Assignment 2

ADEPU VASISHT

GATE EC PROBLEM 30

If E denotes the expectation, the variance of a random variable X is given by ?

- (A) $E[X^2] - E^2[X]$
- (B)
- $E[X^2] + E^2[X]$ $E^2[X]$ (C)

SOLUTION

The expectation of a random variable X is given by

$$E[X] = \sum_{all \ x} x \Pr(x)$$

The expectation of a random variable is also known as mean of random variable and denoted as μ

The expectation of a function g(X) is given by

$$E[g(X)] \sum_{all \ x} g(x) \Pr(x)$$

The variance of a random variable X is given as

$$Var(X) = E[(X - \mu)^2]$$

We know that

$$E[(X - \mu)] = \sum_{all \ x} (x - \mu)^2 \Pr(x)$$
 (1)

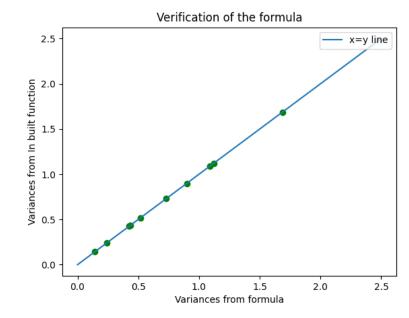
$$E[(X - \mu)] = \sum_{all \ x} (x^2 - 2\mu x + \mu^2) \Pr(x)$$
(2)
=
$$\sum_{all \ x} x^2 \Pr(x) - 2\mu \sum_{all \ x} x \Pr(x) + \mu^2 \sum_{all \ x} \Pr(x)$$
(3)
=
$$E[X^2] - 2\mu \cdot \mu + \mu^2 (1)$$
(4)
=
$$E[X^2] - \mu^2$$
(5)

$$= E[X^2] - \mu^2 \tag{5}$$

$$= E[X^2] - E^2[X] (6)$$

THE PYTHON CODES

We run a simulation using binomial distribution with random probabilities and random number of values the random variable can take. We then plot variance calculated using the above formula on the X-axis while on the Y-axis we use variance from the inbuilt function inside the scipy library. If the formula is correct then the plotted points should be around the x=y line. The graph is shown below.



Hence option A is the correct answer