Department of Computer Science and Engineering, MNIT Jaipur
CST-905 Research methodology

Time: 2 hrs 30 min **Max. Marks: 50**

Attempt **any five** questions. All questions carry equal marks. Show your work so that partial marks can be awarded even if the final result is not correct,

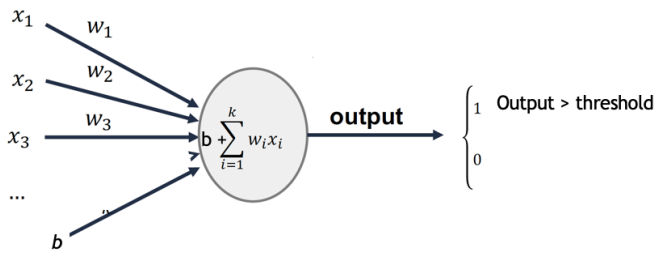

Figure 1

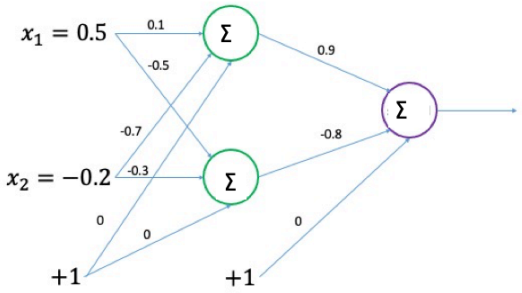

Figure 2

1) (a) Define "Correlation Coefficient" and explain its significance in data analysis.
(b) For X = {1, 5, 3, 7. 10} and Y = {-2, -4, 0, 3, 2}, compute correlation coefficient.
(c) What are minimum and maximum values of correlation coefficient? Justify your answer.
(d) Through graphs or otherwise, illustrate case where coefficient tends to zero.

2) Covariance between two variables X and Y is defined as

$$\text{cov}(x, y) = \frac{\sum_{k=1}^{N} (X_k - \mu_x)(Y_k - \mu_y)}{N - 1}$$

(a) Using above definition (μ_x, μ_y are average for *X* and *Y* respectively), prove the following
(i) average(*aX*) = *a*.average(*X*), *a* is a constant
(ii) average(*a* + *X*) = *a* + average(*X*), *a* is a constant
(iii) cov(*aX*, *bY*) = *ab* cov(*Y, X*)
(iv) cov(*X*+*a*, *Y*+*b*) = cov(*Y, X*)

3) (a) Two batteries are randomly chosen from a group of 3 new, 2 used but still working, and 3 defective batteries. If we let X denote the number of new and Y denote used but still working batteries that are chosen, then determine the joint probability mass function of *X* and *Y* , *p*(*i,* j) = *P*{*X*=*i, Y*=*j*}.

(b) *p*(*x, y*), the joint probability mass function of X and Y, is as follows
p(0, 0) = 0.20,
p(0, 1) = 0.35,
p(1, 0) = 0.15,
p(1, 1) = 0.30.
Calculate the conditional probability mass function of X given that (a)Y=0, (b) Y = 1.

4) (a) Explain working of a linear perceptron.
(b) What would be outcome for following linear perceptron (Figure 1)
$x_1 = 1$, $x_2 = -1$, $x_3 = 1$, $w_1 = 0.2$, $w_2 = -0.3$, $w_3 = 0.4$, threshold = 0.5
If actual output = 1 - output (computed by you), how would weights and bias be updated if learning rate = 0.1.
(c) What would be outcome for model in Figure 2

5) For the following matrix, compute its inverse using LU decomposition followed byforward/ backward substitution or any other method.

$$\begin{pmatrix} \mathbf{1} & \mathbf{2} & \mathbf{3} \\ \mathbf{2} & \mathbf{4} & \mathbf{5} \\ \mathbf{3} & \mathbf{2} & \mathbf{7} \end{pmatrix}$$

6) Compute DFT for following
   (a) [1, 2, 3, 2]
   (b) [1, 1, 2, 2]
   (c) What would be Fourier transform for a periodic sinusoidal wave? How would the transform change with phase angle?

7) A given machine has 8 bit registers. For floating point representation, 5 bits are used for integer part and 3 bits are used for fraction part. Identify which of the following computation shall result in Overflow and/or underflow. (All numbers are binary and unsigned)
   1) 101.11 x 011.101
   2) 111.01 x 100.10
   3) 011.110 x 101.111