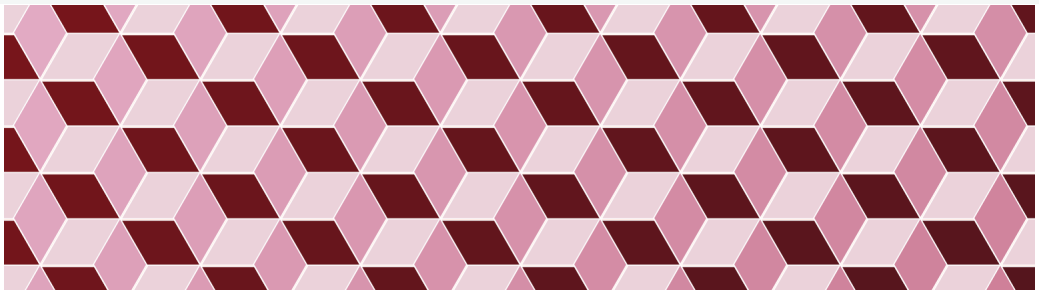


15-104 Introduction to Computing for Creative Practice

Fall 2021

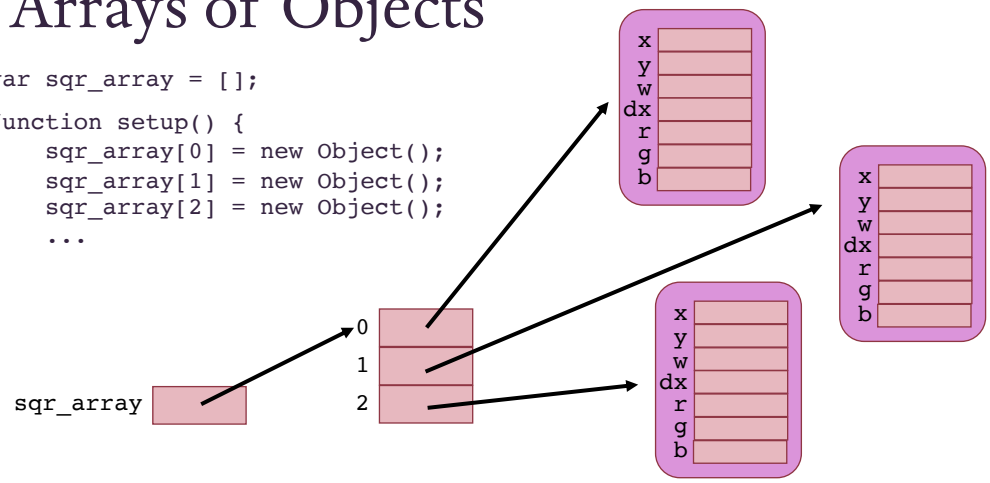
17 More Objects (based on examples from Khan Academy)

Instructor: Tom Cortina, tcortina@cs.cmu.edu, GHC 4117, 412-268-3514

1

Arrays of Objects

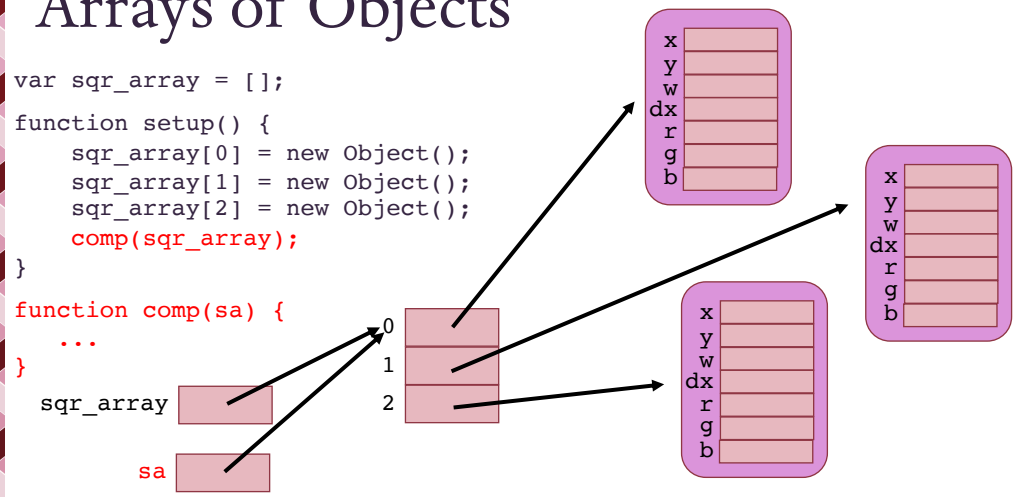
```
var sqr_array = [];

function setup() {
    sqr_array[0] = new Object();
    sqr_array[1] = new Object();
    sqr_array[2] = new Object();
    ...
}
```



2

Arrays of Objects

```
var sqr_array = [];

function setup() {
    sqr_array[0] = new Object();
    sqr_array[1] = new Object();
    sqr_array[2] = new Object();
    comp(sqr_array);
}

function comp(sa) {
   ...
}
```



3

Functions as Values

- Recall we define functions in p5.js this way:

```
function area() {
   return width * height;
}
```

- We treat `area` as something special but it's just another variable.
- It's a global variable whose value is not a number or string or array, but instead its value is a function that can compute something.
- Since `area` is essentially a variable, we can assign another variable to it.

```
var canvasArea = area;
var x = canvasArea();
```

4

Anonymous Functions

- Some languages like Javascript allow for **anonymous functions**.
  These are functions that have no name, but they can be assigned to variables.
  Then when you use the variable as a function, you run the function.

```
var area = function() {
    return width * height;
}
function setup() {
    createCanvas(200, 300);
    print(area);
}
```

prints:

```
f() {
    return width * height;
}
```

```
var area = function() {
    return width * height;
}
function setup() {
    createCanvas(200, 300);
    print(area());
}
```

prints:

```
60000
```

5

Anonymous Functions

- Anonymous function can have parameters as well.

```
var volume = function(depth) {
    return width * height * depth;
}
function setup() {
    createCanvas(200, 300);
    print(volume);
}
```

prints:

```
f(depth) {
    return width * height * depth;
}
```

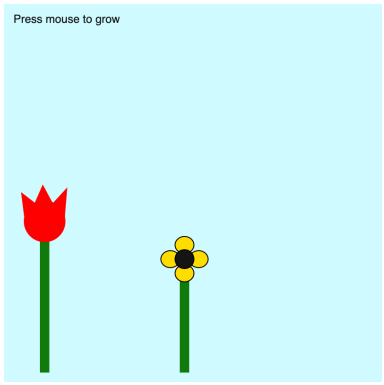
```
var volume = function(depth) {
    return width * height * depth;
}
function setup() {
    createCanvas(200, 300);
    print(volume(4));
}
```

prints:

```
240000
```

6

Example: Flower Grower (Khan Academy)



Properties of each flower:
- x
- y
- height

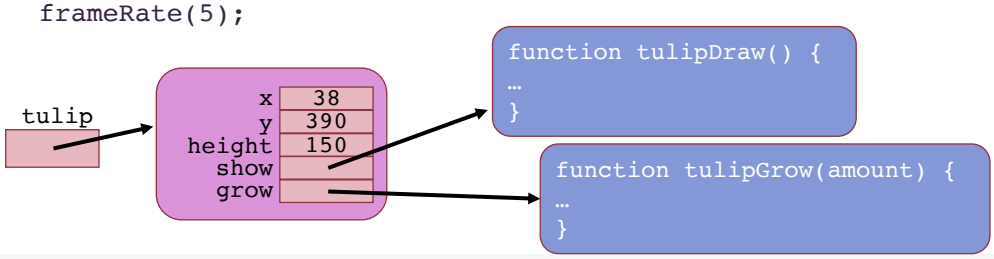
Behaviors of each flower:
- show itself (draw on the canvas)
- grow by some amount
- make itself (create or construct)

Objects not only can hold properties (fields) but they can also hold behaviors (functions) that they can perform on themselves.

7

Main program (focus on the tulip)

```
var tulip;
var sunflower;

function setup() {
    createCanvas(400, 400);
    tulip = makeTulip(38, 390, 150);
    sunflower = makeSunflower(186, 390, 100);
    frameRate(5);
}
```



8

Main program (cont'd)

```
function draw() {
    background(207, 250, 255);
    tulip.show();
    sunflower.show();
    noStroke();
    text("Press mouse to grow", 10, 20);
};
function mousePressed() {
    tulip.grow(5);
    sunflower.grow(10);
}
```

9

this

- When we define a function that will be a behavior for an object, we will likely need to reference the properties of the object.
- We use the reference `this` to indicate that we are writing a function and we are referencing a property of this object while performing the function.
- Example: Suppose our object is a square box that has properties: `x`, `y`, and `w`, and we are programming a behavior `area` for the box that allows it to return its own area. We would write its function this way:

```
function area() {
   return this.w * this.w;
}
```

This function `area` would be stored as a property in the object alongside `x`, `y`, and `w`! Remember that functions are values too!

10

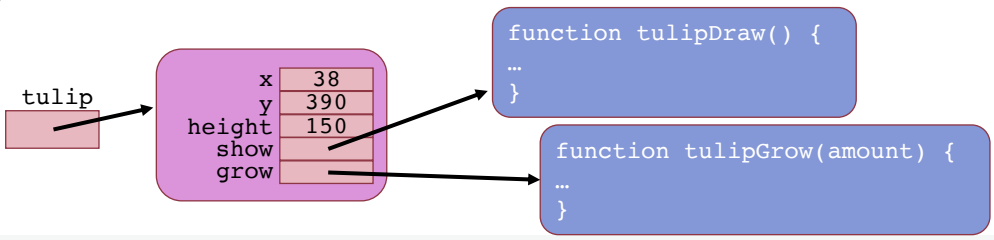
Tulip behaviors

```
function tulipDraw() {
    noStroke();
    fill(16, 122, 12);
    rect(this.x, this.y - this.height, 10, this.height); // stem
    fill(255, 0, 0); // red for petals
    var y = this.y - this.height;   // to save some code
    ellipse(this.x + 5, y, 44, 44);
    triangle(this.x - 16, y, this.x + 20, y, this.x - 20, y - 31);
    triangle(this.x - 14, y, this.x + 24, y, this.x + 3, y - 39);
    triangle(this.x + -4, y, this.x + 26, y, this.x + 29, y - 36);
};

function tulipGrow(amount) {
    this.height += amount;
};
```

11

Tulip behaviors (cont'd)

```
// makeTulip is a special behavior called a CONSTRUCTOR.
// It constructs an instance of the object.

function makeTulip(tx, ty, th) {
    var tulip = {x: tx, y: ty, height: th,
                 show: tulipDraw, grow: tulipGrow};  // new object
    return tulip; // return the new object
};
```



12

Sunflower behaviors

```
function sunflowerDraw() {
    noStroke();
    fill(16, 122, 12);
    rect(this.x, this.y - this.height, 10, this.height);
    stroke(0, 0, 0);
    fill(255, 221, 0); // yellow
    var y = this.y - this.height;
    ellipse(this.x - 10, y, 20, 18);
    ellipse(this.x + 5, y - 15, 20, 18);
    ellipse(this.x + 5, y + 15, 20, 18);
    ellipse(this.x + 20, y, 20, 18);
    fill(20, 20, 20); // dark center
    ellipse(this.x + 5, y, 20, 20);
};
```

13

Sunflower behaviors (cont'd)

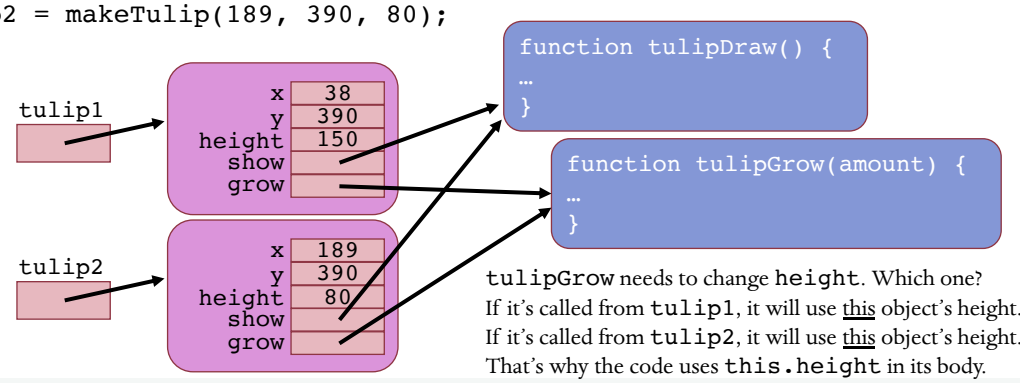
```
function sunflowerGrow(amount) {
    this.height += amount;
};

// makeSunflower is a special behavior called a CONSTRUCTOR.
// It constructs an instance of the object.

function makeSunflower(sx, sy, sh) {
    var sunflower = {x: sx, y: sy, height: sh,
                     show: sunflowerDraw, grow: sunflowerGrow};
    return sunflower; // return the new object
};
```

14

Revisiting `this`

Why do we need `this` in the methods?

```
tulip1 = makeTulip(38, 390, 150);
tulip2 = makeTulip(189, 390, 80);
```



`tulipGrow` needs to change `height`. Which one?
If it's called from `tulip1`, it will use this object's height.
If it's called from `tulip2`, it will use this object's height.
That's why the code uses `this.height` in its body.

15

Methods

The behaviors of an object are called **methods**.

Note that we defined tulip and sunflower to have the same method names: `show` and `grow`. (They call different functions, of course.)

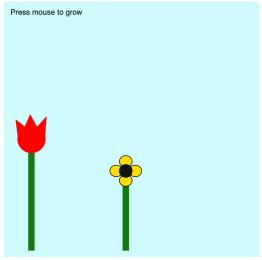
This way, if we had a variable that was either a tulip or a sunflower, we could call `show` either way and it would work!

```
...
var flower = tulip;
flower.show();
flower = sunflower;
flower.show();
...
```

16

Array of 2 Flowers: Main program

```
var tulip;
var sunflower;
var flowers = []; // an empty array

function setup() {
    createCanvas(400, 400);
    tulip = makeTulip(38, 390, 150);
    sunflower = makeSunflower(186, 390, 100);
    flowers.push(tulip);
    flowers.push(sunflower);
    // or, you could write flowers = [tulip, sunflower];
    frameRate(5);
}
```



17

Array of 2 Flowers: Main program

```
function draw() {
    background(207, 250, 255);
    for (var i = 0; i < flowers.length; i++) {
        flowers[i].show();
    }
    noStroke();
    text("Press mouse to grow", 10, 20);
};

function mousePressed() {
    for (var i = 0; i < flowers.length; i++) {
        flowers[i].grow(5);
    }
}
```

18

Random Acts of Flowers (Main Program)

```
var tulip;
var sunflower;
var flowers = []; // an empty array

function setup() {
    createCanvas(400, 400);
    tulip = makeTulip(38, 390, 150);
    sunflower = makeSunflower(186, 390, 100);
    flowers.push(tulip);
    flowers.push(sunflower);
    frameRate(5);
}
```

19

Random Acts of Flowers (Main Program)

```
function draw() {
    background(207, 250, 255);
    for (var i = 0; i < flowers.length; i++) {
        flowers[i].show();
    }
    noStroke();
    fill(0);
    text("Press key for acts of random flowers.", 10, 20);
    text("Press mouse to grow", 10, 35);
};
```

20

Random Acts of Flowers (Main Program)

```
function mousePressed() {
    for (var i = 0; i < flowers.length; i++) {
        flowers[i].grow(5);
    }
}
function keyPressed() {
    // allFlowers is an array of constructors!
    var allFlowers = [makeTulip, makeSunflower];
    // flowerMaker is a random constructor from the array
    var flowerMaker = random(allFlowers);
    flowers.push(flowerMaker(random(width),
                 height - random(100),
                 90 + random(50)));
}
```

21

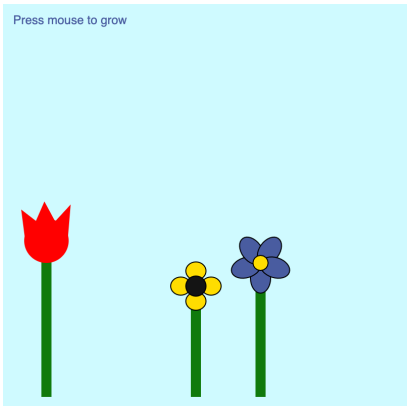
Try This

\

Add a violet to the previous programs.

Give each flower a different amount to grow by when the mouse is clicked.

Modify the random flower generator so it displays only the most recent 10 flowers.



22