COMPUTER PROGRAMMING LABORATORY
Experiment # 6:
Data Structures

OBJECTIVES

The main purpose of this experiment is to introduce you to data structures. In this experiment, firstly, lists, strings, dictionaries and sets are examined. Then, some examples are studied.

QUESTIONS

1) The local driver's license 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 randomly generate the student's answers for each of the 20 questions and store the answers in another list.

After the student's answers have been generated, 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.)

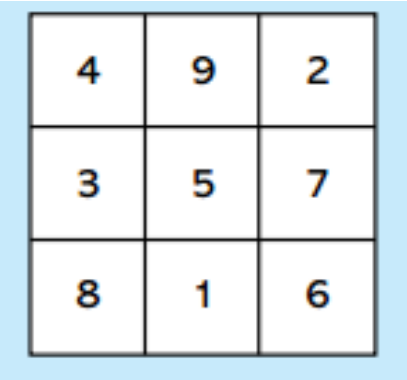
It should then display the total number of correctly answered questions, the total number of incorrectly answered questions, and a list showing the question numbers of the incorrectly answered questions.

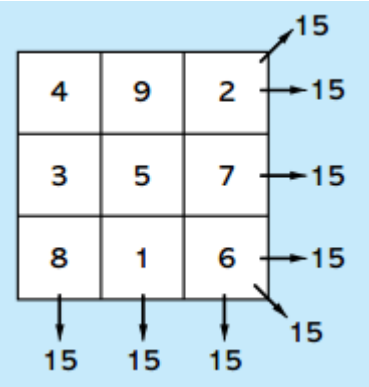
2) The Lo Shu Magic Square is a grid with 3 rows and 3 columns, shown in Figure. The Lo Shu Magic Square has the following properties:

- The grid contains the numbers 1 through 9 exactly.
- The sum of each row, each column, and each diagonal all add up to the same number.

Write a Python program to simulate a magic square using a two-dimensional list. Write a function that generates **a grid with 3 rows and 3 columns**. **The grid must be met the first property, which is given above.**

Then, write another function that accepts the two-dimensional list as an argument and determines whether the list is a Lo Shu Magic Square.





3) Many companies use telephone numbers like 555-GET-FOOD so the number is easier for their customers to remember. On a standard telephone, the alphabetic letters are mapped to numbers in the following fashion:

A, B, and C = 2
D, E, and F = 3
G, H, and I = 4
J, K, and L = 5
M, N, and O = 6
P, Q, R, and S = 7
T, U, and V = 8
W, X, Y, and Z = 9

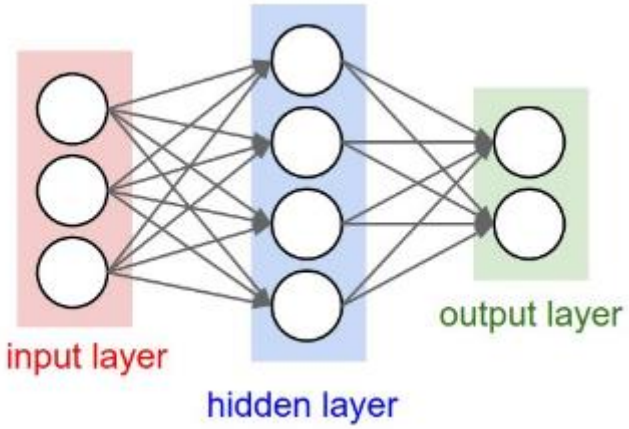
Write a program that asks the user to enter a 10-character telephone number in the format XXX-XXX-XXXX. The application should display the telephone number with any alphabetic characters that appeared in the original translated to their numeric equivalent.

For example, if the user enters 555-GET-FOOD, the application should display 555-438-3663.

4) Write a program that generates 100 random numbers between 1 and 10. The program should store the frequency of each number generated in a dictionary with the number as the key and the amount of times it has occurred as the value.

For example, if the program generates the number 6 a total of 11 times, the dictionary will contain a key of 6 with an associated value of 11. Once all of the numbers have been generated, display information about the frequency of each number.

5) An example of simple neural network architecture is given. A 2-layer Neural Network has one hidden layer of 4 neurons and one output layer with 2 neurons and three inputs. The following network has 4 + 2 = 6 neurons (not counting the inputs), w_1 ([4 x 3]) + w_2([2 x 4]) = 20 weights and b_1(4) + b_2(2) = 6 biases, for a total of 26 learnable parameters. Functional form of the 2-layer network is $h_1 = f(w_1 * x + b_1)$ and $score = w_2 * x + b_2$. Every activation function f (or non-linearity) takes a single number and performs a certain fixed mathematical operation on it. You can use sigmoid as activation function: $f(x) = \frac{1}{1+e^{-x}}$.



A gray scale image (32x32) is given. Design the neural network includes one hidden layer and output layer. While hidden layer has 48 neurons, output layer has 3 neurons for cat, dog and bird classes. Then assign the image to related class according to maximum of score index. For example if second index of the score is maximum, the image must be labelled to dog class. The image pixel, weight matrices and biases must be in between 0-1 and generate them randomly. Print the class of the image. (Hint: Image matrices must be flattened to (32*32,1)).

6) Write a program to calculate evaluation metrics of classification problem such as precision, recall, and F1. Assume that we have 3 classes and 100 samples. First 40 samples belong to Class 1, last 10 samples belong to Class 3, and the remaining samples belong to Class 2. You will generate results randomly in interval [1, 3] for 100 samples. First find sample indices for classes in results. Then, determine True Positive (TP), False Positive (FP), and False Negative (FN) for classes as follows.

$$TP = r_i \cap gt_j, where\ r_i \in result\ Indices\ and\ gt_j \in ground\ truth\ Indices$$
$$FP = r_i \backslash gt_j, where\ r_i \in result\ Indices\ and\ gt_j \in ground\ truth\ Indices$$
$$TP = gt_j \backslash r_i, where\ r_i \in result\ Indices\ and\ gt_j \in ground\ truth\ Indices$$

Lastly, calculate precision, recall, and F1 for that class as follows:

$$precision = \frac{|TP|}{|TP| + |FP|}$$

$$recall = \frac{|TP|}{|TP| + |FN|}$$

$$F1 = 2x\frac{precision\ x\ recall}{precision + \ recall}$$