1 Administrative Topics

- Return the quizzes
- Office hours: M:1-4, T:1-5, F: 12-2 (note change on Fri)

2 Object-Oriented Design

One of the most striking aspects of the code we have been stepping through recently is the number of symbol tables and the number of arrows on the board. This is indicative of a truly object-oriented design—other words a design that relies on objects with data and responsibilities. We see lots of symbol tables in the beginning because objects are created at the beginning of the code; we are setting up the objects so they can do all the work.

OO design is built around certain design principles. There are four chief principles we will talk about this class (see below). We have already covered two—modularity and encapsulation, although we haven’t necessarily used those terms. Today, we are going to talk about the third—a powerful concept called inheritance. The fourth, polymorphism, is related to inheritance, and we will talk about that later in the week.

- Modularity: making functional units that can be re-used in many contexts (we see this in procedural programming as well—we should break down the problem into parts that are logically self-contained)
• Encapsulation: information hiding – ensuring code that uses a class object does not need to know any of its implementation details.

• Inheritance: capturing commonality in a base class that can be extended to handle special cases

• Polymorphism: the ability to treat different objects the same way

3 Inheritance

We would like to avoid duplication of fields and code, if possible.

• Duplication of code creates more potential for mistakes

• Consolidating code reduces time spent programming

• Consolidated code is easier to debug

The model developed to represent this kind of relationship is called inheritance. A parent class contains all of the common code and data elds, while the child, or derived class contains the unique data or methods required for implementation.

The concept is similar to a taxonomic tree in biology. Mammals all share a set of characteristics that separate them from other creatures, but individual mammal species each have unique attributes. The concept of inheritance is extremely powerful, because it permits you to leverage code many times. Code written for a parent class is reused for each child class.

Note that inheritance is more than simply writing functions outside of a class structure that assume a particular design for the fields of a number of different classes. Inheritance, by incorporating the methods inside the parent class, follows the principle of encapsulation: only the programmer writing the parent class needs to know the particulars of implementation.

3.1 Student Class Example

Let’s redesign the Student class to make it more realistic. In particular, let’s design two classes – one for matriculated students (those in a degree
program) and one for non-matriculated students. Here are the lists of data fields I want for each of them.

- **Student Class**
  - name
  - id
  - grades

- **MatriculatedStudent Class**
  - name
  - id
  - grades
  - year

We will derive the MatriculatedStudent class from the Student class. This means the MatriculatedStudent class will have everything the Student class has and more.

We begin by defining the Student class:

```python
class Student:
    def __init__(self, name, id):
        self.name = name
        self.id = id
        self.grades = []

    # accessor methods
    def getName(self):
        return self.name

    def getId(self):
        return self.id

    # return a clone of the grades
    def getGrades(self):
        grades = []
        for grade in self.grades:
            grades.append(grade)
        return grades
```

```python
```
grades.append(grade)
return grades

# return a list numeric grades only
def getNumberGrades(self):
    grades = []
    for grade in self.grades:
        if type(grade) == int or type(grade) == float:
            grades.append(grade)
    return grades

# return the GPA computed from the numeric grades
def getGPA(self):
    grades = self.getNumberGrades()
    if len(grades) == 0:
        return 0.0
    tot = 0.0
    for grade in grades:
        tot += grade
    return tot/len(grades)

# add a grade (a number between 0 and 4 or a single letter)
def addGrade(self, grade):
    self.grades.append(grade)

and testing it

if __name__ == '__main__':
    s = Student("Holly Highschool", 210291)
    print(s.getName())
    s.addGrade(3.0)
    print(s.getGPA())

Then, we define the MatriculatedStudent class:

class MatriculatedStudent(Student):
    def __init__(self, name, id, year):
        Student.__init__(self, name, id)
        self.year = year

    def getYear():
        return self.year

    def setYear(self, year):
        self.year = year
Notice that in line 1, we specify that MatriculatedStudent is derived from the Student class using the parentheses.

Notice that in lines 2–4, we write an __init__ method that overrides that in the Student class. But note also that we actually call the Student.__init__ explicitly (we are using modularity and avoiding code duplication). Then, we add the year field.

Lines 6–10 simply add the accessor and mutator for the year.

And we test this code:

```python
if __name__ == '__main__':
    s = MatriculatedStudent( "Fred Firstyear", 897987, 2013 )
    s.addGrade( 2.3 )
    s.addGrade( 2.5 )
    s.addGrade( 3.3 )
    s.addGrade( 3.1 )
    print s.getName()
    print s.getGPA()
```

The line `s.addGrade(2.3)` works because the MatriculatedStudent inherited the addGrade method from Student.

Here are a few notes on terminology:

- Class Student
  - is a parent class
  - is a base class

- Class Matriculated Student
  - is a child class
  - is a derived class
  - inherits methods from its parent class
  - can override any of those methods