probability

1. Binomial Distribution MCQ

Discrete | Success/failure experiments

A fair coin is tossed 4 times. What is the probability of getting exactly 2 heads?

Options:

- (a) 3/8
- (b) 6/16
- (c) 6/8
- (d) 1/2

Solution:

Binomial Formula:

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

where:

- $n = 4$ (number of trials)
- $k = 2$ (successes)
- $p = 0.5$ (probability of head)

Now:

$$\binom{4}{2} = \frac{4 \times 3}{2 \times 1} = 6$$

Thus:

$$P(X = 2) = 6 \times (0.5)^2 \times (0.5)^2 = 6 \times 0.25 \times 0.25 = 6 \times 0.0625 = 0.375$$

$0.375 = \frac{3}{8}$

✅ Correct Answer: **(a) 3/8**

Feature	Permutation	Combination
Order	Matters	Doesn't matter
Formula	$\frac{n!}{(n-r)!}$	$\frac{n!}{r!(n-r)!}$
Use case	Arrangements, rankings, passwords	Teams, groups, lottery selections

$$P(A/B) = \frac{P(B/A) \cdot P(A)}{P(B)}$$

Topics for Probability & Stats

1. Basic Combinatorics and Probability
2. Bayes Theorem and Conditional Probability
3. Probability Distributions
4. Random Variables, Expectation and Variance
5. Moments
6. Central Limit Theorem
7. Statistical Models: Regression
8. Hypothesis Testing, P-value

- Moments are important in probability to describe the distribution.
- First two moments (mean, variance) are most commonly asked.
- Third (skewness) and fourth (kurtosis) help in understanding shape.
- Shortcut Memory Line: Mean → Spread → Skew → Peak.

Moment	Formula	Meaning
1st	$E(X)$	Mean (Center)
2nd	$E[(X-\mu)^2]$	Variance (Spread)
3rd	$E[(X-\mu)^3]$	Skewness (Asymmetry)
4th	$E[(X-\mu)^4]$	Kurtosis (Peakedness)

$\text{Var}(X) = \text{Average of squares} - (\text{Average})^2$

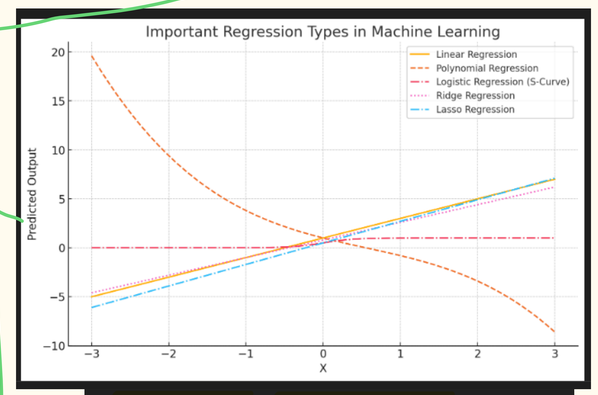
$Y = a + bx \rightarrow$ curve fitting

✅ If the P-value < α, you Reject H_0 directly.
No need to calculate z-score manually if p-value is already given.

- baki is same theory as of normal distribution and confidence level

A Type I error is made if we reject the null hypothesis when it is true.

A Type II error is made if we accept the null hypothesis when it is false.



- **Linear Regression** (simple straight prediction)
- **Polynomial Regression** (curvy fit for complex data)
- **Logistic Regression** (S-curve for classification)
- **Ridge Regression** (linear but regularized to avoid overfitting)
- **Lasso Regression** (linear with sparsity for feature selection)

2. Poisson Distribution MCQ

Discrete | Events in a time interval

The average number of typing errors per page is 2. What is the probability of exactly 1 error on a page?

Options:

- (a) 0.1353
- (b) 0.2707
- (c) 0.4060
- (d) 0.5413

Solution:

Poisson Formula:

$$P(X = k) = \frac{e^{-\lambda} \lambda^k}{k!}$$

where:

- $\lambda = 2$
- $k = 1$

Now:

$$P(1) = \frac{e^{-2} \times 2^1}{1!} = e^{-2} \times 2$$

Given $e^{-2} \approx 0.1353$,

Thus:

$$P(1) = 0.1353 \times 2 = 0.2706$$

✅ Correct Answer: **(b) 0.2707**

3. Normal Distribution MCQ

Continuous | Natural measurements (height, weight)

In a normal distribution, mean = 70 and standard deviation = 10. What is the z-score of a value 85?

Options:

- (a) 1.5
- (b) 2.0
- (c) 2.5
- (d) 3.0

Solution:

Z-score Formula:

$$Z = \frac{X - \mu}{\sigma}$$

where:

- $X = 85$
- $\mu = 70$
- $\sigma = 10$

Thus:

$$Z = \frac{85 - 70}{10} = \frac{15}{10} = 1.5$$

✅ Correct Answer: **(a) 1.5**

4. Exponential Distribution MCQ

Continuous | Time between events

The average time between arrivals of buses at a stop is 20 minutes. What is the probability that the next bus arrives within 10 minutes?

Options:

- (a) 0.3935
- (b) 0.4866
- (c) 0.6321
- (d) 0.7311

Solution:

Exponential Formula:

$$P(T \leq t) = 1 - e^{-\lambda t}$$

where:

- $\lambda = \frac{1}{20}$ per minute
- $t = 10$

Now:

$$P(T \leq 10) = 1 - e^{-\frac{10}{20}} = 1 - e^{-0.5}$$

Given $e^{-0.5} \approx 0.6065$,

Thus:

$$P(T \leq 10) = 1 - 0.6065 = 0.3935$$

✅ Correct Answer: **(a) 0.3935**

The weight of mangoes in a farm is normally distributed with mean 400g and standard deviation 50g. If a sample of 25 mangoes is taken,
find the distribution of the sample mean.

Given:

- $\mu = 400$
- $\sigma = 50$
- $n = 25$

Using CLT formula:

- Mean of sample mean = 400
- Standard deviation of sample mean (Standard Error):

$$\text{SE} = \frac{\sigma}{\sqrt{n}} = \frac{50}{\sqrt{25}} = \frac{50}{5} = 10$$

✅ Answer:

$$\bar{X} \sim N(400, 10)$$

👉 This means:
Sample means are **normally distributed** with mean **400** grams and standard deviation **10** grams.