

MACHINE LEARNING – UNIT V

NOTES

RGPV Exam-Oriented Notes

 Easy + Detailed + One-Day Before Exam Preparation

UNIT V SYLLABUS

1. Bayesian Learning
 2. Bayes Optimal Classifier
 3. Naïve Bayes Classifier
 4. Bayesian Belief Networks
 5. Mining Frequent Patterns
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1. BAYESIAN LEARNING

Definition

Bayesian Learning is a probabilistic learning method based on Bayes Theorem used to predict outcomes using probability.

Bayes Theorem

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

$$P(A)P(A)P(A)$$

$$0.20$$

$$P(B|A)P(B|\neg A)P(B|A)$$

$$0.85$$

$$P(B|\neg A)P(B|\neg A)P(B|\neg A)$$

$$0.10$$

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \approx 0.68, P(B) \approx 0.25$$

$$P(A|\neg B) = \frac{P(B|\neg A)P(A)}{P(\neg B)} \approx 0.68, P(\neg B) \approx 0.25$$

$$P(B) = 0.25P(B|A)P(A) + 0.17P(B|\neg A)P(A) \approx 0.68$$

Posterior = useful evidence / total evidence

Meaning of Terms

Symbol	Meaning
$P(A B)$	$P(B)$
$P(B A)$	$P(A)$
$P(A)$	Prior probability
$P(B)$	Evidence probability

Easy Explanation

Bayesian Learning updates probability when new information becomes available.

Example:

If a student studies more,
probability of passing increases.

Working of Bayesian Learning

1. Start with prior probability.
 2. Collect new evidence.
 3. Update probability using Bayes theorem.
 4. Make prediction.
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Example

Suppose:

$$P(\text{Disease}) = 0.01$$

$$P(\text{Test Positive} \mid \text{Disease}) = 0.95$$

Using Bayes theorem, probability of disease can be calculated.

Advantages

- ✓ Handles uncertainty well
 - ✓ Works with incomplete data
 - ✓ Simple probabilistic approach
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Disadvantages

- ✗ Requires probability estimation
- ✗ Assumes independence in some cases

Applications

- Medical diagnosis
- Spam filtering
- Risk prediction
- Fraud detection

Conclusion

Bayesian Learning uses probability theory to improve predictions using new evidence.

2. BAYES OPTIMAL CLASSIFIER

Definition

Bayes Optimal Classifier is a theoretical classifier that gives minimum possible classification error.

Easy Explanation

It selects the class having highest probability.

Working

Calculate probability of each class



Choose class with highest probability

Example

Suppose probabilities are:

Class A = 0.80

Class B = 0.20

Final Prediction:

Class A

Important Point

Bayes Optimal Classifier is considered:

Best possible classifier

because it minimizes prediction error.

Advantages

- ✓ Minimum classification error
 - ✓ Strong theoretical model
 - ✓ Accurate probabilistic prediction
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Disadvantages

- ✗ Computationally expensive
 - ✗ Difficult probability calculations
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Applications

- Pattern recognition
 - Statistical prediction
 - AI classification systems
-

Conclusion

Bayes Optimal Classifier predicts the most probable class with minimum error.

3. NAÏVE BAYES CLASSIFIER

Definition

Naïve Bayes is a probabilistic classification algorithm based on Bayes theorem with assumption of feature independence.

Easy Explanation

It assumes that all features are independent from each other.

Example:

Spam email prediction:

Words are treated independently.

Formula

$$P(C|X) = \frac{P(X|C)P(C)}{P(X)}$$

$$P(A)P(A)P(A)$$

$$0.20$$

$$P(B|A)P(B|A)P(B|A)$$

$$0.85$$

$$P(B|\neg A)P(B|\neg A)P(B|\neg A)$$

$$0.10$$

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \approx 0.68, P(B) \approx 0.25$$

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \approx 0.68, P(B) \approx 0.25$$

$$P(B) = 0.25, P(B|A)P(A) = 0.17, P(A|B) \approx 0.68$$

Posterior = useful evidence / total evidence

Meaning

Symbol	Meaning
C	Class
X	Feature set
P(C X)	P(X C)

Working of Naïve Bayes

1. Calculate prior probabilities.
 2. Calculate conditional probabilities.
 3. Apply Bayes theorem.
 4. Select class with highest probability.
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Example

Email contains:

Free, Offer, Prize

Classifier predicts:

Spam

Types of Naïve Bayes

Type	Use
Gaussian Naïve Bayes	Numerical data
Multinomial Naïve Bayes	Text classification
Bernoulli Naïve Bayes	Binary features

Advantages

- ✓ Simple and fast
 - ✓ Works well with text data
 - ✓ Requires less training data
 - ✓ High efficiency
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Disadvantages

- ✗ Assumes feature independence
 - ✗ Less accurate for correlated features
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Applications

- Spam filtering
 - Sentiment analysis
 - Document classification
 - Medical diagnosis
-

Conclusion

Naïve Bayes is a simple and efficient probabilistic classifier widely used for text classification.

4. BAYESIAN BELIEF NETWORKS

Definition

Bayesian Belief Network (BBN) is a graphical probabilistic model representing relationships among variables.

Easy Explanation

BBN shows how variables depend on each other using probability and graphs.

Structure

Nodes → Variables

Edges → Dependencies

Example

Rain → Wet Road → Accident

Rain affects wet road.

Wet road affects accident probability.

Features

Feature	Meaning
Directed Graph	Shows dependency direction
Probabilistic Model	Uses probabilities
Conditional Dependence	Variables affect each other

Advantages

- ✓ Handles uncertainty
 - ✓ Represents relationships clearly
 - ✓ Useful for probabilistic reasoning
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Disadvantages

- ✗ Complex for large networks
 - ✗ Requires probability knowledge
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Applications

- Medical diagnosis
 - Risk analysis
 - Decision support systems
 - Fault detection
-

Conclusion

Bayesian Belief Networks model uncertain relationships between variables using probabilities.

5. MINING FREQUENT PATTERNS

Definition

Frequent Pattern Mining is the process of finding repeated patterns or relationships in large datasets.

Easy Explanation

It identifies items that occur together frequently.

Example:

Customers buying Bread also buy Butter

Important Terms

Term	Meaning
Itemset	Group of items
Support	Frequency of occurrence
Confidence	Reliability of rule

Working

1. Scan dataset.
 2. Find frequent itemsets.
 3. Generate association rules.
 4. Select strong patterns.
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Example

Milk + Bread → Frequently Purchased Together

Advantages

- ✓ Finds hidden relationships
 - ✓ Useful for business analysis
 - ✓ Improves recommendations
-

Disadvantages

- ✗ Computationally expensive
 - ✗ Large datasets require more processing
-

Applications

- Market basket analysis
 - Recommendation systems
 - Web usage analysis
 - Fraud detection
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Conclusion

Frequent Pattern Mining helps discover useful hidden patterns in large datasets.



MOST IMPORTANT 7-MARK

QUESTIONS

1. Explain Bayesian Learning.
 2. Explain Bayes Theorem.
 3. Explain Bayes Optimal Classifier.
 4. Explain Naïve Bayes Classifier.
 5. Explain Bayesian Belief Networks.
 6. Explain Frequent Pattern Mining.
 7. Explain support and confidence.
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MOST IMPORTANT 14-MARK

QUESTIONS

★ Very Important

1. Explain Bayesian Learning with Bayes theorem.
 2. Explain Naïve Bayes Classifier with example.
 3. Explain Bayes Optimal Classifier.
 4. Explain Bayesian Belief Networks with applications.
 5. Explain Frequent Pattern Mining with examples.
 6. Differentiate Bayesian Learning and Naïve Bayes.
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PYQ-BASED EXPECTED QUESTIONS

★ **High Probability**

- Explain Naïve Bayes Classifier.
- Explain Bayesian Learning.

- Explain Bayesian Belief Networks.
 - Explain Frequent Pattern Mining.
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Medium Probability

- Explain Bayes Optimal Classifier.
 - Explain Bayes theorem with example.
 - Differentiate Bayesian Learning and Naïve Bayes.
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ONE-NIGHT REVISION

- ✓ Bayesian Learning uses probability
 - ✓ Bayes theorem updates probabilities
 - ✓ Bayes Optimal gives minimum error
 - ✓ Naïve Bayes assumes feature independence
 - ✓ BBN represents variable relationships
 - ✓ Frequent Pattern Mining finds repeated itemsets
 - ✓ Support = Frequency
 - ✓ Confidence = Reliability
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SMART STUDY PLAN

FIRST STUDY

1. Naïve Bayes
2. Bayesian Learning
3. Frequent Pattern Mining

SECOND PRIORITY

4. Bayesian Belief Networks
5. Bayes Optimal Classifier

LAST REVISION

6. Support and Confidence
7. Applications

FINAL EXAM TIP

For 14-mark answers always write:

1. Definition
2. Formula
3. Working Steps
4. Example
5. Advantages
6. Disadvantages
7. Applications
8. Conclusion

This presentation style helps score higher marks in RGPV exams.