

## Chapter 6: Javascript: Introduction to Scripting

CS 80: Internet Programming

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### Welcome to Javascript!

- What is javascript?
  - Client side scripting language
- What is scripting?
  - Generally tied with interpreted languages, meaning the code is translated to machine code right before execution (vs. compiled code)

### Welcome to Javascript!

Why do we care?

- HTML and CSS give us a lot of control over content, structure, and presentation, but we still lack the ability to have dynamic or computational websites
- Javascript offers client-side programming, enabling fun stuff like these:
  - <https://codepen.io/HarrisCarney/pen/dPjKyK>
  - <https://codepen.io/GabbeV/pen/viAec>
  - <https://codepen.io/dissimulate/details/eZxEBO/>
- Clearly some powerful stuff!
- We will start small and with fundamentals; there are many libraries to help you with graphics
- We will concentrate on logic

### Getting Started

- `<script>` HTML element allows us to add Javascript to our HTML document
  - Typically goes in the `<head>` portion of the document
- Example:

```
1 <script type="text/javascript"> script_stuff </script>
```

### Example: hello\_world.html

```
1 <!DOCTYPE html>
2 <!-- Fig. 6.1: welcome.html -->
3 <!-- Displaying a line of text. -->
4 <html>
5
6 <head>
7   <meta charset="utf-8">
8   <title>A First Program in JavaScript</title>
9   <script type="text/javascript">
10     // the document object accesses the current HTML document
11     // writeln is a method that writes a line to the document
12     // the enclosed argument to writeln is the content to write to the
13     // document
14     document.writeln("<h1>Welcome to JavaScript Programming!</h1>");
15   </script>
16 </head>
17
18 <body>
19   <!-- Notice our empty body -->
20
21 </body>
22 </html>
```

### Example: hello\_world.html

- Finally we see the object model!
- We will see more, but for now:
- `document` is the HTML document, represented through a javascript object
  - We will cover this concept in more detail in Chapter 12 (Document Object Model)
- `.writeln()` is a method within the `document` object
  - It writes content to the HTML document, followed by a new line (that's the `\n`)
  - `"<h1>Welcome to JavaScript Programming!</h1>"` is a **string** and is the content to write to the HTML document

### External Javascript Files

- Example

```
1 <script src="srcipt.js">
```

- Loads the Javascript in `srcipt.js` into this HTML document

## Javascript Basics

### Statements and Keywords

- **Keywords** are words with special meaning to javascript
  - `var` is an example
- A **statement** is a program statement to execute by the javascript interpreter
  - Statements are terminated with a semicolon `;`, as in `hello_world.html`

## Javascript Basics

### Variables

- A **variable** is a container to store data in
  - Think about this like a math variable, but in javascript, variables can store any data
  - Declared with `var myVar;`
    - \* Can declare multiple variables at once with a comma-serparated list
      - E.g. `var myVar, myVar1, myVar2;`
  - Assign the variable a value with `myVar = 5;`

### Example: `hello_world_variables.html`

```
1 <!DOCTYPE html>
2 <!-- Fig. 6.1: welcome.html -->
3 <!-- Displaying a line of text. -->
4 <html>
5
6 <head>
7   <meta charset="utf-8">
8   <title>A First Program in JavaScript</title>
9   <script type="text/javascript">
10     // declare a variable to hold our string
11     var text = "<h1>Welcome to JavaScript Programming!</h1>";
12     var myDocVar = document;
13
```

```
14     // use the variables to write the content to the document
15     myDocVar.writeln(text);
16 </script>
17 </head>
18
19 <body>
20     <!-- Notice our empty body -->
21 </body>
22
23 </html>
```

## Javascript Basics

### Variables

- Sidenote: Javascript variables do not have a type; their type is determined by the content they store
  - What does this mean? Well, we've seen `var` be assigned to a string (`hello_world_variables.html`) and to a number (above, `myVar = 5;`).
    - \* So `var` represents any variable, could be a string, could be an int
    - \* This contrasts with many programming languages, like C/C++, Java
    - \* Moreover, a variable is not bound to a particular type. We can reassign it at any time to any type (e.g. `myVar = 5; myVar = "cheese";`)

## Javascript Basics

### Variables

- Despite the fact variables can store any types, we still have to have a notion of types (take more CS courses to learn more about this!)
  - **String:** a string of text. E.g. `var myVar = "cheese";`
    - \* Can use double or single quotes, but must be consistent (whatever you start the string with, you must end the string with)
  - **Number:** a number. E.g. `var myVar = 5;`
  - **Boolean:** True/False value. E.g. `var myVar = true;`

## Javascript Basics

### Variables

- **Array:** multiple of values in one variable. E.g. `var myVar = [5, "cheese", false];`
  - Elements are accessed using 0-indexing
  - E.g. `myVar[0]` is 5, `myVar[2]` is **false**
- **Object:** everything in javascript is an object, and you can store objects in variables. E.g. `var myVar = document;`

### Javascript Basics

- **Identifiers**
  - Formal name for a variable's name (e.g. `myVar`)
  - Can contain letters, digits, underscores, and dollar signs.
  - Must not begin with a digit and must not be a keyword

### Javascript Basics

- Comments
  - Single line: start with `//`
  - Multiline: start with `/*` ends with `*/`

### Javascript Basics

- **Literals** are literal values you provide your script
  - They do not change value
  - Can you spot the literal?
    - \* `var myVar = 5;`
    - \* `var myVar = "cheese";`
  - These are not modifiable, fixed values provided by you, the programmer.

### Javascript Basics

#### Basic Operators

- **Basic Operators** define operations on variables or literals. Used to process data. We will talk about more as we go along.

## Javascript Basics

### Basic Operators

- **Addition/Concatenation:** +, used to add two numbers together, or merge two strings
  - `6 + 9`; yields 15
  - `"Hello " + "world!"` yields `"Hello world!"`

## Javascript Basics

### Basic Operators

- **Subtract, multiply, divide:** -, \*, /, used just as they in basic math (you can't divide a string by another string, concatenation is special!)
  - `6 * 5`; yields 30

## Javascript Basics

### Basic Operators

- **Assignment:** =, we've already seen this. It's used to take a value (either an object or a literal) and assign it another object (typically a variable)
  - `var myVar = 6 * 5`; assigns `myVar` to 30

## Javascript Basics

### Basic Operators

- **Remainder:** %, used to perform modulo.
  - Modulo/remainder division finds the remainder of an integer division
  - E.g. `11 % 5` yields 1 because `11 = 5 * 2 + 1`
    - \* We are interested in the 1, since that is the remainder when you divide 11 by 5

## Javascript Basics

### Operator Precedence

- Remember PEMDAS? (Parenthesis, Exponents, Multiplication and Division, and Addition and Subtraction)
  - Defines the mathematical order-of-operations

## Javascript Basics

### Escape Sequences

- Used to give or take away meaning from special characters
- `\n`: a new line (carriage return, like hitting enter)
- `\t`: a tab
- `\\`: a literal backslash (since `\` normally has special meaning - to escape other characters!)
- `\"`: double quote - for nested double quotes
  - Need to escape so we don't accidentally end the string!
- `'`: single quote - for nested single quotes
  - Need to escape so we don't accidentally end the string!

## Javascript Basics

### Examples

- `alert.html`
  - `window` object refers the browser's window
  - `alert` opens a dialog to display the string
  - Take a look at `window` methods and attributes: [http://www.w3schools.com/jsref/obj\\_window.asp](http://www.w3schools.com/jsref/obj_window.asp)

### Example: `alert.html`

```
1 <!DOCTYPE html>
2 <!-- Fig. 6.3: welcome3.html -->
3 <!-- Alert dialog displaying multiple lines. -->
4 <html>
5
6 <head>
7   <meta charset="utf-8">
8   <title>Printing Multiple Lines in a Dialog Box</title>
9   <script type="text/javascript">
10     // Your book does the following <!-- // --> pattern inside the
       script tag all the time
11     // DONT DO THIS! It's for ANCIENT browsers that do not support
       scripts (and interprets them as an HTML comment)
12     // Seriously, I cannot stress how pointless this practice is, and
       you should not be doing it
```

```
13     <!--
14     window.alert("Welcome to\nJavaScript\nProgramming!");
15     // -->
16 </script>
17 </head>
18
19 <body>
20   <p>Click Refresh (or Reload) to run this script again.</p>
21 </body>
22
23 </html>
```

## Javascript Basics

### Examples

- `dynamic_welcome.html`
  - Again using `window` with `prompt()` method to ask for user input
  - Creates a dynamic welcome page
  - We couldn't do with this HTML and CSS

### Example: `dynamic_welcome.html`

```
1 <!DOCTYPE html>
2 <!-- Fig. 6.5: welcome4.html -->
3 <!-- Prompt box used on a welcome screen -->
4 <html>
5
6 <head>
7   <meta charset="utf-8">
8   <title>Using Prompt and Alert Boxes</title>
9   <script type="text/javascript">
10     var name;
11     // string entered by the user
12     // read the name from the prompt box as a string
13     name = window.prompt("Please enter your name");
14     document.writeln("<h1>Hello " + name + ", welcome to JavaScript
15                       programming!</h1>");
16   </script>
17 </head>
```



```
17
18 <body></body>
19
20 </html>
```

## Javascript Basics

### Examples

- `addition.html`
  - `parseInt()` function converts a string to an integer

### Example: `addition.html`

```
1 <!DOCTYPE html>
2 <!-- Fig. 6.7: addition.html -->
3 <!-- Addition script. -->
4 <html>
5
6 <head>
7   <meta charset="utf-8">
8   <title>An Addition Program</title>
9   <script type="text/javascript">
10     <!--
11     var firstNumber; // first string entered by user
12     var secondNumber; // second string entered by user
13     var number1; // first number to add
14     var number2; // second number to add
15     var sum; // sum of number1 and number2
16     // read in first number from user as a string
17     firstNumber = window.prompt("Enter first integer");
18     // read in second number from user as a string
19     secondNumber = window.prompt("Enter second integer");
20     // convert numbers from strings to integers
21     number1 = parseInt(firstNumber);
22     number2 = parseInt(secondNumber);
23     sum = number1 + number2; // add the numbers
24 //    sum = firstNumber + secondNumber; // add the numbers (as strings)
25     // display the results
26     document.writeln("<h1>The sum is " + sum + "</h1>");
27     // -->
```

```
28     </script>
29 </head>
30
31 <body></body>
32
33 </html>
```

## Javascript Basics

### Operators and Conditionals

- We need a way to encode logic - a way to direct the program based on the program's state
- Primary method of controlling a programs flow
- Basic idea: "if a condition is true, execute some code"
  - We can stop at the if or say "if a condition is true, execute some code, otherwise, execute this other code"

## Javascript Basics

### Operators and Conditionals

- Example:

```
1 // basic conditional
2 if(5 <= 10){
3     document.writeln("5 is indeed less than 10");
4 } else {
5     document.writeln("5 is somehow not less than 10...");
6 }
```

## Javascript Basics

### Operators and Conditionals

- But we can do even more by nesting if's!
  - Also allows us to check for multiple potential conditions at once (e.g. `if(cond) ...else if(cond) ...else...`)

## Javascript Basics

### Operators and Conditionals

- Example: where `time` is the hour of the day (0-23)

```

1 // order of the conditionals matters; what happens if we flip them
  ?
2 if (time < 10) {
3   greeting = "Good morning";
4 } else if (time < 20) {
5   greeting = "Good day";
6 } else {
7   greeting = "Good evening";
8 }

```

## Javascript Basics

### Equality and Relational Operators

Standard algebraic equality operator or relational operator	JavaScript equality or relational operator	Sample JavaScript condition	Meaning of JavaScript condition
<i>Equality operators</i>			
=	==	x == y	x is equal to y
≠	!=	x != y	x is not equal to y
<i>Relational operators</i>			
>	>	x > y	x is greater than y
<	<	x < y	x is less than y
≥	>=	x >= y	x is greater than or equal to y
≤	<=	x <= y	x is less than or equal to y

**Figure 1:** Javascript relational operators

## Javascript Basics

### Operators and Conditionals

- Difference between `===` and `==`
  - `===` is a more strict comparison operator
  - E.g. `"75" == 75` yields true but `"75" === 75` yields false

## Javascript Basics

### Operators and Conditionals

- Compound conditionals:
  - Use logical operations `AND`, `OR`, and `NOT`
  - `AND` is represented with `&&`
  - `OR` is represented with `||`
  - `NOT` is represented with `!`
  - Combining conditions allows us to use much more powerful program flow

## Javascript Basics

### Operators and Conditionals

- Compound conditionals will evaluate left to right
  - If the program can determine the overall value of the compound conditional, it will stop evaluating the rest of the conditional
  - E.g. Suppose `cond_a` is `true` and `cond_b` is `false`.
    - \* `if(cond_a || cond_b)` doesn't need to look at the value of `cond_b`, the overall condition is determined by `cond_a`.
    - \* Similarly, `if(cond_b cond_a)` doesn't need to look at the value of `cond_a`, since `cond_b` already determined the overall state of the compound conditional.
    - \* Remember: left to right!
  - **Key takeaway** order matters!

## Javascript Basics

### Operators and Conditionals

- Example: (pay close attention to evaluation order)

```
1 // be careful analyzing this conditional
2 if(cond_a && cond_b){
3     // only executes if cond_a AND cond_b are true
4 } else if(cond_a || cond_d){
```

```
5    // only executes if 1) cond_a is true AND cond_b is false (think
    //    about why) OR cond_d is true
6  } else if(!cond_d){
7    // only executes if cond_a is false AND cond_d is true
8  } else {
9    // will this ever execute?
10   // otherwise
11 }
```

### Exercise

- Display the current day and time in the following format:

```
1 Today is: Friday
2 Current time is: 4:50:22PM
```

- **First step:** look at the `Date()` javascript function
  - [http://www.w3schools.com/jsref/jsref\\_obj\\_date.asp](http://www.w3schools.com/jsref/jsref_obj_date.asp)

### Example: date\_print.html

```
1 <!DOCTYPE html>
2 <html>
3
4 <head>
5   <meta charset="utf-8">
6   <title>Display Date</title>
7   <script type="text/javascript">
8     var today = new Date();
9     var day = today.getDay();
10    var daylist = ["Sunday", "Monday", "Tuesday", "Wednesday ", "
    Thursday", "Friday", "Saturday"];
11
12    document.writeln("Today is: " + daylist[day] + "<br>");
13
14    var hour = today.getHours();
15    var minute = today.getMinutes();
16    var second = today.getSeconds();
17    console.log("hour: " + hour);
18    var postpand = "";
```

```
19     if (hour >= 12) {
20         postpand = "PM";
21     } else {
22         postpand = "AM";
23     }
24     if (hour >= 12) {
25         hour = hour - 12;
26     }
27     if (minute < 10) {
28         minute = "0" + minute;
29     }
30     if (second < 10) {
31         second = "0" + second;
32     }
33     document.writeln("Current time is: " + hour + ":" + minute + ":" +
34         second + postpand);
35 </script>
36 </head>
37 <body>
38 </body>
39
40 </html>
```

## Exercise

- Write a program that determines if the inputted year is a leap year:
  - Every year that is divisible by 4, except for years divisible by 100, except for years that are divisible by 400
- **First step:** come up with an algorithm to check

## Example: leap\_year\_checker.html

```
1 <!DOCTYPE html>
2 <html>
3
4 <head>
5     <meta charset="utf-8">
6     <title>Leap Year Checker</title>
7     <script type="text/javascript">
```

```
8     var year, leapYear = false,
9         leapYearText = "";
10    year = parseInt(window.prompt("Input a year: "));
11    if (year % 100 === 0) {
12        if (year % 400 === 0) {
13            leapYear = true;
14        }
15    } else if (year % 4 === 0) {
16        leapYear = true;
17    }
18    if (!leapYear) {
19        leapYearText = " not";
20    }
21    document.writeln("<h2>" + year + " is" + leapYearText + " a leap
22                      year</h2>");
23 </script>
24 </head>
25 <body>
26 </body>
27
28 </html>
```

## Developer Tools

- No program is perfect at first
- We need a way to examine program state as the program is running
  - This will enable us to understand and fix problems in our code
- Debugging will help fix any error, but it's particularly good for identifying edge cases you may have not considered when writing your program
  - Common edge cases: empty string "", zero 0, negative numbers, etc

## Developer Tools

- The debugger is present in any modern browser and has two main elements for javascript: console and debugger
- **Since we are editing the program as it executes, we need to remember where we are in execution**
  - Variables may not exist yet

- How to write information to the console to inspect state:
  - Use a `console.log()` statement in your javascript
  - The value/text arguments will be printed to the Console section of the Developer Tools

### Developer Tools

- Setting a breakpoint
  - Breakpoints say "when you hit this line of code, pause the program for me"
  - They allow you to inspect variable/program state during execution
  - Enable a breakpoint by clicking the line number
  - Important semantic note: The line of the breakpoint has **not** executed yet. It is about to execute
    - \* E.g. if we set a breakpoint on line 9, line 9 hasn't executed when the breakpoint triggers (line 8 has, however)
    - \* Keep this in mind!

### Developer Tools

- Stepping through a program
  - Once we are at a breakpoint we have multiple options to control the program:
    - \* Step Over: step over the current line of code. This means if we are at a function call, **do not** move the debugger into the function. Instead, the function will execute, and the program will pause after function completes
    - \* Step Into: If the program is about to call a function, move the debugger into that function and pause execution
    - \* Step Out: Finish the current function call and pause execution at the calling function
    - \* Continue: Continue the program's execution; basically unpauses the program

### Developer Tools

- We can also call functions or inspect variables while paused using the console
  - Move to the console, and type a javascript statement to execute
    - \* Can also just type variable names to get their value
  - If the javascript statement we called doesn't have a return value (e.g. statement doesn't yield a value), then the console will report `undefined`.



## Javascript Functions

- Functions enable reusable code
- Sum example:

```
1 // function declaration
2 function sum1(a, b){
3   // do other amazing javascript things here
4   return a + b;
5 }
```

- We can then call `sum(10, 5)` which would return 15

## Javascript Functions

- Assigning functions to variables
- Sum example:

```
1 // anonymous function assigned to variable
2 var sum2 = function(a,b){
3   return a + b;
4 }
```

- We can then call `sum2(10, 5)` which would return 15

## Javascript Functions

### Hoisting

- The only thing you need to remember is that functions of the form of `sum1` are "hoisted" to the top of your program, meaning they can be used *before* they are declared