Impact Lab 2023: Programming Fundamentals
Lecture 4: Arrays and More Objects

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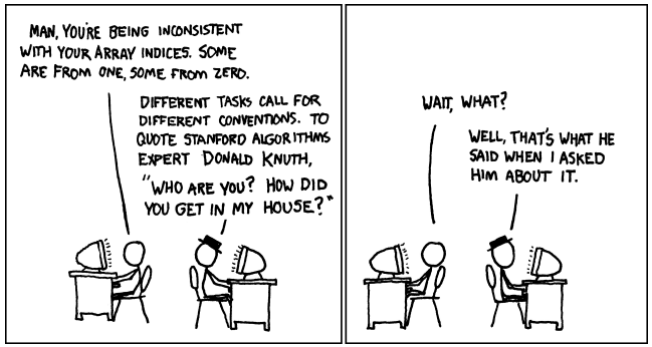
School of Computing and Data Science

Wentworth Institute of Technology



Object References

- Objects are accessed via the object reference.
- An object's data and methods are accessed via the dot(`.`) operator.
- The dot operator follows the reference to the object.
- The variable '**`radius`**' is known as an instance variable because it is dependent on the specific instance.

Instantiation and assignment

```
circle1 = new Circle();
```

Accessing the Radius Variable

```
circle1.radius
```


Using the Rectangle Class

In the index.html file, add your new JavaScript file like this:

```
<script src="sketch.js"></script>
<script src="Rectangle.js"></script>
```

This gives your sketch (main program) access to the code that you wrote in your new file.

Now, create a rectangle object in your main sketch and run the **`getArea()`** function. Print out the resulting value.

Update our Bouncing Ball

Let's update our bouncing ball program to use an object for the ball instead of having all the code in the main file, setup, and draw.

Also, let's add a "kick" that adds some random velocity when we click the mouse.

We'll need to lookup how to detect a mouse click.

Bubbles!

Let's make a Bubble class.

Each bubble will be a circle with an outline only.

They move by randomly jittering around on the screen.

They'll have two methods, **`move()`** and **`show()`** that we will call from **`draw()`**.

Initial Object Wrap up

- A class defines a complex variable type
  - Contains its own data fields and functions that are only for use with objects of that class
- There are many predefined classes in JavaScript.
- You can also define your own classes
  - Often done to represent an entity in your program that requires more than one variable
- This is just the beginning of object oriented (OO) software development

Topics for Today

- **Arrays**
- Arrays and Objects
- Object Communication

What is an Array?

An **array** is a list of variables of the same type that represents a set of related values

What if we need to keep track of 1000 items? → Use 1000 variables! `num1, num2, …`

Actually, you use an **array**

Creating an Array

In JavaScript, an **array** is an object, but it also has some new syntax.

The new special symbols, used to denote an array are square brackets: `[]`

The idea is to create a collection of variables all of the same type in just one step:

```
let myArray=[];
let anotherArray=[1,2,3,4,5];
let yetAnotherArray=["hello","world"];
```


Creating an Array

```
let myArray=[];
let anotherArray=[1,2,3,4,5];
let yetAnotherArray=["hello","world"];
```

Start by creating a regular variable with **`let`** and seeing it equal to `[]`

This new array can hold as many elements as you want, including predefined values.

A Collection of Variables

You can think of creating an array as declaring many individual variables:

```
let counts=[];
```

This is similar, but not exactly the same as declaring many separate variables:

```
let counts0, counts1, counts2, counts3, counts4, counts5, counts6, counts7;
```


Accessing Array Elements

To actually use an individual element in the array, you must specify the **`index`** of the element in brackets

Be careful not to confuse the two uses of brackets (array creation versus array use)

Example: Array named counts. Setting the value at index 7 to 10:

```
// create an array
let counts=[];
// assign element 7 a value of 10
counts[7] = 10;
```

Arrays in Memory

Arrays are stored in memory so that all the elements in the array are **sequential**

```
let counts=[0,0,0,0,0,0,0,0];
counts[3] = 10;
```

address	value	variable
1000	0	counts[0]
1004	0	counts[1]
1008	0	counts[2]
1012	10	counts[3]
1016	0	counts[4]
1020	0	counts[5]
1024	0	counts[6]
1028	0	counts[7]
1032		
1036		

Array Elements and Length

IMPORTANT NOTE: Arrays start at index **0** and go through index **size-1**

Use **ARRAY.length** to get the size of the array

Arrays do **NOT** start at index 1!

Array indices do not have to be hard coded, they can be any expression that evaluates to an integer:

```
let temperatures = [];
for (let i = 0; i < 64; i++) {
  temperatures[i] = 50;
}
```

What does this code do?

Out of Bounds

You should always have to ensure that your program only uses valid elements/indices for an array

You shouldn't access an index greater than or equal to the length of the array

For the most part, if you access an index that hasn't been set, it will be evaluated to **undefined**.

```
let myArray = [];
myArray[0] = 5;  // ok
myArray[9] = -6; // ok
print(myArray[-1]); // will print undefined
print(myArray[10]); // will print undefined
```


How Useful is it, Really?

If I have many ellipses to draw, I can use an array to store some of the data:

```
let nums=[100,25,72,45];
function draw(){
  background(0);
  ellipse(100,200,nums[0],nums[0]);
  ellipse(200,200,nums[1],nums[1]);
  ellipse(300,200,nums[2],nums[2]);
  ellipse(400,200,nums[3],nums[3]);
}
```

But, there's still a bunch of repeated code...

How Useful is it, Really?

Use a loop!

```
let nums=[100,25,72,45];
function draw(){
  background(0);
  for(let i=0;i<4;i++){
      ellipse((i+1)*100,200,nums[i],nums[i]);
  }
}
```

Loops and Arrays are almost always used together

Topics for Today

- Arrays
- **Arrays and Objects**
- Object Communication

Let's Go Back to Bubbles!

We've already defined our bubbles and created multiple bubbles.

```
let bubble0;
let bubble1;
let bubble2;
let bubble3;
let bubble4;
```

But...that's a lot of copied code.

And what if I want 1000 bubbles?

Close...but still not great.

```
let bubbles=[];
bubbles[0]=new Bubble(…);
```


Let's Go Back to Bubbles!

We can use a loop again to create all our bubbles.

```
for(let i=0;i<5;i++){
  bubbles[i]=new Bubble(…);
}
```

Now, I can create as many bubbles as I want!

Depending on the values that we use to initialize the bubble, we may need an equation to determine positions, sizes, etc.

Adding Bubbles

What if we wanted to create a bubble every time we clicked the mouse?

Arrays are actually objects too! They have many features that allow us to add/remove/manipulate elements of an array.

```
function mousePressed(){
  let size=random(10,50);
  let b = new Bubble(mouseX,mouseY,size);
  bubbles.push(b);
}
```

Change **mousePressed()** to **mouseDragged()**

Adds **b** to the next available space in the **bubbles** array.

Mouse Interaction

We have a function called **mousePressed()** that p5.js can use to check if we click the mouse.

Unfortunately, p5.js can't tell we click on a shape, even with **mousePressed()**.

We have to come up with our own equation to determine if we've clicked on an object.

We need some code to tell us a point we click on is within a circle...Does that sounds familiar?

A Quick Note on Style

When creating classes, it's useful to limit what external information a class needs.

For example, our bubble class needs to know about **mouseX** and **mouseY**.

This is called a dependency.

What if we decided to change to a different graphics library that didn't have **mouseX** and **mouseY**?

We should write our classes in such a way that they have the fewest dependencies possible.

Bubbles Exercise

Let's play with the **Bubble** class and mouse interaction.

Removing Elements from an Array

Maybe we want to pop our bubbles when we click.

There are several ways to remove elements in an array depending on what you want to remove.

`pop()` removes the last element

`splice()` removes at a selected index

If we know the index of the bubble in the array, we can just remove it so it no longer draws.

Let's play around with removing elements. We need to take care in certain situations.

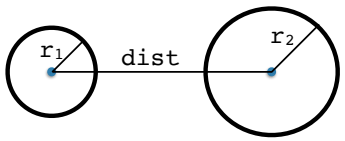
Topics for Today

- Arrays
- Arrays and Objects
- **Object Communication**

Object Communication

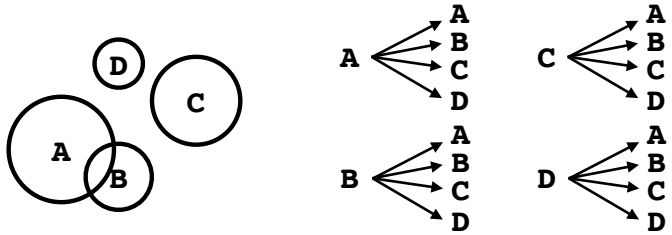
We can already tell if an object and the mouse interact, but what about multiple objects?

For circles, it's nice and easy, but for other objects it can be very complicated.



More Nested Loops

If I have many bubbles, I need to check every pairwise combination of bubbles.



So, we pick a bubble, loop though every other bubble, and check if they touch.