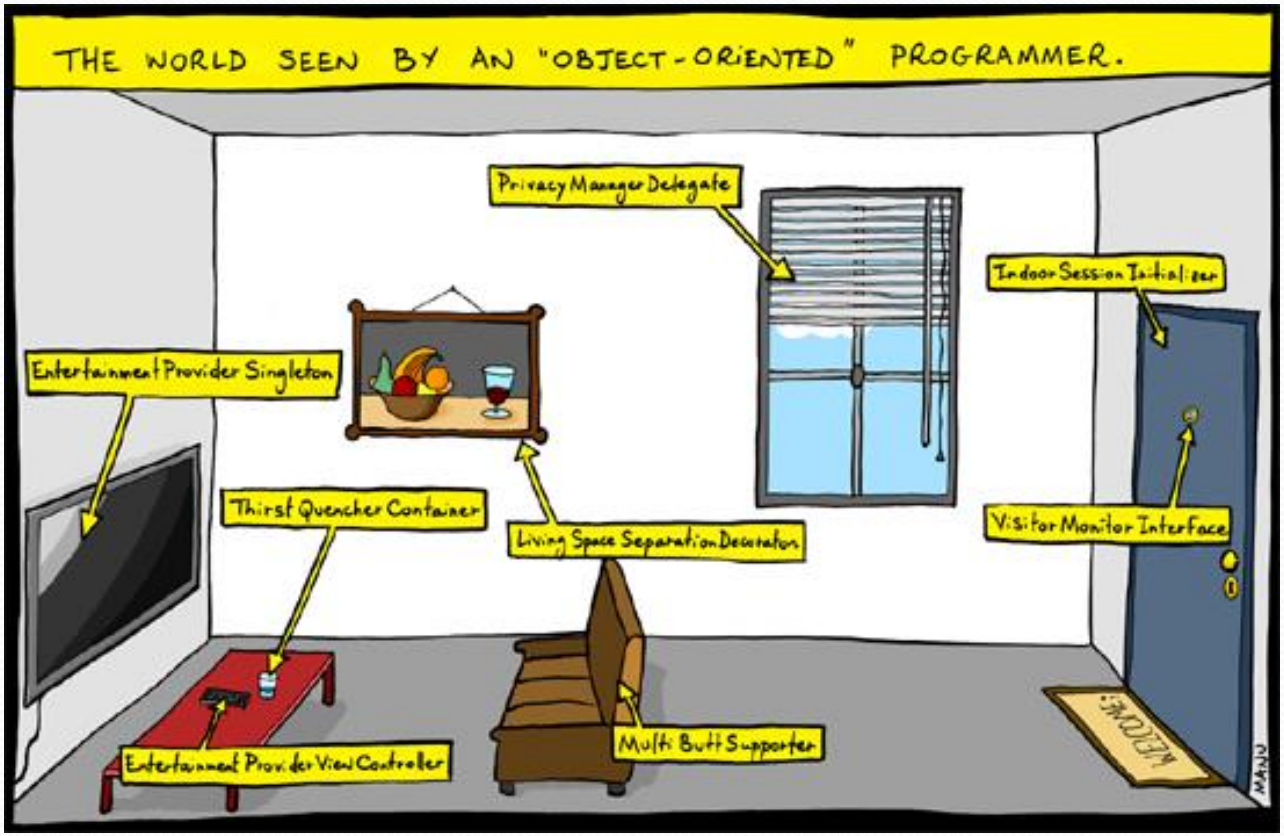
CS 142, Spring 2024

Lecture 2: Review and introduction to `Lists`

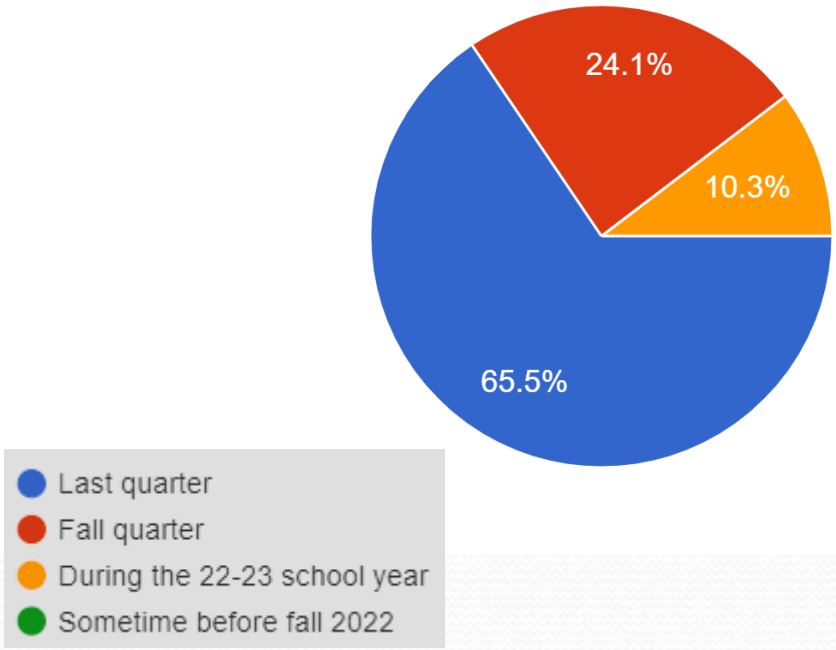


Thanks to Marty Stepp and Stuart Reges for parts of these slides!

Survey Results

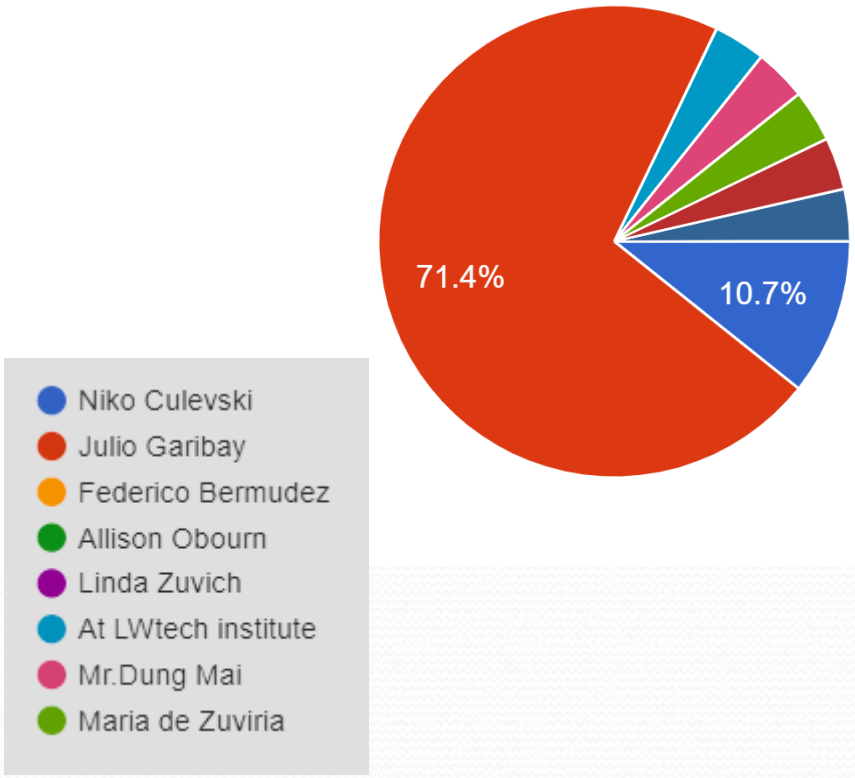
When did you take CS& 141

29 responses



Who was your CS& 141 instructor?

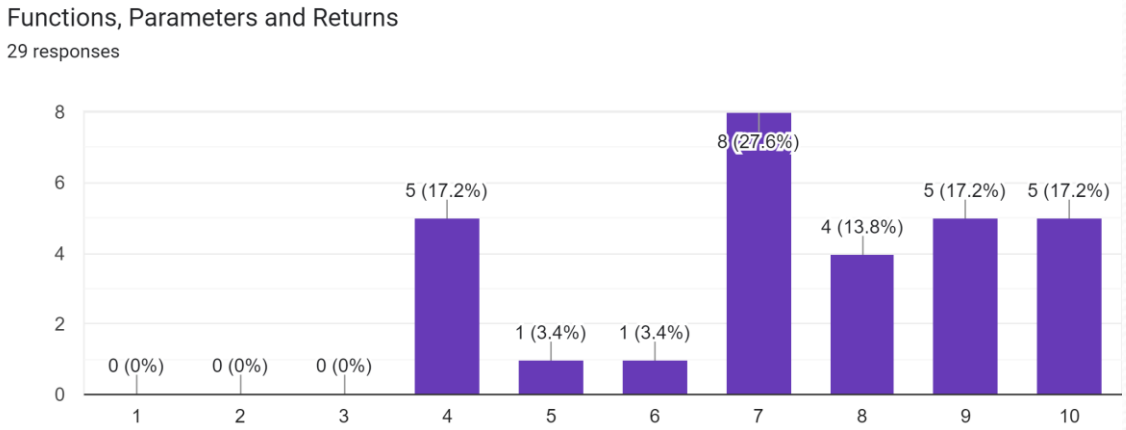
28 responses

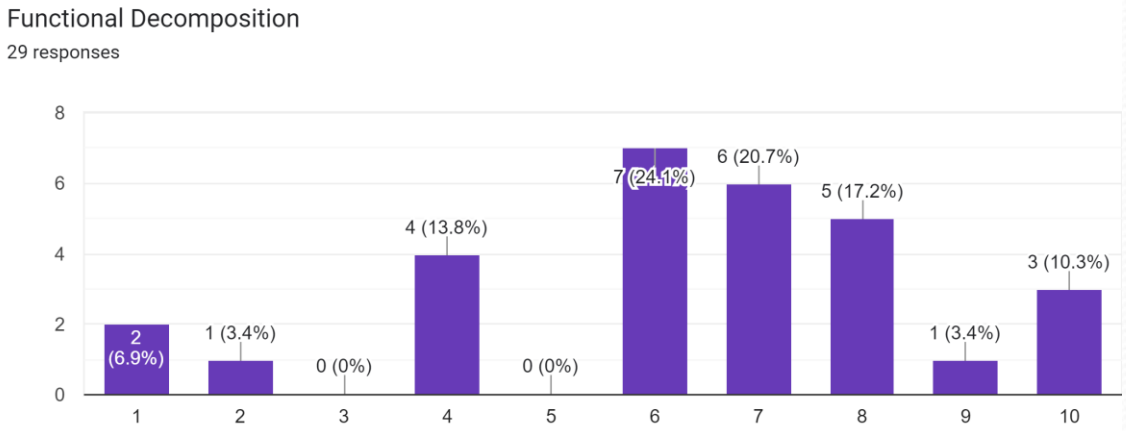


Topic Survey Results

Most students indicated they were pretty comfortable with:

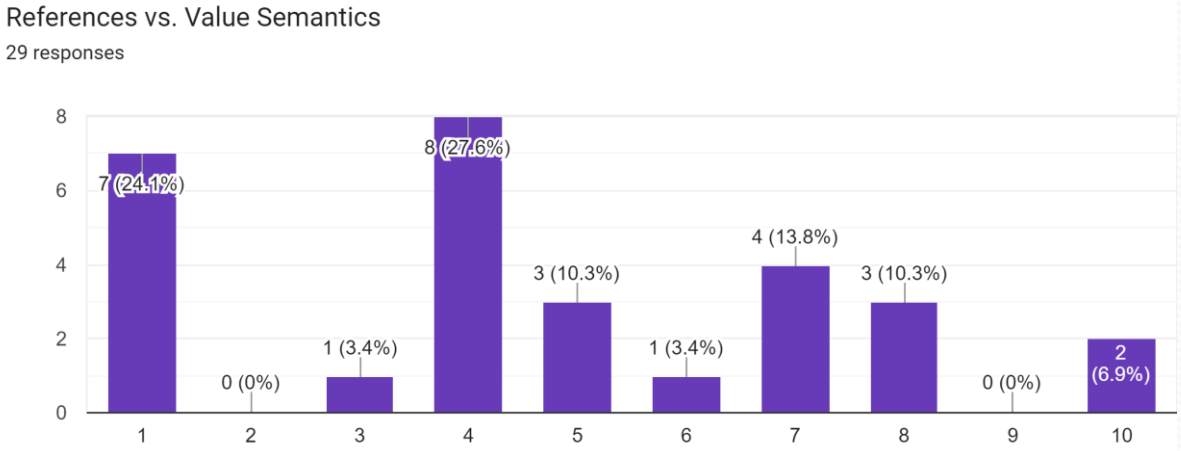
- variables
- expressions
- `for` loops
- `while` loops
- `if/else` statements
- Boolean logic

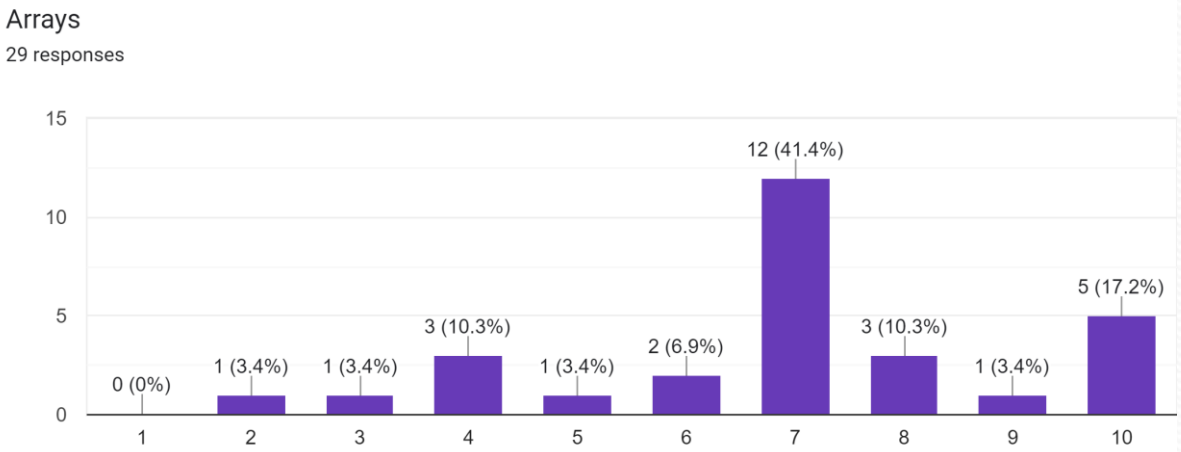




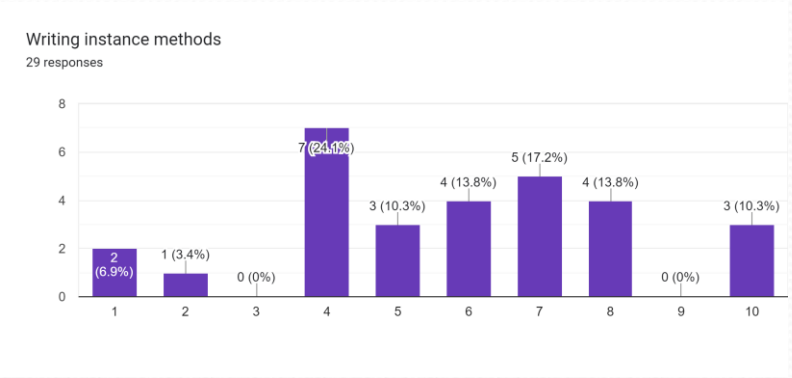
Topic Survey Results

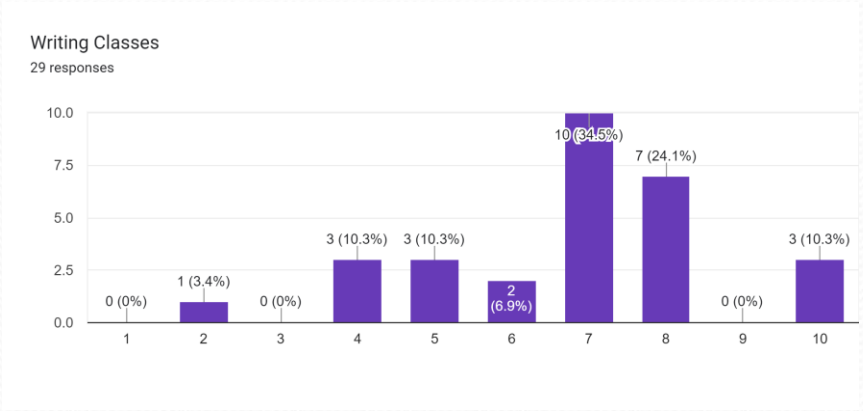
Methods, how parameters are passed to them and how and when to create them appears to be an area many students are unsure about

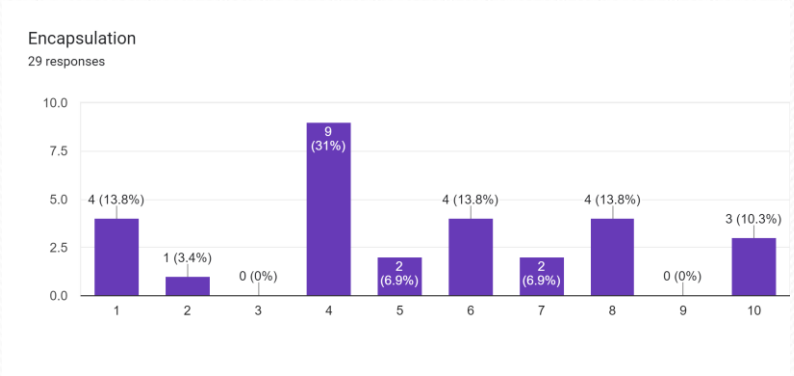


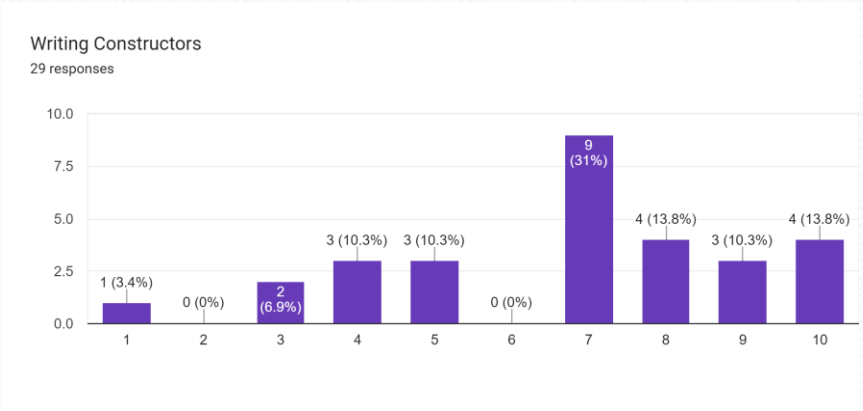


Topic Survey: Objects





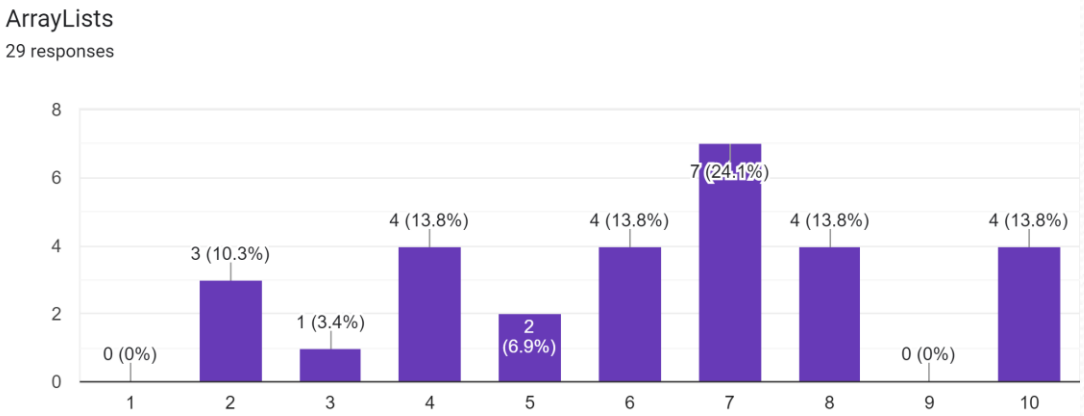


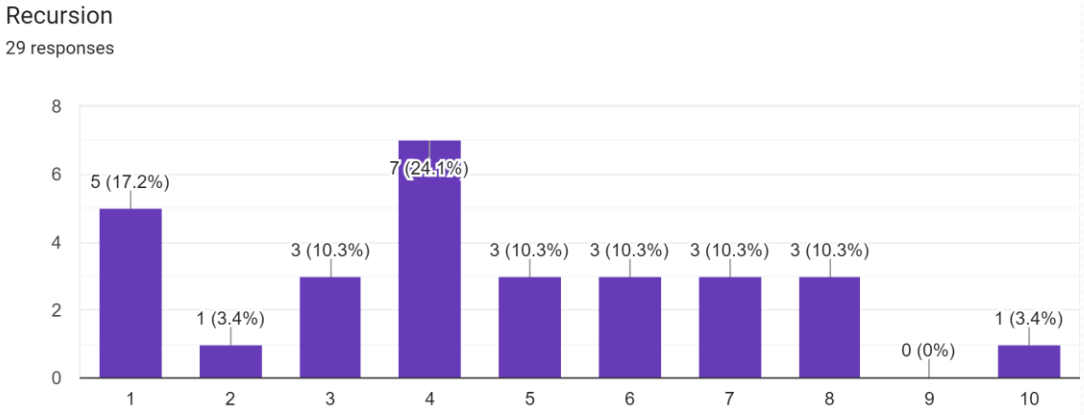


Topic Survey: Advanced

I **do not expect** you to know either of these topics!

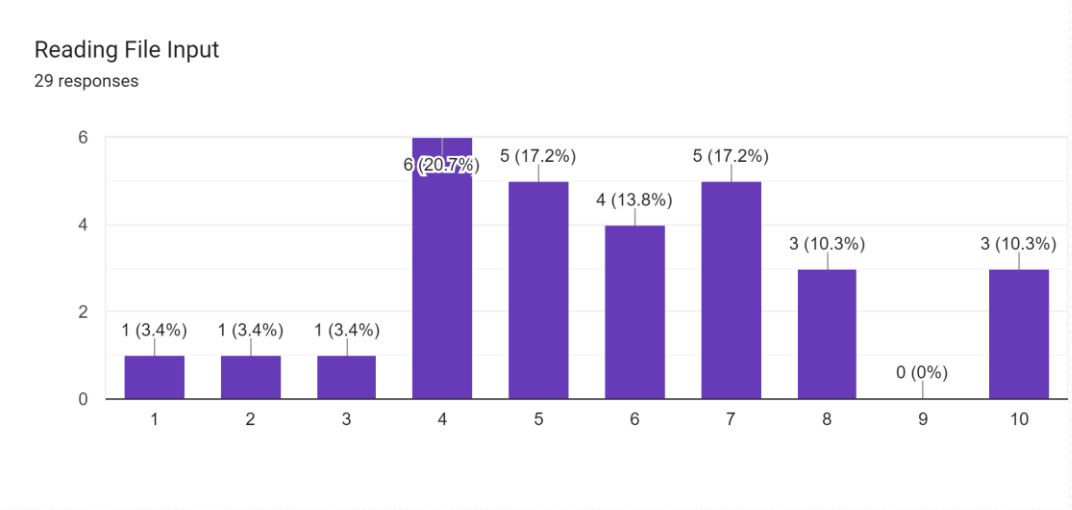
I only asked as I know a few instructors like to discuss them very briefly in CS& 141.

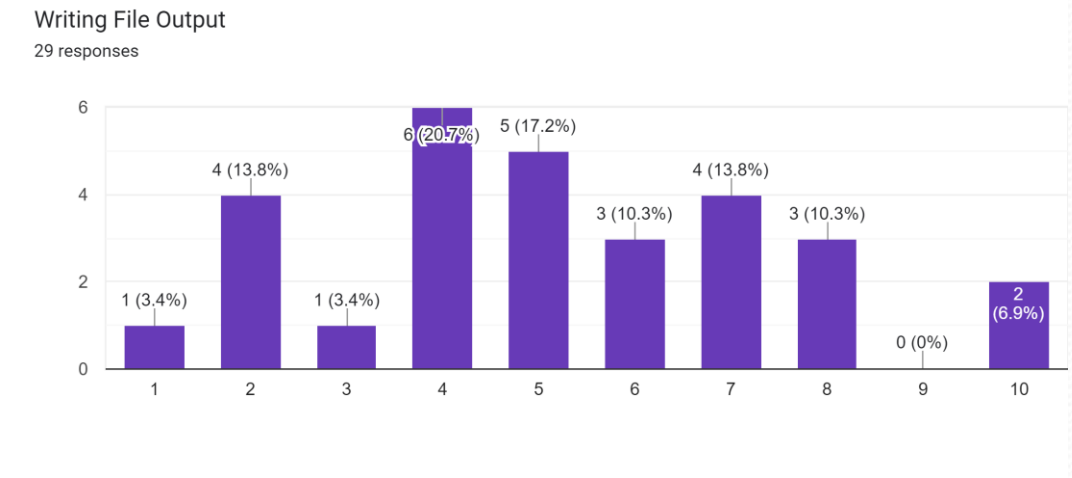




Topic Survey: Needing Review

We will review how to work with files and what is and isn't good style.





What does this code do?

```
public static void main(String[] args) {
    int a = 7;
    int b = 35;
    int[] list = {2, 14};
    change(a, b, list);
    System.out.println(a + " " + b + list[0] + list[1]);
}

public static void change(int a, int b, int[] list) {
    a = b;
    list[0] = list[1];
    System.out.println(a + " " + b + list[0] + list[1]);
}
```

- What does this code do?

Value semantics

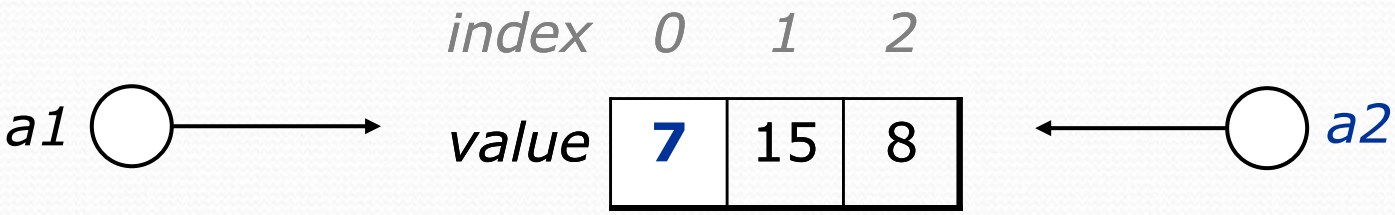
- **value semantics**: Behavior where values are copied when assigned, passed as parameters, or returned.
  - All primitive types in Java use value semantics.
  - When one variable is assigned to another, its value is copied.
  - Modifying the value of one variable does not affect others.

```
int x = 5;
int y = x;        // x = 5, y = 5
y = 17;           // x = 5, y = 17
x = 8;            // x = 8, y = 17
```

Reference semantics (objects)

- **reference semantics**: Behavior where variables actually store the address of an object in memory.
  - When one variable is assigned to another, the object is *not* copied; both variables refer to the *same object*.
  - Modifying the value of one variable *will* affect others.

```
int[] a1 = {4, 15, 8};
int[] a2 = a1;              // refer to same array as a1
a2[0] = 7;
System.out.println(Arrays.toString(a1)); // [7, 15, 8]
```

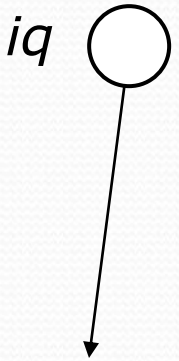


Arrays pass by reference

- Arrays are passed as parameters by *reference*.
  - Changes made in the method are also seen by the caller.

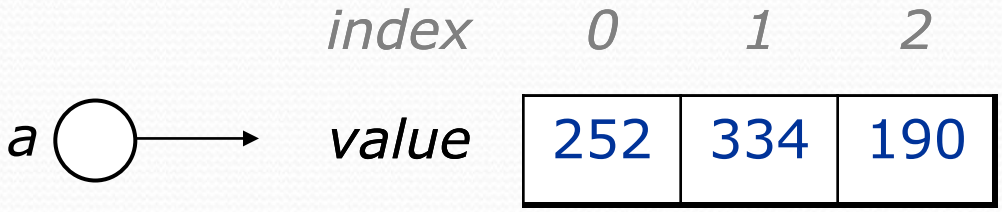
```
public static void main(String[] args) {
    int[] iq = {126, 167, 95};
    increase(iq);
    System.out.println(Arrays.toString(iq));
}

public static void increase(int[] a) {
    for (int i = 0; i < a.length; i++) {
        a[i] = a[i] * 2;
    }
}
```



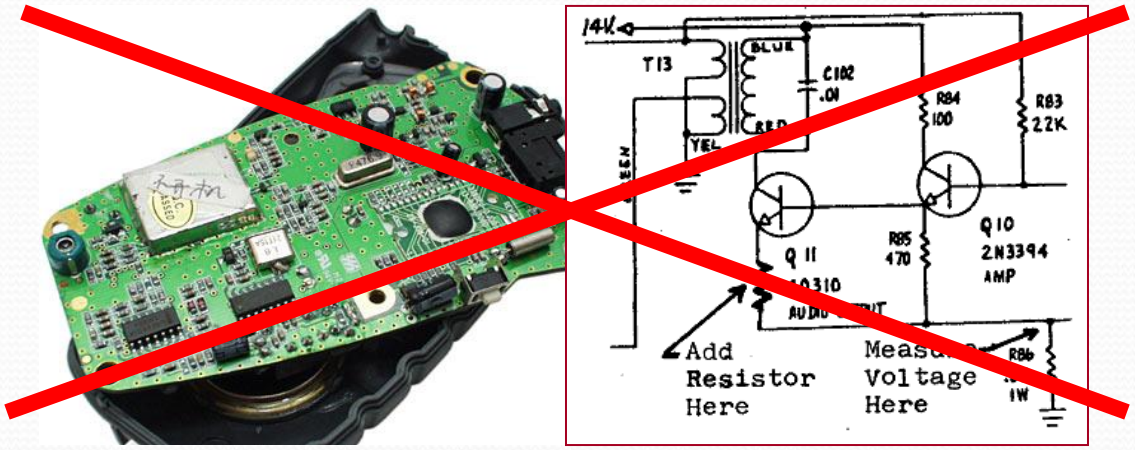
  - Output:

```
[252, 334, 190]
```



Abstraction

- **abstraction**: A distancing between ideas and details.
  - We can use objects without knowing how they work.
- abstraction in a cell phone:
  - You understand its external behavior (buttons, screen).
  - You don't understand its inner details, and you don't need to.

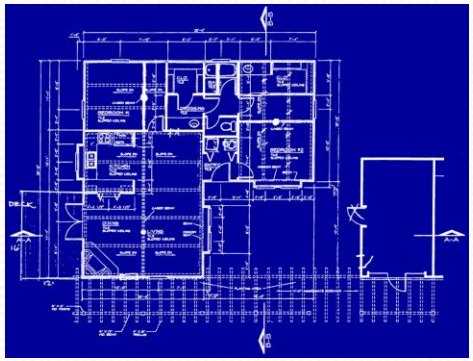


Blueprint analogy

iPhone blueprint

state:
- current song
- volume
- battery life

behavior:
- power on/off
- change station/song
- change volume
- choose random song



creates

iPhone #1

state:
- song = "1,000,000 Miles"
- volume = 17
- battery life = 2.5 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPhone #2

state:
- song = "Letting You"
- volume = 9
- battery life = 3.41 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

iPhone #3

state:
- song = "Discipline"
- volume = 24
- battery life = 1.8 hrs

behavior:
- power on/off
- change station/song
- change volume
- choose random song

`Point` objects (desired)

```
Point p1 = new Point(5, -2);
Point p2 = new Point();          // origin, (0, 0)
```

- Data in each `Point` object:

Field name	Description
`x`	the point's x-coordinate
`y`	the point's y-coordinate

- Methods in each `Point` object:

Method name	Description
`setLocation(`**x**`, `**y**`)`	sets the point's x and y to the given values
`translate(`**dx**`, `**dy**`)`	adjusts the point's x and y by the given amounts
`distance(`**p**`)`	how far away the point is from point *p*
`draw(`**g**`)`	displays the point on a drawing panel

Fields

- **field**: A variable inside an object that is part of its state.
  - Each object has *its own copy* of each field.

- Declaration syntax:

```
type name;
```

  - Example:

```
public class Student {
    String name;     // each Student object has a
    double gpa;      // name and gpa field
}
```

Instance methods

- **instance method** (or **object method**): Exists inside each object of a class and gives behavior to each object.

```
public type name(parameters) {
    statements;
}
```

  - same syntax as static methods, but without `static` keyword

Example:

```
public void shout() {
    System.out.println("HELLO THERE!");
}
```

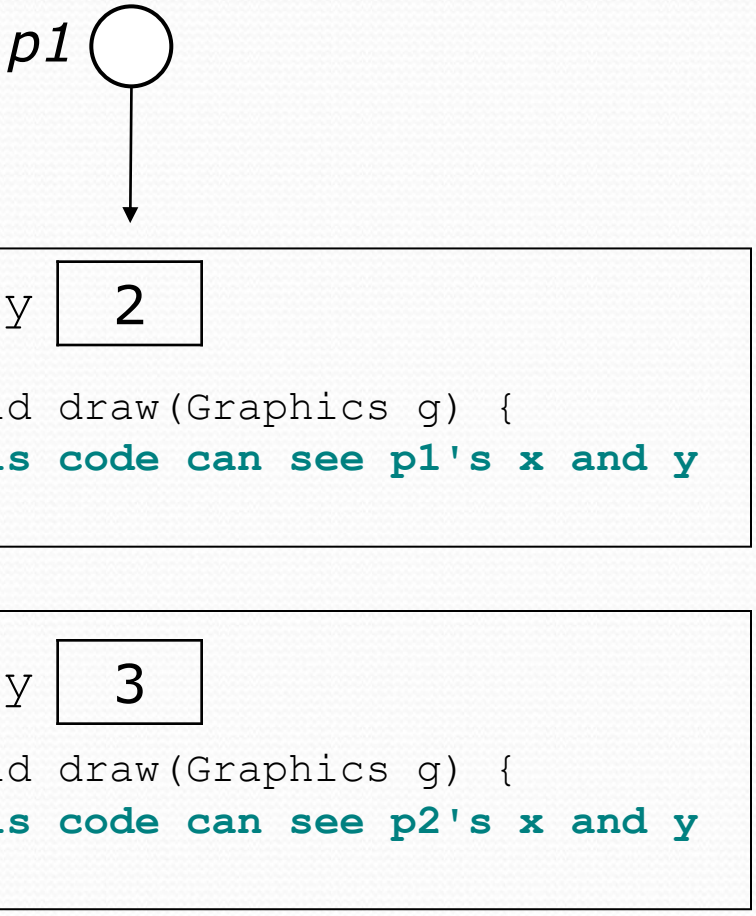
`Point` objects w/ method

- Each `Point` object has its own copy of the `draw` method, which operates on that object's state:

```
Point p1 = new Point();
p1.x = 7;
p1.y = 2;

Point p2 = new Point();
p2.x = 4;
p2.y = 3;

p1.draw(g);
p2.draw(g);
```



Class example with methods

```
public class Point {
    int x;
    int y;

    public void translate(int dx, int dy) {
        x = x + dx;
        y = y + dy;
    }

    public double distanceFromOrigin() {
        return Math.sqrt(x * x + y * y);
    }
}
```

Constructors

- **constructor**: Initializes the state of new objects.

```
public type(parameters) {
    statements;
}
```

  - runs when the client uses the `new` keyword
  - no return type is specified;
    it implicitly "returns" the new object being created

  - If a class has no constructor, Java gives it a *default constructor* with no parameters that sets all fields to 0.

Multiple constructors

- A class can have multiple constructors.
  - Each one must accept a unique set of parameters.

- *Exercise:* Write a `Point` constructor with no parameters that initializes the point to (0, 0).

```
// Constructs a new point at (0, 0).
public Point() {
    x = 0;
    y = 0;
}
```

Printing objects

- By default, Java doesn't know how to print objects:

```
Point p = new Point();
p.x = 10;
p.y = 7;
System.out.println("p is " + p);  // p is Point@9e8c34


// better, but cumbersome;              p is (10, 7)
System.out.println("p is (" + p.x + ", " + p.y + ")");


// desired behavior
System.out.println("p is " + p);  // p is (10, 7)
```

The `toString` method

tells Java how to convert an object into a `String`

```
Point p1 = new Point(7, 2);
System.out.println("p1: " + p1);

// the above code is really calling the following:
System.out.println("p1: " + p1.toString());
```

- Every class has a `toString`, even if it isn't in your code.
  - Default: class's name `@` object's memory address (base 16)

```
Point@9e8c34
```

`toString` syntax

```
public String toString() {
    code that returns a String representing this object;
}
```

- Method name, return, and parameters must match exactly.

- Example:

```
// Returns a String representing this Point.
public String toString() {
    return "(" + x + ", " + y + ")";
}
```

Private fields

- A field can be declared *private*.
  - No code outside the class can access or change it.

```
private type name;
```

  - Examples:

```
private int id;
private String name;
```

- Client code sees an error when accessing private fields:

```
PointMain.java:11: x has private access in Point
System.out.println("p1 is (" + p1.x + ", " + p1.y + ")");
                                   ^
```

Accessing private state

- We can provide methods to get and/or set a field's value:

```
// A "read-only" access to the x field ("accessor")
public int getX() {
    return x;
}

// Allows clients to change the x field ("mutator")
public void setX(int newX) {
    x = newX;
}
```

  - Client code will look more like this:

```
System.out.println("p1: (" + p1.getX() + ", " + p1.getY() + ")");
p1.setX(14);
```

Encapsulation

- **encapsulation**: Hiding implementation details of an object from its clients.
  - Encapsulation provides *abstraction*.
    - separates external view (behavior) from internal view (state)
  - Encapsulation protects the integrity of an object's data.