Lecture 17
Object-oriented thinking
Why Object-Oriented Programming?

- Abstraction and modularity
Class Abstraction

• In order to use a class, you don’t need to know how it was written, you may not even need to *look* at the actual class.

• Everything you need to be able to use it will be public, everything else is hidden away in the class.

• A class can also be referred to as an *abstract data type* (ADT).
Abstraction and Modularity

• For example, USB devices

• You don’t need to know how each work internally, just how to talk to each of them

• You can plug them into many different computers and expect them to work the same
Abstraction and Modularity

- Our classes are the same - reusable, if you design them correctly and know how to interface with them
Robot object

```
Robot

- leftMotorPin: int
- rightMotorPin: int
- servoPin: int
- leftLED: int
- rightLED: int

+ Robot()
+ moveForward(forHowManyMillis:int): void
+ moveBackward(forHowManyMillis: int): void
+ turnLeft(degrees: double): void
+ turnRight(degrees: double): void
+ wave(): void
+ wink(whichSide: String): void
+ blink(): void
```
Practice: Write a test class for this Robot object

• Public methods are:
  • constructor that accepts a PApplet instance (I’ll explain)
  • moveLeft()
  • moveRight()
  • moveUp()
  • moveDown()
  • draw()
• When we’re designing classes, we have to start thinking about the relationships between our classes.

• Association, aggregation, composition
Association

- Just means a general relationship between 2 classes
• in UML, an association is a solid line

• Take and teach are *labels* for the relationship, and the arrows show the direction

• Teacher is the *role*

• *Multiplicity* describes how many of the class’s objects are involved. * is unlimited, m…n means m to n inclusive
Association

- You implement these associations using data fields and methods

```java
public class Student {
    private Course[] courseList;
    
    public void addCourse(Course s) { ... }
}
```

```java
public class Course {
    private Student[] classList;
    private Faculty faculty;
    
    public void addStudent(Student s) { ... }
    
    public void setFaculty(Faculty faculty) { ... }
}
```

```java
public class Faculty {
    private Course[] courseList;
    
    public void addCourse(Course c) { ... }
}
```
Aggregation

- Aggregation is an association that represents ownership
- “has-a” relationship. As in, a Student has a Name
Aggregation and Composition

• Owner object is the *aggregating object*, and it’s class is the *aggregating class*. The subject is the *aggregated object or class*.

• An object can be owned by several aggregating objects, but if it is exclusively owned, the relationship is called a *composition*.

• For example, “a student has a name” is a composition.

• What about “a student has an address”?
Aggregation and Composition

- In UML, a filled diamond is attached to aggregating class in a composition, empty diamond is attached to aggregating class in aggregation.
Aggregation and Composition

• **Tip:** An aggregation relationship is usually represented by a data field in the *aggregating* class

```java
public class Name {
    ... 
}
```

```java
public class Student {
    private Name name;
    private Address address;
    ... 
}
```

```java
public class Address {
    ... 
}
```

Aggregated class

Aggregating class

Aggregated class
Aggregation and Composition

• What about “a person has a supervisor”?
Designing a class example

• Let’s design a Course class
Designing a class example

<table>
<thead>
<tr>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>-courseName: String</td>
</tr>
<tr>
<td>-students: String[]</td>
</tr>
<tr>
<td>-numberOfStudents: int</td>
</tr>
<tr>
<td>+Course(courseName: String)</td>
</tr>
<tr>
<td>+getCourseName(): String</td>
</tr>
<tr>
<td>+addStudent(student: String): void</td>
</tr>
<tr>
<td>+dropStudent(student: String): void</td>
</tr>
<tr>
<td>+getStudents(): String[]</td>
</tr>
<tr>
<td>+getNumberOfStudents(): int</td>
</tr>
</tbody>
</table>
public class Course {
    private String courseName;
    private String[] students = new String[100];
    private int numberOfStudents;

    public Course(String courseName) {
        this.courseName = courseName;
    }

    public void addStudent(String student) {
        students[numberOfStudents] = student;
        numberOfStudents++;
    }

    public String[] getStudents() {
        return students;
    }

    public int getNumberOfStudents() {
        return numberOfStudents;
    }

    public String getCourseName() {
        return courseName;
    }
}