**NATIONAL UNIVERSITY OF COMPUTER & EMERGING
SCIENCES ISLAMABAD CAMPUS
INTRODUCTION TO COMPUTING (CS101) - FALL 2017
ASSIGNMENT-3**

Due Date: October 29, 2017 (09:00pm)
Instructions:

1. *Write Python program for all the problems.*
2. *Solution to all the problems should be written in a separate (.py) file.*
3. *Submit the source code (i.e. python code in .py file) via slate. Submissions via email will not be accepted.*
4. *Moreover, you must submit your notebook file (.ipynb) as well with all the codes and their outputs in different cells.*
5. *Use proper naming convention to name the file containing source code. For example, the file containing the source code for first question of the first assignment should be named as i17xxxx_assignment_3_q1.py, replace i17xxxx with your student number.*

1. Write a program that filters positive elements out of a list. The program should build a new filtered list while the original list should remain unchanged. For example, if a list containing the elements 2, −16, 2, −5, 0, 1, −2, −3 is used in the program, the program should build a new list containing -16, -5, -2, -3. Note the original ordering of the non-negative values is unchanged in the result.

2. Write a program that finds the smallest and largest substring in a given string. For example, if string contains following value = 'My Village is a beautiful place', your program should print "a" and "beautiful".

3. Write a program that counts up the number of consonants contained in a string. Valid consonants are all the values except vowels: 'a', 'e', 'i', 'o', and 'u'. For example, if string contains following value = 'azcbobobegghakl', your program should print:
   Number of consonants: 10
   You can use raw_input function to take input from the user.

4. Write a program that prints the number of times the string 'bob' occurs in a user input. For example, if string contains following value = 'azcbobobegghakl', then your program should print
   Number of times bob occurs is: 2
   You can use raw_input function to take input from the user.

5. Write a code that prints the most frequently occurring element of a list of integers. Break ties by choosing the lower value. For example, if the list passed contains the values [27, 15, 15, 11, 27], your method should return 15.

6. Islamabad Traffic office has asked you to create an application that grades the written portion of the driver's license exam. The exam has 20 multiple-choice questions. Here are the correct answers:

1. A	6. B	11. A	16. C
2. C	7. C	12. D	17. B
3. A	8. A	13. C	18. B
4. A	9. C	14. A	19. D
5. D	10. B	15. D	20. A

Your program should store these correct answers in a list. The program should read the student's answers for each of the 20 questions and store the answers in another list. After the student's answers have been read, the program should display a message indicating whether the student passed or failed the exam. (A student must correctly answer 15 of the 20 questions to pass the exam.) It should then display the total number of correctly answered questions, the total number of incorrectly answered questions, and a list showing the question numbers of the incorrectly answered questions.

7. Write a Python program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings.
Sample List: ['abc', 'xyz', 'aba', '1221']
Expected Result : 2

8. Write a Python program to get a list, sorted in increasing order by the last element from a given list.
Sample List: [[2, 5], [1, 2], [4, 4], [2, 3], [2, 1]]
Expected Result : [[2, 1], [1, 2], [2, 3], [4, 4], [2, 5]]

9. Write a Python program to create a list by concatenating a given list which range goes from 1 to n.
Sample list: ['p', 'q']
n =5
Sample Output : ['p1', 'q1', 'p2', 'q2', 'p3', 'q3', 'p4', 'q4', 'p5', 'q5']

10. Write a python program to calculate trace of matrix. Trace of an n-by-square matrix is defined to be the sum of the elements on the main diagonal (the diagonal from the upper left to the lower right).
Mat= [[3, 4, 5], [1, 2, 3], [4, 7, 1]]
Trace = 6

11. Write a Python function to check whether a number is perfect or not.
According to Wikipedia : In number theory, a perfect number is a positive integer that is equal to the sum of its proper positive divisors, that is, the sum of its positive divisors excluding the number itself (also known as its aliquot sum). Equivalently, a perfect number is a number that is half the sum of all of its positive divisors (including itself).
Example: The first perfect number is 6, because 1, 2, and 3 are its proper positive divisors, and 1 + 2 + 3 = 6. Equivalently, the number 6 is equal to half the sum of all its positive divisors: (1 + 2 + 3 + 6) / 2 = 6. The next perfect number is 28 = 1 + 2 + 4 + 7 + 14. This is followed by the perfect numbers 496 and 8128.

12. Write a program that produces as output the lyrics of the song, "There Was An Old Lady." Use functions (functions) for each verse and the refrain. Here are the song's complete lyrics:

```
There was an old lady who swallowed a fly.
I don't know why she swallowed that fly,
Perhaps she'll die.

There was an old lady who swallowed a spider,
That wriggled and iggled and jiggled inside her.
She swallowed the spider to catch the fly,
I don't know why she swallowed that fly,
Perhaps she'll die.


There was an old lady who swallowed a bird,
How absurd to swallow a bird.
She swallowed the bird to catch the spider,
She swallowed the spider to catch the fly,
I don't know why she swallowed that fly,
Perhaps she'll die.

There was an old lady who swallowed a cat,
Imagine that to swallow a cat.
She swallowed the cat to catch the bird,
She swallowed the bird to catch the spider,
She swallowed the spider to catch the fly,
I don't know why she swallowed that fly,
Perhaps she'll die.

There was an old lady who swallowed a dog,
What a hog to swallow a dog.
She swallowed the dog to catch the cat,
She swallowed the cat to catch the bird,
She swallowed the bird to catch the spider,
She swallowed the spider to catch the fly,
I don't know why she swallowed that fly,
Perhaps she'll die.

There was an old lady who
swallowed a horse, She died of
course.
```

You goal will be to identify a repetitive verses and refrains and write functions corresponding to them

13. Write a function toNumbers(strList) that receives a list of strings as input, and converts each element from string to integer and updates the list so that it now contains integers. Each element of strList represents a number.

14. The ancient Greeks classify numbers geometrically. For example, a number was called "triangular" if that number of pebbles could be arranged in a symmetric triangle. The first ten triangular numbers are 0, 1, 3, 6, 10, 15, 21, 28, 36, and 45. Write and test the boolean function:

int isTriangular(int n)
This function returns 1 if the given integer n is a triangular number, and 0 otherwise.

$T_1 = 1 \quad T_2 = 3 \quad T_3 = 6 \quad T_4 = 10 \quad T_5 = 15$
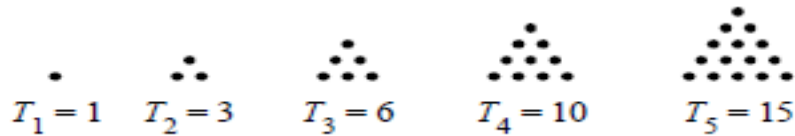
15. Write a program that produces Christmas trees as output. It should have a function with two parameters: one for the number of segments in the tree and one for the height of each segment. For example, the following tree on the left has 3 segments of height 4 and the one on the right has 2 segments of height 5.
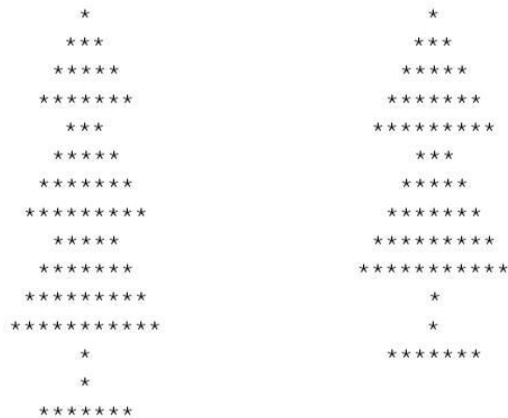
16. We consider the following piecewise constant function

$$f(t) = \begin{cases} 1, & 0 < t < T/2, \\ 0, & t = T/2, \\ -1, & T/2 < t < T \end{cases}$$

Sketch this function on a piece of paper. One can approximate f(t) by the sum

$$S(t; n) = \frac{4}{\pi} \sum_{i=1}^{n} \frac{1}{2i - 1} \sin\left(\frac{2(2i - 1)\pi t}{T}\right).$$

It can be shown that $S(t; n) \to f(t)$ as $n \to \infty$.

a) Now Write a Python function S (t, n, T) for returning the value of S(t; n).
b) Write a Python function f (t, T) for computing f (t).
c) Write out tabular information showing how the error=f(t) − S(t; n) varies with "n" and "t" for the cases where n = 1, 3, 5, 10, 30, 100 and t = αT with T = 2π, and α = 0.01, 0.25, 0.49.
d) Find the best values of α and n that gives minimum error.

17. Write a function named reverse_vertical that accepts a string as its parameter and prints each letter of the string in reverse order in separate lines. For example, a call of reverse_vertical("hey now") should produce the following output:

w

o

n

y

e

h

18. In physics, an object that is in motion is said to have kinetic energy. The following formula can be used to determine a moving object's kinetic energy:

$$KE = \frac{1}{2} mv^2$$

The variables in the formula are as follows: KE is the kinetic energy, m is the object's mass in kilograms, and v is the object's velocity in meters per second. Write a function named kinetic_energy that accepts an object's mass (in grams) and velocity (in kilometers per second) as arguments. The function should return the amount of kinetic energy that the object has. Write a program that asks the user to enter values for mass and velocity, and then calls the kinetic_energy function to get the object's kinetic energy.

19. Write a function that produces the following output. Use a function parameter to make it possible to change the number of stairs in the figure. You can use write other helper functions as well.

```
                      O    * * * * * * *
                     /|\  *           *
                     / \ *            *
                  O    * * * * * *      *
                 /|\  *                *
                 / \ *                 *
              O    * * * * * *          *
             /|\  *                    *
             / \ *                     *
          O    * * * * * *              *
         /|\  *                        *
         / \ *                         *
      O    * * * * * *                  *
     /|\  *                            *
     / \ *                             *
   O    * * * * * *                     *
  /|\  *                               *
  / \ *                                *
  * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

20. Write a function that produces the following rocket ship figure as its output. Use a function parameter to make it possible to change the size of the rocket (the following output uses a size of 2). You can use write other helper functions as well.

```
        /**\
       //**\\
      ///**\\\
     ////**\\\\
    /////**\\\\\
   +=*=*=*=*=*=*+
   |../\..../\..|
   |./\/\../\/\.|
   |/\/\/\/\/\/\|
   |\/\/\/\/\/\/|
   |.\/\/..\/\/.|
   |..\/....\/..|
   +=*=*=*=*=*=*+
   |\/\/\/\/\/\/|
   |.\/\/..\/\/.|
   |..\/....\/..|
   |../\..../\..|
   |./\/\../\/\.|
   |/\/\/\/\/\/\|
   +=*=*=*=*=*=*+
        /**\
       //**\\
      ///**\\\
     ////**\\\\
    /////**\\\\\
```