CS6

Practical System Skills

Fall 2019 edition

Leonhard Spiegelberg
lspiegel@cs.brown.edu

18 Javascript/JSON

CS6 Practical System Skills

Fall 2019

Leonhard Spiegelberg *lspiegel@cs.brown.edu*

18.01 History of Javascript

⇒ created by Brendan Eich in 1995 for Netscape Navigator

⇒ positioned originally as web "companion" for Java, though there is no connection between Java and Javascript

⇒ scripting language for webpages

—> typically used to manipulate documents on the client-side, i.e. javascript allows client-side computing.

—> also used for server-side scripting (node.js + more)

18.02 The big picture

HTML
content

specify content with tags, e.g.

```
<p>this is a
<b>bold</b>
statement</p>
```

CSS
presentation

rules to style the content

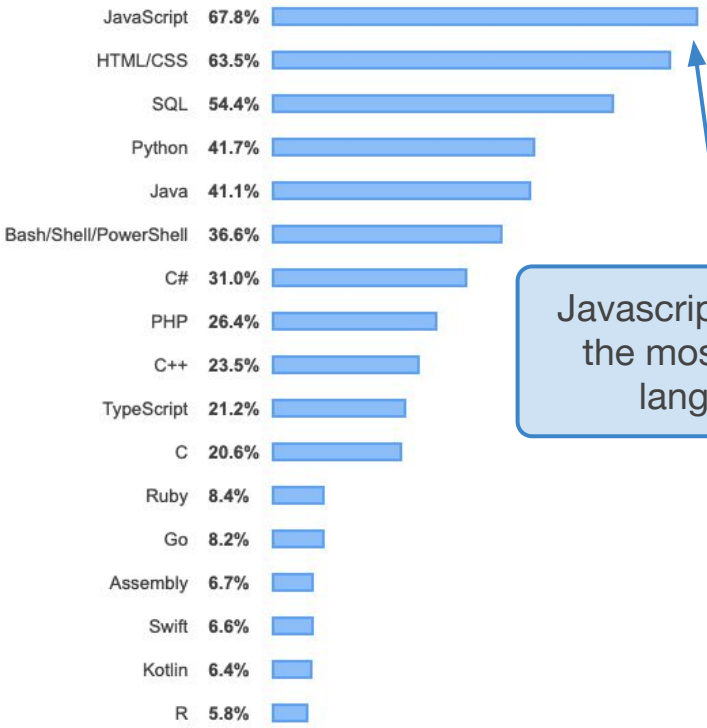
```
p { color: red; }
```

Javascript
behavior

run logic to change content/presentation dynamically

```
alert("Hi!");
```

18.02 Why bother to learn another language?



Javascript is among the most popular languages

Rank	Language	Type	Score
1	Python		100.0
2	Java		96.3
3	C		94.4
4	C++		87.5
5	R		81.5
6	JavaScript		79.4
7	C#		74.5
8	Matlab		70.6
9	Swift		69.1
10	Go		68.0

Stackoverflow 2019 survey
https://insights.stackoverflow.com/survey/2019#overview

IEEE Spectrum 2019 survey
https://spectrum.ieee.org/computing/software/the-top-programming-languages-2019

18.02 Resources for Javascript

Book:

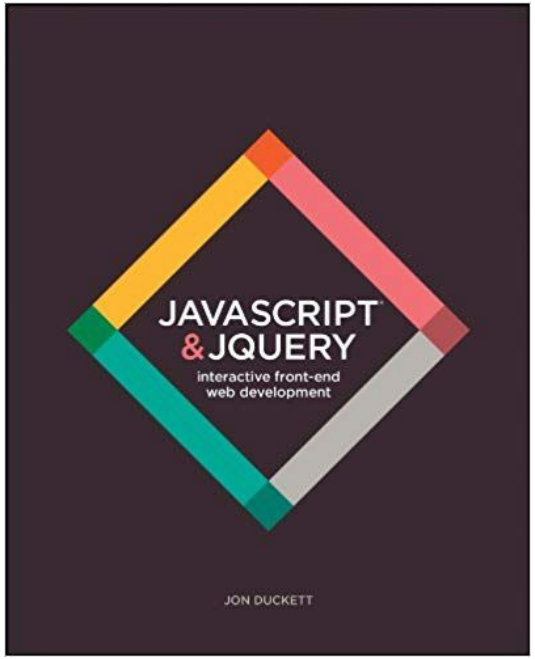
Duckett, Jon, Gilles Ruppert, and Jack Moore. *JavaScript & jQuery : interactive front-end web development.* Indianapolis, IN: Wiley, 2014. Print.

Today: Chapters 1-8

Web:

developer.mozilla.org/en-US/docs/Web/JavaScript

javascript.info



18.02 How to work with Javascript

⇒ Chrome/Firefox/Safari have a built-in Javascript console that can be used to execute/develop code in a REPL:

	Mac	Win
Chrome	`Cmd + Opt + J`	`Ctrl + Shift + J`
Firefox	`Cmd + Opt + K`	`Ctrl + Shift + K`
Safari	`Cmd + Opt + C`	

⇒ very useful for developing small snippets are online services like jsfiddle.net or codepen.io/pen/

18.02 Basic Javascript

⇒ Javascript is a weakly typed dynamic language similar to Python

⇒ C-like statements (optionally) terminated with ;

⇒ boolean expressions with `true`/`false` and `&&` / `||`

⇒ increment `++` and decrement `--` operators

⇒ C-like comments using `//` or `/* … */`

```
1 + 3
4 * (5 - 3) ** 3
"There are " + 26 + " letters"
true && ("hello" > 'world')
10 & 3
```

no casting of 26 to string necessary

18.02 Hello world in Javascript

⇒ To write Javascript code as part of a HTML page,
you have the following options:

1. embedded, write (similar to style tags for CSS) code within `<script>....</script>` tags

2. external scripts, i.e. put JavaScript code into a separate file and include it via `<script src="<path"></script>`

Note: code within tags will be ignored if src is given...

⇒ you can add as many script tags to a HTML page as you like!

18.02 Where to place javascript file?

⇒ script tag can be placed

1. in the `head` section
2. in the `body` section
3. after the `</body>` tag (i.e. before `</html>`)

⇒ position of the script tags in the document determines when the script is executed.

—> **Best practice:** Include scripts in head, page specific code in body

18.02 Hello world in Javascript

⇒ we can output "Hello world" via `document.write(...)`

```
<!DOCTYPE html>
<html lang="en" dir="ltr">
  <head>
    <meta charset="utf-8">
    <title>Hello world with Javascript</title>
    <script type="text/javascript">
      document.write("Hello world");
    </script>
  </head>
  <body>
  </body>
</html>
```

You often see `type="text/javascript"` or `language="javascript"`. Not necessary anymore though, default scripting language is JavaScript.

18.03 Javascript variables

⇒ you can define variables using the following keywords in Javascript:

1. `let message = "Hello world"`
2. `const message = "Hello world"` (constant)
3. `var message = "Hello world"` (old style, don't use)
4. `message = "Hello world"` (implicit global, don't use)

⇒ variable names must only contain alphanumeric characters, $ or _. The first character must not be a digit.

—> I.e. `$ = 20` is legal JavaScript! We'll see this when working with jQuery.

18.04 Javascript functions

⇒ Functions are first-class objects in Javascript. They can be declared using the `function` keyword or as lambda/anonymous functions , e.g. via `=>`.

```
function sum(a, b) {
  return a + b;
}

// function expression, assign to diff identifier
let diff = function(a, b) { return a - b; }

// you can either use an expression or a sequence of statements in { ... }
let pow = (a, b) => a ** b

let x = 10
const y = 42

document.write(sum(x, sum(y, 1) + diff(y, x) * pow(2, 3)))
```

18.05 var vs. let

⇒ Prefer to use `let`. There's a subtle difference in `var`/`let`: `let` declares block variables, i.e. they can be only accessed in the scope where they were declared. var declares global variables at function-level. (details e.g. on https://javascript.info/var).

```
{
  let message = "hello world";
}
document.write(message); // Uncaught ReferenceError: message is not defined

{
  var message = "hello world";
}
document.write(message) // works
```

18.06 Control structures

⇒ JavaScript has C-like control structures: `for`/`while`/`if`

```
for(let i = 0; i < 5; i++) {
  document.write(i * i + '<br>')
}

let counter = 0;
while(counter < 10) {
  console.log(counter)
  counter += 2
}

if(counter == 10)
  document.write('counter is 10')
else
  document.write('counter is not 10')
```

output to console

18.07 String formatting in Javascript

⇒ There's no builtin sprintf / format, however you can create strings using Javascript's implicit string conversions or via the toString method for each object.

⇒ to convert a string object to int or float type use

`parseInt` / `parseFloat` or constructors `Boolean` / `Number`

18.08 Arrays in Javascript

⇒ Arrays can be declared using `[...]` similar to Python.

```
let arr = [1, 2, 3, 4, 5, 'hello']

arr.length

arr[3] // 0, ..., length-1 indices are allowed

arr[1] = 42

arr.concat([1, 2, 3])
```

18.09 Javascript Objects

⇒ Everything in Javascript is an object. An object can have one or more properties to which a value can be assigned to.

```
let hotel = new Object(); // create new, empty object

hotel.name = 'Quay'
hotel.rooms = 40
hotel.booked = 25

hotel.checkAvailability = function() { return this.rooms -
this.booked; }

hotel.rooms          // access rooms via . syntax
hotel['rooms']       // or via [key]

delete hotel.name    // remove property from object

hotel.stars = 5      // add new property
hotel['stars'] = 5   // alternative
```

18.09 Javascript Objects

⇒ Instead of assigning properties in statements, Objects can be also constructed using literal syntax:

```
let user = {name: 'Tux',
            profession: 'penguin',
            age: 30}
```

Note: This also works with functions!

18.09 Javascript Objects - Constructor

⇒ to define custom structures/objects, a constructor syntax can be used:

```
function Hotel(name, rooms, booked) {
    this.name = name;
    this.rooms = rooms;
    this.booked = booked;
    this.checkAvailability = function() {
        return this.rooms - this.booked;
    };
}


// use constructor
let quayHotel = new Hotel('Quay', 40, 25);
let parkHotel = new Hotel('Park', 120, 77);
```

DOM manipulation

18.10 DOM manipulation using Javascript

DOM = Document Object Model, every element in a HTML page is represented as Object that can be manipulated

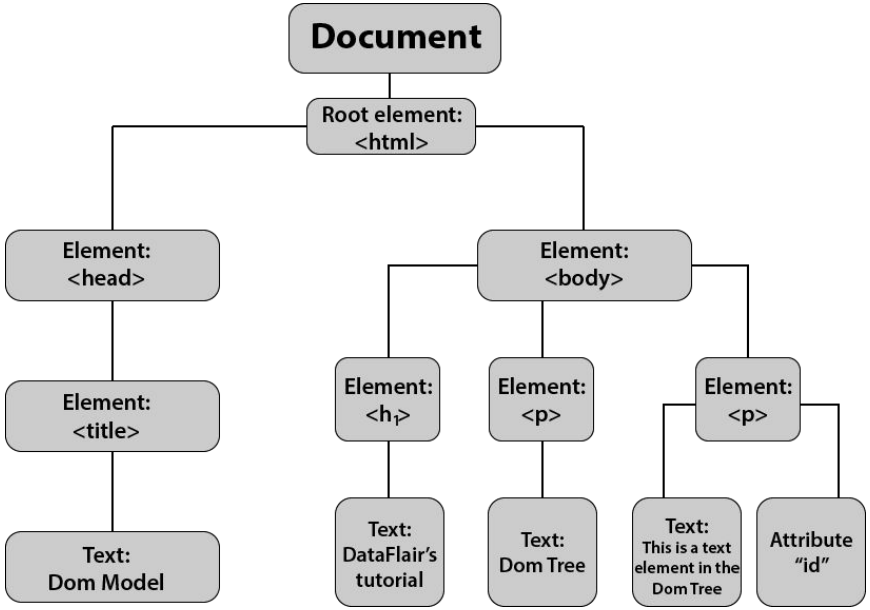
⇒ the objects are organized as nodes in a tree, the DOM-tree

⇒ via Javascript nodes can be added, altered, removed

⇒ root node is `document`

18.10 DOM tree example

```
<html>
  <head>
    <title>DOM Model</title>
  </head>
  <body>
    <h1>DataFlair's Tutorial</h1>
    <p>DOM Tree</p>
    <p id = "text">This is a text
element in the DOM tree.</p>
  </body>
</html>
```



Example taken from: https://data-flair.training/blogs/javascript-dom/

18.10 Basic DOM manipulation

⇒ Javascript provides several functions to create & place nodes

Example:

```
let paragraph = document.createElement("p");

let content = document.createTextNode("This is some text the
paragraph contains....");

paragraph.appendChild(content);

// append paragraph tag after body tag
document.body.appendChild(paragraph);
```

18.10 Javascript DOM functions

accessing/finding elements	creating elements/manipulating element	manipulating the tree

`document.getElementById(id)`
`document.getElementsByTagName (name)`
`document.querySelector(selector)`
`document.querySelectorAll(selector)`
	`document.createElement (name)`
	`parentNode.appendChild (node)`
	`element.innerHTML`
	`element.style.left`
	`element.setAttribute ()`
	`element.getAttribute ()`
	`element.addEventListener ()`
		`parentNode.appendChild (node)`
		`parentNode.remove Child (node)`
		`parentNode.replace Child (old, new)`

A great resource for this is: https://developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model/Introduction

18.11 Javascript event handlers

⇒ Nodes in the DOM tree can have event handlers to specific events assigned. I.e. if a certain event happens, some code is executed.

⇒ The general syntax is `<element event="some code">`

—> `element` is some HTML tag

—> `event` is one specific event type, e.g. `onload, onclick, …`

⇒ complete list of events is available at https://developer.mozilla.org/en-US/docs/Web/Events

⇒ alternatively, an event handler can be assigned directly via e.g. `node.onload = …` or via `addEventListener`

18.11 Javascript DOM events example

```
<button id="btn" onclick="click_btn();">Click me!</button>
<p id="btn-target"></p>
<span>Some text...</span>

<script type="text/javascript">
    function click_btn() {
      let p = document.getElementById("btn-target");
      p.textContent = "You clicked a button, awesome"
    }

    // add event listener to span elements
    let span = document.querySelector('span')
    span.addEventListener('mouseover', function() {
        this.style.backgroundColor = "#ff0000"; });
    span.addEventListener('mouseout', function() {
        this.style.backgroundColor = "#00ff00"; });
</script>
```

jQuery

18.12 What is jQuery?

⇒ "write less, do more" library

⇒ makes life easier by helping with

- HTML/DOM manipulation
- CSS manipulation
- HTML DOM events
- AJAX (requests!)

⇒ >25% of all websites use jQuery (still).

18.12 Why do we need a library?

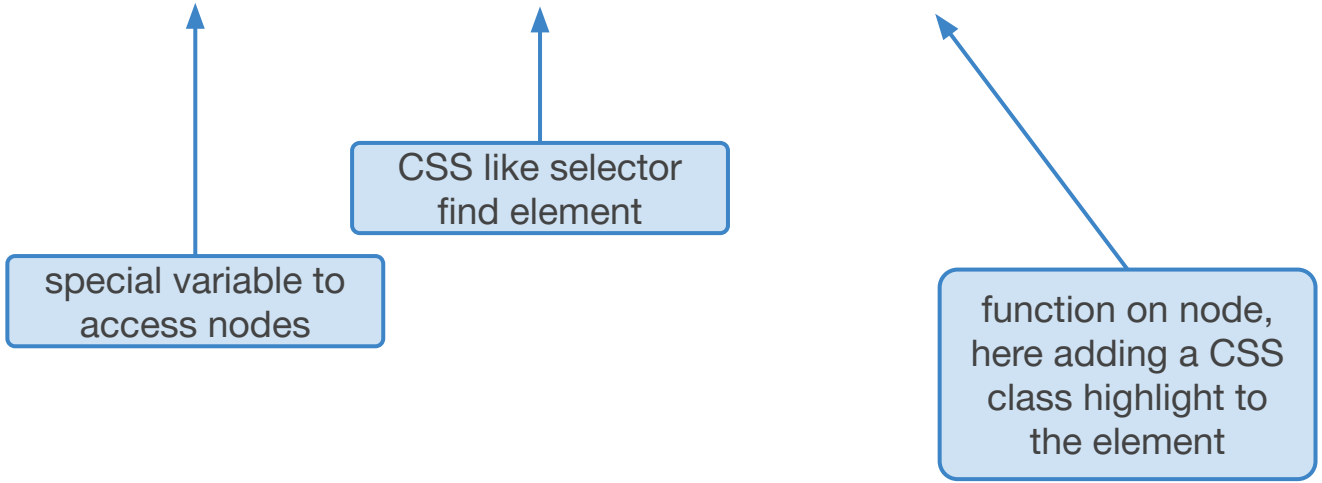
⇒ **Problem:** Browser incompatibility. Versions/Vendors/Devices/…

⇒ There is not one javascript standard, different browsers support and provide different functions.

⇒ jQuery to provide standard interface across browsers.

18.12 Basic jQuery

Basic Usage: `$('#btn-target').addClass('highlight')`



18.12 Where to put jQuery code

⇒ Loading a website might take a while. However, often adding event listeners or manipulating the DOM makes only sense when the website is fully loaded.

⇒ jQuery provides a special `.ready()` method which will execute its argument when the document is "ready"

```
$(document).ready(function() {
// write all code here...
});

// alternative:
$(function() {
// write all code here
});
```

18.13 Basic jQuery methods

⇒ `.html()` allows to retrieve the html of the first matched element, `.html(...)` allows to set the html of the first matched element

⇒ `.text()` / `.text(...)` returns the text content of the element and its children.

⇒ `.before()`/`.after()` allow to insert content before/after an element

⇒ `.prepend()`/`.append()` insert content inside the element

⇒ `.attr(name)` retrieves value of attribute name `.attr(name, value)` allows to update the attribute name with value

⇒ `.addClass(cls)` / `.removeClass(cls)` add/remove CSS class to element.

⇒ `.css(...)` allows to get or change css rules.

Passing data

18.14 Backend vs. Frontend

Backend: what happens on the server side

Frontend: what happens on the local machine (i.e. in the browser)

⇒ We've seen that we can manipulate the DOM tree with Javascript on the client side, i.e. all logic runs in the browser once the script is downloaded.

⇒ How can we pass data from the backend to the frontend?

⇒ How can we request data from the backend?

⇒ In which format shall we pass data?

18.14 Backend meets Frontend and vice versa

⇒ How can we pass data from the backend to the frontend?

HTTP requests! GET/POST/… to an URI and process the response or via templating when generate the intially requested page.

⇒ How can we request data from the backend?

issue HTTP requests via Javascript and process the response

⇒ In which format shall we pass data?

Good question...

18.14 Serialization and Deserialization

⇒ To pass data between two actors, we need to exchange it in some format because each side

- may have a different representation
- has the data scattered in main memory (not in one location)

⇒ Ideally, both actors can convert their representation quickly to the format (serialization) and convert the format quickly to their representation (deserialization)

⇒ Javascript brings a default serialization format called JSON = Javascript Object Notation to the table

18.14 JSON = JavaScript Object Notation

⇒ details under https://www.json.org/

⇒ encode data similar to python dictionaries as

```
{"key" : value, ...}
```

⇒ Arrays via `[...]`

⇒ can be nested

Note: In JSON keys are always strings. Strings need to be always quoted with "! (escape " via \")

Example:

```
{
  "color" : "purple",
  "id" : 210,
  "composition" : {
    "R" : 70,
    "G" : 39,
    "B" : 89
  }
  "names" : ["violet", "lilac"]
}
```

18.14 JSON in Javascript/Python

⇒ Javascript and python both have support for JSON already built in

Javascript

```javascript
let msg = {name: "tux", profession: "penguin", location: 'antarctica'}

// serialize
// yields "{"name":"tux","profession":"penguin","location":"antarctica"}"
let str = JSON.stringify(msg)

// deserialize
// yields {name: "tux", profession: "penguin", location: 'antarctica'}
JSON.parse(str)
```

Python

```python
import json
msg = '{"name":"tux","profession":"penguin","location":"antarctica"}'
# yields {'name': 'tux', 'profession': 'penguin', 'location': 'antarctica'}
user = json.loads(msg)
# yields '{"name": "tux", "profession": "penguin", "location": "antarctica"}'
json.dumps(user)
```

18.14 Connecting via Ajax Requests

Ajax = asynchronous javascript and xml

⇒ allows to make HTTP requests via JavaScript whose response can be used to alter the webpage after the request succeeded.

⇒ easiest to do with jQuery which provides `$.get(...)` and `$.post(...)` functions to perform GET or POST requests.

⇒ Often, requests are made to endpoints which return JSON data (MIME: `application/json`).

⇒ **Next lecture:** RESTful APIs/design - usually based on JSON.

Demo

Examples from today available under github.com/browncs6/JSExamples

End of lecture.

Next class: Tue, 4pm-5:20pm @ CIT 477