

# Computer Programming – CS 6011

## Lecture 11: JavaScript

Fall 2023

- Topics
  - JavaScript
  - Document Object Model (DOM)

# Web page

- HTML: Describes the structure of a web page
- CSS: Describes the styling of a web page

# Web page

- HTML: Describes the structure of a web page
- CSS: Describes the styling of a web page
- JavaScript (JS): Makes the webpage interactive

# Introduction to JavaScript

- While not actually “Java” – the syntax / usage is similar
- Designed to allow programmers to make web pages interactive
- JavaScript:
  - Scripting language
    - No need for a compiler
    - Rendering is handled by the browser
  - Uses mostly objects (in the same way Java does)
  - Garbage collected
  - Recently added “Classes” – but for now we are going to use just ‘basic’ JS

# Dynamic Typing

- Unlike C++/Java, JavaScript variables don't have explicit types!
- Note, values DO have types.
  - "123" is a string
  - 123 is an int
  - true is a Boolean, etc.
- Declaring variables:
  - `let x;` // x is now a variable – note we did not declare a type for it.
  - `let y = 10;`
    - `y = "hello";` // Legal – but DON'T do it!!! Why?
  - `var x;` // Old version – better not to use it.

# Don't use Var, use Let

## Some differences

- `var` has different scoping than `let`
  - `Var` has function scope
  - `Let` has block scope
- Hoisting

```
x = 3
```

```
var x; // Legal to 'declare x' after assigning it (if you use var).  
// Can not do that with let
```

# Data types in JavaScript

- `let varName;`
- `x = 3; // Number`
- `xStr = "hello"; // String`
- `xArray = [ 4, 7.2, "hello" ]; // Array`
  - Notice something different about this type of array?
- `empObj = {};` *// x is an empty object*
- `stdObj = { "name": "John", "gpa": 3.7, "year": 3 }; // Create a "complete" object`



# JavaScript Objects

- Objects in JavaScript are very similar to Maps:
  - Map: A list of `Key` – `Value` pairs.
  - And can be accessed in either of two ways:
    - `myObject.field` // Let's use this one for the most part.
    - `myObject[ 'field' ]`
- Objects have no pre-set structure (no class definition as seen in C++ or Java)
  - And thus (in bad programs), the “same” type of object could have some different fields...

# JavaScript Objects Example

- In C++/Java, we define classes, then create objects from them.
- In JavaScript, it is a little different.

```
let xObj = {}; // xObj is an object – Haven't created a class for xObj  
xObj.someField = 4; // xObj now has a field named "someField".  
console.log(xObj.someField ); // Prints 4 to the CONSOLE!!!
```

- Add a method to object x:

```
xObj.aMethod = function() { console.log( "Hello" ); };  
xObj.aMethod(); // Calls the method (and prints hello).
```

# JavaScript Objects Example

- Note: " " and ' ' mean the same thing in JavaScript: both delimit strings.
- `xObj = {};` // Creates an empty object.
- Approach 1  
`xObj.a = 7;` // Adds a field (member variable) to the object.
- Approach 2  
`xObj[ 'b' ] = "Hello";` // Adds another field.
- `xObj.a == xObj[ 'a' ] == 7` // Two ways to access the a field that is in x.
- `xObj.b == xObj[ 'b' ] == "Hello"` // True
- If you know your fields ahead of time, you can create an object literal like this:  
`xObj = { a: 7, b: "Hello" };`

# JSON

- JavaScript Object Notation (JSON)

```
{ a: 4, b: "Hello", "2" : "two" }
```

- Used to represent objects and pass them (their data) around in many different applications.
- Exchanging structured data
  - Write it to / read it from disk
  - Across the network (Typically between a server and web applications)

# JSON Example

- Comments `//` are NOT allowed in JSON. Below are just for informational purposes!!!

```
{  
  "book": [ // <- Notice the [ (square bracket)... what does it mean?  
    {      // [ ] means array... so this is an array of what?  
      "id": "444",           // The { } means object, so an array of objects...  
      "language": "C",      // id, language, edition, author are all what?  
      "edition": "First",   // Fields of the object.  
      "author": "Dennis Ritchie"  
    },  
    {  
      "id": "555",  
      "language": "C++",  
      "edition": "second",  
      "author": "Bjarne Stroustrup"  
    }  
  ]  
}
```

- To use the above JSON, it would be written as a String (surrounded with “ ”).

# Methods

- How do we add a method to an object?
  - Add a new field to the object (where the field is a function):

```
let myObj = { };  
myObj.methodX = function( a, b ) { ... }
```

- Methods are treated the same way as member variables (fields) – you just add them to your object.
  - Note: just like variable types in JavaScript, you don't specify function (return) types (or parameter types).

# More JS syntax

- `this`
  - The current object
  - Print out the value of `this` to see which object you are currently working with
- for each loops
  - `for( let prop in obj )` // Iterate through the *properties* of an object.
  - `for( let val of array )` // Iterate through the items in an array.
  - `for( let i = 0; i < arr.length; i++ )` // Can also use normal for loop.
- `3 == '3'` // true – JS tries to convert things to match
  - `3 === '3'` // false – strict equality (probably should just use this)

# More JS syntax

- In JavaScript, Strings are compared using ==

```
let s1 = "hello"  
let s2 = "hello"  
s1 == s2 // true
```

- Create constants using:

```
const MAX_NUMBER = 1000;
```

- String or Number?

- `let x = Math.random().toFixed( 2 ); // x => 0.35`

- In the above case, x is a string, NOT a number, so:

- `x += 10;` The result would be: **0.3510**

- `x = Number( x ); // Turn x back into a number.`



# JavaScript Functions

- JS Functions are similar to C++ functions (with a couple of differences).

## 1) Declare/Define a function:

```
function myFunctionName( param1, param2 ) { ... }
```

## 2) Create a function and store it in a variable:

```
let myFunctionName = function( param1, param2 ) { ... }
```

- What differences do you see in the above function declarations vs a Java/C++ function declaration?
  - Parameters do not have a type specified.
  - The return type is not listed.
  - Can create a variable of type “function” directly.
  - We can store functions in variables!
- Functions can be defined anywhere – including within other functions.

# Passing Function Parameters

```
function doit( x, y, z ) {  
}
```

- Calling doit

```
doit( 1 )  
doit( 1, 2 );  
doit( 1, 2, 3 );
```

- All valid ways to call `doit`... however, `y` and `z` will be *undefined* if not passed in.
- Very flexible
- Note: *arguments* is a hidden variable that is an array of parameters passed to the function.
  - `x == arguments[ 0 ]`

# Example

```
function doit( x1, x2, x3 ) {  
    console.log( arguments.length );  
    console.log( arguments[0] );  
    console.log( x2 );  
}
```

- `doit( 99 )` displays:

`1`

`99`

`undefined // Kind of null.`

# Using “use strict”

- “use strict”; // At the beginning of your script! Note: “ ” are required.
  - This mode changes previously allowed “bad syntax” into real errors.
  - `x = 3.14;` // ERROR: x was not declared.
  - `function doit( p1, p1 ) { }` // ERROR – don’t name your parameters the same...
  - `let MAX_VALUES = 123` // (Sometimes) ERROR: No semicolon

# Loading/Running JS code

- No **Main**, JavaScript just starts in your file and runs the code.
- JavaScript runs on the browser – after the HTML has been loaded.
- When does JavaScript code run?
  - As soon as it is seen.
  - After all the code / images / css / etc is loaded...

```
function main() {  
    console.log( "Everything is loaded!" );  
}  
window.onload = main;
```

- Note “main” is not a key word. You may also write:

```
window.onload = function() {  
    console.log( "Everything is loaded!" );  
}
```

# Adding JS to your Webpage

- Option 1 (Recommended)

- Place your JS code in a separate file and link it to your html file through the “script” tag:

```
<head>
```

```
    <script type="text/javascript" src="myScript.js"/>
```

```
</head>
```

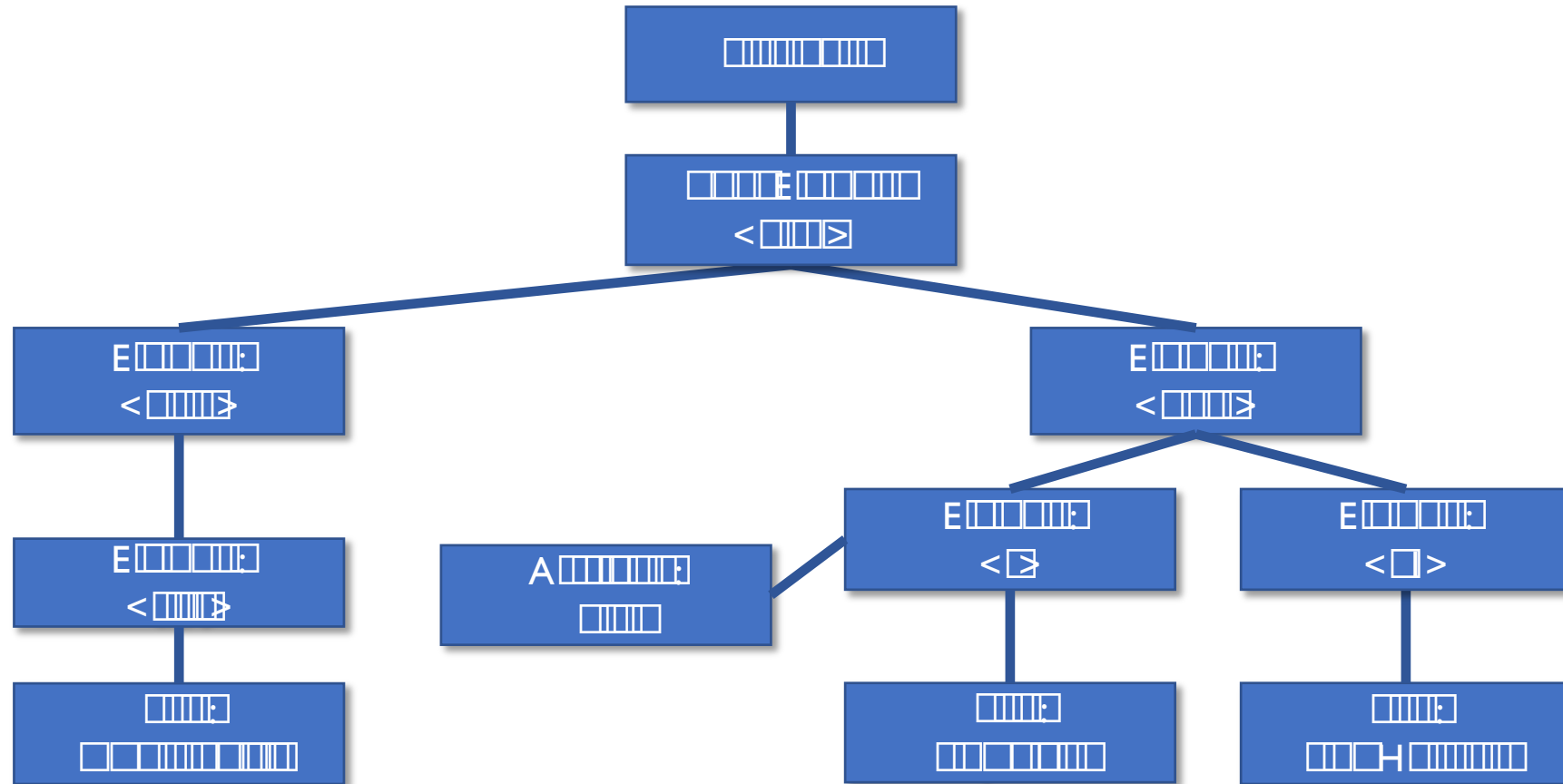
- Option 2

- Place your JS code directly in your html file
- To see the console output, look at your browser’s developer tools panel. This panel has a lot of useful info about what is happening in your web page.
  - `console.log( 'My debug message' );`
  - Note, you can write and run code in the console.

# HTML Document

```
<html>
  <head>
    <title> My Page Title </title>
  </head>
  <body>
    <p> A paragraph with a
      <a href="www.google.com">link to google</a>
    </p>
  </body>
</html>
```

# HTML representation



- This does not exactly match the previous slide but gives you the idea.



# Document Object Model (DOM )

- When your browser requests and receives a webpage, it doesn't just display the HTML as it receives it.
- The page is stored internally as an object. Specifically, as a “Tree” of “Nodes”
  - Similar to the GUI layout / widgets from the Synthesizer assignment.
  - The DOM is the representation of the current webpage.
- A node is an HTML element (basically a tag, or an attribute of a tag).
- A “Tree” is a way of connecting the nodes such that each node has exactly one parent, and possibly several children. (Similar to a family tree.)
- Remember, the purpose of JavaScript is to manipulate webpages – or more specifically to manipulate the DOM.

# JavaScript + DOM

- JavaScript has built-in methods for interacting with the DOM
  - Selecting elements
  - Traversing the tree
  - Modifying nodes
  - Modifying the tree

# document

- *document* is a variable that refers to the page you are viewing in your browser.
  - *document* is created automatically for you – it already exists as your code starts executing.
- `document.writeln( "<p> CS 6011 </p> " );`
  - Adds the text directly to the documents body.
  - Note: Deletes anything that was in the document from the HTML file.
- Most of the JavaScript API methods for interacting with the DOM are part of the *document* object.
- `document.body` – The `<body>` element of the DOM.

# Selecting Elements (JS)

```
let elems = document.getElementsByTagName( tagName ); // eg: 'p'
```

- returns an array of nodes

```
let elem = document.getElementById( someId ); // returns 1 element.
```

- returns a single node with that ID (as IDs should be unique!)

```
let elems = document.getElementsByClassName( someClassName );
```

- returns a list of nodes with the class you gave to them (as can be referenced by CSS)

```
let elem = document.querySelector( "#elemId" );
```

```
let elems = document.querySelectorAll( ".myclass" );
```

- Take a “css like selector string” and return the first/all matching elements.
- Like a combination of the get functions.
- #idName                      Get element with id “idName”
- p.example                    Get a <p class=“example”> element.

# Traversing the Tree

- Once you have an element (using one of the methods from the previous slide)...
- Elements have a `.children` field which is a list of child nodes.
  - Note: Text nodes are not listed in the children...
    - Use `.childNodes` if you wish to see the Text nodes too.
- `querySelector()` works with a node and returns matching nodes that are descendants of a given node.

```
let firstHeading = myDiv.querySelector( 'h1' );  
let allH2sInMyDiv = myDiv.querySelectorAll( 'h2' );
```

# Modifying Node Examples

- Modifying a CSS property:

```
myElement.style.background = "rgb( 255, 0, 0 )";
```

```
myElement.style.background = "red";
```

- You can change (replace all of) the actual HTML too:

```
myElement.innerHTML = "<p>The new HTML code</p>";
```

- To just update the text of a node:

```
myElement.textContent = "New text...";
```

# Modifying the Tree

- Create and return a new element:

```
let myNewElem = document.createElement( tagName );  
let myPar = document.createElement( 'p' );
```

- Add a new child to an element:

```
element.appendChild( someElement );
```

- Create a text node to add to an element with text inside:

```
let myText = document.createTextNode( "Some Text" );
```

- Removing elements:

```
element.remove(); // Removes element from its parent.
```

```
node.removeChild( child ); // Removes child from node.
```

# Monday Assignment(s)

- In class example...
- HW 4 – Synthesizer GUI – Final
- Lab – JS Hello World
- Lab – DOM Manipulation