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Question Paper Code : 91935

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Sixth Semester

Biomedical Engineering

CS 3491 — ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

(Common to : Electronics and Communication Engineering/Electronics and
Telecommunication Engineering/Medical Electronics)

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is constraint satisfaction problem?
2. Define rational agent.
3. How Bayesian network works?
4. State the principle of acting under uncertainty.
5. Differentiate between soft margin and hard margin.
6. Mention the purpose of discriminant function.
7. How ensemble learning improves the performance of machine learning models?
8. What are the merit and demerits of instance based learning?
9. In a neural network, what is the purpose of the back propagation algorithm, and how does it use the gradient of the error to update the weights during training?
10. Why are activation functions important in neural networks, and how do they impact the model's ability to learn complex patterns?

PART B — (5 × 13 = 65 marks)

11. (a) Explain in detail the concept of heuristic search strategies. How do they differ from uninformed search strategies? Discuss various heuristic search techniques such as A* Search With their working principles, advantages, and limitations. Illustrate your explanation with suitable examples.

Or

- (b) Discuss the role of local search techniques and adversarial search strategies in solving optimization problems. Highlight the similarities and differences between local and adversarial search in terms of objective, strategy and application areas. Support your discussion with appropriate examples.
12. (a) Weather forecasting is a critical task in agriculture, disaster management, and daily planning. Meteorologists rely on historical weather data to make predictions about future conditions. Suppose a weather station wants to automate the prediction of whether it will rain on a particular day based on previous patterns of weather features such as humidity, temperature, wind speed and cloud cover.

Using the data given below, apply the Naïve Bayes classification model to predict whether it will rain or not using {Humidity = "Normal" Temperature = "mild", Wind = "weak", Sky = "Overcast"}, given its features.

Humidity	Temperature	Wind	Sky	Rain (Class label)
High	Hot	Strong	Clear	Yes
Normal	Mild	Weak	Cloudy	No
High	Cool	Strong	Overcast	Yes
Normal	Hot	Weak	Clear	No
High	Mild	Weak	Cloudy	Yes
Normal	Cool	Strong	Overcast	No
High	Hot	Weak	Clear	Yes
Normal	Mild	Strong	Overcast	No
High	Cool	Weak	Cloudy	Yes
Normal	Hot	Strong	Clear	No

- (i) What evaluation metrics would you use to assess the performance of your model? Justify your choice. (9)
- (ii) What are the limitations of using Naïve Bayes in weather forecasting, and how can the model be improved? (4)

Or

- (b) Explain the concept of probabilistic reasoning in artificial intelligence. How does it support decision-making under uncertainty? Provide relevant examples where probabilistic reasoning is essential, and explain how inference is performed in such models.

13. (a) Explain how a probabilistic discriminative model differs from a generative model in the context of this spam detection task. In your perspective which model is more advantageous and why?

Or

- (b) Explain the working principle of Random Forests. Describe the role of bootstrapping and feature randomness in constructing Random Forests. Also, discuss its advantages, limitations, and typical real-world applications where Random Forests perform well.

14. (a) All shopping malls have food courts which might include dishes like those given below. Use k-means for clustering into three clusters by considering the Manhattan distance metric. Suppose that the initial seeds are F4, F7, and F9.

Food Id	Item	Calories	Carbohydrates	Proteins
F1	Aloo Curry	105	15	1
F2	Cabbage	131	7	2
F3	Pumpkin	67	7	2
F4	Mutter Paneer	147	11	9
F5	Chana Dhal	99	13	5
F6	Moong Dhal	211	31	13

Food Id	Item	Calories	Carbohydrates	Proteins
F7	Besan Khadi	100	15	3
F8	Kofta Curry	147	13	3
F9	Milk	67	4	3
F10	Cheese	348	6	24

Apply k-means for 2 iterations. Trace the following intermediate results, at the end of each iteration. Find the new clusters formed and Calculate the Centroid of the new clusters.

Or

- (b) What is a Gaussian Mixture Model (GMM)? Explain how GMMs are used for clustering and density estimation. Describe in detail the role of the Expectation-Maximization (EM) algorithm in fitting a GMM.
15. (a) Discuss in detail about perceptron and multilayer perceptron with suitable illustrations.

Or

- (b) Explain the role of the ReLU (Rectified Linear Unit) activation function in deep neural networks. Further, elaborate on the importance of hyper parameter tuning in training deep learning models. What are the key hyper parameters that affect model performance, and what techniques can be used to optimize them? Provide examples to illustrate how improper tuning may lead to underfitting or overfitting.

PART C — (1 × 15 = 15 marks)

16. (a) Consider the database about customer's purchase of all electronics. The attributes are age, income, student category, rating and the class label Y or N (Y-Yes, buys computer, N-No, Don't buys computer). The training data set is given below :

Age	Income	Student	Rating	Class Label
Youth	High	No	Fair	No
Youth	High	No	Excellent	No
Middle_aged	High	No	Fair	Yes

Age	Income	Student	Rating	Class Label
Senior	Medium	No	Fair	Yes
Senior	Low	Yes	Fair	Yes
Senior	Low	Yes	Excellent	No
Middle-aged	Low	Yes	Excellent	Yes
Youth	Medium	No	Fair	No
Youth	Low	Yes	Fair	Yes
Senior	Medium	Yes	Fair	Yes
Youth	Medium	Yes	Excellent	Yes
Middle_aged	Medium	No	Excellent	Yes
Middle_aged	High	Yes	Fair	Yes
Senior	Medium	No	Excellent	No

Determine the class label using decision tree induction method and describe about decision tree.

Or

- (b) A telecom company wants to predict whether a customer will churn (leave the service) in the next 6 months based on their usage data. The company has a rich dataset that includes customer demographics, service usage, contract type, and payment history. The objective is to build a predictive model to classify customers as either “Churn” or “No Churn” using the K-Nearest Neighbors (KNN) algorithm. Discuss about the need for K-Nearest Neighbors (KNN).

Customer ID	Age	Tenure (Months)	Service Type	Monthly Spend (\$)	Payment Method	Contract Type	Customer Support Calls	Churn
1	45	12	Premium	85	Credit Card	Two-Year	2	0
2	29	3	Standard	50	Bank Transfer	Month-to-Month	8	1
3	63	30	Standard	60	Direct Debit	One-Year	1	0

Customer ID	Age	Tenure (Months)	Service Type	Monthly Spend (\$)	Payment Method	Contract Type	Customer Support Calls	Churn
4	40	8	Premium	90	Credit Card	Month-to-Month	5	1
5	52	24	Premium	120	Credit Card	Two-Year	3	0
6	35	18	Standard	70	Credit Card	One-Year	4	1
7	50	60	Premium	100	Bank Transfer	Two-Year	0	0
8	27	1	Standard	40	Direct Debit	Month-to-Month	10	1
9	55	36	Premium	95	Credit Card	One-Year	2	0
10	39	15	Standard	75	Bank Transfer	One-Year	6	0