Pattern Recognition Techniques

2009/2010

Exam N 12 January 2010 Duration: 1h00

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	20		
2)	30		
3)	10		

Graded by:

Question 1

□ **20 pts**

Question 1

□ **20 pts**

Explain the following:

(a) Fisher Linear Discriminant

(b) Confusion Matrix

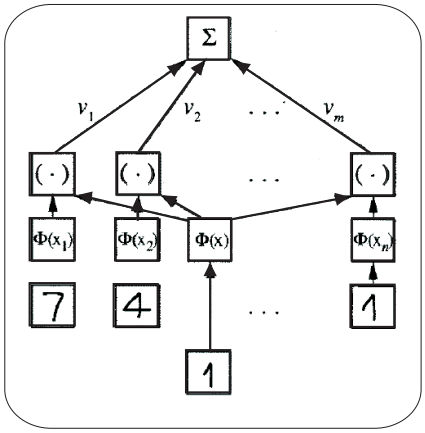
(c) MAP (Maximum Posterior Probability) Classifier

(d) Maximum Margin Separation in SVM

Question 2

□ **30 pts**

Consider the following figure representing a handwritten recognition digits system. Suppose that each digit is represented by an image of 16×16 pixel. Answer the following questions.



a) Describe how would you arrange (in a training data set) each one of the samples to be given as input (to the system)?

b) Give (and describe) a method to preprocess data

c) Suppose your classifier choice is an SVM. Is your classifier Linear or Non-Linear (and why)?

d) Indicate the properties of the kernel function writting an example with two data samples of your handwritten data

e) How would you test your system? Describe how the system represented in the Figure works (detailed steps). (Hint: use the (formal) equation of the SVM decision function in your final step)

Question 3

□ **10 pts**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation)? Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2009/2010

Exam R 27 January 2010 Duration: 1h30 ± 15 min

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	20		
2)	30		
3)	10		

Graded by:

Question 1

□ **20 pts**

Explain the following:

(a) Slack Variables

(b) ROC Curve

(c) MAP (Maximum Posterior Probability) Classifier

(d) BootStrap Method

Question 2

□ **30 pts**

Consider the following figure representing the misclassified samples obtained from an handwritten recognition digits system. Suppose that each digit (from $1 \longrightarrow 9$) is represented by an image of 16×16 pixel and the total samples per digit is 10.

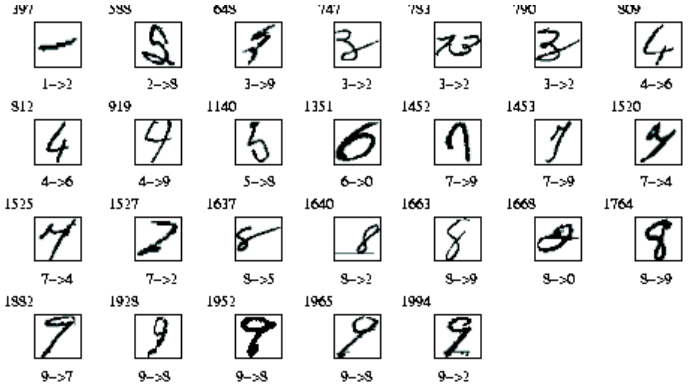


Figure 1: Misclassified Samples

a) Choose one of the data sampling methods (holdout, crossvalidation, bootstrap, etc.) for classifier design and describe in detail how would you arrange the data (train/test) for your experimental tests.

b) Give (and describe) a method to preprocess data

c) Suppose your classifier choice for the multiclass problem above is an SVM. Which decisions would you make to cope with the fact that SVM is a binary classifier?

d) Establish the settings (free parameters, kernel type, etc.) of the SVM baseline classifier defined in 2. c) for handle out your experiments.

e) Imagine that a certain point you obtain the 'bad' results, misclassified samples, illustraded in Figure 1. Certainly you would try to improve your classifier by changing the setup configurations of alinea c)? Give a detailed explanation/discussion how you would improve the classifier performance measures. (Hint: Use the trade-off between misclassification and machine complexity in SVM addressing you answer in a formal (mathematically) manner)

e) After the classifier design phase how would you test new samples. (Hint: use the (formal) equation of the SVM decision function)

Question 3

□ **10 pts** Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation)? Give a short summary of the content and explain why it was interesting.

In case you already answered this question, describe a classifier at your choice and point out why this pattern recognition technique was interesting?

Pattern Recognition Techniques

2008/2009

Exam N 9 January 2009 Duration: 2h00

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	20		
2)	20		
3)	20		
4)	20		
5)	20		

Graded by:

Question 1

□ **20 pts**

Question 1

□ **20 pts**

Explain the following:

(a) Distance Minimum Classifier

(b) ROC Curve

(c) k-Nearest Neighbor

(d) Covariance Matrix

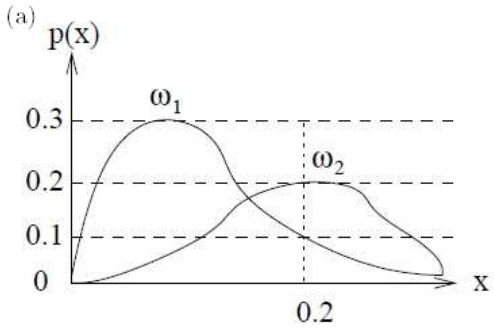
(f) Minimum Risk Bayes Classifier

Question 2

□ **20 pts**

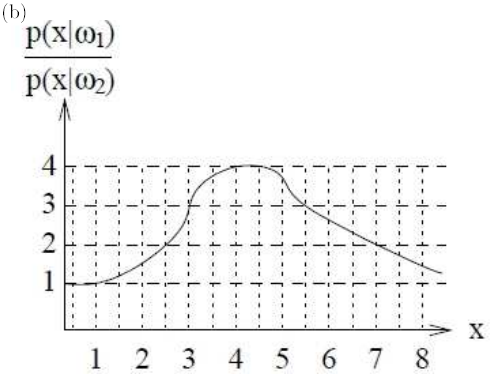
Answer the following questions:

(a)



Write the classification rule for $x = 0.2$

(b)



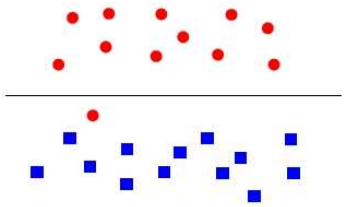
The Figure presents the likelihood ratio for two classes. What are the decision regions, when $P(\omega_1) = 1/3$ and $P(\omega_2) = 2/3$.

Question 3

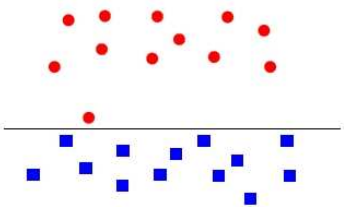
□ **20 pts**

Consider an SVM classifier represented in the Figure. Write clearly which case (a) or (b) corresponds to large C or small C.Explain why.

(a) value of C:



(b) value of C:



Question 4

□ **20 pts**

Consider the design of an image database query system. The system should be able to find images in the database which are similar to a given query image. Describe the process and steps of designing the system and present a high-level design of the system. State your assumptions and justify your choices by arguments.

Question 5

□ **20 pts**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2008/2009

Exam R 30 January 2009 Duration: 2h00

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	20		
2)	20		
3)	20		
4)	20		
5)	20		

Graded by:

Question 1

□ **20 pts**

Explain the following:

(a) Hierarchical Clustering

(b) Principal Component Analysis

(c) Mahalanobis Distance

(d) Bayes Classifier

(e) Large Margin Classifier

Question 2

□ **20 pts**

a) Present the k-means algorithm. Explain how it works. Remember that an algorithm is an accurate step-by-step procedure how to solve a problem.
b) Give a detailed explanation of Cluster Assessment

Question 3

□ **20 pts**

Consider the Bayesian classifier in case of classes of the normal distribution (three classes). Assume that:

$$\Sigma_i = \Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}, \forall i = 1,2,3 \text{ and } \mu_1 = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 2 \\ 0 \end{bmatrix} \text{ and } \mu_3 = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

and $P(\omega_1) = P(\omega_2) = P(\omega_3)$.
Calculate the discriminant functions for each class and determine decision surfaces between classes. Plot the separating hyperplanes. To which classes belong the samples:

$$x_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad x_2 = \begin{bmatrix} 4 \\ 3 \end{bmatrix} \quad x_3 = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

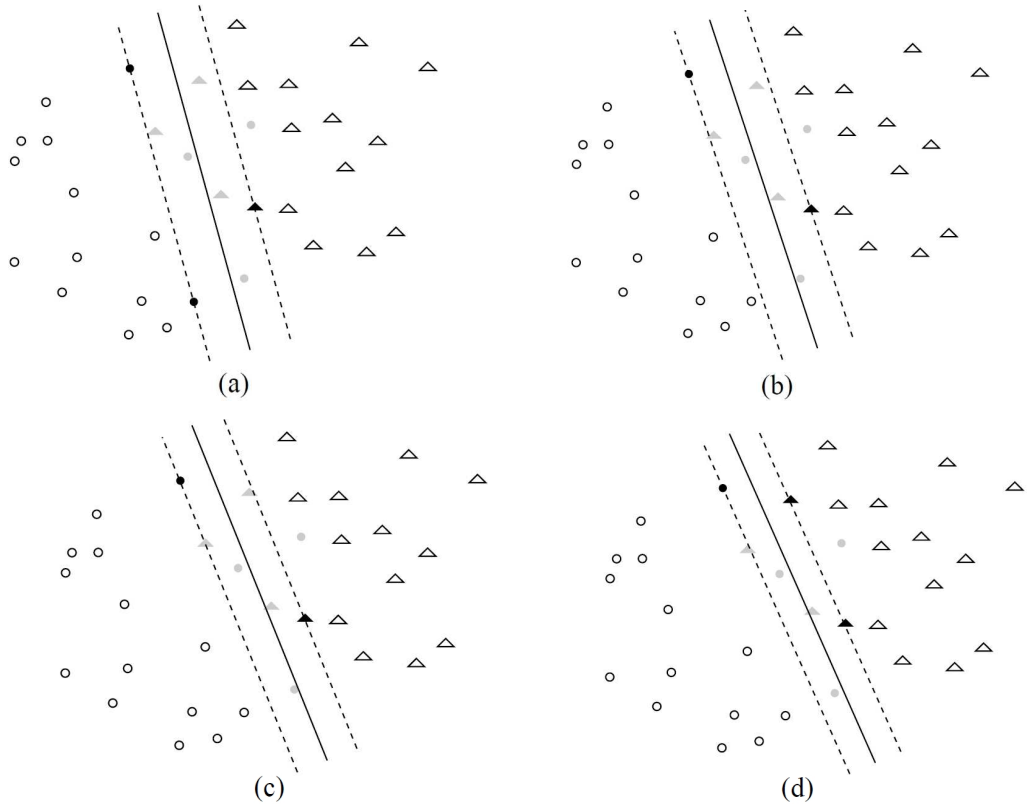
Hint: $g_i(x) = w_i^T x + w_{i0}$ where $w_i = \Sigma^{-1}\mu_i$ and $w_{i0} = -\frac{1}{2}\mu_i^T\Sigma^{-1}\mu_i + \log P(\omega_i)$.

Question 4

□ **20 pts**

Explain the effect of C in an SVM illustrated in the figures below from $a \longrightarrow d$

To illustrate the effect of C assign their correct values $C = 7.5$, $C = 4.0$, $C = 4.8$ and $C = 6.7$ to the legends from $a \longrightarrow d$ in the Figure below.



Question 5

□ **20 pts**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2007/2008

Exam N 11 January 2008 Duration: 2h00

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	25		
2)	25		
3)	25		
4)	25		
5)	25		

Graded by:

Question 1

□ **25 pts**

Explain the following:

(a) Discriminant Function

(b) Hierarchical Clustering

(c) Euclidean and Mahalanobis Distance Metrics

(d) Principal Component Analysis

(e) Optimal Separating Hyperplane

Question 2

□ **25 pts**

Compare statistical pattern recognition and machine learning (neural, genetic algorithms, evolutionary computation, decision trees, etc.) pattern recognition.

Question 3

□ **25 pts**

Distinguish between hierarchical clustering and k-means clustering. Devise examples where they can be applied and explain why.

Question 4

□ **25 pts**

Consider the Bayesian classifier in case of classes of the normal distribution (three classes). Assume that:

$$\Sigma_i = \Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 1/2 \end{bmatrix}, \forall i = 1, 2, 3 \text{ and } \mu_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 4 \\ 1 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

and $P(\omega_1) = P(\omega_2) = P(\omega_3)$.

Calculate the discriminant functions for each class and determine decision surfaces between classes. Plot the classes and the separating hyperplanes.

Hint: $g_i(x) = w_i^T + w_{i0}$ where $w_i = \Sigma^{-1}\mu_i$ and $w_{i0} = -\frac{1}{2}\mu_i^T\Sigma^{-1}\mu_i + \log P(\omega_i)$.

Question 5

□ **25 pts**

Support Vector Machines are the state-of-the art learning classifiers. Explain and write the solution provided by the SVM. Why sparsity is achieved? Consider a SVM classifier with Gaussian Kernel. Explain how the decision surface is influenced by varying the SVM parameters (C and σ)?(draw in each case the decision surface for a simple two class problem)

Question 6

□ **25 pts**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2007/2008

Exam R 1 February 2008 Duration: 2h00

Name : **ID:**

Workload (hr): **Email:**

Questions may be answered in Portuguese or English.

Question	pts	Results	Graded by:
1)	20		
2)	20		
3)	20		
4)	20		
5)	20		

Graded by:

Question 1

□ **20 pts**

Explain the following:

(a) Discriminant Function

(b) Hierarchical Clustering

(c) Mahalanobis Distance Metrics

(d) Optimal Separating Hyperplane

Question 2

□ **20 pts**

Compare statistical pattern recognition with machine learning pattern recognition.

Question 3

□ **20 pts**

Consider the Bayesian classifier in case of classes of the normal distribution (three classes). Assume that:

$$\Sigma_i = \Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 1/2 \end{bmatrix}, \forall i = 1,2,3 \text{ and } \mu_1 = \begin{bmatrix} 0 \\ 2 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 4 \\ 1 \end{bmatrix} \text{ and } \mu_3 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

and $P(\omega_1) = P(\omega_2) = P(\omega_3)$.

Calculate the discriminant functions for each class and determine decision surfaces between classes. Plot the classes and the separating hyperplanes.

Hint: $g_i(x) = w_i^T x + w_{i0}$ where $w_i = \Sigma^{-1}\mu_i$ and $w_{i0} = -\frac{1}{2}\mu_i^T\Sigma^{-1}\mu_i + \log P(\omega_i)$.

Question 4

□ **20 pts**

Support Vector Machines are the state-of-the art learning classifiers.

(a) Explain and write the solution provided by the SVM.

(b) Why sparsity is achieved?

(c) Consider a SVM classifier with Gaussian Kernel. Explain how the decision surface is influenced by varying the SVM parameters (C and σ)?(draw in each case the decision surface for a simple two class problem)

Question 5

□ **20 pts**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2006/2007

Exame N 23 Janeiro 2007 Duração: 2h00

Nome (Completo): **Número:**

Horas de Estudo: **Email:**

Questions may be answerered in Portuguese or English.

Pergunta	Points	Results	Grade by:
1)	20		
2)	20		
3)	20		
4)	20		
5)	20		

Visto por:

Question 1

□ **20 points**

Explain the following:

(a) Feature Extraction

(b) Discriminant Function

(c) Decision Surface

(d) Structural Pattern Recognition

Question 2

□ **20 points**

Classification and clustering. Present one method for classification and one method for clustering. Give the corresponding examples how to apply them.

Question 3

□ **20 points**

Consider the Bayesian classifier in case of classes of the normal distribution (three classes). Assume that:

$$\Sigma_i = \Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 1/2 \end{bmatrix}, \forall i = 1, 2, 3 \text{ and } \mu_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 4 \\ 1 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

and $P(\omega_1) = P(\omega_2) = P(\omega_3)$.

Calculate the discriminant functions for each class and determine decision surfaces between classes. Plot the classes and the separating hyperplanes.

Hint: $g_i(x) = w_i^T + w_{i0}$ where $w_i = \Sigma^{-1}\mu_i$ and $w_{i0} = -\frac{1}{2}\mu_i^T\Sigma^{-1}\mu_i + \log P(\omega_i)$.

Question 4

□ **20 points**

Explain the basic idea of SVM. Explain why SVM determines the optimal linear discriminant. In your explanation consider (a) principle of structural minimization (b) margin of separation and (c) support vectors.

Question 5

□ **20 points**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.

Pattern Recognition Techniques

2006/2007

Exame R 1 Fevereiro 2007 Duração: 2h00

Nome (Completo): **Número:**

Horas de Estudo: **Email:**

Questions may be answerered in Portuguese or English.

Pergunta	Points	Results	Grade by:
1)	20		
2)	20		
3)	20		
4)	20		
5)	20		

Visto por:

Question 1

□ **20 points**

Explain the following:

(c) Decision Surface

(d) Parametric and non-parametric distribution

(e) Clustering

(d) Structural Pattern Recognition

Question 2

□ **20 points**

Give an algorithm for hierarchical clustering. Explain which kind of data set is suitable to your algorithm and which kind is unsuitable.

Question 3

□ **20 points**

Consider the Bayesian classifier in case of classes of the normal distribution (three classes). Assume that:

$$\Sigma_i = \Sigma = \begin{bmatrix} 1 & 0 \\ 0 & 1/2 \end{bmatrix}, \forall i = 1,2,3 \text{ and } \mu_1 = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 4 \\ 1 \end{bmatrix} \text{ and } \mu_2 = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

and $P(\omega_1) = P(\omega_2) = P(\omega_3)$.

Calculate the discriminant functions for each class and determine decision surfaces between classes. Plot the classes and the separating hyperplanes.

Hint: $g_i(x) = w_i^T x + w_{i0}$ where $w_i = \Sigma^{-1}\mu_i$ and $w_{i0} = -\frac{1}{2}\mu_i^T\Sigma^{-1}\mu_i + \log P(\omega_i)$.

To which classes belong the vectors $[3\ 0]^T$, $[0\ 1]^T$ and $[2\ 2]^T$?

Question 4

□ **20 points**

Explain the basic idea of SVM. Explain why SVM determines the optimal linear discriminant. In your explanation consider (a) principle of structural minimization (b) margin of separation and (c) support vectors.

Question 5

□ **20 points**

Seminar Presentations. Which seminar presentation was the most interesting one (excluding your own presentation). Give a short summary of the content and explain why it was interesting.