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Ques 1: Discuss the Concept related to distribution of sample mean, particularly in the Context of the Central Limit Theorm (CLT). Furthermost, explain why this distribution often exhibits a normal or bell shaped pattern as per CLT.

Answer → The Central Limit Theorm (CLT) states that the distribution of sample mean will Approach a normal distribution as the sample size increases, regardless of the distribution of the population. This is Because of averige effecting, which Cause the individual value in the sample to be averaged out as the sample size increases.

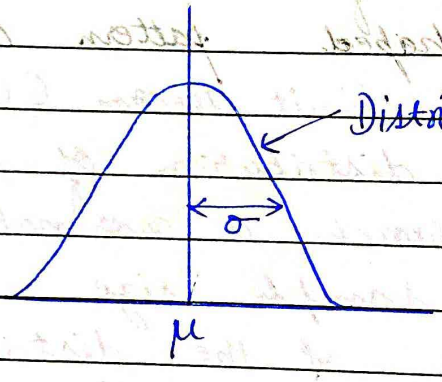
$$\rightarrow Z = \frac{\bar{x} - \mu}{\sigma / \sqrt{n}}$$

formula uses ($\bar{x}$) for the sample mean.

$$\rightarrow Z = \frac{x - \mu}{\sigma}$$

formula uses (x) for the individuals data.

The distribution of sample mean often exhibits a normal or bell-shaped pattern as per the CLT because of the averaging effect. When we take a random sample from the population and calculate the mean, we are essentially averaging out the individual value in the sample. As the sample size increases, the averaging effect become stronger and the distribution of sample mean become normal.



Ques 2:- Discuss the principle behind a sampling technique used to ensure representative samples, especially when dealing with diverse population. Additionally, highlight its significance in practical application.

Answer:- Stratified random sampling is a sampling technique that is used to ensure representative samples, especially when dealing with diverse population. The principle behind stratified random sampling is to divide the

population into subgroup, or strata, based on the one or more important characteristics, such as age, gender, race or ethnicity. Then a random sample is taken from each stratum. This ensure that all subgroups of the population are represented in the sample in proportion to size in population.

Significance of practical Application :-
Stratified random sampling is significant in practical Application such as market research, public health behaviour, Education research, etc. because it help research to make feasible to entire population based on a smaller sample size. This is important because it is often not feasible or cost-effective to survey or collect data from the entire population.

Ques-3 Elaborate on binomial distribution by taking account of any two real world scenarios. Also find, the probability for same.

Answer :- 'Binomial distribution' is a probability distribution that describe the

likelihood of a certain number of success in a sequence of independent trials, where each trial has only 2 possible outcomes. The two possible outcome are often labeled as "sucess" and "failure", but they can also be labeled "head" and "tail", "yes" and "no", or any other two mutually exclusive events.

→ Here are 2 real world scenario's that can be modeled using the binomial distribution:

- Tossing a coin 10 times and counting the number of heads: This is a classic example of binomial experiment. Each toss is an independent trial with two possible outcome.
- Testing a new drug for treatment of particular disease: Each patient who is given the drug is independent trial. There are 2 possible outcome either (sucess), i.e. patient gets cured or (failed), not cured.

$$P(X = k) = {}^{n}C_{k} * p^{k} * (1-p)^{(n-k)}$$

X = random variable of intrest.
k = specific number of success.
n = no. of trials.
p = probability of success on each trial.

Ques-4 Provide an explanation of the Central limit theorm (CLT) and its relevance in shaping the distribution of sample mean, possibility with an example, without directly asking for a description.

Answer-4 The CLT (Central limit Theorm) states that the distribution of sample mean will be approximately normally distributed, regardless of the shape of the population distribution, as long as the sample size is large enough.

$$\begin{bmatrix} \mu_{\bar{x}} = \mu \\ \sigma_{\bar{x}} = \sigma / \sqrt{n} \end{bmatrix}$$

Sampling distribution of the mean:

$\mu_{\bar{x}}$ = mean of sampling dist

μ = population distribution

$\sigma_{\bar{x}}$ = standard deviation of sampling

σ = standard deviation of population

n = Sample size

CLT is relevant in shaping the distribution of sample mean because it allow us to make inference about the population mean based on the sample mean. The CLT is a powerful tool that allow us to make inference about the population mean.

Ques-5 Discuss a practical scenario in which confidence interval play a pivotal role in aiding decision making process or conducting research without directly requesting an example.

Answer: Confidence interval play a pivotal role in aiding decision making process and conducting research in a wide variety of fields. Here is one practical scenario:

Drug Development →

Drug development is a complex and expensive process. It can take many years and billion of years to develop a new drug and bring it to market. One of the most imp. step in drug development is clinical trials. Clinical trial are studies that are conducted to test the safety and efficacy of new human drug.

In the Content of drug development, confidence interval can be used to make decision about whether or not to processed to the next phase of a Clinical trials or to bring the drug to market. for example, if a Clinical trial show that the new drug is effective and safe, but the cofidence interval for drug effect is wide.

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Ques-6 John randomly pick 4 cards from a deck of 52- ~~week~~ Card and places them back to the deck (Any set of 4 Cards is equally likely). Then, jacob randomly choose 8 card out of same decked (Any set of 8 card is equally likely). Assume that the Choice of 4 Card by john and the Choice of 8 Cards by jacob are independent. What is the probability that all 4 Cards Chosen by john are in the set of 8 Cards chosen by jacob?

Answer: The probability that all 4 Cards Chosen by john are in the set of 8 Cards Chosen by jacob is the probability that jacob pick all 4 of john's Card, plus the probability that jacob pick of 3 Card and 5 other Card.

⇒ The probability that jacob pick all 4 of john's Card is:

$$P(\text{all } 4) = \frac{4!}{(52-4)!\,52!} = \frac{1}{6\,\text{8}4318}$$

⇒ The probability that jacob pick 3 of john Card and 5 other Card:

$$P(3 \text{ and } 5) = \frac{4!\,4!}{(52-4)!\,(52)!} = \frac{4}{664318}$$

→ The probability that jacob pick 2 of john's card & 6 other card:

$$P(2 \text{ and } 6) = \frac{6!\,3!\,4!}{(52-4)!\,52!} = \frac{18}{664318}$$

⇒ Probability that jacob picks 1 of john card and 7 card of other:

$$P(1 \text{ and } 7) = \frac{24 \times 2 \times 3 \times 4!}{(52-4)!\,(52)!} = \frac{54}{664318}$$

∴ Overall prob. that all 4 cards chosen by john are in the set of 8 chosen by jacob is:

$$P(\text{all } 4) + P(3 \text{ and } 5) + P(2 \text{ and } 6) + P(1 \text{ and } 7)$$

$$\Rightarrow \frac{1}{664318} + \frac{4}{664318} + \frac{18}{664318} + \frac{54}{664318}$$

$$\Rightarrow \frac{77}{664318}$$