

IN4MATX 133: User Interface Software

Lecture 5:
Javascript 2

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Announcements

- Reminder: A1 due Monday (10/14) at midnight
- Discussion 10/14 will move onto JavaScript
 - Use Slack and office hours for any outstanding A1 questions
- Start A2 early!
 - Students have found it much more challenging than A1

Today's goals

By the end of today, you should be able to...

- Implement fundamental programming concepts in JavaScript like variables, loops, and conditionals
- Differentiate the roles of arrays and associative arrays
- Implement functional programming concepts in JavaScript like forEach, map, and filter

**JavaScript is just
a programming language**

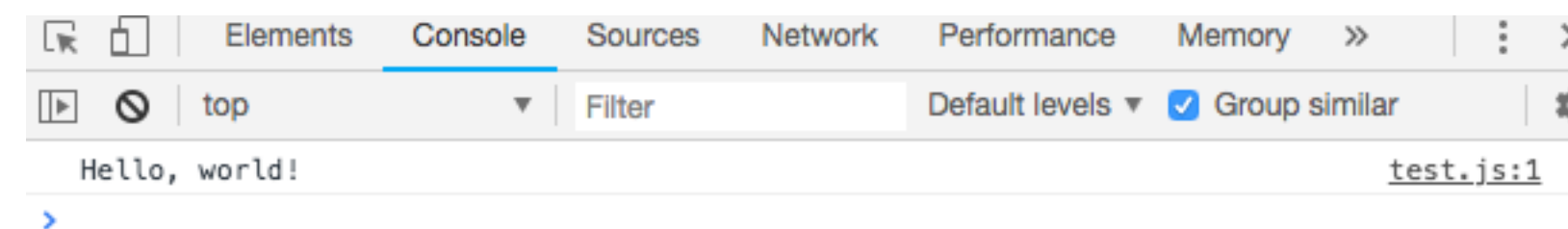
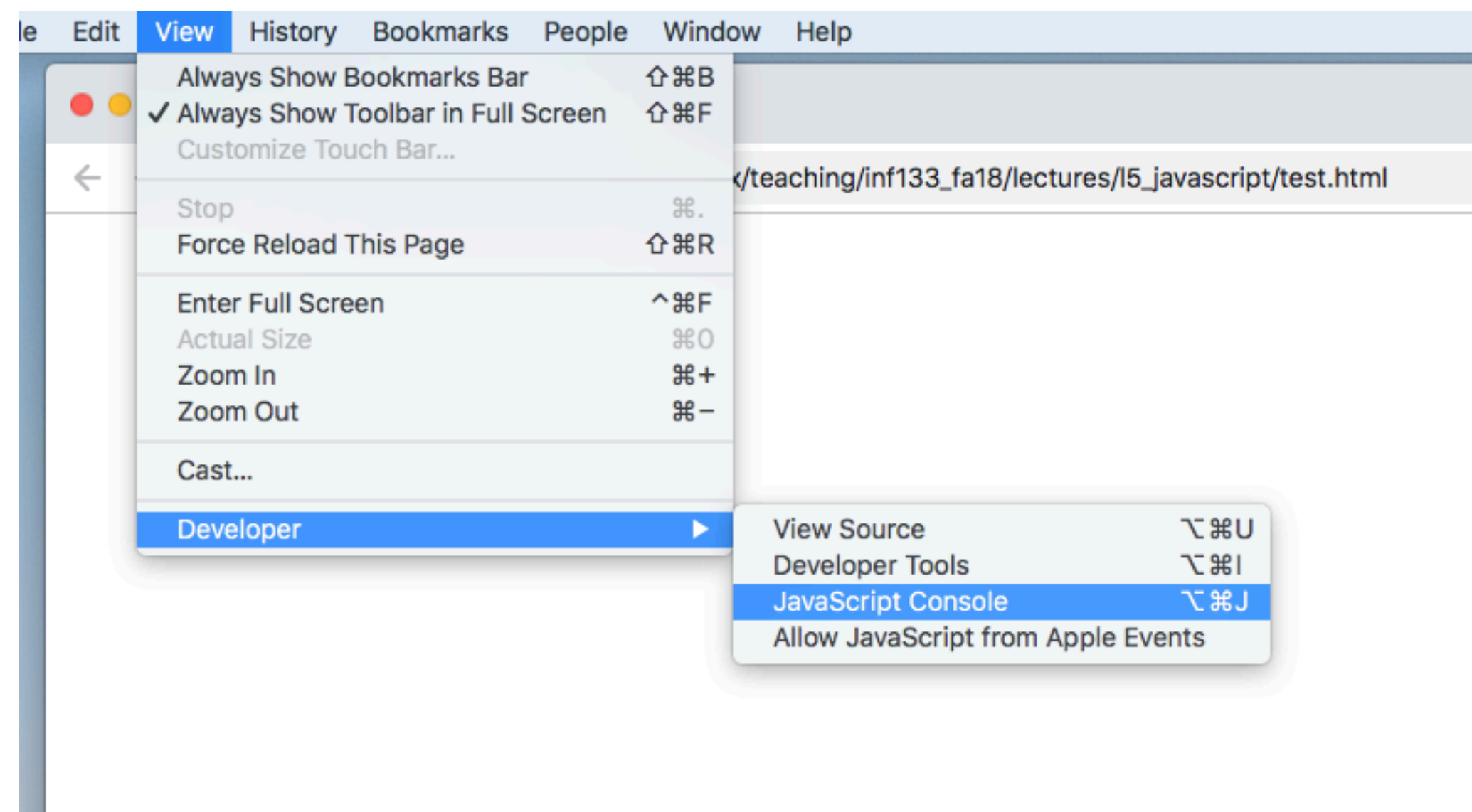
Loading JavaScript

```
<html>  
  <head>  
    <script src="test.js"></script>  
  </head>  
</html>
```

Printing in JavaScript

```
console.log("Hello, world!");
```

- Won't be visible in the browser
- Shows in the JavaScript Console



JavaScript Syntax

- Has functions and objects
 - `foo()` `bar.baz`
 - They look like Java, but act differently

JavaScript Variables

- Variables are dynamically typed

```
var x = 'hello'; //value is a string  
console.log(typeof x); //string
```

```
x = 42; //value is now a Number  
console.log(typeof x); //number
```

- Unassigned variables have a value of `undefined`

```
var hoursSlept;  
console.log(hoursSlept);
```


JavaScript types

```
console.log('40' + 2); // '402'
```

```
console.log('40' - 4); // 36
```

◀ Minus isn't defined for strings,
so JavaScript knows to convert this

```
var num = 10;
```

```
var str = '10';
```

```
//comparisons: these will all be booleans (true/false)
```

```
console.log(num == str); //true
```

```
console.log(num === str); //false
```

```
console.log('' == 0); //true
```

JavaScript loops and conditionals

```
var i = 4.4;
```

```
if(i > 5) {  
  console.log('i is bigger than 5');  
} else if(i >= 3) {  
  console.log('i is between 3 and 5');  
} else {  
  console.log('i is less than 3');  
}
```

```
for(var x = 0; x < 5; x++) {  
  console.log(x);  
}
```

JavaScript methods

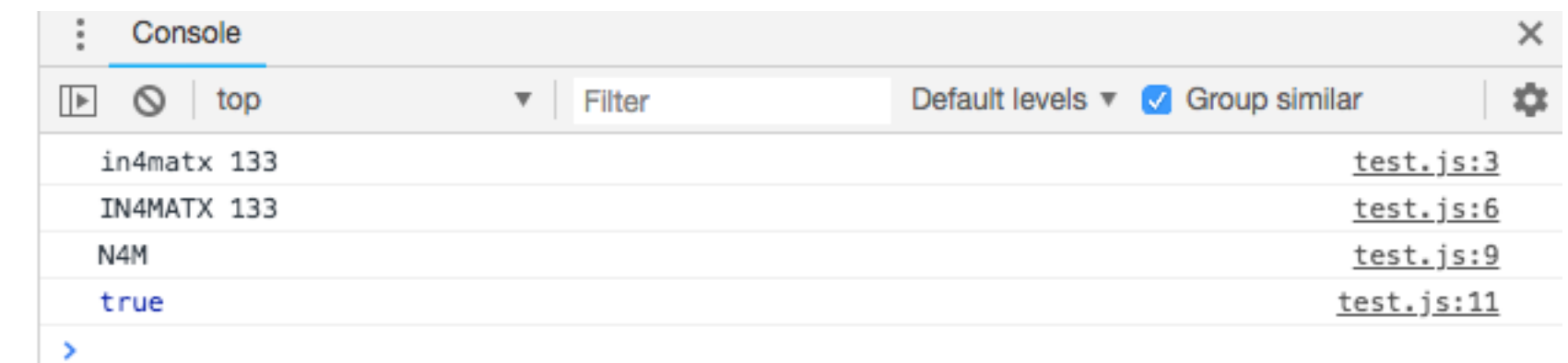
- Called with dot notation

```
var className = 'in4matx 133';  
console.log(className);
```

```
className = className.toUpperCase();  
console.log(className);
```

```
var part = className.substring(1, 4);  
console.log(part);
```

```
console.log(className.indexOf('MATX') >= 0); //whether  
the substring appears
```



JavaScript arrays

- Similar to Java, but can be a mix of different types

```
var letters = ['a', 'b', 'c'];
var numbers = [1, 2, 3];
var things = ['raindrops', 2.5, true, [5, 9, 8]]; //arrays can be nested
var empty = [];
var blank5 = new Array(5); //empty array with 5 items
```

```
//access using [] notation like Java
console.log( letters[1] ); //=> "b"
console.log( things[3][2] ); //=> 8
```

```
//assign using [] notation like Java
letters[0] = 'z';
console.log( letters ); //=> ['z', 'b', 'c']
```

```
//assigning out of bounds automatically grows the array
letters[10] = 'g';
console.log( letters );
    //=> [ 'z', 'b', 'c', , , , , , , , 'g' ]
console.log( letters.length ); //=> 11
```

JavaScript arrays

- Arrays have their own methods

//Make a new array

```
var array = ['i', 'n', 'f', 'x'];
```

//add item to end of the array

```
array.push('133');  
console.log(array); //=> ['i', 'n', 'f', 'x', '133']
```

//combine elements into a string

```
var str = array.join('-');  
console.log(str); //=> "i-n-f-x-133"
```

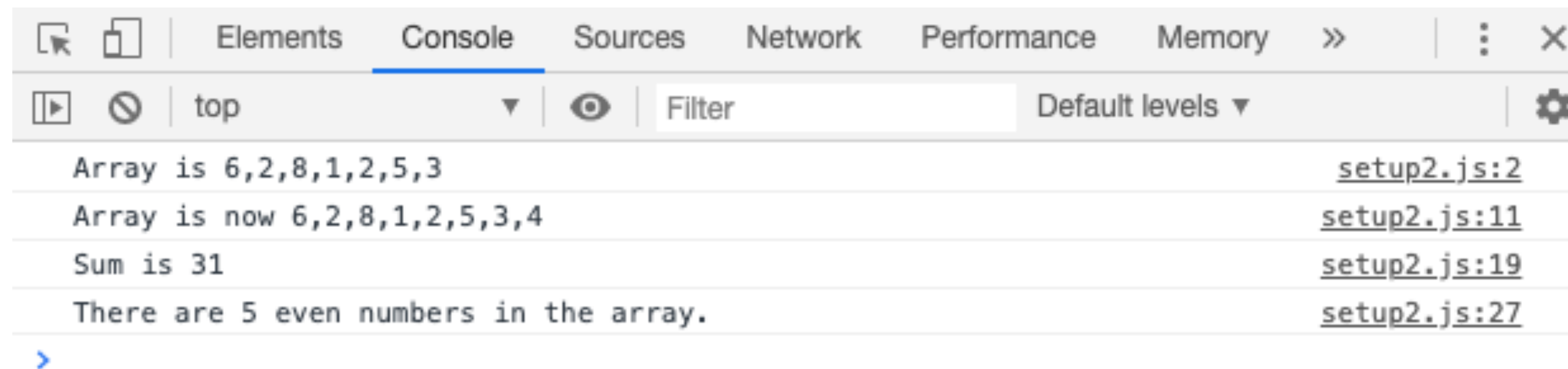
//get index of an element (first occurrence)

```
var oIndex = array.indexOf('x'); //=> 3
```

//remove 1 element starting at oIndex

```
array.splice(oIndex, 1);  
console.log(array); //=> ['i', 'n', 'f', '133']
```

Array methods



Question

What will be shown in the console?

```
var array = ['1', 'fish', 2, 'blue'];  
array[5] = 'dog';  
array.push('2');  
array[2] = array[array.length - 1] - 4;  
array[0] = typeof array[2];  
array[4] = array.indexOf('blue');  
  
console.log(array.join('*'));
```

- ☐ A number*fish*2*-1*dog*0
- ☐ B undefined*fish*2*undefined*dog*2
- ☐ C string*fish*2*24*dog*2
- ☐ D undefined*fish*2*undefined*dog*2
- ☐ E number*fish*-2*blue*3*dog*2

Question

What will be shown in the console?

```
var array = ['1', 'fish', 2, 'blue'];  
array[5] = 'dog';  
array.push('2');  
array[2] = array[array.length - 1] - 4;  
array[0] = typeof array[2];  
array[4] = array.indexOf('blue');  
  
console.log(array.join('*'));
```

- ☐ A number*fish*2*-1*dog*0
- ☐ B undefined*fish*2*undefined*dog*2
- ☐ C string*fish*2*24*dog*2
- ☐ D undefined*fish*2*undefined*dog*2
- ☒ E number*fish*-2*blue*3*dog*2

JavaScript arrays

- Similar to Java, but can be a mix of different types

```
var letters = ['a', 'b', 'c'];
```

```
var numbers = [1, 2, 3];
```

```
var things = ['raindrops', 2.5, true, [5, 9, 8]]; //
```

arrays can be nested

```
var empty = [];
```

```
var blank5 = new Array(5); //empty array with 5 items
```

//access using [] notation like Java

```
console.log( letters[1] ); //=> "b"
```

```
console.log( things[3][2] ); //=> 8
```

JavaScript objects

- An unordered set of key and value pairs

- Like a HashMap in Java or a dictionary in Python

- Sometimes called *associative arrays*

Quotes around keys are optional



```
ages = {alice:40, bob:35, charles:13}
```

```
extensions = {'daniel':1622, 'in4matx':9937}
```

```
num_words = {1:'one', 2:'two', 3:'three'}
```

```
things = {num:12, dog:'woof', list:[1,2,3]}
```

```
empty = {}
```

```
empty = new Object(); //empty object
```

JavaScript Object Notation (JSON)

```
{  
  "first_name": "Alice",  
  "last_name": "Smith",  
  "age": 40,  
  "pets": ["rover", "fluffy", "mittens"],  
  "favorites": {  
    "music": "jazz",  
    "food": "pizza",  
    "numbers": [12, 42]  
  }  
}
```

- Used in many APIs to send/receive data

Accessing properties

- Values (or properties) can be referenced with the array[] syntax

```
ages = {alice:40, bob:35, charles:13}
```

```
//access ("look up") values
```

```
console.log( ages['alice'] ); //=> 40
```

```
console.log( ages['bob'] ); //=> 35
```

```
console.log( ages['charles'] ); //=> 13
```

```
//keys not in the object have undefined values
```

```
console.log( ages['fred'] ); //=> undefined
```

```
//assign values
```

```
ages['alice'] = 41;
```

```
console.log( ages['alice'] ); //=> 41
```

```
ages['fred'] = 19; //adds the key and assigns  
                  //a value to it
```

Accessing properties

- Values can also be referenced with dot notation

```
var person = {  
  firstName: 'Alice',  
  lastName: 'Smith',  
  favorites: {  
    food: 'pizza',  
    numbers: [12, 42]  
  }  
};
```

```
var name = person.firstName; //get value of 'firstName' key  
person.lastName = 'Jones'; //set value of 'lastName' key  
console.log(person.firstName+' '+person.lastName); //"Alice Jones"
```

```
var topic = 'food'  
var favFood = person.favorites.food; //object in the object  
                                     //object          //value
```

```
var firstNumber = person.favorites.numbers[0]; //12  
person.favorites.numbers.push(7); //push 7 onto the Array
```

Functions

- Functions in JavaScript are like static methods in Java

//Java

```
public static String sayHello(String name){  
    return "Hello, "+name;  
}  
  
public static void main(String[] args){  
    String msg = sayHello("IN4MATX 133");  
}
```

Parameters have no type

//JavaScript

function sayHello(name) { ← Parameters are comma-separated

↑ **return** "Hello, "+name;

No access modifier

var msg = sayHello("IN4MATX 133");
or return type

Functions

- In Javascript, all parameters are optional

```
function sayHello(name)
```

```
{
```

```
    return "Hello, "+name;
```

```
}
```

```
//expected; parameter is assigned a value
```

```
sayHello("In4MATX 133"); //"Hello, IN4MATX 133"
```

```
//parameter not assigned value (left undefined)
```

```
sayHello(); //"Hello, undefined"
```

```
//extra parameters (values) are not assigned
```

```
//to variables, so are ignored
```

```
sayHello("IN4MATX", "133"); //"Hello, IN4MATX"
```

Now for the confusing part...

Functions are objects

```
//assign array to variable
var myArray = ['a', 'b', 'c'];

var other = myArray;

//access value in other
console.log( other[1] ); //print 'b'
```

```
//assign function to variable
function sayHello(name) {
    console.log("Hello, "+name);
}

var other = sayHello;

//prints "Hello, everyone"
other('everyone');
```

Functions are objects

```
//assign array to variable
var myArray = ['a', 'b', 'c'];

var other = myArray;

//access value in other
console.log( other[1] ); //print 'b'
```

```
//assign function to variable
var sayHello = function(name) {
    console.log("Hello, "+name);
}

//second variable, same object
var greet = sayHello;

//execute object named `greet`
greet('everyone');
//prints "Hello, everyone"
```

Functions are objects

```
var obj = {};  
var myArray = ['a', 'b', 'c'];
```

```
//assign array to object  
obj.array = myArray;
```

```
//access with dot notation  
obj.array[0]; //gets 'a'
```

```
//assign literal (anonymous value)  
obj.otherArray = [1,2,3]
```

```
var obj = {}  
function sayHello(name) {  
    console.log("Hello, "+name);  
}
```

```
//assign function to object  
var obj.sayHi = sayHello;
```

```
//access with dot notation  
obj.sayHi('all'); //prints "Hello all"
```

```
//assign literal (anonymous value)  
obj.otherFunc = function() {  
    console.log("Hello world!");  
}
```



How “non-static”
methods are made

Anonymous variables

```
var array = [1,2,3]; //named variable (not anonymous)  
console.log(array); //pass in named var
```

```
console.log( [4,5,6] ); //pass in anonymous value
```

Anonymous variables

//named function

```
function sayHello(person) {  
    console.log("Hello, "+person);  
}
```

//anonymous function (no name!)

```
function(person) {  
    console.log("Hello, "+person);  
}
```

//anonymous function (value) assigned to variable

```
var sayHello = function(person) {  
    console.log("Hello, "+person);  
}
```

Anonymous variables

//anonymous functions often follow
an "arrow" (abbreviated) syntax

```
var sayHello = (person) => {  
    console.log("Hello, "+person);  
}
```

```
sayHello('IN4MATX 133');
```

Passing functions

- Since functions are objects, they can be passed like variables

//anonymous function syntax

```
var doAtOnce = function(funcA, funcB) {  
    funcA();  
    console.log(' and ');  
    funcB();  
    console.log(' at the same time! ');  
}
```

```
var patHead = function(name) {  
    console.log("pat your head");  
}
```

```
var rubBelly = function(name) {  
    console.log("rub your belly");  
}
```

No parens,
just passing variable



```
doAtOnce(patHead, rubBelly);
```

Callback functions

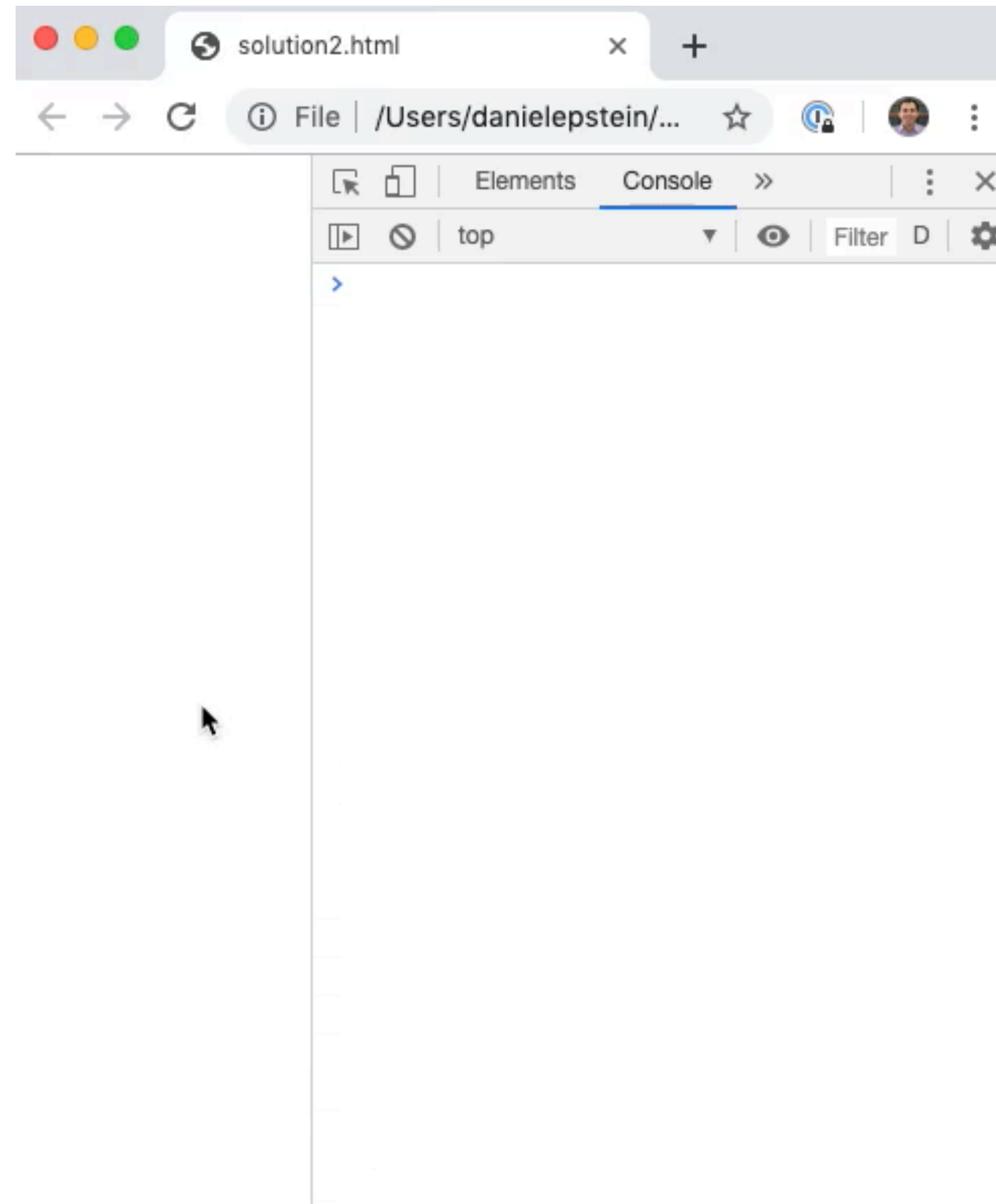
- A function that is passed to *another* function for it to “call back to” and execute

```
function doLater(callback) { ← Takes in a callback
  console.log("I'm waiting a bit...");
  console.log("Okay, time to work!");
  callback();
}
```

```
function doHomework() {
  ...
};
```

doLater(doHomework); ← Pass in the callback function

Callback functions



Callback function example: `forEach`

- To iterate through each item in a loop, use the `forEach` function and pass it a function to call on each array item

//Iterate through an array

```
var array = ['a', 'b', 'c'];  
var printItem = function(item) {  
    console.log(item);  
}
```

```
array.forEach(printItem); ← Callback
```

//more common to use anonymous function

```
array.forEach(function(item) {  
    console.log(item);  
});
```

Callback function example: map

- `map` applies the function to each element in an array and returns a *new* array of elements returned by the function

```
var array = [1,2,3];  
var squared = function(n) {  
    return n*n;  
};
```

```
array.map(squared); //returns [1,4,9]
```

//more common to do this inline:

```
array.map(function(n) {  
    return n*n;  
});
```

Callback function example: `filter`

- `filter` applies the function to each element in an array and returns a *new* array of only the elements for which the function returns true.

```
var array = [3, 1, 4, 2, 5];
```

```
var isACrowd = array.filter(function(n) {  
    return n >= 3;  
}); //returns [3, 4, 5]
```

Callback function example: reduce

- `reduce` applies the function to each element in an array to update an “accumulator” value. The callback function should return the “updated” value for the accumulator.

```
var array = [1, 2, 3, 4];
```

```
var sum = array.reduce(function(total, current) {  
    var newTotal = total + current;  
    return newTotal;  
}, 0); //returns 1+2+3+4=10
```

Question

Which will set `max` to the max of array `numbers`?
(Whitespace does not matter in JavaScript)

A

```
var max = Number.NEGATIVE_INFINITY;
numbers.forEach(function(num) {
  if(num > max) {
    max = num;
  }
});
```

B

```
var max =
numbers.reduce(function(max, num) {
  if(num > max) {
    max = num;
  }
  return max;
}, Number.NEGATIVE_INFINITY);
```

C

```
var max = Number.NEGATIVE_INFINITY;
for(var i=0;i < numbers.length; i++) {
  if(num > max) {
    max = num;
  }
}
```

D Two of the above

E All of the above

Question

Which will set `max` to the max of array `numbers`?
(Whitespace does not matter in JavaScript)

A

```
var max = Number.NEGATIVE_INFINITY;
numbers.forEach(function(num) {
  if(num > max) {
    max = num;
  }
});
```

B

```
var max =
numbers.reduce(function(max, num) {
  if(num > max) {
    max = num;
  }
  return max;
}, Number.NEGATIVE_INFINITY);
```

C

```
var max = Number.NEGATIVE_INFINITY;
for(var i=0;i < numbers.length; i++) {
  if(num > max) {
    max = num;
  }
}
```

D Two of the above

E All of the above

Today's goals

By the end of today, you should be able to...

- Implement fundamental programming concepts in JavaScript like variables, loops, and conditionals
- Differentiate the roles of arrays and associative arrays
- Implement functional programming concepts in JavaScript like forEach, map, and filter

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Lecture 5:
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Some useful JavaScript methods and important notes

null, undefined, and NaN

- `null`: a nonexistent object
 - Therefore it is an object, just uninitialized

```
var nullObj = null;
```

```
console.log(typeof nullObj); //object
if(!nullObj) {
  console.log("It's falsy");
}
//but it's not equal to false
console.log(nullObj == false); //false
```

null, undefined, and NaN

- `undefined`: an undefined primitive value
 - Therefore it's a primitive value, like a number or a string
- ```
var undefinedObj;
```

```
console.log(undefinedObj); //undefined
console.log(typeof undefinedObj); //undefined
if(!undefinedObj) {
 console.log("It's falsy");
}
//but it's not equal to false
console.log(undefinedObj == false); //false
```

<https://codeburst.io/understanding-null-undefined-and-nan-b603cb74b44c>

# null, undefined, and NaN

- NaN: Not a Number
  - Will be the result of any computation on an `undefined` value
  - Or any other impossible computation
  - But it's type is a number (despite the name)

```
console.log('12' - 5); // 7
console.log('word' - 5); // NaN
console.log(undefined * 3); // NaN
console.log(typeof NaN); // number
if(NaN) {
 console.log("It's not falsy!");
}
```

<https://codeburst.io/understanding-null-undefined-and-nan-b603cb74b44c>

# Useful array methods

- JavaScript arrays have stack functions
  - `.push()` and `.pop()` to add and remove the last item, respectively
- Arrays can be combined with `.concat()`
- `.sort()` will sort alphabetically/numerically by default
  - But can take in a comparator
  - For example, sort by the count attribute of an object:

```
array.sort(function(a, b) {
 return a.count - b.count;
});
```

<https://medium.com/@DaphneWatson/10-useful-javascript-array-methods-8ffe22e7a959>

# Useful object methods

- `Object.keys (object/dictionary/associative-array)`
  - returns an array containing the keys
  - order is not guaranteed
  - Or `Object.values (object)` to get an array of the values
  - Or `Object.entries (object)` to get an array containing an array of key, value pairs

```
obj = { pet1: 'Dog', pet2: 'Cat' };
```

```
console.log(Object.entries(obj));
// [["pet1", "Dog"], ["pet2", "Cat"]]
```

<https://codeburst.io/useful-javascript-array-and-object-methods-6c7971d93230>

# Scoping

- Variables are scoped to wherever they are defined
  - So if they are within a function, they will only be visible within that function

```
var globalScopedVar = "I'm global!";
```

```
function func() {
 var funcScopedVar = "I'm only visible in this
function!";
 return funcScopedVar;
}
```

```
console.log(funcScopedVar); //undefined
```



# Hoisting

- Functions can be either *declared* or *expressed*, and the two are treated differently in scoping
  - Declaration: `function name() {}`
  - Expression: `var name = function() {}`
- Both are called the same way: `name()`

# Hoisting

- Variable and function declarations get *hoisted* to execute before the rest of the code
  - Assignment occurs later, where you specify it

```
bar();
var foo = 42;
function bar() {}
//=> is interpreted as
var foo;
function bar() {}
bar();
foo = 42;
```

<https://stackoverflow.com/questions/7609276/javascript-function-order-why-does-it-matter>

# Hoisting

- Function expressions get initialized at the top of the code, but not assigned

```
bar();
function bar() {
 foo();
}
var foo = function() {}
//=> turns into
var foo;
function bar() {
 foo(); //error! not yet defined
}
bar();
foo = function() {}
```

<https://stackoverflow.com/questions/7609276/javascript-function-order-why-does-it-matter>