10.009 The Digital World

Term 3. 2018

Problem Set 2 (for Week 2)

Last update: January 19, 2018

Due dates:

- **Problems: Cohort sessions**: Following week: Monday 11:59pm.
- **Problems: Homework**: Same as for the cohort session problems.
- **Problems: Exercises**: These are practice problems and will not be graded. You are encouraged to solve these to enhance your programming skills. Being able to solve these problems will likely help you prepare for the midterm examination.

Objectives:

1. Learn to write and use functions.
2. Learn basic techniques for program debugging.
3. Learn to input data from the keyboard and handle user input.

Note: Solve the programming problems listed below using your favourite text editor. Make sure you save your programs in files with suitably chosen names, **and try as much as possible to write your code with good style (see the style guide for python code)**. In each problem find out a way to test the correctness of your program. After writing each program, test it, debug it if the program is incorrect, correct it, and repeat this process until you have a fully working program. Show your working program to one of the cohort instructors.

Problems: Cohort sessions

1. *Functions: Temperature conversion:* Write a function named `farenheit_to_celsius`. This function takes a fahrenheit value as input and returns its centigrade equivalent. Recall: If C denotes the centigrade value and F its fahrenheit equivalent, then $F = C * 9/5 + 32$. For example:

```
>>>print(fahrenheit_to_celsius(32))
0.0
>>>print(fahrenheit_to_celsius(-40))
-40.0
>>>print(fahrenheit_to_celsius(212))
100.0
```

2. *Functions: multivalued:* Recall the following equation that gives the height of a ball at time t when it is thrown with an initial velocity of v_0.

$$y(t) = v_0 t - \frac{1}{2} g t^2$$

Write a function named `position_velocity()` that takes v_0 and t as inputs and returns $y(t)$ and $y'(t)$, where $y'(t)$ is the first derivative of $y(t)$ with respect to t. Use your knowledge of calculus to find the formula to calculate $y'(t)$. Define the gravitational constant g, where appropriate? **Round the output to two decimal places** using `round(n,d)`. Use $g = 9.81\ m\ s^{-2}$.

```
>>>print(position_velocity(5.0, 10.0))
(-440.5, -93.1)
>>>print(position_velocity(5.0, 0.0))
(0.0, 5.0)
>>>print(position_velocity(0.0, 5.0))
(-122.62, -49.05)
```

3. *Functions: Number of years and days:* Write a function `minutes_to_years_days` that takes in minutes as its input parameter, and returns the number of years and days for the minutes. For examploe, if the function takes in 527040 minutes, it is equivalent to 366 days, and so it will return 1 year and 1 day. For simplicity, assume a year has 365 days. For example,

```
>>>print(minutes_to_years_days(1000000000))
(1902, 214)
>>>print(minutes_to_years_days(2000000000))
(3805, 63)
```

Test the function by writing a test program that prompts the user, using `input`, to enter the minutes and print the output of the function. Here is a sample run:

```
Enter the number of minutes: 1000000000
1000000000 minutes is approximately 1902 years and 214 days.
```

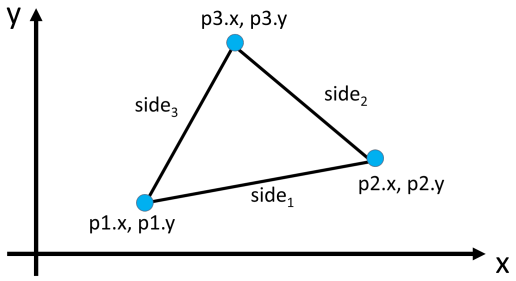
4. *Functions: Area of a Triangle:* Write a function that takes in the three points (x1,y1), (x2,y2), and (x3,y3) of a triangle and returns its area. The formula for computing the area of a triangle is

$$\begin{aligned} s &= (side_1 + side_2 + side_3)/2 \\ area &= \sqrt{s(s - side_1)(s - side_2)(s - side_3)} \end{aligned}$$

where $side_n$ is the length of one of the sides of a triangle. The three points are of the type Coordinate defined as:

```
class Coordinate:
  x=0
  y=0
```

See the figure below. **Round your answer to two decimal places**. To test the function,



you can use the following code:

```
print("Test Case 1")
p1=Coordinate()
p1.x=1.5
p1.y=-3.4
p2=Coordinate()
p2.x=4.6
p2.y=5
p3=Coordinate()
p3.x=9.5
p3.y=-3.4

ans=area_of_triangle(p1,p2,p3)
print(ans)

print("Test Case 2")
p1=Coordinate()
p1.x=2.0
p1.y=-3.4
p2=Coordinate()
p2.x=4.6
p2.y=5
```

```
p3=Coordinate()
p3.x=9.5
p3.y=-1.4

ans=area_of_triangle(p1,p2,p3)
print(ans)

print("Test Case 3")
p1=Coordinate()
p1.x=1.5
p1.y=3.4
p2=Coordinate()
p2.x=4.6
p2.y=5
p3=Coordinate()
p3.x=-1.5
p3.y=3.4

ans=area_of_triangle(p1,p2,p3)
print(ans)

print("Test Case 4")
p1=Coordinate()
p1.x=-1.5
p1.y=3.4
p2=Coordinate()
p2.x=4.6
p2.y=5
p3=Coordinate()
p3.x=4.3
p3.y=-3.4

ans=area_of_triangle(p1,p2,p3)
print(ans)
```

The expected output should be:

```
Test Case 1:
33.6
Test Case 2:
28.9
Test Case 3:
2.4
Test Case 4:
25.38
```

Write a test program that prompts the user to enter the coordinates of the three sides and display the area. Here is a sample run:

```
Enter x coordinate of the first point of a triangle: 1.5
Enter y coordinate of the first point of a triangle: -3.4
Enter x coordinate of the second point of a triangle: 4.6
Enter y coordinate of the second point of a triangle: 5
Enter x coordinate of the third point of a triangle: 9.5
Enter y coordinate of the third point of a triangle: -3.4
```

```
The area of the triangle is 33.6
```

Vocareum Submission: Submit only the function definition without the test program.

5. *Functions: Compound value:* Suppose you deposit $100 on the first day of each month into a savings account with an annual interest rate of 5%. The bank calculates the interest gained and credits the amount to you at the end of the month. The monthly interest rate is 0.05/12=0.00417. At the end of the first month, the value in the account is

   $100 * (1 + 0.00417) = 100.417$

   At the end of the second month, the value in the account is

   $(100 + 100.417) * (1 + 0.00417) = 201.252$

   At the end of the third month, the value in the account is

   $(100 + 201.252) * (1 + 0.00417) = 302.507$

   and so on.

```
>>>print(compound_value_sixth_month(100,0.05))
608.81
>>>print(compound_value_sixth_month(100,0.03))
605.27
>>>print(compound_value_sixth_month(200,0.05))
1217.62
>>>print(compound_value_sixth_month(200,0.03))
1210.54
```

   Write a function that takes in a monthly saving amount and an annual interest rate, and returns the account value at the end of the sixth month. Write a test program that prompts the user to input his or her monthly saving amount and displays the account value. **Round the final output to 2 decimal point**. Here is a sample run.

```
Enter the monthly saving amount: 100
Enter annual interest rate: 0.05
After the sixth month, the account value is 608.81
```

   Vocareum Submission: Submit only the function definition without the test program.

6. **Checkoff** Get a checkoff from an instructor by showing your test programs for Q 3, 4, and 5.

Problems: Homework

1. *Functions: Temperature conversion:* Write a function named `celsius_to_fahrenheit` that returns the fahrenheit equivalent of a centigrade value input as an argument.

```
>>>print(celsius_to_fahrenheit(0))
32.0
>>>print(celsius_to_fahrenheit(-40))
-40.0
>>>print(celsius_to_fahrenheit(100))
212.0
```

2. *Functions: Volume of a cylinder* Write a function that takes in the radius and the length of a cylinder and returns the area and volume using the following formulas:

$$\begin{aligned} area &= radius * radius * \pi \\ volume &= area * length \end{aligned}$$

Round your answer to two decimal place and output both the area and volume as a tuple.

For example,

```
>>>print(area_vol_cylinder(1.0,2.0))
(3.14, 6.28)

>>>print(area_vol_cylinder(2.0,2.3))
(12.57, 28.9)

>>>print(area_vol_cylinder(1.5,4))
(7.07, 28.27)

>>>print(area_vol_cylinder(2.2,5.0))
(15.21, 76.03)
```

3. *Functions: Wind-chill temperature* How cold is outside? The temperature alone is not enough to provide the answer. Other factors including wind speed, relative humidity, and sunshine play important roles in determining coldness outside. In 2001, the National Weather Service (NWS) implemented the new wind-chill temperature to measure the coldness using temperature and wind speed.

$$t_{wc} = 35.74 + 0.6215t_a - 35.75v^{0.16} + 0.4275t_a v^{0.16}$$

where t_a is the outside temperature measured in Fahrenheit and v is the speed measured in miles per hour. t_{wc} is the wind-chill temperature.

Write a function that takes in a temperature and a wind speed and returns the wind-chill temperature.

```
>>>print(wind_chill_temp(5.3,6))
-5.56706845588

>>>print(wind_chill_temp(2.2,4))
-6.34646224199
```

Write a test program that prompt the user to key in the temperature and the wind speed as follows.

```
Outside temperature in Fahrenheit: 5.3
Wind speed in  miles per hour: 6
wind chill index: -5.56707
```

Vocareum Submission: Submit only the function definition without the test program.

4. *Functions: BMI:* Write a function that takes in your weight in pounds and your height in inches, and returns the Body Mass Index (BMI) of the person. The BMI can be calculated by taking the weight in kilograms and dividing it by the square of your height in meters. You can assume that the height is never zero. Note that one pound is 0.45359237 Kg and one inch bis 0.0254 meters. For example:

```
>>>print(bmi(120,60))
23.4356526546
>>>print(bmi(100,50))
28.1227831856
>>>print(bmi(200,80))
21.9709243637
>>>print(bmi(95.5,50))
26.8572579422
```

Write a test program that request for weight and height from a user as follows.

```
Weight in pounds: 95.5
Height in inches: 50
BMI: 26.8573
```

Vocareum Submission: Submit only the function definition without the test program.

5. *Functions: Future investment value:* Write a function that takes in an investment amount, the annual interest rate in percentage, and the number of years, and returns the future investment value using the following formula:

$$futureInvestmentValue = investmentAmount \times (1 + monthlyInterestRate)^{numberOfMonths}$$

For example:

```
>>>print(investment_val(1000,4.25,1))
1043.34
>>>print(investment_val(1500,3.25,2))
1600.6
>>>print(investment_val(1000,2.25,0.5))
1011.3
>>>print(investment_val(2000,4.25,3))
2271.46
```

Round the answer to two decimal places.

Write a test program that keys in the investment amount, annual interest rate, and the number of years. Here is a sample run:

```
Enter investment amount: 1000
Enter annual interest rate (%): 4.25
Enter number of years: 1
Accumulated value is 1043.33
```

Vocareum Submission: Submit only the function definition without the test program.

End of Problem Set 2.