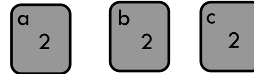
ECS 162
WEB PROGRAMMING

4/22

Scalar Objects

- String, Number, Boolean, undefined, null
  - Assigned by value

```
let a = 2;
let b = a;
let c = 2;
```



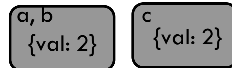
- Three variables, each containing 2

```
a === c  //  true
```

Compound Objects

- Array, Object
  - Assigned by reference

```
let a = {"val": 2};
let b = a;
let c = {"val": 2};
```



- There are two references (a and b) to one object

```
a === b // true
a === c  // false
```

We've been using this

```
let temp = document.getElementById("tempPgh");
temp.textContent = "72\u00b0";
```

- Here temp is a new reference to an existing object (part of the DOM). Changing its textContent property changes the DOM.

```
// does not change the DOM
let temp = document.getElementById("tempPgh");
let tStr = temp.textContent;  // a whole new string
tStr = "72\u00b0";
```

Functions

- Since functions are objects, they have properties.

```
let f = function () {
        console.log(f.animal);
}
f.animal = "cow";
```

- Functions are also assigned by reference

```
let g = f;
g.animal = "sheep";
```

- There is one function, and it prints "sheep"
- f and g are both references to the function

Garbage Collection

- Javascript has garbage collection, unlike C, C++ or Java.
- Notice we never allocate space for objects, and we don't have to free them.
- What is garbage collection?

Garbage Collection

- Javascript has garbage collection, unlike C, C++ or Java.
- Notice we never allocate space for objects, and we don't have to free them.
- What is garbage collection?
- The interpreter keeps track of the number of references to each variable. If the number of references goes down to zero, it reclaims the memory, and the variable is gone.
- How do references to a variable disappear?

Variable destruction

- How do references to a variable disappear?
- The reference to a variable is removed when the block it belongs to exits.

```
function changeTemp() {
        let t = document.getElementById("temp");
        t.textContent = "72\u00b0";
}
```

- During the function, the object with id "temp" had two references.
- After the function exits, it has one.

Listener for image download

- In collectPastDoppler, we set a listener for when an image has finished downloading.

```
let newImage = new Image();
newImage.onload = function () {
    // console.log("got image "+filename);
    addToArray(newImage);
}
newImage.onerror = function() {
    // console.log("failed to load "+filename);
}
newImage.src = "http://radar.weather.gov/ridge/RadarImg/N0R/DAX/"+filename;
```

- This is the fourth listener we've seen (onclick, onload for JSON, setInterval in animation, onload for image)

Callback functions

- The functions called by the listeners – onclick, onload, setInterval – are called callback functions.
- This pattern – set up a listener with a callback function – occurs all over Web code.
- Javascript is designed to handle it gracefully.
- Particular interesting, useful language feature: closure.

Closure

```
function tryToGetImage(dateObj) {
        …
    let newImage = new Image();
    newImage.onload = function () {
        addToArray(newImage);
    }
```

- The variable newImage belongs to tryToGetImage().
- newImage should disappear when tryToGetImage exits.
- But it is still there when the anonymous callback function runs, much later!

Closure

```
function tryToGetImage(dateObj) {
        …
    let newImage = new Image();
    newImage.onload = function () {
        addToArray(newImage);
    }
```

- *Any function created inside a block creates new references to all the variables from that block.*
- This is called a closure.
- We say that newImage is in the closure of the anonymous function.

Closure

- Lets look at a simpler example (from Elequent Javascript):

```
function wrapValue(n) {
    let local = n;
    return () => local;
}
let wrap1 = wrapValue(1);
let wrap2 = wrapValue(2);
```

Closure

- Lets look at a simpler example (from Elequent Javascript):

```
function wrapValue(n) {
    let local = n;
    return function () = { return local; };
}
let wrap1 = wrapValue(1);
let wrap2 = wrapValue(2);
```

- Type of wrap1 and wrap2?

Closure

```
function wrapValue(n) {
    let local = n;
    return function () = { return local; };
}
let wrap1 = wrapValue(1);
let wrap2 = wrapValue(2);
console.log( wrap1(), wrap2()) ;
```

- What does it print?

Closure

```
function wrapValue(n) {
    let local = n;
    return function () = { return local; };
}
let wrap1 = wrapValue(1);
let wrap2 = wrapValue(2);
console.log( wrap1(), wrap2()) ;
```

- What does it type?

1 2 – there are two separate functions, each referring to a different local variable "local"

Adding onclick…using Javascript

```
<div class="bird"  id="peacock"
                onclick="disappear('peacock')" >
```

- Consider building the corresponding DOM node in Javascript

```
birdDiv = document.createElement("div");
birdDiv.className = "bird";
birdDiv.id = "peacock";
birdDiv.onclick = "disappear('peacock')";
```

- What is the type of birdDiv.onclick?

Adding an onclick value

```
<div class="bird"  id="peacock"
                onclick="disappear('peacock')" >
```

- Consider building the corresponding DOM node in Javascript

```
birdDiv = document.createElement("div");
birdDiv.className = "bird";
birdDiv.id = "peacock";
birdDiv.onclick = "disappear('peacock')";
```

- What is the type of birdDiv.onclick? STRING, sadly.

How about this?

birdDiv.onclick = disappear('peacock');

- What is the type of birdDiv.onclick?

How about this?

birdDiv.onclick = disappear('peacock');

- What is the type of birdDiv.onclick?
  undefined, since disappear is executed on the right-hand side, and it does not have a return value.

Third try

birdDiv.onclick = disappear;

- What is the type of birdDiv.onclick?

Third try

birdDiv.onclick = disappear;

- What is the type of birdDiv.onclick?
  It's a function, but it's not going to work without it's parameter! It has to know which one to delete!

Three trys, all wrong…

```
birdDiv.onclick = "disappear('peacock')";
birdDiv.onclick = disappear('peacock');
birdDiv.onclick = disappear;
```

Do it using a closure

```
function addOnclick(element, func, param) {
  function noarg() {
      func(param);
      }
  element.onclick = noarg;
  }
addOnclick(birdDiv, disappear, "peacock");
```

- Notice we define a function inside another function.
- What is the type of birdDiv.onclick?

Do it using a closure

```
function addOnclick(element, func, param) {
  function noarg() {
      func(param);
      }
  element.onclick = noarg;
 }
```

- When does "noarg" get called?

Do it using a closure

```
function addOnclick(element, func, param) {
  function noarg() {
      func(param);
      }
  element.onclick = noarg;
 }
```

- When does "noarg" get called? When the button is pushed, long after "addOnclick" has exited.
- But its closure still contains the references to "param" and "func".

Closure

- The closure of a Javascript function contains all the variables in the scope within which the function was defined.
- The closure is part of the function object.
- The closure of "noarg" is "addOnclick"
- The local variables declared in "addOnclick" are available to "noarg", forever.
- If we call "addOnclick" multiple times, we can declare different instances of the local variables, and versions of "noarg" with different closures.

See example in poultry3.js

- Additional things to notice…
  - Uses DOM methods querySelector() and querySelectorAll(), more general variants of getElementById
  - Function can be called before it is defined, thanks to function hoisting.

Anonymous closure

- Closure and anonymous functions are often combined in a powerful but (initially…) mysterious pattern.

```
function addOnclick(element, func, param) {
      element.onclick = function () {
               func(param);
               }
}
```

- Do we prefer the anonymous version?