DEPARTMENT OF BIOTECHNOLOGY, IIT, MADRAS

CHENNAI – 36

BT 3041 Analysis and Interpretation of Biological Data

Class : Btech | Date : 29-3-2017

Time : 8:00-8:50 am | QUIZ 2 Examination | Marks: 25

Part A

1. What are the following conditions that the transfer function, f(x), of a neuron need NOT have for the Universal Approximation theorem to apply? (1 mark) 1

A) Differentiability, B) continuity, C) monotonicity, D) boundedness.

2. Indicate by selecting TRUE or FALSE if the following functions satisfy all the conditions of the Universal Approximation theorem: (5 marks) 5

A) step function, T/F? If FALSE, what condition is violated? F, continuity

B) logistic function, T/F? If FALSE, what condition is violated? T.

C) sign() function, T/F? If FALSE, what condition is violated? F, continuity at x=0

D) tanh() function T/F? If FALSE, what condition is violated? T

E) ramp() function. (Hint: ramp(x) = x, for x>0, ramp(x) = 0 otherwise.) T/F? If FALSE, what condition is violated? F, boundedness.

3. Consider the two discriminant functions, (1 mark) X

$y_1 = g(x_1 - x_2 - 0.5)$ and $y_2 = g(x_1 + x_2 - 0.5)$, g(x) is the logistic function.

If $y_1 > y_2$, X→ Class #1, else X → Class #2. The decision surface separating the two classes is described as,

A) x1 = 0, B) x1-x2 = 0, C) x1 + x2 = 0, D) x2 = 0.

4. Consider the 3 layer MLP whose input/output function is defined as follows. $y_1 = g(x_1)$, $y_2 = g(x_2)$, and $y = g(y_1 + y_2 - 1.3)$ where g(x) is the step function. Which of the following statements is TRUE? (2 marks) 2

A) y is non-zero in the first and second quadrants.

B) y is non-zero in the first quadrant alone.

C) y is non-zero in the third quadrant alone.

D) y is zero in the firsts, second and fourth quadrants.

5. Which of the following is the correct formulation of learning for a linear Support Vector Machine? (1 mark) 1

A) $\max \|w\|^2$, *subject to* $y_i(w \bullet x_j + b) \geq 1,\ j = 1,\ldots,N$

B) $\min \|w\|^2$, *subject to* $y_i(w \bullet x_j + b) \geq 0,\ j = 1,\ldots,N$

C) $\max \|w\|^2$, *subject to* $y_i(w \bullet x_j + b) \leq 1,\ j = 1,\ldots,N$

D) $\min \|w\|^2$, *subject to* $y_i(w \bullet x_j + b) \geq 1,\ j = 1,\ldots,N$

$\|w\|^2$

g(x₁) g(y

y_2 II I

g(x₂)

$y_1 + y_2 - 1.3$

6. For a linear decision surface g(x) = 0, where $g(x) = w^t x + w_0$, the distance of a point x from the decision surface is given as, (1 mark)

A) $\frac{g(x)}{\|w\|^2}$, B) $\frac{g(x)}{\|w\|}$, C) $g(x)\|w\|$, D) $g(x)\|w\|^2$

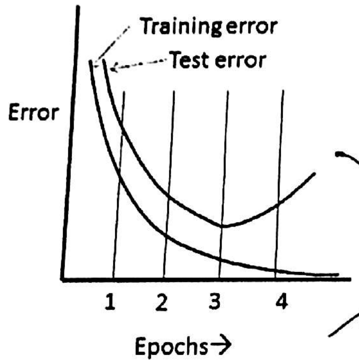
7. A linear discriminant function defined as $y = w^t x - w_0$, is used for a binary classification task such that if y >0, X→ Class #1 (d = +1), else X → Class #2 (d = -1). The learning equations for this task, which are invoked only when there is an erroneous classification, are: (1 mark)

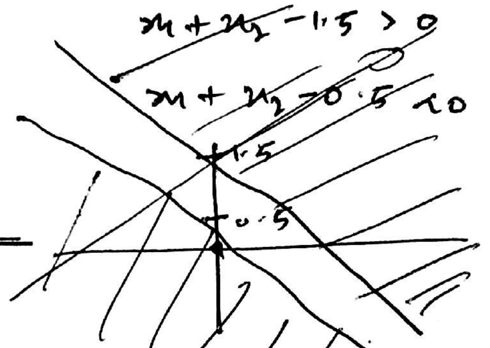
A) $\Delta w = \eta d_i x_i$; $\Delta w_0 = -\eta d_i$, B) $\Delta w = -\eta d_i x_i$; $\Delta w_0 = -\eta d_i$; C) $\Delta w = -\eta d_i x_i$; $\Delta w_0 = \eta d_i$,
D) $\Delta w = \eta d_i x_i$; $\Delta w_0 = \eta d_i$.

8. Consider a MLP defined as, $y_1 = g(x_1 + x_2 - 1.5)$, $y_2 = g(x_1 + x_2 - 0.5)$, and $y = g(y_1 - y_2 - 0.5)$. The region defined by y >0 is best described as, (2 marks)

A) An infinitely long rectangular strip, B) a semi-infinite region, C) an angular region with an infinite area, D) none of the above.

9. The graphs shown below depict training and test error of a MLP. Applied to the four points of interest, which of the following statements about the graph is true? (1 mark)





A) The MLP has lowest training error at 1 and best generalization at 4.
B) The MLP has lowest training error at 3 and best generalization at 1.
C) The MLP has lowest training error at 4 and best generalization at 3.
D) The MLP has lowest training error at 3 and best generalization at 4.

Part B

1. Consider the two discriminant functions,
$y_1 = g(x_1 - x_2 - 0.5)$ and $y_2 = g(x_1 + x_2 + 0.5)$, g(x) is the step function.
If $y_1 = 1$, $y_2 = 0$, X→ Class #1, else if $y_1 = 0$, $y_2 = 1$, X → Class #2. Mark the decision regions in the (x_1,x_2) plane. Indicate the 'gray zones' also. (5 marks)

2. Design a multilayer perceptron (MLP) that can implement an XNOR gate, by simple hand calculations. The MLP must have only 1 hidden layer and 2 neurons in that layer. The nonlinearity, g(x), for every neuron is the step function. The XNOR gate is defined as: (5 marks)

X1	X2	D
0	0	1
0	1	0
1	0	0
1	1	1