CSE 341
Lecture 24

JavaScript arrays and objects

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Arrays

```
var name = [];                      // empty
var name = [expr, ..., expr];       // pre-filled

name[index]                         // access value
name[index] = expr;                 // store value

var stooges = ["Larry", "Moe", "Shemp"];
stooges[2] = "Curly";
```

- the array is the only data structure included in JavaScript (other than objects)

Array features

- JS arrays can store elements of multiple types:

```
> var a = [42, true, "abc"];
```

- arrays can be converted into strings (or call `toString`):

```
> print("hi " + a + " bye");
hi 42,true,abc bye
```

- caution: the `typeof` an array is `object`, not array:

```
> typeof(a)
object
```

Array length

- use the `length` property to find the # of elements:

```
> a.length
3
```

- you can set `length`;
  - if smaller, truncates the array to the new smaller size
  - if larger, all new elements will be `undefined`

```
> a.length = 2;
> a
42,true
```

Non-contiguous arrays

- there is no such thing as an array out-of-bounds error
  - get an element out of bounds → `undefined`
  - set an element out of bounds → length increases to fit
    - any elements in between old/new lengths are `undefined`

```
> var a = [42, 10];
> a[10] = 5;
> a
42,10,,,,,,,,,5
> typeof(a[6])
undefined
> a.length
11
```

Array instance methods

`.concat(`***`expr`***`...)`	returns new array with appended elements/arrays

`.indexOf(`***`expr`***`)`
`.lastIndexOf(`***`expr`***`)`
	index of first/last occurrence of ***expr***; -1 if not found

`.join(`***`separator`***`)`	glues elements together into a string
`.pop()`	remove and return last element
`.push(`***`expr`***`...)`	append value(s) to end of array
`.reverse()`	returns new array w/ elements in opposite order
`.shift()`	remove and return first element
`.slice(`***`start, end`***`)`	returns sub-array from start (incl.) to end (exclusive)

`.sort()`
`.sort(`***`compareFn`***`)`
	sorts array in place, with optional compare function that takes 2 values, returns <0, 0, >0 (`compareTo`)

`.splice(`***`index,`***
  `count, expr``...)`
	Removes ***count*** elements from array starting at ***index***, and inserts any given new elements there

`.toString()`	converts array to string such as `"42,5,-1,7"`
`.unshift(`***`expr`***`...)`	insert value(s) at front of array

Array methods example

```
var a = ["Stef", "Jay"];  // Stef, Jay
a.push("Bob");            // Stef, Jay, Bob
a.unshift("Kelly");       // Kelly, Stef, Jay, Bob
a.pop();                  // Kelly, Stef, Jay
a.shift();                // Stef, Jay
a.sort();                 // Jay, Stef
```

- array serves as many data structures: list, queue, stack, ...
- methods: `concat`, `join`, `pop`, `push`, `reverse`, `shift`, `slice`, `sort`, `splice`, `toString`, `unshift`
  - `push` and `pop` add / remove from back
  - `unshift` and `shift` add / remove from front
    - `shift` and `pop` return the element that is removed

Split and join

```
var s = "quick brown fox";
var a = s.split(" ");  // ["quick", "brown", "fox"]
a.reverse();           // ["fox", "brown", "quick"]
s = a.join("!");       // "fox!brown!quick"
```

- `split` breaks a string into an array using a delimiter
  - can also be used with regular expressions (seen later)
- `join` merges an array into a single string, placing a delimiter between them

"Multi-dimensional" arrays

- JS doesn't have true multi-dimensional arrays, but you can create an array of arrays:

```
> var matrix = [[10, 15, 20, 25],
                [30, 35, 40, 45],
                [50, 55, 60, 65]];
> matrix[2][1]
55
> matrix.length
3
> matrix[1].length
4
```

(broken) for-each loop

```
for (name in expr) { statements; }
```

- JavaScript has a "for-each" loop, but it loops over each *index*, not each value, in the array.
  - in some impl.s, it also loops over the array's *methods*!
  - considered broken; discouraged from use in most cases

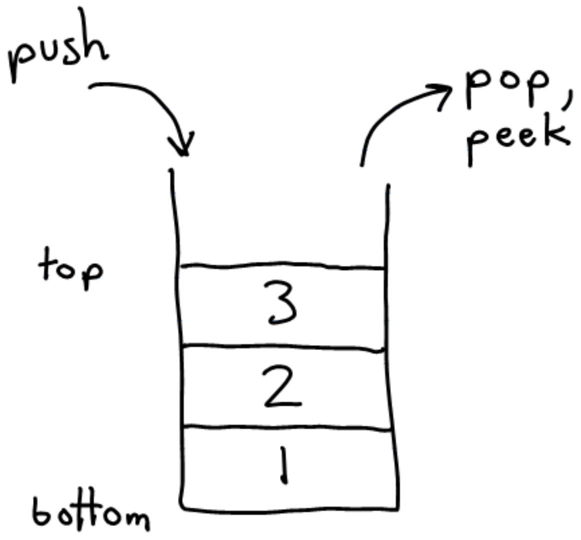
```
> var ducks = ["Huey", "Dewey", "Louie"];
> for (x in a) { print(x); }
0
1
2
```

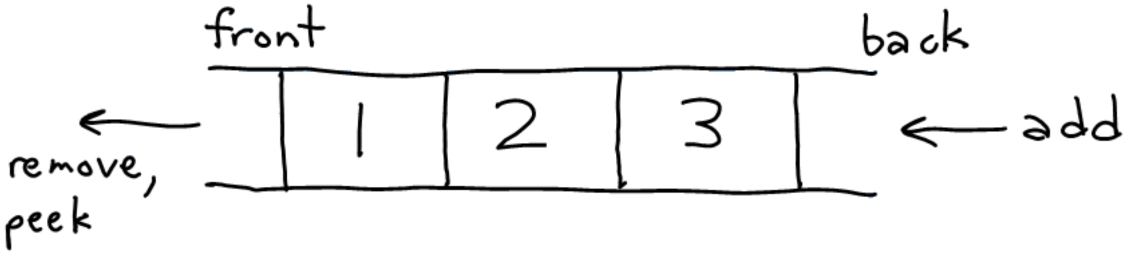
Array exercises

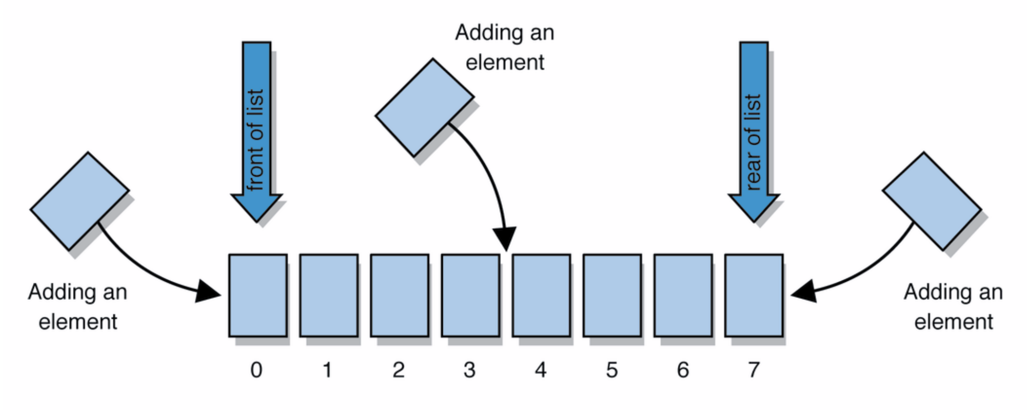
- Write a function `sum` that adds the values in an array.
- Write a function `longestWord` that takes a string and returns the word within that string with the most characters. If the string has no words, return `""`.
- Write a function `rotateRight` that accepts an array and an integer *n* and "rotates" it by sliding each element to the right by 1 index, *n* times.
    - `rotateRight([1, 2, 3, 4, 5], 2);` changes the array to store `[4, 5, 1, 2, 3]`

Simulating other data structures

- JS has no other collections, but an array can be used as...
  - a **stack**: `push, pop, length`
  - a **queue**: `push, shift, length`
  - a **list**: `push/pop/unshift/shift,slice/splice,indexOf...`







Array higher-order methods *

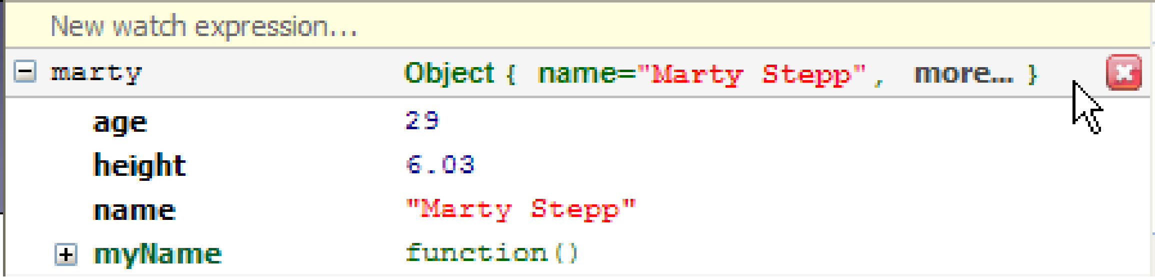
`.every(`***function***`)`	accepts a function that returns a `boolean` value and calls it on each element until it returns `false`
`.filter(`***function***`)`	accepts a function that returns a `boolean`; calls it on each element, returning a new array of the elements for which the function returned true
`.forEach(`***function***`)`	applies a "void" function to each element
`.map(`***function***`)`	applies function to each element; returns new array

`.reduce(`***function***`)`
`.reduce(`***function***`,` ***initialValue***`)`
`.reduceRight(`***function***`)`
`.reduceRight(`***function***`,` ***initialValue***`)`
	accepts a function that accepts pairs of values and combines them into a single value; calls it on each element starting from the front, using the given ***initialValue*** (or element [0] if not passed)
	
	`reduceRight` starts from the end of the array

`.some(`***function***`)`	accepts a function that returns a `boolean` value and applies it to each element until it returns `true`

** most web browsers are missing some/all of these methods*

Objects



```
New watch expression...
marty        Object { name="Marty Stepp", more... }
  age        29
  height     6.03
  name       "Marty Stepp"
  myName     function()
```

- *simple types*: numbers, strings, booleans, null, undefined
  - object-like; have properties; but are *immutable*
  - all other values in JavaScript are objects

- JavaScript objects are mutable key/value collections
  - a container of properties, each with a name and value

- JavaScript **does not have the concept of classes** (!!)
  - every object is "just an object"
  - *(it is possible to relate one object to others; seen later)*

Creating an object

```
{ name: expr,
  name: expr, ...,
  name: expr }
```

- can enclose name in quotes if it conflicts with a keyword

```
> var teacher = { fullName: "Marty Stepp",
    age: 31, height: 6.1, "class": "CSE 341" };
> var emptyObj = {};
```

- an object variable stores a reference to the object:

```
> var refToTeacher = teacher;    // not a copy
```

Accessing object properties

```
object.propertyName
object["propertyName"]
object[expr]
```

- use latter syntax if you don't know prop. name till runtime

```
> teacher.age
31
> teacher["fullName"]
Marty Stepp
> var x = "height";
> teacher[x]
6.1
```

Modifying/removing properties

```
object.propertyName = expr;
object["propertyName"] = expr;
delete object.propertyName;
delete object["propertyName"];
```

- `delete` removes a property from the object

```
> teacher.age = 29;             // if only...
> teacher["height"] -= 0.2;
> delete teacher.age;           // no one will know!
> typeof(teacher.age)
undefined
```

More about properties

- property names can be anything but `undefined`:

```
> var silly = {42: "hi", true: 3.14, "q": "Q"};
```

- you can add properties to an object after creating it:

```
> silly.favoriteMovie = "Fight Club";
> silly["anotherProp"] = 123;
```

- if you access a non-existent property, it is undefined:

```
> silly.fooBar
> typeof(silly.fooBar)
undefined
```

Null/undefined objects

- trying to read properties of null/undefined is an error:

```
> var n = null;
> var u;      // undefined
> n.foo       // error
> u.foo       // error
```

- You can guard against such errors with && and ||:

```
> teacher && teacher.name
Marty Stepp
> n && n.foo
null
> (n && n.foo) || 42    // 42 if n is falsey
42
```

Object methods

- an object can contain **methods** (functions) as properties
  - method can use the `this` keyword to refer to the object

```
function greet(you) {
    print("Hello " + you + ", I'm " + this.fullName);
}
```

```
> teacher.greet = greet;
> teacher.greet("students");
Hello students, I'm Marty Stepp
```

For-each loop on objects

```
for (name in object) { statements; }
```

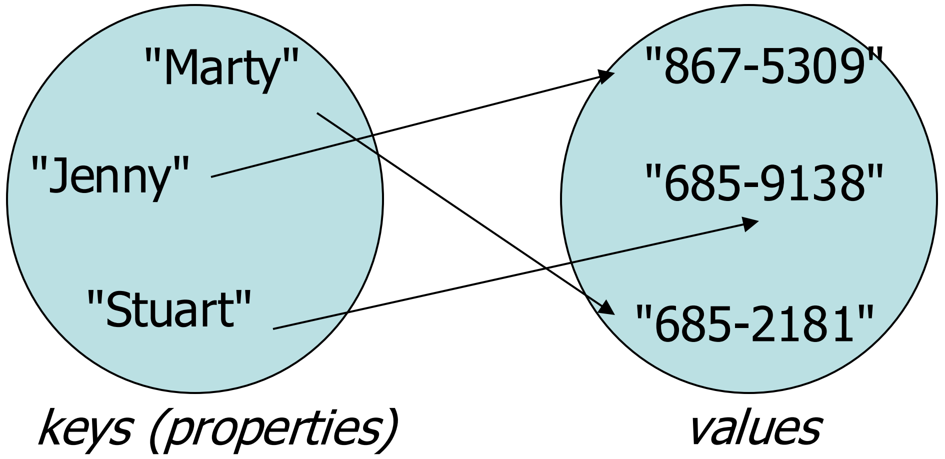
- "for-each" loops over each property's *name* in the object
  - it also loops over the objects's *methods*!
  - usually not useful; discouraged.   also order unpredictable

```
> for (prop in teacher) {
   print(prop + "=" + teacher[prop]); }
fullName=Marty Stepp
age=31
height=6.1
class=CSE 341
greet=function greet(you) {
    print("Hello " + you + ", I'm " + this.fullName);
}
```

Objects as maps

- JS has no **map** collection, but an object can be used as one:
    - the "keys" are the object's properties (property names)

```
> var phonebook = {};
> phonebook["Marty"]  = "685-2181";
> phonebook["Stuart"] = "685-9138";
> phonebook["Jenny"]  = "867-5309";
> phonebook["Stuart"]
685-9138
```

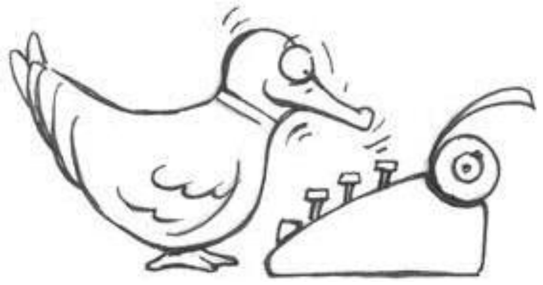


Arrays are (just) objects

- an array is (essentially) just an object with properties named `0`, 1, 2, ..., and a `length` property
  - arrays also contain methods like pop and `slice`

- it's hard to tell whether a given value even IS an array
  - `typeof({name: "Bob", age: 22})` → `"object"`
  - `typeof([1, 2, 3])` → `"object"`

Duck typing



- **duck typing**: Dynamic typing where an object's set of properties, rather than its class, determines its semantics.
  - *"If it walks like a duck, and quacks like a duck, ..."*

- JS code will "work" as long as a value is not used in a way that causes an error.

- Any JS parameter can be of any type, so a function that expects an array can be "tricked" by passing any object that "walks and quacks" like an array...

Duck typing in action

```
function sum(a) {  // add up elements of an "array"
    var total = 0;
    for (var i = 0; i < a.length; i++) {
        total += a[i];
    }
    return total;
}
```

- anything with `length` and numeric props. up to that length works:

```
> var a1 = [3, 4, 5];
> sum(a1)
12
> var o1 = {0:42, 9:77, 1:8, length:2};  // quack
> sum(o1)
50
```