**CS61A Notes – Week 7: OOP Continued**

This week we will be continuing our discussion of Object Oriented Programming. Last week we learned that OOP consists of data abstraction in the form of Classes, or blueprints for creating types of objects, and Objects, an instance of a certain class created according to its blueprint.

We learned how to define classes along with class variables, instance variables and methods, how to create objects and how to inherit from a parent class.

We also saw the use of self in most of our class methods. Let's take a close look at what self is actually referring to.

**1. Self and String Representations**

Define the \_\_init\_\_ method of a class called Time

 class Time(object):

 """ Represents the time of day.

Has a constructor which takes the hour, minute, and second and stores them as attributes. The attributes default to 0 if not provided to init """

 # Your Code Here

 def \_\_init\_\_(self, hour=0, minute=0, second=0):

 self.hour = hour

 self.minute = minute

 self.second = second

Now define an independent function in the global scope called print\_time that takes a Time object and prints out the hour minute and second on one line.

def print\_time(time):

 """ time - an instance of the class Time

print out the hour minute and second of time on one line - hh:mm:ss """

# Your Code Here

print(%.2d:%.2d%.2d %(time.hour,time.minute,time.second))

Once we have defined our Time and class and print\_time function, what would Python print?

>>> start = Time(12,15,50)

>>> start.hour

 12

>>> print\_time(start)

 12:15:50

>>> end = Time(1,30)

>>> print\_time(end)

 01:30:00

>>> midnight = Time()

>>> print\_time(midnight)

 00:00:00

Notice, to call print\_time we have to pass it a Time object as an argument. We can make this look more like OOP by making print\_time a method which is done by moving it inside the class definition

class Time(object):

 def print\_time(time):

 """ Your Code Here """

print(%.2d:%.2d%.2d %(time.hour,time.minute,time.second))

Now what does python print?

>>> start = Time(4,15,30)

>>> start.print\_time(start)

TypeError: print\_time() takes exactly 1 positional argument (2 given)

>>> start.print\_time()

 04:15:30

Note that for our function print\_time(time) we had to pass it an object to assigning it to the parameter time for it to print, now the we have turned print\_time into a method, we get an error when we try to pass it an object to assign time but we get the right output when we don't pass it anything even though the definition calls for one argument. What is going on here?

When we call start.print\_time() we are invoking the print\_time method on start - an instance of the class Time. When a method is invoked on an object, that object is implicitly passed as the first argument to the method. That is, the object that is the value of the <expression> to the left of the dot is passed automatically as the first argument to the method named on the right side of the dot expression. As a result, the object is bound to the parameter self.

When defining methods in a class we use self as the first parameter to denote that this object this method is invoked on will implicitly assigns it**self** to the first parameter. So using self, what should our print\_time method should look like now?

class Time(object):

 def print\_time(self):

 """ Your Code Here """

print(“%.2d:%.2d%.2d” %(self.hour,self.minute,self.second))

Lastly what would python print here:

>>> t1 = Time(3,45,10)

>>> print(t1)

 <\*.Time object at 0x1005c6bd0>

We shouldn’t have to call print\_time every time we want a Time object to print itself out in a readable manner. Luckily Python provides classes with the \_\_str\_\_ method which should return a string representation of the object. So change your print\_time(self) method to \_\_str\_\_(self) making sure to return the string instead of printing it.

class Time(object):

 def \_\_str\_\_(self):

 """ Return a string representation of the object)

return(“%.2d:%.2d%.2d” %(self.hour,self.minute,self.second))

And now try:

>>> t1 = Time(3,45,10)

>>> print(t1)

 03:45:10

**2. Operator Overloading**

Now we are going to add two methods to your Time class. One called time\_to\_int that returns an integer representation of the time in total seconds from midnight, and a static method called int\_to\_time that takes an amount in seconds and returns a Time object with the corresponding time. int\_to\_time is given to you.

class Time(object):

 . . .

 def time\_to\_int(self):

""" Returns the integer representation the time in total seconds """

# Your Code Here

 minutes = self.hour \* 60 + self.minute

 seconds = minutes \* 60 + self.second

 return seconds

 @staticmethod # why staticmethod?

def int\_to\_time(seconds):

""" Takes an argument seconds, and returns a Time object representing the corresponding time """

 time = Time()

 minutes, time.second = divmod(seconds, 60)

 time.hour, time.minute = divmod(minutes, 60)

 return time

Why is int\_to\_time a static method?

What does divmod do?

So we have a time class that can print itself. What would Python print if we try:

>>> time1 = Time(1,45,10)

>>> time2 = Time(2,10,10)

>>> time1 + time2

TypeError: unsupported operand type(s) for +: 'Time' and 'Time'

So far Python doesn’t know how to add to two objects of type Time. We can use the \_\_add\_\_ method here to tell Python how to add two Time objects

Hint: use time\_to\_int and int\_to\_time

class Time(object):

 . . .

 def \_\_add\_\_(self,other):

 # Your Code Here

seconds = self.time\_to\_int()+ other.time\_to\_int()

 return Time.int\_to\_time(seconds)

Now what would Python print?

>>> time1 = Time(1,45,10)

>>> time2 = Time(2,10,10)

>>> time1 + time2

 03:55:20

**3. Type Based Dispatch**

So now Python knows how to add two time objects together, but what if we wanted to simply increment a time object by a number of seconds using something like:

>>> time1 = Time(1,45,10)

>>> time1 + 65

01:46:15

We would have to be able to know if we are adding two Time objects or a Time object and an integer.

Hint: you can use type(object) to check the type of other.

Define methods add\_time(self, other) and increment(self, seconds) and change your \_\_add\_\_(self, other) method to check the type of other and call the correct method to add it.

class Time(object):

 . . .

 def \_\_add\_\_(self,other):

 """ Checks the type of other

 If other is a time object, call add\_time

 If not call increment """

 # Your Code Here

if type(other) is Time:

 return self.add\_time(other)

 else:

 return self.increment(other)

 def add\_time(self,other):

""" Add self and other together and return the resulting Time object """

 # Your Code Here

seconds = self.time\_to\_int() + other.time\_to\_int()

 return Time.int\_to\_time(seconds)

 def increment(self,seconds):

""" Increment self by seconds and return the resulting Time object """

 # Your Code Here

seconds += self.time\_to\_int()

 return Time.int\_to\_time(seconds)

The last thing we need to do is make sure that we can add seconds to a time object from the right hand side of an add operation. It would look something like this:

>>> time1 = Time(1,45,10)

>>> 65 + time1

01:46:15

This is done by implementing the \_\_radd\_\_(self, other) method, which works similarly to \_\_add\_\_ except that other comes from the right hand side of the add operator.

class Time(object):

 . . .

 def \_\_radd\_\_(self,other):

""" Does the same thing as add pretty much but other refers to the value on the right of the + operator """

 # Your Code Here

# radd handles right side non instance so object will always be a non time object (integer in this case)

return self.increment(other)

**4. Inheritance**

Now that we've implemented a Time class that corresponds to a 24 hour clock, let's write another class to represent a twelve hour clock that displays time like this:

>>> start = Time12(14,15,50)

>>> start.hour

2

>>> start.period

PM

>>> print(start)

02:15:50 PM

Fortunately we don't have to rewrite all the methods for Time12, we can have it inherit common operations from the Time class. Think about which methods you would have to overwrite in order to give the Time12 class full functionality.

We should also make sure that Time12 objects are initialized with valid arguments for time. What is a valid range for hour, second and minutes in our new format? What exceptions would you raise for incorrect values?

class Time12(Time):

""" Time12 is a Time object which in a 12 hour time format followed by the period (am/pm). The class inherits from time and should only add attributes and methods that are particular to our new format. It should also check to make sure that inputs are valid and raise an exception if not. """

 # Your Code Here