------|-----------------------------------|
| (...) | (1) Grouping |
| x.y | (2) Member access |
| x[y] | (2) Computed member access |
| new ... | (2) New |
| f(...) | (2) Function call |
| x?.y | (2) Optional chaining |
| new | (3) New without operator list |
| x++ | (4) Postfix increment |
| x-- | (4) Postfix decrement |

Data Types and Operators

| Operators | (Priority) Meaning |
|-----------------|----------------------|
| !x | (5) Logical NOT |
| ~x | (5) Bitwise NOT |
| +x | (5) Unary plus |
| -x | (5) Unary negation |
| ++x | (5) Prefix increment |
| --x | (5) Prefix decrement |
| typeof x | (5) typeof |
| void x | (5) void |
| delete x | (5) delete |
| await x | (5) await |
| x**y | (6) Exponentiation |

Data Types and Operators

| Operators | (Priority) Meaning |
|-----------------------|----------------------------------|
| x*y | (7) Multiplication |
| x/y | (7) Division |
| x%y | (7) Remainder |
| x+y | (8) Addition |
| x-y | (8) Subtraction |
| x<<y | (9) Bitwise left shift |
| x>>y | (9) Bitwise right shift |
| x>>>y | (9) Bitwise unsigned right shift |
| x<y | (10) Less than |
| x<=y | (10) Less than or equal to |
| x>y | (10) Greater than |
| x>=y | (10) Greater than or equal to |
| x in y | (10) In |
| x instanceof y | (10) Instance of |

Data Types and Operators

| Operators | (Priority) Meaning |
|----------------------|----------------------------------|
| x==y | (11) Equality |
| x!=y | (11) Inequality |
| x===y | (11) Strict equality |
| x!==y | (11) Strict inequality |
| x&y | (12) Bitwise AND |
| x^y | (13) Bitwise exclusive OR |
| x y | (14) Bitwise OR |
| x&& y | (15) Logical AND |
| x y | (16) Logical OR |
| x??y | (17) Nullish coalescing operator |
| x?y:z | (18) Conditional |

Data Types and Operators

| Operators | (Priority) Meaning |
|---|--------------------|
| <code>x=y, x+=y, x-=y, x**=y, x*=y, x/=y, x%=y, x<<=y, x>>=y, x>>>=y, x&=y, x^=y, x =y, x&&=y, x =y, x??=y</code> | (18) Assignment |
| <code>yield x</code> | (19) Yield |
| <code>yield* x</code> | (20) Yield |
| <code>x, y</code> | (21) Sequence |

Data Types and Operators

| Expression | Value |
|-----------------------------|-------|
| <code>123 == '123'</code> | true |
| <code>123 == '+123'</code> | true |
| <code>123 === '123'</code> | false |
| <code>123 === '+123'</code> | false |

Equality operator (`==`) does type conversion

Strict equality operator (`===`) suppresses type conversion

Recommendation: Always use `===` instead of `==`

Recommendation: Never mix types!!!

Terminal I/O

Reading from stdin:

```
const readlineSync = require('readline-sync');  
...  
str = readlineSync.question(str);  
str = readlineSync.question();
```

Terminal I/O

Writing to stdout:

```
process.stdout.write(strExpr) ;  
console.log(expr) ;
```

Writing to stderr:

```
process.stderr.write(strExpr) ;  
console.error(expr) ;
```


Agenda

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Exceptions

- Recall circle1.js

```
$ node circle1.js
Enter the circle's radius:
5
A circle with radius 5 has diameter 10
and circumference 31.41592653589793.
$ node circle1.js
Enter the circle's radius:
xyz
A circle with radius NaN has diameter NaN
and circumference NaN.
$ node circle1.js
Enter the circle's radius:
A circle with radius 0 has diameter 0
and circumference 0.
$
```

Exceptions

- See **circle2.js**

```
$ node circle2.js
Enter the circle's radius:
5
A circle with radius 5 has diameter 10
and circumference 31.41592653589793.
$ node circle2.js
Enter the circle's radius:
xyz
Error: Not a number
$ node circle2.js
Enter the circle's radius:
Error: Missing number
$
```

Exceptions

JavaScript standard exceptions:

```
Error  
  EvalError  
  RangeError  
  ReferenceError  
  SyntaxError  
  TypeError  
  URIError  
  AggregateError  
  InternalError
```

https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects

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- **Statements**

Statements

- See **euclidclient1.js**

```
$ node euclidclient1.js
Enter the first integer:
8
Enter the second integer:
12
gcd: 4
lcm: 24
$
```

Statements

Compound statement

```
{  
    statement1;  
    statement2;  
    ...  
}
```

Statements

Variable definition statements

```
let name = expr;  
const name = expr;
```

```
// Pre-ES6  
var name = expr; // name is "hoisted"
```


Aside: Hoisting

```
'use strict';  
...  
function f() {  
    ... // Not OK to use n here.  
    let n = 5;  
    ... // OK to use n here.  
}
```

```
'use strict';  
...  
function f() {  
    ... // OK to use n here.  
    ... // But its value is undefined.  
    var n = 5;  
    ... // OK to use n here.  
}
```

Statements

Function call statement

```
f(expr, expr, ...);
```

return statement

```
return;
```

```
return expr;
```

Statements

if statement

```
if (expr)  
    statement;  
else  
    statement;
```

false, 0, "", '', null, undefined,
NaN mean logical FALSE

Any other value indicates logical TRUE

Statements

while statement

```
while (expr)  
    statement;
```

false, 0, "", ', null, undefined,
NaN mean logical FALSE

Any other value indicates logical TRUE

Statements

do...while statement

```
do  
    statement;  
while (expr);
```

false, 0, "", '', null, undefined,
NaN mean logical FALSE

Any other value indicates logical TRUE

Statements

for statements (by example)

```
for (let i = 0; i < 10; i++)  
  statement;
```

```
for (let i = 0; i < someArray.length; i++)  
  ...someArray[i]...
```

```
for (let element of someArray)  
  ...element...
```

```
for (let property in someObject)  
  ...property...
```

Statements

break statement

```
break;
```

continue statement

```
continue;
```

Statements

try statement

```
try
    statement;
catch (exception)
    statement;
```

throw statement

```
throw object;
```


Summary

- We have covered:
 - Overview
 - Setup
 - Simple programs
 - Functions
 - Standard library
 - Data types and operators
 - Terminal I/O
 - Exceptions
 - Statements