PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester II — Academic Year: 2006
Date: 24 February 2007 — Time: 9:00-12:00
Subject: 240-650 Principles of Pattern Recognition — Room: R300

Instructions:

This exam has 6 problems, 13 pages and 90 points. You may use the back of the pages for scratch work. This exam is open book, so books, notes, calculators, and other related materials are allowed.

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

Name:_____

Student ID: _____

"ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต"

Problem 1

Given a 3-state hidden Markov defined by a transitional probability matrix and a symbol emission probability matrix as shown below:

$$A1 = \begin{bmatrix} 0.8 & 0.2 & 0 \\ 0 & 0.8 & 0.2 \\ 0 & 0 & 1 \end{bmatrix} \qquad B1 = \begin{bmatrix} 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.2 & 0.2 & 0.2 & 0.3 & 0.3 \\ 0.3 & 0.2 & 0.2 & 0.2 & 0.3 \end{bmatrix}$$

Let the set of possible emitting symbols V_k be {a, b, c, d, e}

Ignore the entry and exit states and assume that state 1 is the first state and state 3 is the last state. Answer the following questions:

a) Sketch the HMM structure and label each link with the appropriate probability. (2 points)

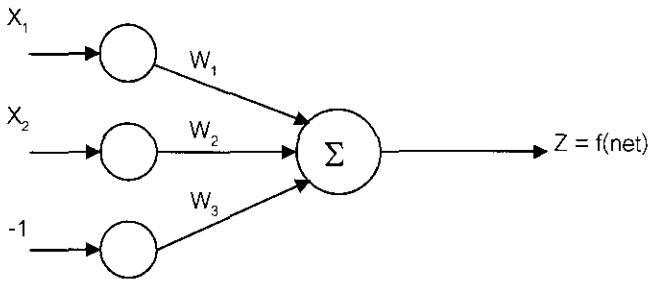
b) Determine the probability that this HMM model will generate the following symbol sequence:

V_k = {a, c, e} (10 points)

c) From the answer in Part (b), determine the most likely state sequence. (3 points)

Problem 2

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

$$J = 0.25(t-z)^4$$

Assume the neurons are linear, i.e. $f(net) = net$

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

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

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 $\frac{\partial J}{\partial W_1} = ?$, $\frac{\partial J}{\partial W_2} = ?$ and $\frac{\partial J}{\partial W_3} = ?$

c) Determine the next updated values of the weights, using a gradient search technique, and a learning rate of 0.1. (5 points)

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

Problem 3

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

[1,3], [2,7], [1,5], [6, 2], [5,9]

Problem 4

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

Class 1: [2,3], [1,3], [2,1]
Class 2: [5,4], [5,5], [4,5]

a) Determine the within class covariance matrices of Class 1 and Class 2 (6 points)

b) Compute the between class covariance matrix (4 points)

Problem 5

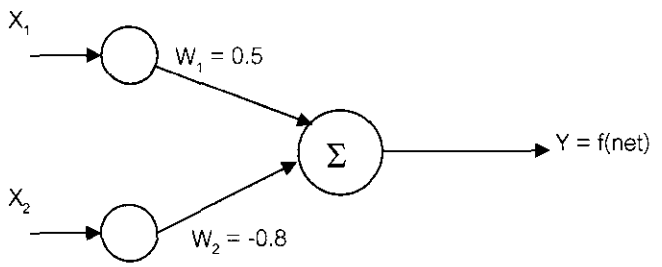
Suppose you are responsible for designing a license plate recognition system for the vehicles that are entering the main gate of PSU. Suppose a video camera has been set up to take a photo of each vehicle, assuming that the license plate can be seen in the photo and you are allowed to use only the photos to perform the license plate recognition. The outputs from you system must include license plate's alphabets, numbers, and province. Answer the following questions:

1. What kind of features that you may use to recognize the alphabets and numbers on the license plate? (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 6

Determine the decision boundary of the following perceptron (10 points)



Where f(net) = $\begin{cases} 1 & net \geq 0 \\ -1 & net < 0 \end{cases}$

---------- End of Exam ----------