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
  - Many of the HTML5 features are exposed through HTML5 JavaScript APIs

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/dat310-2023/info/tree/master/
exercises/js/basics

Syntax

General syntax

- 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
*/
```

General syntax

- Semicolon **;** after each statement (line).
- Curly braces **{ }** for blocks:

Python

```
if x < 5:
    y = y + x
    x = x + 1
```

JavaScript

```
if (x < 5) {
    y = y + x;
    x = x + 1;
}
```

Syntax (best practice)

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

Control statements - if

Condition within paranthesis **()**

```
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";
```

Condition within paranthesis **()**

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

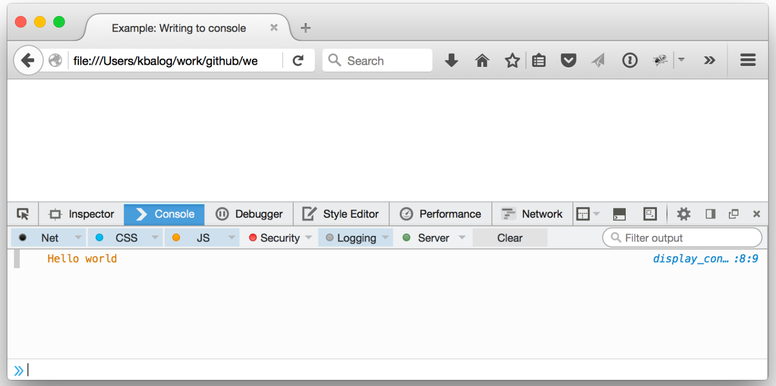
- They work the same way as in Java
- **`break;`** "jumps out" of a loop
- **`continue;`** "jumps over" one iteration in the loop

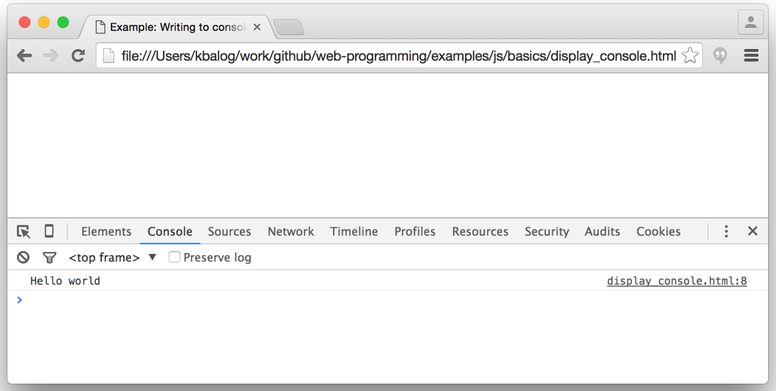
Display possibilities

- 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/dat310-2023/info/tree/master/
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
' ' == 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
' ' === 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

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

  - Using the toString() method of the Number class

```
let num = 6;
let 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)

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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 varible

```
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

- Functions can be added as properties

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

mydog.bark();   // prints Tiffy: Wov!
```

Classes

- Classes
  can be defined with constructor and methods.

```
class Dog {
    constructor(name, weight, breed) {
        this.name = name;
        this.weight = weight;
        this.breed = breed;
    }
    call(){
       console.log(this.name);
    }
 }
```

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

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

Classes

Declare fields.

```
class Dog {
    name;
    weight;
    breed;
    constructor(name, weight, breed) {
        this.name = name;
        this.weight = weight;
        this.breed = breed;
    }
    call(){
       console.log(this.name);
    }
 }
```

Classes

```
class Dog {
    #privatename;
    weight;
    breed;
    constructor(name, weight, breed) {
        this.#privatename = name;
        this.weight = weight;
        this.breed = breed;
    }
    #privatecall(){
        console.log(this.#privatename);}
    call(){ this.#privatecall(); }
 }
```

Private field.

Private method.

- Private fields and methods are prefixed with **#.**
- Private fields need to be declared.

Classes

- Classes
  have other features of Object oriented programming:
- Inheritance
- Static fields
- Static methods
- Getters
- Setters

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

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 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);
```

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)

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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