1 Object Oriented Programming

In a previous lecture, you were introduced to the programming paradigm known as Object-Oriented Programming (OOP). OOP allows us to treat data as objects - like we do in real life.

For example, consider the class **Student**. Each of you as individuals are an instance of this class. So, a student Angela would be an instance of the class **Student**.

Details that all CS 61A students have, such as name, year, and major, are called instance attributes. Every student has these attributes, but their values differ from student to student. An attribute that is shared among all instances of **Student** is known as a class attribute. An example would be the instructors attribute; the instructors for CS 61A, Kevin and Stan, are the same for every student in CS 61A.

All students are able to do homework, attend lecture, and go to office hours. When functions belong to a specific object, they are said to be methods. In this case, these actions would be bound methods of **Student** objects.

Here is a recap of what we discussed above:

- **class**: a template for creating objects
- **instance**: a single object created from a class
- **instance attribute**: a property of an object, specific to an instance
- **class attribute**: a property of an object, shared by all instances of a class
- **method**: an action (function) that all instances of a class may perform
Questions

1.1 Below we have defined the classes Instructor, Student, and TeachingAssistant, implementing some of what was described above. Remember that we pass the self argument implicitly to instance methods when using dot-notation.

class Instructor:
    degree = "PhD (Magic)" # this is a class attribute
    def __init__(self, name):
        self.name = name # this is an instance attribute

    def lecture(self, topic):
        print("Today we're learning about " + topic)

dumbledore = Instructor("Dumbledore")

class Student:
    instructor = dumbledore

    def __init__(self, name, ta):
        self.name = name
        self.understanding = 0
        ta.add_student(self)

    def attend_lecture(self, topic):
        Student.instructor.lecture(topic)
        print(Student.instructor.name + " is awesome!")
        self.understanding += 1

    def visit_office_hours(self, staff):
        staff.assist(self)
        print("Thanks, " + staff.name)

class TeachingAssistant:
    def __init__(self, name):
        self.name = name
        self.students = {}

    def add_student(self, student):
        self.students[student.name] = student

    def assist(self, student):
        student.understanding += 1
What will the following lines output?

```python
>>> snape = TeachingAssistant("Snape")
>>> harry = Student("Harry", snape)
>>> harry.attend_lecture("potions")

Today we're learning about potions
Dumbledore is awesome!

>>> hermione = Student("Hermione", snape)
>>> hermione.attend_lecture("herbology")

Today we're learning about herbology
Dumbledore is awesome!

>>> hermione.visit_office_hours(TeachingAssistant("Hagrid"))

Thanks, Hagrid

>>> harry.understanding

1

>>> snape.students["Hermione"].understanding

2

>>> Student.instructor = Instructor("Umbridge")
>>> Student.attend_lecture(harry, "transfiguration")
# Equivalent to harry.attend_lecture("transfiguration")

Today we're learning about transfiguration
Umbridge is awesome!
```
2 Inheritance

Let’s explore another tool: inheritance. Suppose we want the Dog and Cat classes.

class Dog(object):
    def __init__(self, name, owner):
        self.name = name
        self.owner = owner
    def eat(self, thing):
        print(self.name + " ate a " + str(thing) + "!")
    def talk(self):
        print(self.name + " says woof!")

class Cat(object):
    def __init__(self, name, owner, lives=9):
        self.name = name
        self.owner = owner
        self.lives = lives
    def eat(self, thing):
        print(self.name + " ate a " + str(thing) + "!")
    def talk(self):
        print(self.name + " says meow!")

Notice that there’s a lot of repeated code! This is where inheritance comes in. In Python, a class can inherit the instance variables and methods of another class.

For example: Bar inherits from Foo. We call Foo the base class (the class that is being inherited) and Bar the subclass (the class that does the inheriting). Notice that Foo also inherits from the object class. In Python, object is the top-level base class that provides basic functionality; everything inherits from it.

class Pet(object):
    def __init__(self, name, owner):
        self.is_alive = True  # It’s alive!!!
        self.name = name
        self.owner = owner
    def eat(self, thing):
        print(self.name + " ate a " + str(thing) + "!")
    def talk(self):
        print(self.name)

class Dog(Pet):
    def __init__(self, name, owner):
        Pet.__init__(self, name, owner)
    def talk(self):
        print(self.name + ' says woof!')

Inheritance often represents a hierarchical relationship between two or more classes where one class is a more specific version of the other. For example, a dog is a pet. By making Dog a subclass of Pet, we did not have to redefine self.name, self.owner, or eat. However, since we want Dog to talk differently, we did redefine, or override, the talk method.
Questions

2.1 Implement the Cat class by inheriting from the Pet class. Make sure to use superclass methods wherever possible. In addition, add a lose_life method to the Cat class.

class Cat(Pet):
    def __init__(self, name, owner, lives=9):
        Pet.__init__(self, name, owner)
        self.lives = lives

    def talk(self):
        """A cat says meow! when asked to talk."""

        print('meow!')

    def lose_life(self):
        """A cat can only lose a life if they have at least one life. When lives reaches zero, 'is_alive' becomes False. """

        if self.lives > 0:
            self.lives -= 1
            if self.lives == 0:
                self.is_alive = False
        else:
            print("This cat has no more lives to lose :("

2.2 More cats! Fill in the methods for NoisyCat, which is just like a normal Cat. However, NoisyCat talks a lot, printing twice whatever a Cat says.

class NoisyCat(Cat):
    """A Cat that repeats things twice."""

    def __init__(self, name, owner, lives=9):
        # Is this method necessary? Why or why not?
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```
Cat.__init__(self, name, owner, lives)

def talk(self):
    """Repeat what a Cat says twice."""

Cat.talk(self)
Cat.talk(self)
```

2.3 What would Python display? (Summer 2013 Final)

```python
class A:
    def f(self):
        return 2
    def g(self, obj, x):
        if x == 0:
            return A.f(obj)
        return obj.f() + self.g(self, x - 1)

class B(A):
    def f(self):
        return 4

>>> x, y = A(), B()
>>> x.f()
2
>>> B.f()
Error (missing self argument)
```

```python
>>> x.g(x, 1)
4
>>> y.g(x, 2)
8
```

2.4 Implement the Yolo class so that the following interpreter session works as expected. (Summer 2013 Final)

```python
>>> x = Yolo(1)
>>> x.g(3)
4
>>> x.g(5)
6
>>> x.motto = 5
>>> x.g(5)
10
```
class Yolo:
    def __init__(self, motto):
        self.motto = motto
    def g(self, n):
        return self.motto + n