MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTING AND INFORMATION TECHNOLOGY

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MATHEMATICS AND COMPUTER SCIENCE)

BACHELOR OF SCIENCE (COMPUTER SCIENCE)

SCO 411: NEUTRAL NETWORKS

DATE: 19/10/2020 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer question ONE and any other TWO questions.

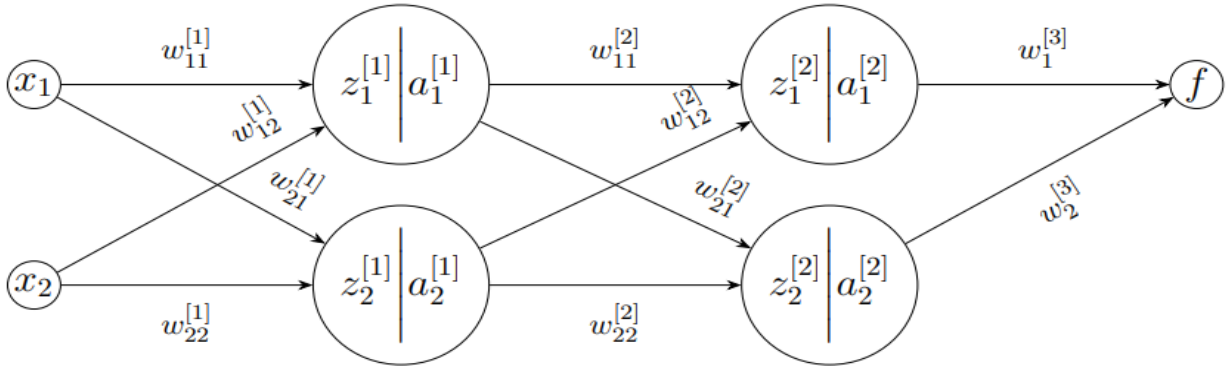
QUESTION ONE (30 MARKS) (COMPULSORY)

a) Fill in one of 'increases', 'decreases' or 'no change' in each of the cells after performing the operation indicated (8 marks)

Operation	Bias	Variance
Regularizing the weights		
Increasing the size of the layers (more hidden units per layer)		
Using dropout to train a deep neural network		
Getting more training data (from the same distribution as before)		

b) Describe any three main differences between the human brain and today's computers in terms of information processing. (6 marks)

c) Consider the three-layer network below (4 marks)



$$Z^{[1]} = \begin{bmatrix} z_1^{[1]} \\ z_2^{[1]} \end{bmatrix} = \begin{bmatrix} w_{11}^{[1]} & w_{12}^{[1]} \\ w_{21}^{[1]} & w_{22}^{[1]} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad , \quad A^{[1]} = \begin{bmatrix} a_1^{[1]} \\ a_2^{[1]} \end{bmatrix} = \begin{bmatrix} \sigma(z_1^{[1]}) \\ \sigma(z_2^{[1]}) \end{bmatrix}$$

$$Z^{[2]} = \begin{bmatrix} z_1^{[2]} \\ z_2^{[2]} \end{bmatrix} = \begin{bmatrix} w_{11}^{[2]} & w_{12}^{[2]} \\ w_{21}^{[2]} & w_{22}^{[2]} \end{bmatrix} \begin{bmatrix} a_1^{[1]} \\ a_2^{[1]} \end{bmatrix} \quad , \quad A^{[2]} = \begin{bmatrix} a_1^{[2]} \\ a_2^{[2]} \end{bmatrix} = \begin{bmatrix} \sigma(z_1^{[2]}) \\ \sigma(z_2^{[2]}) \end{bmatrix}$$

Given the equation below, answer the questions that follows

$$f = w_1^{[3]} a_1^{[2]} + w_2^{[3]} a_2^{[2]},$$

i. Compute

$$\delta_2 = \frac{\partial f(x)}{\partial Z^{[2]}}$$

ii. Compute

$$\delta_1 = \frac{\partial f(x)}{\partial z_1^{[2]}}$$

d) Using a well labelled diagram, explain the basic components of Artificial Neural Network (7 marks)

e) Describe the competitive process of the Self-Organising Map algorithm. (5 marks)

QUESTION TWO (20 MARKS)

a) Define the concepts of dense and sparse random representations. How do their properties compare with those of an orthonormal set of representation vectors. (6 marks)

b) Distinguish between the following (6 marks)

i. Neural networks and artificial Neural Networks

ii. Neural Network architecture and Neural Network layers

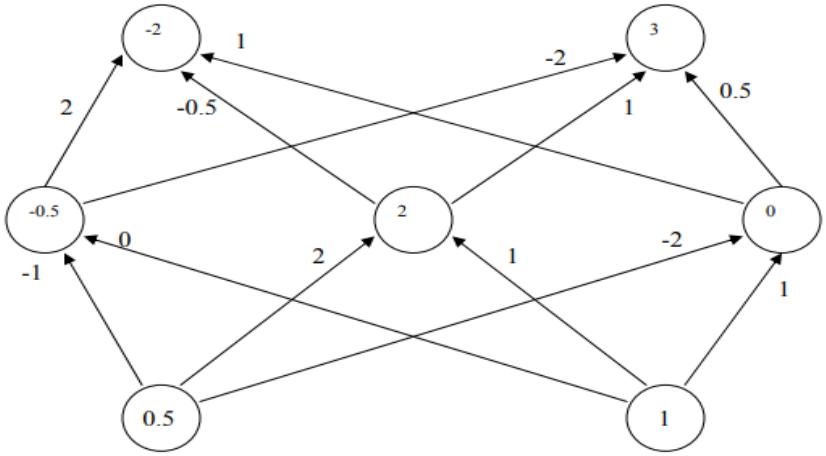
iii. a feedforward network and a recurrent network

c) A student would like to decide whether to attend a wedding party. The decision variables are weather condition, availability of transport, and completion of assignment. Explain how the decision would be made using artificial Neural Network. (8 marks)

QUESTION THREE (20 MARKS)

a) Define Hopefield net and compute the weight matrix for a 4-neuron Hopfield net with the single fundamental memory $\xi 1 = [1,–1, –1,1]$ stored in it. (4 marks)

b) The following is a network of linear neurons, that is, neurons whose output is identical to their net input, oi = neti. The numbers in the circles indicate the output of a neuron, and the numbers at connections indicate the value of the corresponding weight.



i. Compute the output of the hidden-layer and the output-layer neurons for the given input (0.5, 1) and enter those values into the corresponding circles. (3 marks)

ii. What is the output of the network for the input (1, 2), i.e. the left input neuron having the value 1 and the right one having the value 2? Do you have to do all the network computations once again in order to answer this question? Explain why you do or do not have to do this. (5 marks)

c) Describe any two types of learning rules including relevant examples (8 marks)

QUESTION FOUR (20 MARKS)

a) Using well labelled diagrams, Explain any three common activation functions (9 marks)

b) Explain the three phases of training ANN by back propagation (6 marks)

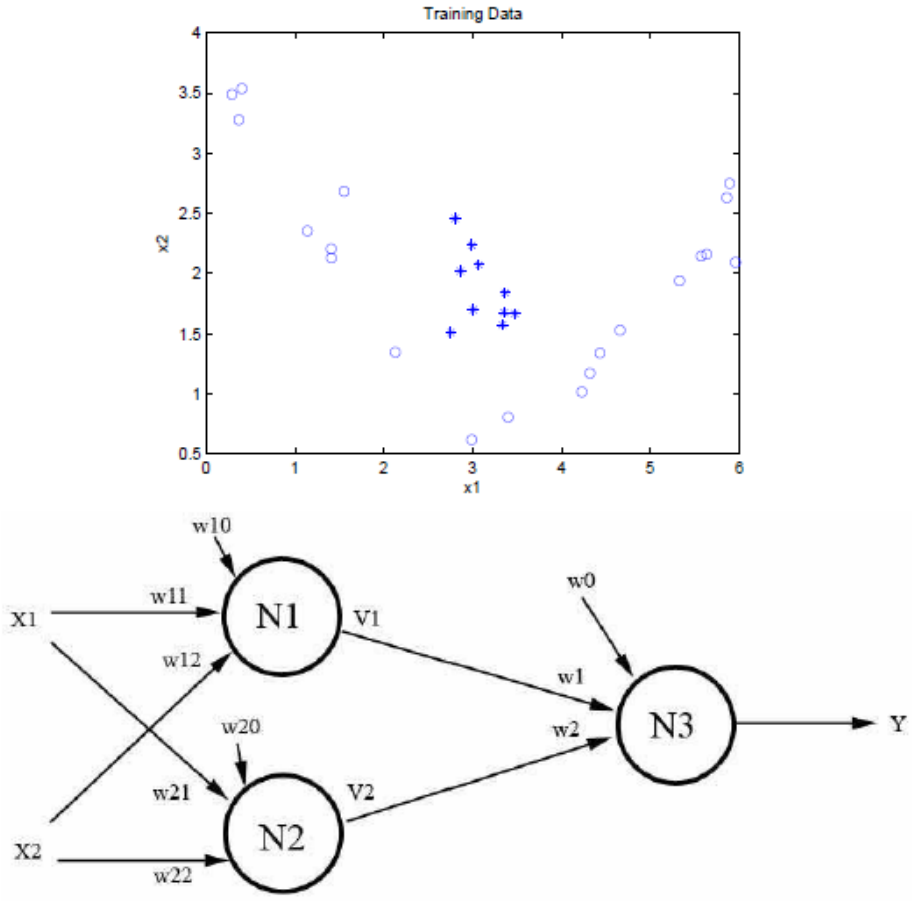
c) Weighting is important in the modeling of neural network problem. Explain the reasons for weight (5 marks)

QUESTION FIVE (20 MARKS)

a) Given the following points (x_1 = -1, x_2 = 1) with target 1, (x_1 = 1, x_2 = 1) with target 1, and (x_1 = 0, x_2 = 2) with target 0. If the classifier has a bias term with a value is fixed at 1, write down the inequalities, represent them in weight space and indicate the feasible region.

(6 marks)

b) Consider the following classification training data (where "*" = true or 1 and "O" = false or 0) and neural network model that uses the sigmoid response function $g(t) = \frac{1}{1+e^{-t}}$.



We would like to set the weights (w) of the neural network so that it is capable of correctly classifying this dataset. Please plot the decision boundaries for N1 and N2 (e.g.,for neuron N1, the line where w10 + w11* X1 + w12 *X2 = 0) on the first two graphs. In the third graph, which has axes V2 and V1, plot {V1(x1, x2), V2(x1, x2)} for a few of the training points and provide a decision boundary so that the neural net will correctly classify the training data. (7 marks)

c) State three types of learning (3 marks)

d) Explain the effect of learning with the following rates (4 marks)

i. too high

ii. low .