MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY
P.O. Box 972-60200 – Meru-Kenya
Tel: +254(0) 799 529 958, +254(0) 799 529 959, + 254 (0) 712 524 293,
Website: info@must.ac.ke Email: info@must.ac.ke

University Examinations 2023/2024

FIRST YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF MASTER IN DATA SCIENCE

CCD 7154: NEURAL NETWORKS

DATE: APRIL 2024   **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

a) You have been provided with the following data set that has 2 attributes (X1, X2). Apply kmeans algorithm to the data using k=2 and taking instances A and C as the initial centroids.   (7 marks)

ID	X1	X2
A	1	1
B	1	0
C	0	2
D	2	4
E	3	5

b) You have been provided with the following data set. Given a learning rate of 0.2 and an initial weight vector of {0, 0.6, 1}, apply the perceptron training rule to learn the weights of a single perceptron. (7 marks)

Attribute 1	Attribute 2	Y
1	1	1
2	-2	-1
-1	-1.5	-1
-2	-1	-1
-2	1	1

c) Define a self-organizing map. (2 marks)

d) Describe the competitive process of the self-organizing map algorithm. (4 marks)

QUESTION TWO (20 MARKS)

a) Explain the differences between feedforward and recurrent neural networks, providing examples of real-world applications for each. (4 marks)

b) Discuss the concept of deep learning and its significance in neural network architectures.
(3 marks)

c) Define "Learning Law:" in Neural Networks and explain any two such learning laws used in Neural Networks . (4 marks)

d) Domain knowledge can be used to determine the value of K in Kmeans clustering. Using a diagram to illustrate, discuss how the elbow method can be used to determine the value of K. (4 marks)

e) Analyze the advantages and disadvantages of convolutional neural networks (CNNs) compared to fully connected networks. (5 marks)

QUESTION THREE (20 MARKS)

a)   Java restaurant in Meru is redesigning its breakfast menu to include meals that are frequently bought together in a combined meal package. The following data was collected for a number of transactions.

Transaction ID	Item Bought
1	Milk, Tea, Cake
2	Eggs, Tea, Cold Drink
3	Milk, Eggs, Tea, Cold Drink
4	Eggs, Cold Drink
5	Juice, Eggs, Tea

    i. Determine item sets with a minimum support of 60%. (4 marks)

    ii. Calculate the confidence for the rules that can be extracted from the frequent item sets obtained in (i) above. (4 marks)

b) Discuss the importance of gradient descent in training neural networks, including its variants and optimization techniques. (8 marks)

c) Consider a logistic regression model with weights $\beta 0 = 0$, $\beta 1 = 0.5$, $\beta 2 = 0.25$ and $\beta 3 = 1$ created to determine whether a news article is about sports. A given news article has a feature vector c= (1,0,1).

    i.   Discuss how you would apply the output of a logistic regression model for classification. (1 mark)

    ii.   Determine the probability of the above news article is about sports. (2 marks)

    iii.   Determine the odds of a news article being about sports from (ii) above.

        (1 mark)

QUESTION FOUR (20 MARKS)

a) Give a detailed explanation of any 4 practical Neural Network application areas that you learnt about from presentations made by your classmates. (8 marks)

b) Clearly discuss the four components of the Directed Random Search Network.

(8 marks)

c) One of the earliest neural networks was the McCulloch-Pitts Neural Network. Explain how the network operates and its possible application areas (4 marks)

QUESTION FIVE (20 MARKS)

You have been selected as one of the key speakers in the first ever neural networks conference to be held in Meru University this year. As part of your presentation you are supposed to present a write-up on the Practical Application areas of NN. Give a detailed explanation of any 4 application areas that you will showcase at the conference. (8 marks)

a) A perceptron is used to learn a simple function. It has two regular inputs, Xl and X2, and an extra fixed input X0, which always has a value of -1. The perceptron's output is such that if summation is greater than zero (0), then output is one (1), else it is zero (0). Given the following training set with inputs (X0,X1,X2), and target output T:

X0	X1	X2	T
-1	1	1	1
-1	1	0	0
-1	0	1	0
-1	0	0	0

Show the change in the weights of the perceptron for every presentation of a training instance. The initial weights are randomly set as WI=0.2, W2=0.3 and W0=0.0 and the learning rate is 0.2. You should iterate over three epochs. Does the perceptron converge? (7 Marks)

b) There are a number of factors that have to be considered during the development of neural networks. List and explain any three of these important factors. (5 marks)