Final Examination: Semester II   Academic Year: 2006
Date: 23 March 2008   Time: 9:00-12:00
Subject: 240-650 Principles of Pattern Recognition   Room: A205

Instructions:

This exam has 6 problems, 11 pages and 85 points. You may use the back of the pages for scratch work. This exam is <u>open book</u>, so books, notes, calculators, and other related materials are allowed.

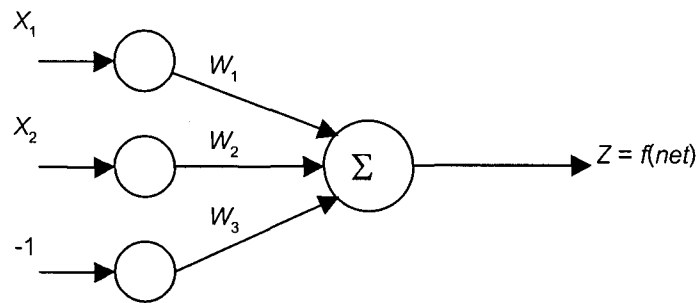| Problem	Points	Score
1	30	_____
2	10	_____
3	10	_____
4	15	_____
5	10	_____
6	10	_____

Name:_____

Student ID: _____

"ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต"

Problem 1

A single neuron has two inputs and a bias term as shown:

This problem deals with the algorithm for adjusting the 3 weights to minimize the error measure

$$J = 0.5(t-z)^2$$

Assume the neurons are linear, i.e. $\quad f(net) = \dfrac{1}{1+e^{net}}$

a)   Determine specific equations for the gradient of J, using all 3 weights. That is, determine

$$\frac{\partial J}{\partial W_1}, \quad \frac{\partial J}{\partial W_2}, \quad \text{and} \; \frac{\partial J}{\partial W_3} \qquad\qquad \text{(10 points)}$$

b)   Numerically evaluate the equations from part a) if $x_1=1$, $x_2=1$, $W_1=W_2=1$, $W_3=0.5$, and $t=0$.   (10 points)

hint: determine $\dfrac{\partial J}{\partial W_1}=?,$ $\dfrac{\partial J}{\partial W_2}=?$ and $\dfrac{\partial J}{\partial W_3}=?$

c) Determine the next updated values of the weights, using a gradient search technique, and a learning rate of 0.15. (5 points)

d)   Compute and compare errors before and after the weight adjustment. (5 points)

Problem 2

Separate the following 2D patterns into 2 clusters using the K-Means clustering algorithm (10 points)

[5,3], [1,7], [2,5], [6,5], [5,2]

Problem 3

Given 2 classes of 2D patterns, each having 3 feature vectors, as the following:

Class 1: [2,3], [1,3], [2,2]
Class 2: [5,2], [5,5], [2,5]

a) Determine the within class covariance matrices of Class 1 and Class 2 (5 points)

b) Compute the between class covariance matrix (3 points)

c) By inspecting the within class covariance matrices and the between class covariance matrix obtained from part a) and b), what can you say about the data? (2 points)

Problem 4

Suppose you are responsible for designing a vehicle identification system to classify the vehicles that are entering the main gate of PSU. Suppose a video camera has been installed to capture the side view of each vehicle. Your system must be able to classify motorcycles and 4-wheel passenger cars (please ignore other kind of vehicles).

Answer the following questions:
1. What kind of features that you may use to classify vehicles? (Give at least 3 features)
2. What kind of classifier would you choose between Neural Networks and HMM? Why?
3. Based on what you have learned in this course, what kind of techniques that can be used to improve the accuracy of the system? (Please give as many techniques as you can).
(15 points)

Problem 5

Determine and sketch the decision boundary of the following perceptron (10 points)
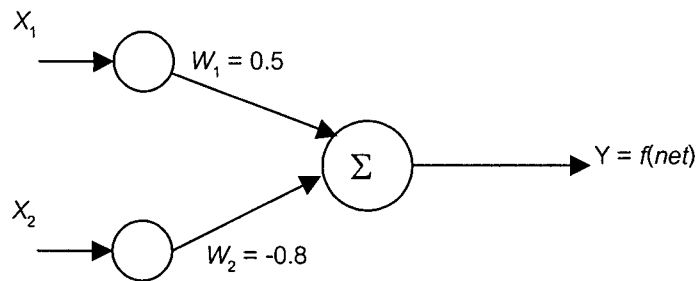
Where $f(net) = (2\ net) - 3$

Problem 6

Explain the principle of Fuzzy Logic and give some examples of its applications.
(10 points)