

Ex/IT/T/423C/2018

Bachelor of Engineering (Information Technology) Examination – 2018  
 (4<sup>th</sup> year, 2<sup>nd</sup> semester)  
 Subject: Pattern Recognition

Time : Three hours

Full Marks: 100

*Different parts of the same question should be answered together*

1. Answer any one from (a) and (b). [10]
  - a. The design of a pattern recognition system usually entails the repetition of a number of different activities. Draw and explain the design cycle.
  - b. A bank classify the customers as good or bad credit risk. Using past data the bank found 1% of good credit risk and 10% of bad credit risk overdrew in any given month. A new customer opens an account and a credit bureau of bank said that there is 70% chance that the customer will be good credit risk. Now, assume the customer overdrew in first month. How dose this alter the bank's opinion of this customer's creditworthiness?
  
2. Answer the following questions both (a) and (b). [20]
  - a. Suppose the weights of randomly selected American female college students are normally distributed with unknown mean  $\mu$  and standard deviation  $\sigma$ . A random sample of 10 American female college students yielded the following weights (in pounds):  
 115 122 130 127 149 160 152 138 149 180  
 Based on the definitions given above, identify the likelihood function and the maximum likelihood estimator of  $\mu$ , the mean weight of all American female college students. Using the given sample, find a maximum likelihood estimate of  $\mu$  as well. (12)
  - b. Consider a two-category classification problem with one-dimensional Gaussian distributions  $p(x|w_i) \sim N(\mu_i, \sigma^2)$ ,  $i=1, 2$  (i.e. they have same variance but different means). Sketch the two posterior probabilities  $P(w_1|x)$  and  $P(w_2|x)$  in one figure assuming same prior probabilities. (8)
  
3. Answer any two from (a), (b) and (c) [20]
  - a. Write the algorithmic steps of k-means clustering concept. Write two advantages and two disadvantages of k-means clustering. (6+2+2)
  - b. Explain PC1 and PC2 of PCA. How the mean and variance affects the concept of LDA, explain with proper figure. (6+4)
  - c. Write the algorithm for KNN classifier. Can you use any distance function of KNN, if yes, suggest one. (6+4)
  
4. Answer any one from the following. [10]

- a. In practice, certain features may be missing from some feature vectors. Write the traditional techniques to complete the missing data. Write the method “Imputing from a Conditional Distribution”. (4+6)
- b. Write the “Known Mean Value Vector  $\mu$ ” and “Unknown Mean Value Vector  $\mu$ ” of Peaking Phenomenon. (5+5)

5. Answer and two from (a), (b) and (c). [40]

- a.
  - i. Below is a diagram if a single artificial neuron (unit):

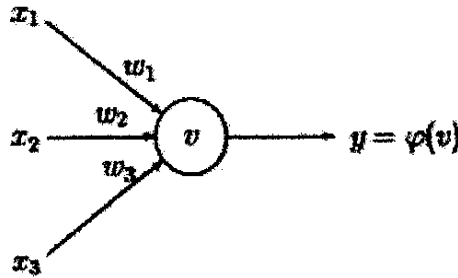


Figure : 1

The node has three inputs  $x = (x_1, x_2, x_3)$  that receive only binary signals (either 0 or 1). How many different input patterns this node can receive? What if the node had four inputs? Five? Can you give a formula that computes the number of binary input patterns for a given number of inputs? (8)

- ii. Consider the unit shown on Figure 1. Suppose that the weights corresponding to the three inputs have the following values:

$$w_1 = 2$$

$$w_2 = -4$$

$$w_3 = 1$$

and the activation of the unit is given by the step-function:

$$\varphi(v) = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

Calculate what will be the output value  $y$  of the unit for each of the following input patterns:

Pattern	$P_1$	$P_2$	$P_3$	$P_4$
$x_1$	1	0	1	1
$x_2$	0	1	0	1
$x_3$	0	1	1	1

(7)

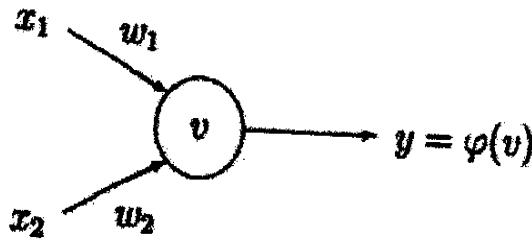
- iii. What is a training set and how is it used to train neural networks? (5)

- b. Logical operators (i.e. NOT, AND, OR, XOR, etc) are the building blocks of any computational device. Logical functions return only two possible values, true or false,

based on the truth or false values of their arguments. For example, operator AND returns true only when all its arguments are true, otherwise (if any of the arguments is false) it returns false. If we denote truth by 1 and false by 0, then logical function AND can be represented by the following table:

$x_1 :$	0	1	0	1
$x_2 :$	0	0	1	1
$x_1 \text{ AND } x_2 :$	0	0	0	1

This function can be implemented by a single-unit with two inputs:



if the weights are  $w_1 = 1$  and  $w_2 = 1$  and the activation function is:

$$\varphi(v) = \begin{cases} 1 & \text{if } v \geq 2 \\ 0 & \text{otherwise} \end{cases}$$

The threshold level is 2 ( $v \geq 2$ ).

- i. Test how the neural AND function works. (8)
- ii. Suggest how to change either the weights or the threshold level of this single-unit in order to implement the logical OR function (true when at least one of the arguments is true):

$x_1 :$	0	1	0	1
$x_2 :$	0	0	1	1
$x_1 \text{ OR } x_2 :$	0	1	1	1

(12)

- c.
  - i. Describe the main steps of the supervised training algorithm? (10)
  - ii. What is the Hopfield Network? Describe with clear picture. Write three uses. (7+3)