

**PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING**

Final Examination: Semester II

Academic Year: 2008

Date: 23 February 2009

Time: 9:00-12:00

Subject: 241-650 Principles of Pattern Recognition

Room: หอประชุม

Instructions:

This exam has 4 problems, 10 pages and 65 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.

<u>Problem</u>	<u>Points</u>	<u>Score</u>
1	25	_____
2	20	_____
3	10	_____
4	10	_____

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: $A1 = \begin{bmatrix} 0.6 & 0.4 & 0 \\ 0 & 0.1 & 0.9 \\ 0 & 0 & 1 \end{bmatrix}$

$$B1 = \begin{bmatrix} 0.2 & 0.2 & 0.2 & 0.1 & 0.3 \\ 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.4 & 0.2 & 0.2 & 0.1 & 0.1 \end{bmatrix}$$

HMM 2: $A2 = \begin{bmatrix} 0.7 & 0.3 & 0 \\ 0 & 0.8 & 0.4 \\ 0 & 0 & 1 \end{bmatrix}$

$$B2 = \begin{bmatrix} 0.2 & 0.2 & 0.3 & 0.2 & 0.1 \\ 0.2 & 0.1 & 0.4 & 0.2 & 0.1 \\ 0.5 & 0.1 & 0.2 & 0.1 & 0.1 \end{bmatrix}$$

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:

$$V_k = \{a, b, d\}$$

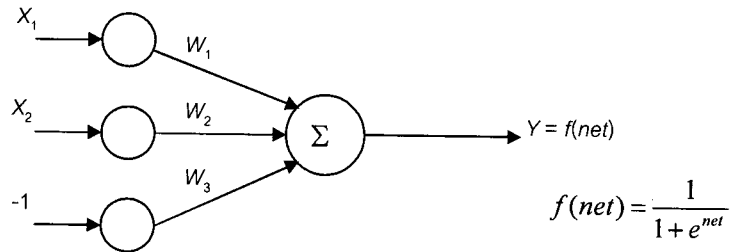
(15 points)

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

Problem 2

Given the following feature vectors and the following neural network structure

Class 1		Class 2	
X_1	X_2	X_1	X_2
2	1	-1	-1
1	2	-2	1



Train the neural networks using the back propagation algorithm under the following conditions:

- 1) Set target values as follow: $Y = 1$ for class 1 and $Y = 0$ for class 2
- 2) Let the initial weights be $w_1 = 0.5$, $w_2 = -0.5$, and $w_3 = 0.2$
- 3) Learning rate = 0.2
- 4) Train the network by presenting every pattern from both classes to the network. Show the error and weight update for each pattern
- 5) Show the weights after one round of training
- 6) Repeat 4) and 5) to train the network for another round

(20 points)

Problem 3

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

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

Class 2: [-1,2], [0,-1], [-2,1]

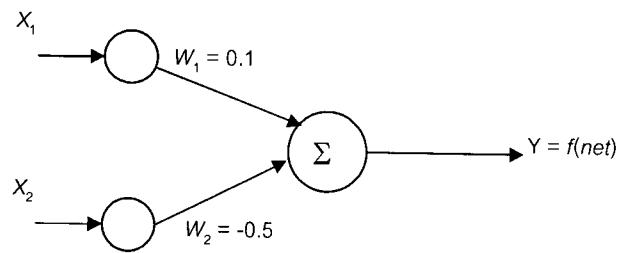
a) Determine the within class covariance matrices of Class 1 and Class 2 (5 points)

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

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



Where $f(\text{net}) = \text{sgn}(\text{net})$

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