

Web Programming

JavaScript Part I.

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JavaScript (JS)

- HTML-embedded scripting language
- Client-side
 - Interpreted by the browser
- Event-driven
 - Execution is triggered by user actions
- Has become a fundamental part of web development
 - Today, JavaScript is **used by 92.6% of all websites**
 - Many of the new HTML5 features are exposed through HTML5 JavaScript APIs

JavaScript vs. Java

- JavaScript doesn't have much to do with Java
 - Syntax is almost the same
 - JS variables are dynamically typed (i.e., type cannot be determined before the script is executed)
 - JS objects are dynamic (members and methods of an object can change during execution)
 - OOP model is different (prototypal vs. classical inheritance)

Uses of JS

- To provide programming capability on the client side
 - Note that JS works even when the client is offline!
- To transfer some of the load from the server to the client
- To create highly responsive user interfaces
- To provide dynamic functionality

Outline for today

- Embedding
- Syntax
- Types and variables
- Objects and functions

Embedding

Embedding in HTML

- **Explicit embedding** (inline)

```
<script>  
</script>
```

- **Implicit embedding** (referencing a separate .js file)

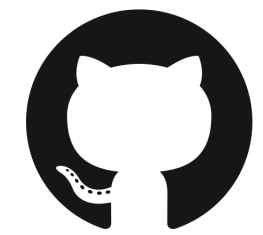
```
<script src="myfile.js"></script>
```

Separate closing tag is needed!
<script src="..." /> will not work!

Execution

- JS in **<head>**
 - Executed as soon as the browser parses the head, before it has parsed the rest of the page
- JS in **<body>**
 - Executed when the browser parses the body (from top to down)

Exercises #1



[github.com/dat310-spring21/course-info/tree/master/
exercises/js/basics](https://github.com/dat310-spring21/course-info/tree/master/exercises/js/basics)

Syntax

General syntax

- Much like Java
- JS is **case-sensitive!**
- Reserved words
 - **function, if, this, return, let, cont, ...**
 - See the full list at http://www.w3schools.com/js/js_reserved.asp
- Comments

```
// single line comment
```

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

Syntax (best practice)

- Each statement is in a separate line, terminated with a semicolon
- No semicolon after }
- Indentation!

Control statements - if

```
if (a > b) {  
    document.write("a is greater than b");  
}  
else {  
    document.write("b is greater than a");  
}
```

- Conditional (ternary) operator

```
let voteable = (age < 18) ? "Too young" : "Old enough";
```

Control statements - switch

```
switch (color) {  
    case "red":  
        // do something  
        break;  
    case "green":  
        // do something else  
        break;  
    default:  
        // default case  
}
```

Control statements - loops

```
for (let i = 0; i < 10; i++) {  
    document.writeln(i);  
}
```

```
let i = 0;  
while (i < 10) {  
    document.writeln(i);  
    i++;  
}
```

Break and continue

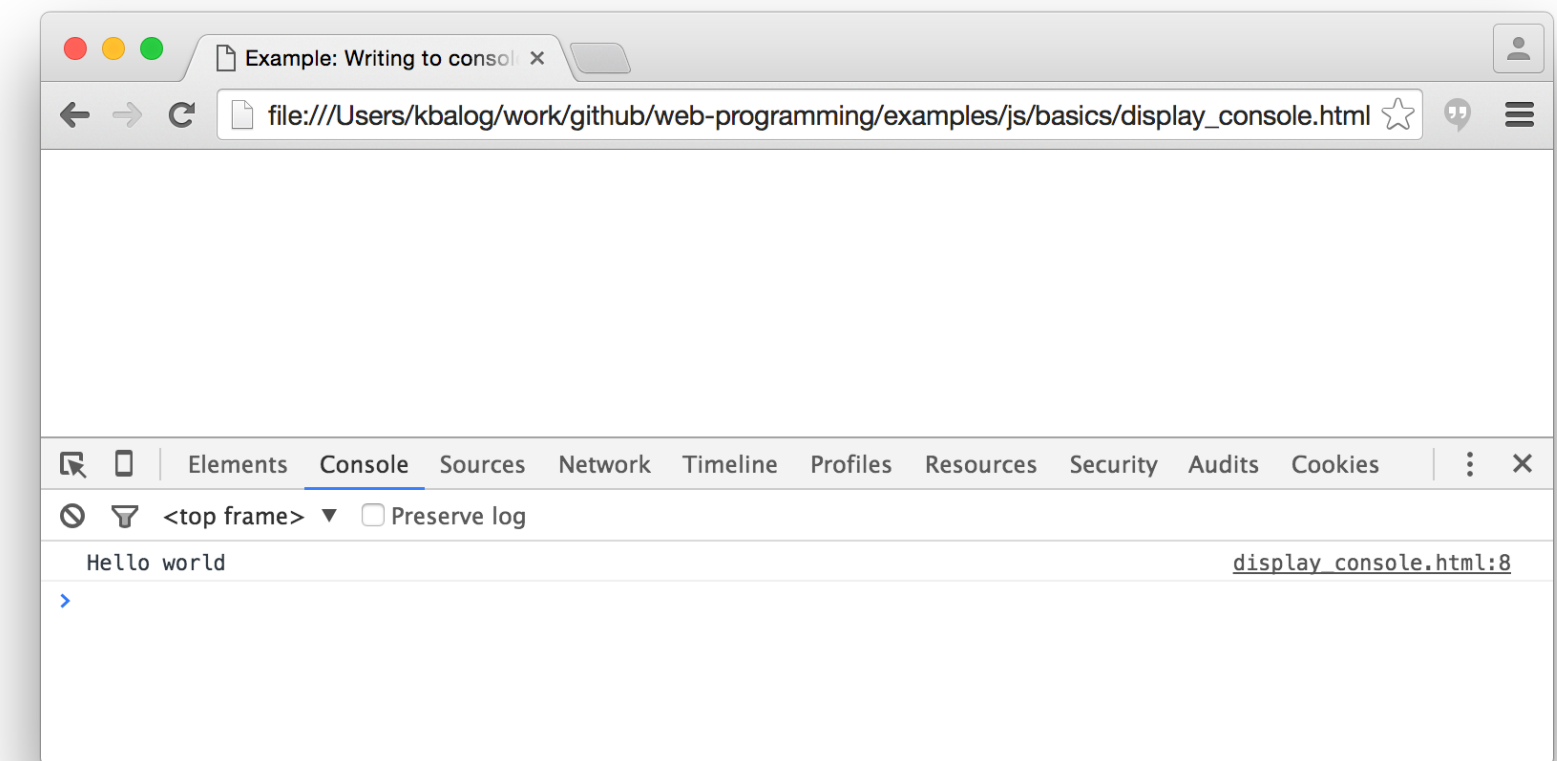
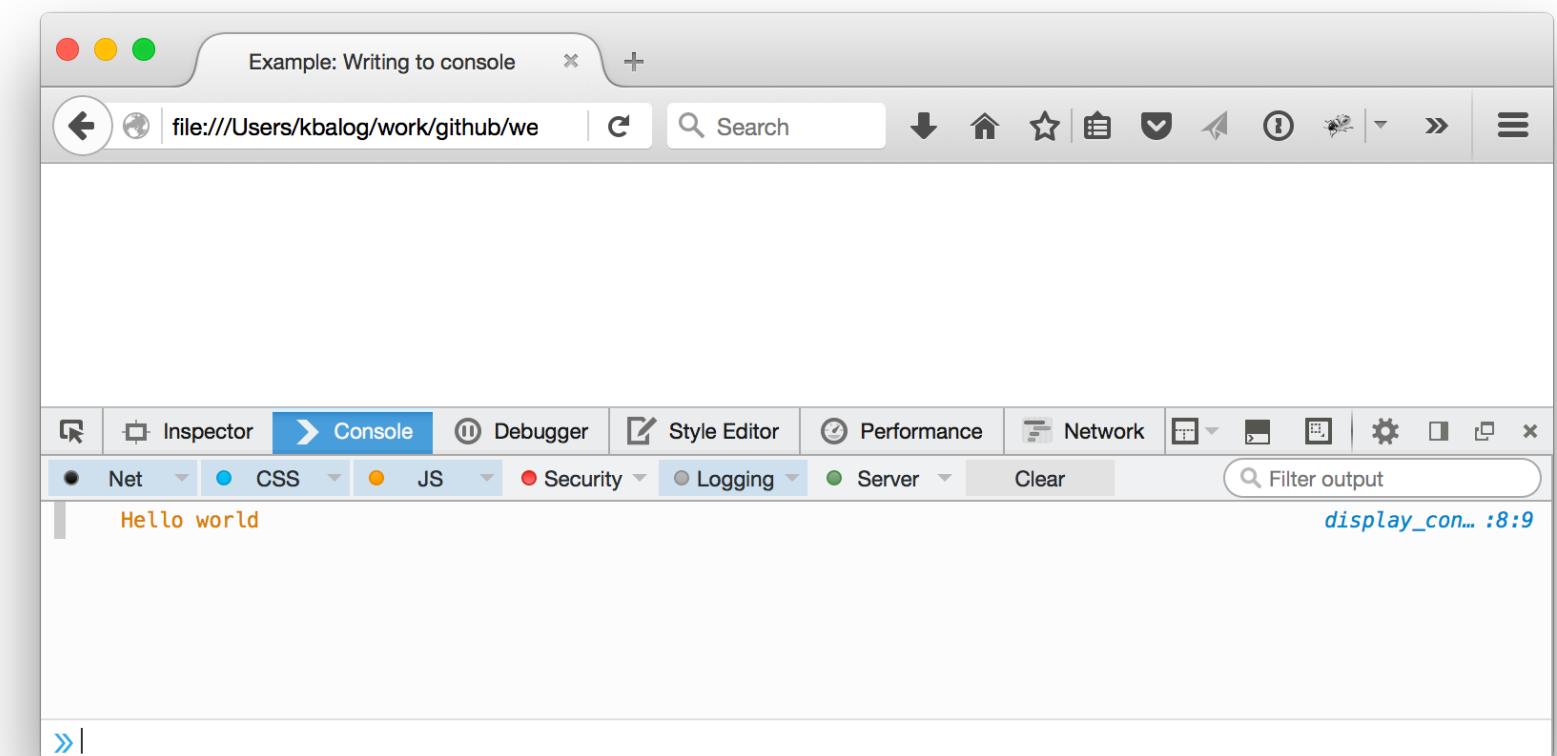
- They work the same way as in Java
- **break;** "jumps out" of a loop
- **continue;** "jumps over" one iteration in the loop

Display possibilities

- JS can "display" data in different ways:
 - Writing into the browser console, using **console.log()**
 - Writing into an alert box, using **window.alert()**
 - Writing into the HTML output using **document.write()**
 - Writing into an HTML element, using **innerHTML**
 - Setting the value of a HTML form element using **element.value**

Where to find the console?

- Firefox
 - Tools/Web Developer/Web console
- Chrome
 - View/Developer/JavaScript console
- Internet Explorer (IE9+)
 - Developer Tools



Exercises #2 (#2b)



[github.com/dat310-spring21/course-info/tree/master/](https://github.com/dat310-spring21/course-info/tree/master/exercises/js/basics)
exercises/js/basics

Types & variables

Declaring variables

- **Explicitly**, using a declaration statement (recommended)

```
let name = "John";
```

- Or

```
var name = "John";
```

Can behave unexpected.

Check https://www.w3schools.com/js/js_let.asp

- **Implicitly**, by assigning it a value (avoid this)

```
name = "John";
```

- JS is loosely typed
 - Type is determined by the interpreter
 - A variable can change its data type

Variable names

- Can contain letters, digits, underscores, and dollar signs
- Must begin with a letter (or \$ or _)
- Variable names are case sensitive!
- Reserved words cannot be used
- Variable naming conventions
 - Use camelCase
 - Variables that begin with \$ are usually reserved for JavaScript libraries
 - Don't start variables with _ unless you have a very good reason to do so (you'll know if you do)

Primitive types

- number
 - **123**, **1.23**, **1.e2**
- string
 - **"John"**, **'August'**
- boolean
 - **true**, **false**
- null
 - **null** (reserved word) — represents "no value"
- undefined
 - variable explicitly defined, but not assigned a value

Data types

- Can contain values
 - string
 - number
 - boolean
 - object
 - function
- Cannot contain values
 - null
 - undefined

The **typeof** operator

- The **typeof** operator can be used to find the data type of a JavaScript variable

```
typeof "John"           // Returns string
typeof 3.14              // Returns number
typeof NaN               // Returns number
typeof false            // Returns boolean
typeof [1,2,3,4]         // Returns object
typeof {name: 'John', age: 34} // Returns object
typeof new Date()        // Returns object
typeof function () {}   // Returns function
typeof myCar             // Returns undefined (if myCar is not declared)
typeof null              // Returns object
```

Implicit type conversions

- Interpreter performs several different implicit type conversions (called *coercions*)
 - When JavaScript tries to operate on a "wrong" data type, it will try to convert the value to a "right" type

```
"August" + 1997 // returns "August1997"  
1997 + "August" // returns "1997August"
```

- The result is not always what you would expect

```
5 + null // returns 5           because null is converted to 0  
"5" + null // returns "5null"  because null is converted to "null"  
"5" + 2 // returns 52          because 2 is converted to "2"  
"5" - 2 // returns 3           because "5" is converted to 5  
"5" * "2" // returns 10        because "5" and "2" are converted to 5 and 2
```

== VS. ===

- Using == (or !=) type coercion will occur
 - This can bring unpredictable results

```
99 == "99"      // true
0 == false      // true
'\n\n\n' == 0    // true
'\n\n\n' == 0    // true
```

- Using === (or !==) type coercion will never occur (recommended)
 - Exact comparison of the actual values

```
99 === "99"     // false
0 === false     // false
'\n\n\n' === 0   // false
'\n\n\n' === 0   // false
```

Predefined objects

- Primitive data types with values can also be objects
 - number => Number
 - string => String
 - boolean => Boolean
- JS coerces between primitive type values and objects
- Don't create Number/String/Boolean objects!
 - Slows down execution speed and complicates the code.

Explicit type conversions

- Typically needed between strings and numbers
- Numbers to strings
 - Using the constructor of the String class

```
var num = 6;  
var str = String(num);
```

- Using the toString() method of the Number class

```
var num = 6;  
var str = num.toString();
```

Explicit type conversions (2)

- Strings to numbers
 - Using the constructor of the Number class

```
let str = "153";  
let num = Number(str);
```

- Using the **parseInt()** or **parseFloat()** global functions

```
let num1 = parseInt("10");  
let num2 = parseFloat("10.33");
```

Operators

https://www.w3schools.com/jsref/jsref_operators.asp

- Comparison
 - `==` (`===`), `!=` (`!==`), `<`, `>`, `<=`, `>=`
- Boolean operators
 - `&&`, `||` (short-circuit)
- Numeric operators
 - `+`, `-`, `*`, `/`, `%`, `++`, `--`
- Bitwise operators
 - `&`, `|`, `~`, `^`, `<<`, `>>`
- String concatenation

```
let str = "two " + "words";
```

- Mind that `+` is addition for numbers and concatenation for strings!

Variable scope

- **global vs. local**
 - within a function, local variables take precedence over global ones
- implicitly declared => global scope
- explicitly declared (with **let** or **var**)
 - outside function definitions => global scope
 - within function definitions => local scope
- Best practice: avoid global variables

Objects & functions

Functions

```
function addOne(num) {  
    return num + 1;  
}  
  
console.log(addOne(3));
```

Functions (2)

- Functions can also be assigned to variables or passed as parameters

```
let plusOne = addOne;  
let result = plusOne(1);    // 2  
  
function op(operation, value) {  
    return operation(value);  
}  
let result2 = op(addOne, 3);    // 4
```

- Nesting functions definitions is possible, but not recommended

Exercise #3 (#3b)



[github.com/dat310-spring21/course-info/tree/master/
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Objects

- Objects can be created ad hoc

```
let mydog = {  
  name: "Tiffy",  
  weight: 3.4,  
  breed: "mixed"  
}
```

- Accessing object properties
 - Can use `objectName.property` or `objectName["property"]`

```
mydog.weight = 3.5;    // assign new weight  
mydog["weight"] = 3.5; // does the same
```

- Can use variable

```
let property = "weight";  
mydog[property] = 3.5; // does the same
```

Object properties

- Properties are dynamic
 - Can be added/deleted any time during interpretation

```
mydog.age = 12;           // adding an age prop.  
delete mydog.weight;    // deleting weight pr.
```

- Checking if a property exists

```
mydog.hasOwnProperty("name") // true
```

- Listing properties

```
for (let prop in mydog) {  
    console.log(prop + ": " + mydog[prop]);  
}
```

Objects: functions as properties

- Objects can be created ad hoc

```
mydog.bark = function() {  
    console.log(this.name + ": Wov!")  
}  
  
mydog.bark();    // prints Tiffy: Wov!
```

Prototypal vs. Classical OOP

- Classical OOP (Java, C++, etc.): objects are created by instantiating classes
- Prototypal inheritance (JS): there are no classes, only objects; generalizations are called prototypes
 - It's simple and dynamic; better for dynamic languages
 - However, JS uses the constructor pattern of prototypal inheritance
 - This was to make it look more like Java, but can be confusing

Object prototypes

- Every JS object has a **prototype**
 - Objects inherit their properties and methods from their prototype
 - The prototype is also an object

- Creating an object prototype

- Using an object constructor function

```
function Dog(name, weight, breed) {  
    this.name = name;  
    this.weight = weight;  
    this.breed = breed;  
}
```

- Then use the **new** keyword to create new objects from this prototype

```
let mydog = new Dog("Tiffy", 3.4, "mixed");
```

Object vs. prototype properties

- New properties can be added to an existing prototype using the **prototype** property
 - All Dog objects will have a gender property

```
Dog.prototype.gender = "unknown";
```

- Vs. adding a new property to a specific object
 - Only the mydog instance will have the gender property

```
mydog.gender = "unknown";
```

Object methods

- Methods can be added by assigning a function to a property
 - Inside the constructor

```
function Dog(...) {  
    ...  
    this.info = function() {  
        console.log("name:  " + this.name);  
        console.log("weight: " + this.weight);  
        console.log("breed:  " + this.breed);  
    };  
}
```

- Or using the **prototype** property

```
Dog.prototype.info = function() {  
    ...  
};
```

Alternatively

- To reuse code and avoid nested functions

```
function printInfo() {  
    console.log("name: " + this.name);  
    console.log("weight: " + this.weight);  
    console.log("breed: " + this.breed);  
}
```

```
function Dog(...) {  
    ...  
    this.info = printInfo;  
}
```

- Or

```
Dog.prototype.info = printInfo;
```

Alternatively using Class

```
function Dog(name, weight, breed) {  
  this.name = name;  
  this.weight = weight;  
  this.breed = breed;  
  this.info = function {  
    console.log("name: " + this.name);  
    ...  
  };  
}
```

```
class Dog {  
  constructor(name, weight, breed){  
    this.name = name;  
    this.weight = weight;  
    this.breed = breed;  
  }  
  // method  
  info() {  
    console.log("name: " + this.name);  
    ...  
  };  
}
```

The instanceof operator

- The **instanceof** operator returns true if an object is created by a given constructor

```
var cars = ["Saab", "Volvo", "BMW"];

cars instanceof Array;           // Returns true
cars instanceof Object;          // Returns true
cars instanceof String;          // Returns false
cars instanceof Number;          // Returns false
```

Exercise #4



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Built-in objects

- Number
- Math
- Array
- String
- Date

The Number object

http://www.w3schools.com/jsref/jsref_obj_number.asp

- Properties
 - Constant values: **Number.MIN_VALUE**, **Number.MAX_VALUE**
- Methods
 - **toString()** — converts to String

```
let num = 6;  
let str = num.toString();
```

The Math object

http://www.w3schools.com/jsref/jsref_obj_math.asp

- Properties
 - Constant values: **Math.PI**
- Methods (call them using **Math.**)
 - **abs(x)** — absolute value
 - **round(x)**, **ceil(x)**, **floor(x)** — rounding
 - **min(x,y,z...)**, **max(x,y,z...)** — min/max value
 - **random()** — random number between 0 and 1
 - **sin(x)**, **cos(x)**, **exp(x)**, ...

The Array object

http://www.w3schools.com/jsref/jsref_obj_array.asp

- Creating

- Using the new keyword

```
let emptyArray = new Array();  
let fruits = new Array("orange", "apple");
```

- Using the array literal (recommended)

```
let emptyArray = [];  
let fruits = ["orange", "apple"];
```

- Properties

- **length** — sets or returns the number of elements
 - only the assigned elements actually occupy space

The Array object (2)

- Methods
 - **join(x,y,...)** — joins two or more arrays
 - **indexOf(x)**, **lastIndexOf(x)** — search for an element and return its position
 - **pop()**, **push(x)** — remove/add element to/from the end of the array
 - **shift()**, **unshift(x)** — remove/add element to/from the beginning of the array
 - **sort()** — sorts the elements
 - **reverse()** — reverses the order of elements
 - **concat(x)** — joins all elements into a string

Array example

```
function printArray(arr) {  
    for (let i = 0; i < arr.length; i++) { // alternative for (var i of arr) {  
        document.write(arr[i] + "<br />");  
    }  
}  
  
let fruits1 = ["orange", "apple"];  
let fruits2 = ["banana", "mango"];  
fruits = fruits1.concat(fruits2); // create a new array by concatenating 2 arrays  
printArray(fruits);  
  
let last = fruits.pop(); // remove last element (mango)  
fruits.push("kiwi"); // add a new element to the end of the array  
fruits.sort(); // sort array  
printArray(fruits);
```

Array iteration

```
// for loop with index integers
for (let i = 0; i < arr.length; i++) {
    document.write(arr[i] + "<br />");
}

// using for element of syntax
for (let element of arr) { // array elements, instead of index
    document.write(element + "<br />");
}

// using forEach
arr.forEach( // pass a function that will be applied to every element
    function(element){
        document.write(element + "<br />");
    }
);
```

The String object

http://www.w3schools.com/jsref/jsref_obj_string.asp

- Properties
 - **length** — length of the string
- Methods
 - **charAt(x)** — returns character at a given position
 - can also use `"Hello"[2]; // gives l`
 - **indexOf(x), lastIndexOf(x)** — search for a substring, return its position
 - **substr(x,y)** — extracts substring
 - **replace(x,y)** — replaces substring
 - **trim()** — removes whitespaces from both ends of a string

The Date object

http://www.w3schools.com/jsref/jsref_obj_date.asp

- Different ways to instantiate:

```
let today = new Date(); // current date  
let dt = new Date(2013, 10, 09); // 2013-10-09
```

- Get day, month, year, etc.
 - **dt.getDay(), dt.getMonth(), dt.getYear()**
- Compare two dates

```
if (dt1 > dt2) {...}
```

- Set date

```
let dt2 = new Date();  
dt2.setDate(dt2.getDate() + 5); // 5 days into the future
```


Exercises #5, #6 (#6b)



[github.com/dat310-spring21/course-info/tree/master/
exercises/js/basics](https://github.com/dat310-spring21/course-info/tree/master/exercises/js/basics)

Best practices

- Avoid global variables
- Put variable declarations at the top of each script or function
- Initialize variables when declaring them
- Treat numbers, strings, or booleans as primitive values, not as objects
- Use `[]` instead of `new Array()`
- Beware of automatic type conversions
- Use `===` comparison
- Use strict mode `"use strict";`
 - Add `"use strict";` in top of script

References

- W3C JavaScript and HTML DOM reference
<http://www.w3schools.com/jsref/default.asp>
- W3C JS School
<http://www.w3schools.com/js/default.asp>
- Mozilla JavaScript reference
<https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference>