[Code partially from Zelle/Lambert]

V.Rego,

Nov 3, 2015

Week 11, Examples 1

```
#__________________Cannonball with simple
graphics______________________________
#1.py

#Here is the code from 4.py of Week11-Lec1. We modified it VERY slightly by
adding a graphics
# window and a circle to represent the CB.

''' Look for lines flagged with "##".
    These are the only lines that were changed or added.

    In particular, look at how we passed the graphics window to the
    constructor so that
    the projectile class has access to a window to draw in. Look at how we
defined instance
    variables and got a circle object for this class.

    NOTE: In this example we gave the Projectile class the ability to do the
graphing.

    Sometimes you may not want to do that. You may want to keep all the
graphics outside
    such a class. If we wanted to take this route in this example, we can
simple define the
    circle object in the main program and then use "move" inside the while
loop to draw
    cb once we have its position.

    DIMENSIONING: In this example, its possible that the cb flies out of the
window. It means
    velocity and/or angle are very high and our window was not big enough.
To solve this
    problem, you can

    (a) run the loop once without graphics and get the max height and max
distance, or
    (b) use calculus to get max height and max distance.

    Once you have the proper dimensions (max height, max distance) for any
given input parameters,
    you can create a graphics window to handle that size and then run the
```
simulation again, but
this time graph the cb.

...

# HW: How would you make the graphics work for any projectile input
parameters?

from graphics import * ##
from math import sin, cos, radians

def wait():
    x = input() ##

class Projectile:
    def __init__(self, angle, velocity, height, w):
        self.xp = 0
        self.yp = 0
        theta = radians(angle)
        self.xv = velocity * cos(theta)
        self.yv = velocity * sin(theta)
        self.win = w
        
        self.c = Circle(Point(self.xp, self.yp), 30) ##
        self.c.draw(self.win)
        
        self.c.setFill("red")

    def position_update(self, t):
        oldx = self.xp ##
        oldy = self.yp ##

        self.xp = self.xp + t * self.xv
        yv_new = self.yv - 9.8 * t
        average_velocity = (self.yv + yv_new) / 2
        self.yp = self.yp + t * average_velocity
        self.yv = yv_new
        self.c.move(self.xp-oldx, self.yp-oldy) ##
def height(self):
    return(self.yp)

def distance(self):
    return(self.xp)

#_____________ code below is not in the class
#_______________________________________________________________________
def get_input_values():
    a = eval(input("Enter launch angle (degrees): "))
    v = eval(input("Enter initial velocity (meters/sec): "))
    h = eval(input("Enter initial height (meters): "))
    t = eval(input("Enter small time-interval between position updates of cb: "))
    return(a,v,h,t)

# Here is a main program that uses the above class definition for projectiles
# Note that you can add as many methods as you need, and you can make them as complex as you need

def main():
    win = GraphWin("Cannonball trajectory",800,800)  ##
    win.setCoords(-50,-50,4050,8050)  ##

    angle, vel, h0, t = get_input_values()

    cb = Projectile(angle, vel, h0,win)

    while (cb.height() >= 0):
        cb.position_update(t)

        print ("CB is now {0:0.2f} meters high and is {1:0.2f} meters away.").format(cb.height(),cb.distance())

    wait()

main()
#2.py

# You have now seen how we defined
# a Projectile class (so we could get a cannonball object), and
# a MSD (many-sided random die) class, so we could toss very general die in games/gambling
# REVIEW, to make sure you understand class. Let's use the MSD

#msd.py an n-sided die, using Python class definition

from random import randrange

# notice below how we will defin a class, it's constructor (a function that initializes it), and
# its any methods.

# 1. How to define the class and constructor function?

class MSD:

    def __init__(self, n):
        # self is a "special parameter" used to make whatever object you are
        # defining refer (point) to itself.
        # You don't have to use the word "self"
        # but the convention is to use that
        # word because other languages
        # also use it, though they do not
        # have to use it as a parameter

        self.n = n
        self.value = 1  # any valid value is okay for an initial value

    ''' notice the word self. It helps the class refer to ITS OWN variables. These are called "instance variables". The first parameter in each call, while defining the class, will always be "self".
    '''

    # __init__() will give the caller an MSD object. But what can he do with it? To use this object
    # he needs functions, but such functions in a class are called "methods".

    ''' Let's write some functions that do the kinds of things we do when we play with dice
```python
def roll(self):
    # note that roll() throws but does not return a value

    self.value = randrange(1,self.n + 1)  # adding 1 because of how randrange works
    # calling roll is like crossing the MSD object

""" Again, look at how we had to use "self" as the first (and in this case only) parameter. It allows the die to get a random integer and store it in its own variable "self.value"

The functions below are similar.
""

def getValue(self):
    # to get the face value after throwing we must call getValue()

    return(self.value)  # notice how we are working with the instance variables defined
    # in the class init function?

__init__() is the CONSTRUCTOR

def setValue(self, value):

    self.value = value  # since self always has to be there, we'll say setValue() has only
    # one parameter which is "value"

""" instance variables + methods = attributes [that's class terminology]""

# Now you know everything you need to know to define a class. To know how to write a class
# you need to think of your application in terms of objects (i.e., projectiles, dice, airplanes, shapes).

# If you look at 3.py in the Week11/Lecture 1 example set you will see a main() that create
# 3 MSD objects for 3 players in a simple game. This is how you will create and use objects
# in general.
#
```
# Datafile for next program (in 3.py)

# save this tab-separated data "as is" in file "list.txt" and then run the program

# the format is: student name, total credit-hours, grade-points based on total credit-hours (e.g. A at 3 credits gives 4X3 = 12 pts, if A=4)
# make sure there is no blank line at the end of the file, or the program will try to read it

Abercrombie, Fitch 129 230
Baggins, Bilbo 100 370
Baggins, Frodo 93 320
Cromwell, Oliver 150 160
Duck, Daffy 121 75
Fudd, Elmer 120 75
Fisher, Kin 130 139
Gearloose, Gyro 50 160
Defrog, Kermit 60 100
Scissorhands, Edward 100 200
Dagreek, Zorba 175 321

#_____ Example: Using Python "class" for data processing_____________________
#3.py

class Student:

    def __init__(self, name, hours, points):  # constructor for class "Student"
        self.name = name
        self.hours = float(hours)  # cast it as a real number
        self.points = float(points)  # "      (will help when using division later)

    def Name(self):  # in this way, the caller accesses instance variable via
        return (self.name)  # a method, and so does not touch it directly and

    def Hours(self):  # possibly mess
        return(self.hours)
def Points(self):
    return(self.points)

def gpa(self):
    return(self.points/self.hours)

#________________________ Student Class ends here _________________________

def makeStudent(istring):
    #str is "tab separated": name, hours, points [see datafile list.txt]
    #makeStudent returns a Student Object

    name, hours, points = istring.split("\t")

    return (Student(name,hours,points))    # IMPORTANT! Observe how it
    # returns a
    # Student object via the constructor

#Let's write a program to find max gpa, min gpa and average gpa

def main():

    infile = open("list.txt","r")

    high = makeStudent(infile.readline())    #assume temporarily that
    first student is both
    low  = high                                #
    highest and lowest gpa student

    # small but important point to note here: both low and high are now
    # referring to the exact same student object and two different
    # objects with the same values for instance variables.

    total_points = 0                          # for
    total_hours = 0                           # average gpa

    for line in infile:

        s = makeStudent(line)

        if (s.gpa() > high.gpa() ): high = s    #update
        if (s.gpa() < low.gpa() ): low = s      #
        likewise

        total_points = total_points + s.Points()
        total_hours = total_hours + s.Hours()
infile.close()  # loop is done, change indentation to exit

print("\n")
print("Highest:")
print(high.Name(), "\t", high.Hours(), "(hours)\t", high.gpa(), "(gpa)")
print("\n")

print("Lowest:")
print(low.Name(), "\t", low.Hours(), "(hours)\t", low.gpa(), "(gpa)")
print("\n")

print("Average over all data:"\n\ttotal_hours, "(hours)\t\t", total_points/total_hours, "(gpa)")


main()

# ____________________________ CRAPS (game rules)___________________________

There is a single player.

The player rolls a pair of dice (i.e., two dice, having 6 sides)

Record the "initial roll" (i.e., first roll of both dice)

Player LOSES: if die1 + die2 is equal to 2, 3, or 12

Player WINS: if die1 + die2 is equal to 7 or 11

If player neither wins nor loses on initial roll, player continues to roll.

On any roll:

player WINS: if die1 + die 2 = sum of die1 and die2 on the "initial roll"
player LOSES: if die1 + die2 equals 7

We'll have a Die class (so we can have two 6-sided dice)

We'll have a Player class (so the player object can get 2 die objects and play the game using methods in the Player class and methods in the Die class)

# What does the Die method do?

```
d = Die()               returns a die object, face = 1
```

```
d.roll()                   rolls the die, so face is 1 or 2 or 3 ... or 6.
It only rolls, does not return a face
```

```
d.getFace()          returns the face value
```

```
d.__str__()           same as str(d); returns string representation of die's face value
```

# What does the Player method do?

```
p = Player()                         returns a new Player object. This object plays the game.
p.play()                                plays the game; if player wins it returns True, else False
```

```
p.getNumberOfRolls()        returns the number of rolls
```

```
p.__str__()                          same as str(p); it returns a formatted string representation of the number of rolls
```

#___________ Python Classes to play a game of Craps____________________________
#5.py
IMPORTANT: I have put (a) Class Die, (b) Class Player, and (2) two functions that play games, invoked by main() in this one file 5.py.

So there are there separate things (modules) in this one file. This makes it easy to upload as 5.py, and also makes it easy to run in class.

However, what YOU need to do is to

(a) put the Class Die in file die.py [this file will say "from random import randint" at the top]

(b) put the Class Player in file craps.py [this file will say "from die import Die" at the top]

(c) put the two last functions in a separate file along with main(). Call it anything you want, but this is the module you will run.

So you now see how

** different classes go into different files as separate modules **

... and you can import these classes for use wherever you want ... 

File: die.py

This module defines the die class ...

from random import randint

class Die:
    
    """This class offers a 6-sided die""

    def __init__(self):
        """The initial face of the die""
        self.face = 1

    def roll(self):
        """Make face of die some random number between 1 and 6""
        self.face = randint(1,6)

    def getFace(self):
        return(self.face)
def __str__(self):
    return(str(self.face))  #will be useful in building history of tosses

#-----------------------------------------------------------------------------------
#-----------------------------------------------------------------------------------
#-----------------------------------------------------------------------------------

...  

File: craps.py

This module studies and plays the game of craps

#from die import Die

class Player:
    
    def __init__(self):
        """Player object gets a pair of dice and an empty list of rolls."""

        self.die1 = Die()
        self.die2 = Die()
        self.rolls = []

    def __str__(self):
        #always make sure the indentation is correct

        """Returns the string representation of the history of rolls"""

        result = " "
        for (v1, v2) in self.rolls:

            result = result + str((v1, v2)) + " " + str(v1 + v2) + "\n"

        return(result)

    def getNumberOfRolls(self):
        """Returns the number of rolls in one game"""
        return (len(self.rolls))

    def play(self):
        """Plays one game, saves all the rolls for that game, and finally returns True for a win and False for a loss."""

        self.rolls = []
self.die1.roll()
self.die2.roll()

(v1, v2) = (self.die1.getFace(), self.die2.getFace())
self.rolls.append((v1, v2))

initialSum = v1 + v2

if (initialSum in (2, 3, 12)):
    return False  # loss
elif (initialSum in (7, 11)):
    return True   # win

while True:  # otherwise keep playing
    self.die1.roll()
    self.die2.roll()

    (v1, v2) = (self.die1.getFace(), self.die2.getFace())
    self.rolls.append((v1, v2))

    sum = v1 + v2

    if (sum == 7):
        return False
    elif (sum == initialSum):
        return True

# from craps import Player

# Now some functions that interact with the user to play the game

def playOneGame():
    """ Plays a single game and prints the results."""

    player = Player()
    youWin = player.play()

    print(player)  # print forces a call to str(player) so it can print a string

    if youWin:
        print(" You win!")
# Now some functions that interact with the user to play the game

def playOneGame():
    """ Plays a single game and prints the results."""

    player = Player()
    youWin = player.play()

    print(player)  # print forces a call to str(player) so it can print a string

    if youWin:
        print(" You win!")
    else:
        print(" You lose!")

def playManyGames():
    """ Plays a number of games and prints statistics."""

    number = int(input("How many games will you play? "))

    wins = 0
    losses = 0
    winRolls = 0
    lossRolls = 0

    player = Player()

    for count in range(number):

        hasWon = player.play()
        rolls = player.getNumberOfRolls()
        if hasWon:
            wins = wins + 1
            winRolls = winRolls + rolls
        else:
            losses = losses + 1
            lossRolls = lossRolls + rolls

    print("Total number of wins: ",wins)
    print("Total number of losses: ",losses)

    print("Average number of rolls per win: %0.2f" % (winRolls / wins))
    print("Average number of rolls per loss: %0.2f" % (lossRolls / losses))
    print("Winning percentage: %0.3f" % (wins / number))
def main():
    print("Play one game: \n")
    playOneGame()
    print(" ")

    print("Now play many games. \n")
    playManyGames()

main()