PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester II — Academic Year: 2005
Date: 27 March 2006 — Time: 9:00-12:00
Subject: 240-650 Principles of Pattern Recognition — Room: A401

Instructions:

This exam has 5 problems, 12 pages and 100 points. Please show all your work. If your answer is incorrect, this will maximize your partial credit for a problem. 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	25	_____
2	30	_____
3	10	_____
4	20	_____
5	15	_____

Name:_____

Student ID: _____

"ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต"

Problem 1

Given two 3-state hidden Markov models each one is defined by a transitional probability matrix and a symbol emission probability matrix as shown below:

HMM 1:

$$A1 = \begin{bmatrix} 0.9 & 0.1 & 0 \\ 0 & 0.5 & 0.5 \\ 0 & 0 & 1 \end{bmatrix} \qquad B1 = \begin{bmatrix} 0.1 & 0.2 & 0.2 & 0.2 & 0.3 \\ 0.1 & 0.2 & 0.1 & 0.4 & 0.2 \\ 0.4 & 0.2 & 0.1 & 0.2 & 0.1 \end{bmatrix}$$

HMM 2:

$$A2 = \begin{bmatrix} 0.7 & 0.3 & 0 \\ 0 & 0.6 & 0.4 \\ 0 & 0 & 1 \end{bmatrix} \qquad B2 = \begin{bmatrix} 0.2 & 0.2 & 0.3 & 0.2 & 0.1 \\ 0.2 & 0.1 & 0.4 & 0.2 & 0.1 \\ 0.5 & 0.1 & 0.2 & 0.1 & 0.1 \end{bmatrix}$$

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 two HMM's and label each link with the appropriate probability. (5 points)

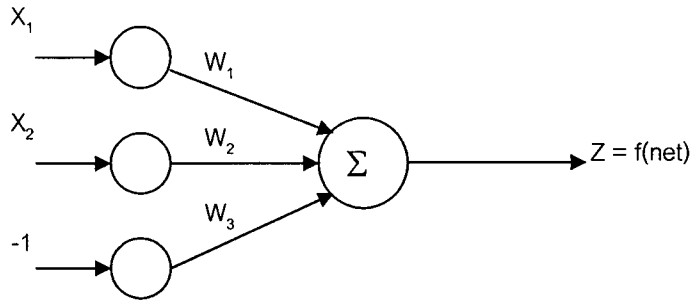
b) Use Trellis diagram to determine the most likely model that generates the following symbol sequence:

$V_k = \{c, b, a\}$ (15 points)

c) From the most likely model obtained in part (b), determine the most likely state sequence. (5 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

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

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

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

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

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

For a feed-forward neural network, what happen to the training process if the weights are initialized so as to have identical value? (10 points)

Problem 4

Given a set of 2D feature vectors:

[2,3], [1,3], [2,1], [1,1]

a) Determine the mean vector and the covariance matrix of the features (10 points)

b) Compute the Principle Component Analysis (PCA) transform for this set of data (10 points)

Problem 5

Take everything you have learned from this course to design a human face recognition system, assuming that you have a large set of photos of difference faces, which can be used as your training and test patterns. Describe all steps needed to accomplish this assignment, including feature extraction issues, classifier selection, training and testing. (15 points)