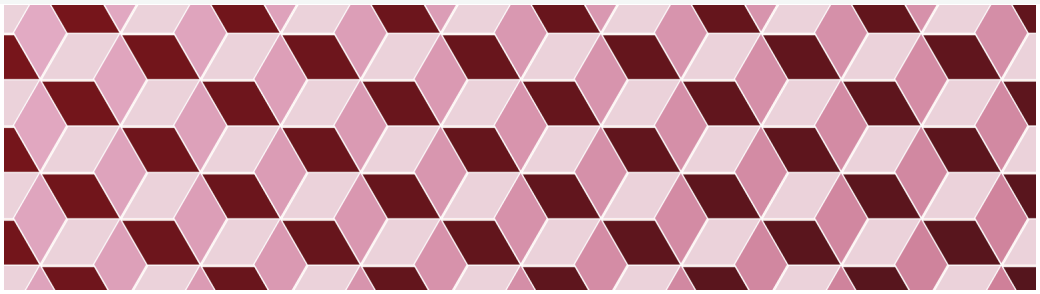

15-104 Introduction to Computing for Creative Practice

Fall 2020

16 Objects

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Variables

- In Javascript, we have seen that we can store a single data value in a variable.

```
var x = 15104;
var winner = true;
var boxColor = "purple";
```

- We can also reference an array from a variable.

```
var temps = [79, 81, 57, 64, 63, 57, 58]
```

- But we also saw multiple variables holding data for the same object we were drawing on the canvas (e.g. drawing one box on the canvas):

```
var x, y, dx, dy, c;
```

- Although they're individual variables, they're all connected to the same shape.

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Objects

- In Javascript, an **object** can be defined using a variable. However, the object has properties and behaviors associated with the object.
- An object can be defined literally

```
var sqr = {x: 100, y: 100, w: 50, dx: 5,
           r: 255, g: 255, b:0};
```

- To access any properties of the object, we use dot notation, listing the object variable name followed by a dot followed by the property (field) of the object.

```
fill(sqr.r, sqr.g, sqr.b);
rect(sqr.x, sqr.y, sqr.w, sqr.w);
sqr.x += sqr.dx;
if (sqr.x > width) { sqr.x = -sqr.w };
```

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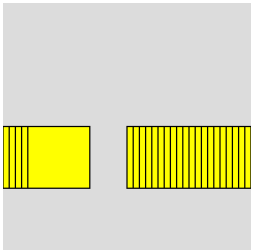
A square object

```
var sqr = {x: 100, y: 100, w: 50, dx: 5, r: 255, g: 255, b:0};
function setup() {
    createCanvas(200, 200);
    background(220);
    frameRate(30);
}
function draw() {
    fill(sqr.r, sqr.g, sqr.b);
    rect(sqr.x, sqr.y, sqr.w, sqr.w);
    sqr.x += sqr.dx;
    if (sqr.x > width) { sqr.x = -sqr.w; }
}
```



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Objects

- To access any properties of the object, you can also treat the object variable like an array and use the field name, in quotes, as the index:

```
fill(sqr["r"], sqr["g"], sqr["b"]);
rect(sqr["x"], sqr["y"], sqr["w"], sqr["w"]);
sqr["x"] += sqr["dx"];
if (sqr["x"] > width) { sqr["x"] = -sqr["w"]; }
```

- We will prefer the dot notation since this is common across languages.

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Objects

- We can also create objects by construction within our program code.

```
var sqr;
function setup() {
    createCanvas(200, 200);
    background(220);
    frameRate(5);
    sqr = new Object();
    sqr.x = 100; sqr.y = 100; sqr.w = 50; sqr.dx = 5;
    sqr.r = 255; sqr.g = 255; sqr.b = 0;
}
```

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Objects and Equality

- Consider the following Javascript code:

```
var sqr1;
var sqr2;
function setup() {
    sqr1 = {x: 100, y: 100, w: 50, dx: 5,
            r: 255, g: 255, b:0};
    sqr2 = new Object();
    sqr2.x = 100; sqr2.y = 100; sqr2.w = 50; sqr2.dx = 5;
    sqr2.r = 255; sqr2.g = 255; sqr2.b = 0;
    print(sqr1 == sqr2);
}
```

- Although both objects are exactly the same, this prints `false`. Why?

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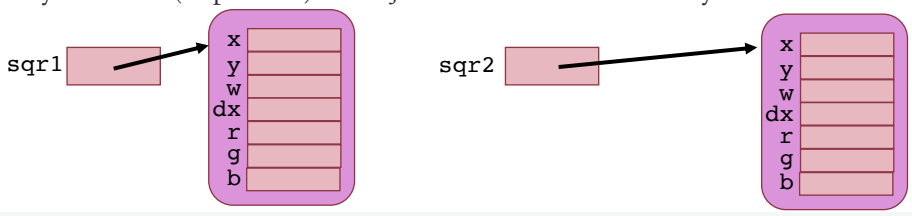
Objects and Equality

- Each variable points to ("references") its own object.
- This reference is typically a memory address where the object is stored.
- The operator == is testing the contents of the variables `sqr1` and `sqr2` which are memory addresses.
  - Remember, these object variables do not hold the objects themselves. They reference (or point to) the objects somewhere in memory.



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Objects and Equality

- Consider the following Javascript code:

```
var sqr1;
var sqr2;
function setup() {
    sqr1 = {x: 100, y: 100, w: 50, dx: 5,
            r: 255, g: 255, b:0};
    sqr2 = sqr1;
    print(sqr1 == sqr2);
}
```

- Now, this code prints `true`. Why?

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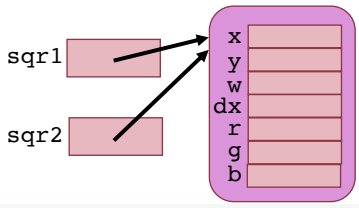
Objects and Equality

- Using the reference principle, when we assign `sqr2` with the value stored in `sqr1`, str1 contains the location of the object (not the object itself).
- So `sqr2` gets a copy of the location of the object.
- Now `sqr1` and `sqr2` are both referencing (pointing to) the same object.
- This reference is typically a memory address where the object is stored.



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Aliasing

- In the previous example, `sqr2` is an **alias** of `sqr1`.
  - They both essentially point to the same thing.
- If we change the object through one alias, we will see that change through the other alias.

```
sqr1 = {x: 100, y: 100, w: 50, dx: 5,
        r: 255, g: 255, b:0};
sqr2 = sqr1;
sqr2.w = 75;
print(sqr1.w);       // prints 75
```

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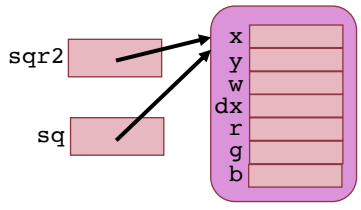
Objects and Function Calls

- Whenever you call a function with a parameter, a copy of the argument is passed to the function and stored in the parameter.
- The same happens with objects, so when you call a function and pass an object, you're really passing a reference to it which is stored in the parameter.
- So the parameter acts like an alias of the original object variable.

```
function draw_sqr(sq) {
...
}

draw_sqr(sqr2);
```



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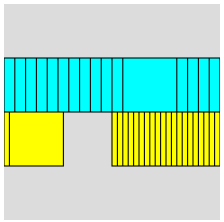
Two square objects

```
var sqr1 = {x: 100, y: 100, w: 50, dx: 5, r: 255, g: 255, b:0};
var sqr2 = {x: 50, y: 50, w: 50, dx: 10, r: 0, g: 255, b:255};

function setup() {
    createCanvas(200, 200);
    background(220);
    frameRate(5);
}
```



```
function draw() {
    draw_sqr(sqr1);
    draw_sqr(sqr2);
}

function draw_sqr(sq) {
    fill(sq.r, sq.g, sq.b);
    rect(sq.x, sq.y, sq.w, sq.w);
    sq.x += sq.dx;
    if (sq.x > width) { sq.x = -sq.w; }
}
```

`sq` is an alias, first for `sqr1`, then for `sqr2`

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Arrays of Objects

- You can even have an array of objects!

```
var sqr_array = [];

function setup() {
    sqr_array[0] = {x: 100, y: 100, w: 50, dx: 5,
                    r: 255, g: 255, b:0};
    sqr_array[1] = {x: 50, y: 50, w: 50, dx: 10,
                    r: 0, g: 255, b:255};
    ...
}
function draw() {
    fill(sqr_array[0].r, sqr_array[0].g, sqr_array[0].b);
    square(sqr_array[0].x, sqr_array[0].y, sqr_array[0].w);
    ...
```

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Many Boxes (again)

```
var bx = [];   // array of boxes

function setup() {
    createCanvas(200, 200);
    for (i = 0; i < 100; i++) {
        bx[i] = new Object();
        bx[i].x = random(width);
        bx[i].y = random(height);
        bx[i].dx = random(-5, 5);
        bx[i].dy = random(-5, 5);
        bx[i].c = color(random(255), random(255), random(255));
    }
    frameRate(5);
}
```

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Many Boxes (again)

```
function draw_box(b) {
    fill(b.c);
    rect(b.x, b.y, 10, 10);
}

function update_box(b) {
    b.x += b.dx;
    b.y += b.dy;
    if (b.x > width) b.x = 0;
    else if (b.x < 0) b.x = width;
    if (b.y > height) b.y = 0;
    else if (b.y < 0) b.y = height;
}
```

These functions run some generic box object b. (b is an alias.)

Note there is no subscript since this should work for any of the box objects.

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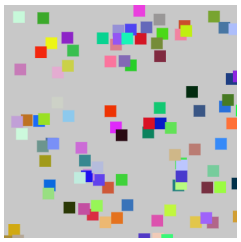
Many Boxes (again)

```
function draw() {
    background(200, 200, 200);
    noStroke();
    for (i = 0; i < 100; i++) {
        draw_box(bx[i]);
        update_box(bx[i]);
    }
}
```



For each of the 100 box objects, send the i^{th} box object to the two helper functions to draw and update each box.

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Try This

- Modify the horizontally moving box program so that the box reappears at some new random vertical position when it reappears on the left side.
- Modify the many boxes programs so that all of the boxes get new random colors when the mouse is clicked.

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