Total No. of Questions: 6 *Total No. of Printed Pages: 3*

Enrollment No.....

Faculty of Engineering

End Sem Examination Dec-2023

CS3EA04 Pattern Recognition

Programme: B.Tech. Branch/Specialisation: CSE All

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. In the context of Bayes Decision Theory, what is the aim of minimum-error rate classification? **1**

(a) Maximizing classification accuracy
(b) Minimizing the probability of false positives
(c) Minimizing the probability of misclassification
(d) Maximizing the probability of true negatives

ii. In Bayesian Belief Networks, what does a directed acyclic graph represent? **1**

(a) Conditional dependencies among variables
(b) Probability distributions of variables
(c) Decision boundaries
(d) Unsupervised learning relationships

iii. What does Maximum-Likelihood estimation aim to find in statistical modeling? **1**

(a) The maximum possible number of iterations for convergence
(b) The parameter values that maximize the probability of observing the given data
(c) The minimum error between predicted and actual values
(d) The average likelihood across all observations

iv. In Gibbs Sampling algorithm, what does each iteration involve? **1**

(a) Sampling a single variable conditioned on all other variables
(b) Simultaneously updating all variables
(c) Ignoring conditional probabilities for sampling
(d) Sequentially updating all variables based on a chosen order

v. What does Fisher Discriminant Analysis (FDA) aim to achieve in comparison to PCA? **1**
(a) Maximize class separability rather than data variance
(b) Minimize feature space
(c) Identify non-linear relationships among features
(d) Maximize overall variance without considering classes

vi. What role do Parzen Windows play in non-parametric estimation? **1**
(a) They are used for model fitting in linear regression
(b) They estimate the probability density function based on data points
(c) They reduce dimensionality in high-dimensional datasets
(d) They are applied to perform feature selection in machine learning

vii. What is the primary objective of K-means clustering? **1**
(a) Maximizing the variance within clusters
(b) Minimizing the sum of squared distances within clusters
(c) Maximizing the distance between clusters
(d) Minimizing the entropy within clusters

viii. What distinguishes Unsupervised Bayesian Learning from traditional clustering algorithms like K-Means? **1**
(a) It involves a supervised learning approach for clustering
(b) It incorporates prior knowledge about the data distribution through probabilistic models
(c) It always assumes equal-sized clusters
(d) It uses distance-based measures for cluster assignments

ix. What is a primary objective of Support Vector Machines (SVMs) in classification tasks? **1**
(a) Maximizing the number of support vectors
(b) Minimizing the margin between classes
(c) Finding the hyperplane that maximizes the distance between classes
(d) Fitting decision boundaries to outliers

x. Which pattern recognition application often uses SVMs for tasks like object detection and image classification? **1**
(a) Natural Language Processing
(b) Image Analysis
(c) Speech Recognition
(d) Time Series Forecasting

Q.2 i. What defines the decision surface in a classification problem? How does it impact the performance of a machine learning model? **2**

ii. Compare supervised and unsupervised pattern recognition. **3**
iii. Explain minimum error rate classification in detail. **5**
OR iv. Discuss Decision Tree learning based on the CART approach. **5**

Q.3 i. What is the difference between Bayesian estimate and maximum likelihood estimation? **2**
ii. Explain Hidden Markov model and its role in the classifier design. **8**
OR iii. Explain the workings of the Gibbs sampling. Provide an illustrative example of how Gibbs sampling is used in a specific context. **8**

Q.4 i. Explain the principal component analysis for dimensionality reduction. **3**
ii. Describe Fisher Discriminant Analysis (FDA) with example. Also give its advantages and limitations. **7**
OR iii. Explain K-nearest neighbor classifier with suitable example. **7**

Q.5 i. Explain k-means clustering algorithm. **4**
ii. Explain the concept of Unsupervised Bayesian Learning and its significance. Discuss how Unsupervised Bayesian Learning differs from Supervised Learning. **6**
OR iii. Enlist and explain any two criterion functions for clustering in detail. **6**

Q.6 Attempt any two:
i. Formulate SVM as an optimization problem. How support vector machines can be used for classification of data which are not linearly separable? **5**
ii. Provide example of specific image analysis application where pattern recognition techniques are pivotal. Prove that how image analysis enhance image understanding. **5**
iii. Describe the role of pattern recognition in biometric technologies such as facial recognition and Optical Character Recognition (OCR). Highlight the unique challenges associated with each biometric modality. **5**

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Marking Scheme
Pattern Recognition-CS3EA04 (T)

Q.1	i)	C) Minimizing the probability of misclassification		**1**
	ii)	A) Conditional dependencies among variables		**1**
	iii)	B) The parameter values that maximize the probability of observing the given data		**1**
	iv)	A) Sampling a single variable conditioned on all other variables		**1**
	v)	A) Maximize class separability rather than data variance		**1**
	vi)	B) They estimate the probability density function based on data points.		**1**
	vii)	B) Minimizing the sum of squared distances within clusters.		**1**
	viii)	B) It incorporates prior knowledge about the data distribution through probabilistic models.		**1**
	ix)	C) Finding the hyperplane that maximizes the distance between classes		**1**
	x)	B) Image Analysis		**1**
Q.2	i.	defines the decision surface	1 Mark	**2**
		Impact on the performance	1 Mark	
	ii.	Compare	(1 Mark*3)	**3**
	iii.	Concept Explanation	2 Marks	**5**
		Methods to Achieve Minimum Error Rate	2 Marks	
		Applications	1 Mark	
OR	iv.			**5**
		Tree Construction	2 Marks	
		Node Splitting or Tree Pruning	2 Marks	
		Applications	1 Mark	
Q.3	i.	Difference between …..estimation	(1 Mark *2)	**2**
	ii.	Components of Hidden Markov Model (HMM)	4 Marks	**8**
		Role in Classifier Design	4 Marks	
OR	iii.	Step-by-Step Procedure	4 marks	**8**
		Illustrative Example	4 marks	
Q.4	i.	Purpose of dimensionality reduction.	1 Mark	**3**
		Working Principle (Variance Maximization)	2 Marks	
	ii.	Fisher Discriminant Analysis (FDA) process	3 Marks	**7**
		(FDA) with example	2 Marks	
		advantages and limitations	2 Marks	
OR	iii.	K-nearest neighbor classifier process	4 Marks	**7**
		KNN Example	3 Marks	
Q.5	i.	Algorithm Steps	3 Marks	**4**
		Key Aspects and Considerations	1 Mark	
	ii.	Concept of Unsupervised	3 Marks	**6**
		Unsupervised …… Learning	3 Marks	
OR	iii.	Two criterion functions for clustering in detail.	(3 Mark *2)	**6**
Q.6		Attempt any two:		
	i.	Formulate SVM	3 Marks	**5**
		Vector machines can be used for classification	2 Marks	
	ii.	Example of specific image analysis application	3 Marks	**5**
		image analysis advantages	2 Marks	
	iii.	Facial recognition …… (OCR).	3 Marks	**5**
		Unique challenges with each biometric modality.	2 Marks	

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