SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING-IoT Including CS & BCT

COURSE NAME :19SB701 PATTERN RECOGNITION TECHNIQUES IN CYBER CRIME

IV YEAR / VII SEMESTER

Unit II- **CLASSIFIERS BASED ON BAYESIAN DECISION THEORY**

Topic :Normal Density

In Bayesian Decision Theory, the "normal density" often refers to the normal (or Gaussian) distribution, which plays a crucial role in many statistical

It make the Decision-making problems due to its mathematical properties and prevalence in natural phenomena.

Key Concepts of Normal Density in Bayesian Decision Theory:

Normal (Gaussian) Distribution:

The normal distribution is a continuous probability distribution characterized by its mean μμ and variance σ2σ 2 .

The probability density function (PDF) is given by:

$$f(x|\mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$$

In Bayesian contexts, this distribution is commonly used for modeling the likelihood of data and the prior/posterior distributions over parameters.

Likelihood Function:

In a Bayesian framework, given a dataset $x=\{x1,x2,\ldots,xn\}$x={x 1 ,x 2 ,…,x n }, the likelihood of observing this data under a normal distribution is:

$$L(\mu, \sigma^2 | \mathbf{x}) = \prod_{i=1}^{n} f(x_i | \mu, \sigma^2)$$

This likelihood function is crucial for updating beliefs about the parameters μ\muμ and σ2\sigma^2σ2 when combined with prior distributions.

Prior and Posterior Distributions:

Prior:

Represents the initial belief about the parameters before observing any data.

In Bayesian analysis, the conjugate prior for the mean μμ of a normal distribution (with known variance $\sigma 2$σ 2) is also normally distributed.

Posterior:

After observing the data, the posterior distribution represents the updated belief about the parameters.

If the prior is normal and the likelihood is normal, the posterior is also normal (this is a key advantage of the normal distribution in Bayesian analysis).

Decision Rule:

In Bayesian Decision Theory, the goal is to minimize expected loss.

The decision rule often involves finding the parameter values that maximize the posterior distribution (Maximum A Posteriori estimation) or minimize the expected loss.

Applications:

The normal distribution is used in various applications like classification, regression, and hypothesis testing.

In classification, for example, the decision boundary between classes is determined by the likelihood ratio, which, in the case of normal distributions, results in a linear/quadratic decision boundary depending on whether the covariance matrices are equal or different.

MCQ

1:Which of the following is the formula for the probability density function (PDF) of a normal distribution?

A) $f(x|\mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left(-\frac{(x-\mu)^2}{2\sigma^2}\right)$

B) $f(x|\mu, \sigma^2) = \frac{1}{\sigma^2} \exp\left(\frac{x-\mu}{\sigma}\right)$

C) $f(x|\mu, \sigma^2) = \frac{1}{\sigma} \left(\frac{x-\mu}{2\sigma^2}\right)$

D) $f(x|\mu, \sigma^2) = \frac{1}{\sqrt{2\pi}} \exp\left(\frac{x-\mu}{\sigma}\right)$

Answer: A

2.In Bayesian Decision Theory, what is the term used to describe the distribution that represents the initial belief about the parameters before observing any data?

A) Likelihood

B) Posterior

C) Prior

D) Loss function

Answer: C

3. Which of the following statements is true regarding the normal distribution in Bayesian analysis?

A) The posterior distribution is never normal, regardless of the prior.

B) The conjugate prior for the mean of a normal distribution with known variance is also normally distributed.

C) The likelihood function for a normal distribution is unrelated to the data.

D) The decision boundary in classification using normal distributions is always linear.

Answer: B

Any Query????

Thank you……