MODULE - 3

9/1/2024

STATISTICAL INFERENCE - 1

Introduction: Sampling distribution, Standard error, testing of hypothesis, levels of significance, test of significances, confidence limits, simple sampling of attributes, test of significance for large samples, comparison of large samples.

Statistics deals with collection, analyses, interpretation & presentation of numerical data

Main purpose of statistics is to make an accurate conclusion using a limited sample about a greater population.

Population: A large collection of individuals or attributes or numerical data. It can also be called as universe.

Sample: A finite subset of the population. sample size. The no. of individuals in a sample is called sample size.

If the sample size n is less than or equal to 30, then the sample is said to be small otherwise large sample.

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Statistics can be classified into 2 categories:

1) Descriptive statistics
2) Inferential statistics

i) Descriptive statistics: It describe the data.

ii) Inferential statistics: It helps you make predictions from the data.

Statistical Inference: It is the process of analysing the result and making conclusions from the data subject to random variation (or)

It is the process of drawing conclusion about an underlying population based on a sample (or) subset of the data.

Main types of statistical inference are:

- Estimation
- Hypothesis testing

- Sampling: The process of selecting a sample from the population is called sampling.

Random sampling: The selection of an individual from the population in such a way that each has the same chance of being selected.

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Sampling with and without replacement:

Sampling where a no. of the population may be selected more than once is called as sampling with replacement.

If a no. can not be choosen more than once is called sampling without replacement.

Standard error:

Standard error of a statistic is the approximate std-deviation of a statistical sample population.

(or)

It is a statistical term that measures the accuracy with which a sample distribution represents a population by using std. deviation.

The reciprocal of std. error is called Precision.

Hypothesis:-(or Statistical Hypothesis)

It is a statement that can be tested by scientific research. If we want to test a relationship b/w 2 or more things, we need to write hypothesis before we start experiment (or) data collection.

Eg: Consumption of apple everyday leads to visit the doctor fewer times.

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Difference between Null hypothesis and Alternative hypothesis:

Null hypothesis	Alternative hypothesis
• It predicts there is no relationship b/w 2 variables.	• It predicts there is a relationship b/w 2 variables.
• It is denoted by H_0	• It is denoted by H_1 or H_a.
• It is followed by "=" sign (equals)	• It is followed by "≠", ">", "<" signs.
• A statement about a population parameter	• A statement that directly contradicts the null hypothesis.
• Eg: New drug does not reduce the no. of days to recover from a disease compare to a std. drug	• Eg: New drug reduce the no. of days to recover from a disease compare to a std. drug.

Eg:- Bed rest will not relives severe asthama.
Here, the Independent variable is bed rest
dependent variable is asthama.

H_0:- Independent variable does not have any casual relationship with dependent variable.

H_1/H_a:- Independent variable has a relationship with dependent variable.

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Test of significance (Test of Hypothesis):-

The process which helps us to decide about the acceptance of rejection of the hypothesis is called test of significance i.e; To reach to any decision about the population (parameter) it is essential to make certain assumption such an assumption is called as statistical hypothesis. The validity of which is to be tested by analysing the sample. The procedure which decides a certain hypothesis is True or False is called Test hypothesis.

In a test process, there can be 4 possible situations:

	Accepting the hypothesis	Rejecting the hypothesis
Hypothesis is True (H_0)	correct decision	wrong decision (Type-I error)
Hypothesis is false (H_0)	wrong decision (Type-II error)	correct decision

In order to minimize both these types of errors we need to increase the sample size.

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Type-I error	Type-II error
• A Type-I error occurs if a null hypothesis is rejected that is actually true is the population.	• A Type-II error occurs if a null hypothesis is not rejected that is actually false in the population.
• H_0 is rejected instead of accepting.	• H_0 is accepted instead of rejecting
• Eg:- There is no relationship b/w eating chocolate & back pain H_0-true- rejecting instead of accepting.	• Eg:- There is no relationship b/w eating chocolate and tooth ache. H_0-false- Accepting instead of rejecting

Significance level:

Significance level are also known as alpha level (α-level) (or) level of significance.

It is a parameter used in hypothesis testing to determine the threshold at which the null hypothesis is rejected.

It is denoted by α.

The significance level represents the probability of rejecting (or) accepting the null hypothesis.

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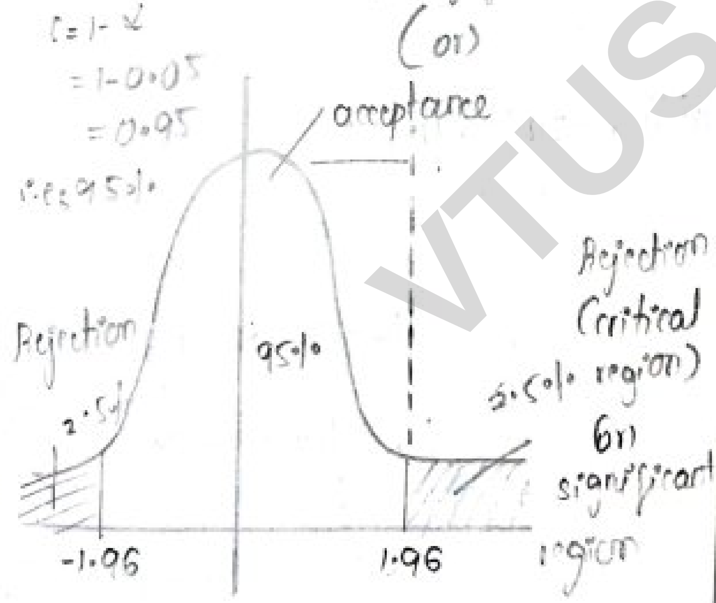
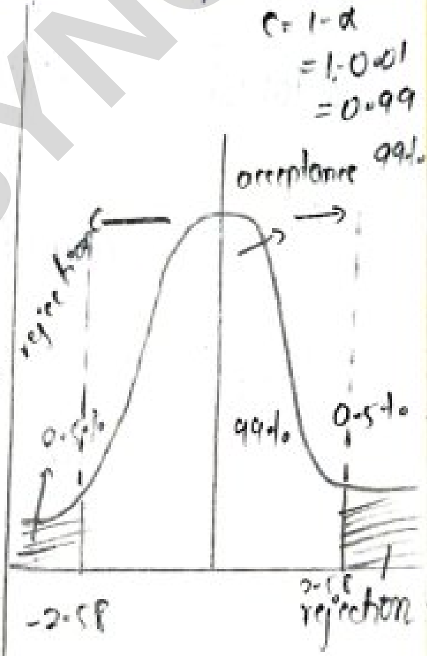
Commonly used significance levels are (0.05) and (0.01) i.e; 5% level of significance and 1% level of significance respectively. [α=5% (0.05) or 1% (0.01)]

Confidence interval [level of confidence-c]:

It is a type of interval calculation in statistics derived from observed data and holds the actual value of an unknown parameter. It's linked to the confidence level which measures how confident the interval is the in estimating the determined parameter [i.e; $c=1-\alpha$]



sure.
95% of correct decision
5% chance of wrong of decision



99% of confidence of correct decision
1% chance of wrong

One-tailed and two-tailed tests:

In our acceptance or rejection of hypothesis we concentrate on the value of z on both sides of the mean such a test is called 2-tailed test. If we concentrate on only one side of the mean, such a test is called 1-tailed test.

Test	Critical / significant level of z	
	5% level	1% level
1-tailed	-1.645 to 1.645	-2.33 or 2.33
2-tailed	-1.96 and 1.96	-2.58 and 2.58

Eg: Drug manufacture company

Manufacture company says — 500mg of drug

$H_0 - \mu = 500mg$

$H_1 : \mu \neq 500mg$ [2 tailed test or 2-tailed alternative test]

decision making test

$H_1 : \mu < 500mg$ [1-tailed test]

"<" - left tailed test

$H_1 : \mu > 500mg$ [1-tailed test]

">" - right tailed test

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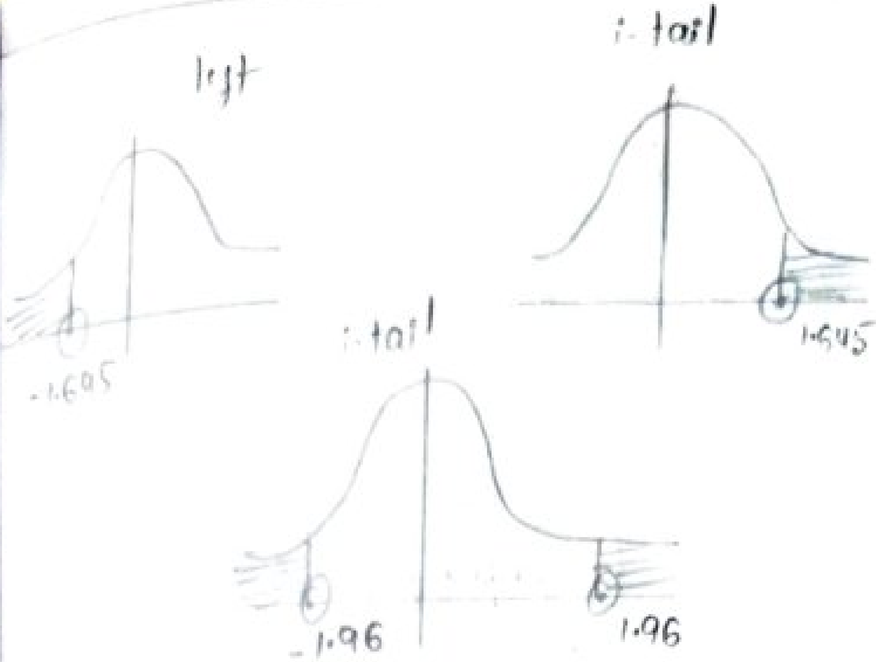

<u>NOTE:</u> we use H_1 i.e "$\neq$" – To test when the population is about decision making.

"<" – Validity of a claim

">" – Testing of research hypothesis.

Computation of Test statistic:

For any statistical inference we assume the hypothesis initially and then compute. We can compute their statistic test [z-test, t-test, χ^2-test, F-test] and it depends on population of a sample.

<u>NOTE:</u> z-test → when $n \geq 30$. Std. deviation of population is known.

t-test → when $n < 30$. Std. deviation of population is unknown.

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WORKING PROCEDURE:-

Test of significance for large samples.

1) Test of signifance of proportions.

i) assume H_0

ii) Find $\boxed{Z = \frac{x-\mu}{\sigma}}$ i.e; $\boxed{Z = \frac{x-np}{\sqrt{npq}}}$

Here, x is observed no. of success in a sample size 'n' [Given:].

$\mu = np$ - It is the expected no. of success in a sample size 'n' [which we will be finding].

n - sample size

iii) $|z| > Z_\alpha$ - rejecting hypothesis (H_0)

$|z| < Z_\alpha$ - accepting hypothesis (H_0)

α - level of significance

$Z_\alpha = 2.58$ - 1% level of significance

$Z_\alpha = 1.96$ - 5% level of significance

NOTE:- This test is used to find significant difference b/w proportion of the sample and the population i.e; differences b/w observed and expected.

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PROBLEMS:-

A coin is tossed 1000 times and head turns upto 540 times beside on the hypothesis that the coin is unbiased?

Null hypothesis, H_0

let the coin be unbiased

Given: sample size, $n = 1000$

Observed no. of heads on 1000 times of tossing of a coin

$x = 540$

Expected no. of heads $= \mu = np$

p - probability of getting a head in one toss

$p = 1/2 \Rightarrow \mu = 1000 \times 1/2$

$\boxed{\mu = 500}$

$p + q = 1$

$q = 1 - p \Rightarrow 1 - \frac{1}{2} \Rightarrow \boxed{q = \frac{1}{2}}$

Test of significance $\Rightarrow z = \frac{x - \mu}{\sigma} = \frac{x - np}{\sqrt{npq}}$

$$z = \frac{540 - 1000 \times \frac{1}{2}}{\sqrt{1000 \times \frac{1}{2} \times \frac{1}{2}}}$$

$$z = \frac{40}{\sqrt{250}} \Rightarrow \boxed{z = 2.53}$$

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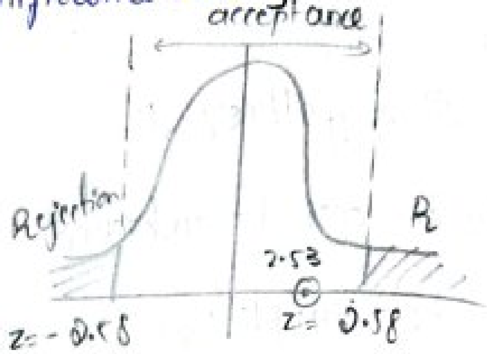
$|z| < z_\alpha$

$2.53 < 2.58$

[$z_\alpha = 2.58$ for 1% of significance level]

∴ Accept the hypothesis H_0

∴ The coin is unbiased



2) A die is thrown 9000 times and a throw of 3 (or) 4 was observed 3240 times. Show that die cannot be regarded as an unbiased one.

⇒ Let us assume Null hypothesis, H_0 = die cannot be regarded as an unbiased one.

Given: n = sample size = 9000 times

observed no. of success, $x = 3240$

Expected no. of success, $\mu = np$

p - probability of getting 3 or 4 is $\frac{1}{6} + \frac{1}{6} = \frac{2}{6} = \frac{1}{3}$

$q = 1 - p \Rightarrow 1 - \frac{1}{3}$. $\boxed{q = \frac{2}{3}}$

Test of significance, $z = \frac{x - \mu}{\sigma} = \frac{x - np}{\sqrt{npq}}$

$$z = \frac{3240 - 9000 \times \frac{1}{3}}{\sqrt{3000 \times \frac{2}{3}}}$$

$$z = \frac{240}{\sqrt{2000}}$$ $\boxed{z = 5.37}$

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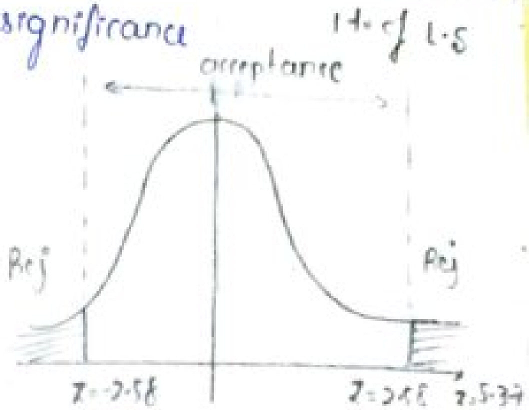
$|z| > z_\alpha$ for 1% level of significance

$z_\alpha = 2.58$



$|z| > z_\alpha$

Rejecting the hypothesis H_0

i.e; the die is biased.

3) In 324th throws of a 6 faced die and odd number turned up 181 times. It is possible (or) reasonable to think that the die is an unbiased one?

⇒ Let us assume Null Hypothesis, H_0 = the die is an unbiased one.

Given: n = sample size = 324

observed no. of success, $x = 181$

Expected no. of success, $\mu = np$

p-probability of getting an odd number, is, $\frac{3}{6} = \frac{1}{2}$

$q = 1-p \Rightarrow 1 - \frac{1}{2}$ $\boxed{q = \frac{1}{2}}$

$\mu = np$

$\mu = 324 \times \frac{1}{2}$

$\boxed{\mu = 162}$

Test of significance, $z = \frac{x-\mu}{\sigma} = \frac{x-np}{\sqrt{npq}}$

$$z = \frac{181-162}{\sqrt{162 \times \frac{1}{2}}}$$

$$z = \frac{19}{\sqrt{81}} = \frac{19}{9} \Rightarrow \boxed{z = 2.11}$$

$|z| < z_\alpha$

$2.\cancel{1} < 2.58$ for

$z_\alpha = 2.58$ for 1% level of significance.

$\therefore$ Accept the hypothesis H_0

$\therefore$ The die is unbiased

Test for Difference of Proportion

Let A and B be a large population with respect to certain attributes among their members. Consider two independent large samples of sizes n_1 and n_2 from the population A and B respectively.

Let x_1 and x_2 be the observed no. of success in these samples respectively.

Random sampling with replacement:

The items are drawn one by one & are put back to the population before the next draw.

Formula: $\mu_{\bar{x}} = \mu$ where $\mu_{\bar{x}}$ is a mean of sample.

μ - mean of population.

$$\sigma_{\bar{x}^2} = \frac{\sigma_{x^2}}{\sqrt{n}}$$

$\sigma_{\bar{x}}$ - S.d of the sample

σ_x - S.d of population

n - size of the sample, N - size of population.

where, $\mu = \frac{\Sigma f}{N}$ - sum of all frequencies / Total no. of data

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Sampling without replacement:

The items are drawn one by one and are not put back to the population before the next draw

Formula:
$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}}^2 = \left[\frac{N-n}{n-1}\right]\frac{\sigma^2}{n}$$

(or)

$$\sigma_{\bar{x}}^2 = c\,\frac{\sigma^2}{n}$$

where, c is the correction factor

If N - very large, then c=1

$$\boxed{V = \Sigma(x_i - \mu)^2}$$

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PROBLEMS:-

1) A population consists of 5 numbers 2, 3, 6, 8, 11, consider all possible samples of size 2 which can be drawn with replacement, from this population, find the
(i) mean and S.D of the population
(ii) mean and S.D of the sampling distribution without replacement & with replacement?

$\Rightarrow$ Given: size of a Sample, $n = 2$

Size of the population, $N = 5$

(i) μ and σ_x of the population

$$\mu = \frac{\Sigma f}{N}$$

$$\mu = \frac{2+3+6+8+11}{5}$$

$$\boxed{\mu = 6}$$

$$\sigma_x^2 = \frac{1}{n} \Sigma (x_i - \mu)^2$$

$$= \frac{1}{5}\left[(2-6)^2 + (3-6)^2 + (6-6)^2 + (8-6)^2 + (11-6)^2\right]$$

$$\sigma_x^2 = \frac{1}{5}[16+9+0+4+25]$$

$$\sigma_x^2 = \frac{54}{5}$$

$$\sigma_x^2 = \frac{54}{5} = 10.8$$

$$\boxed{\sigma_x^2 = 10.8}$$

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ii) μ and σ with replacement

$$\boxed{\mu_{\bar{x}} = \mu = 6}$$

Here, $\mu_{\bar{x}}$ is the mean of sampling with replacement & μ is mean of the population.

$$\sigma_{\bar{x}} = \frac{\sigma_x^2}{\sqrt{N}}$$

Standard Deviation, $\sigma_{\bar{x}}^2 = \frac{\sigma_x^2 (\sigma^2)}{\cancel{N}n} = \frac{\frac{54}{5}}{2} = \frac{3.28}{\sqrt{5}}$ $= 5.4$

$\sigma_{\bar{x}}$ is a SD with replacement & σ is a SD of population, $\boxed{\sigma_{\bar{x}} = 2.32}$ $\quad \sigma_x$ $\quad \sigma_{\bar{x}} = \sqrt{5.4}$

μ and σ without replacement

$$\boxed{\mu_{\bar{x}} = \mu = 6}$$ → mean of sampling without replacement.

$$\sigma_{\bar{x}}^2 = \left[\frac{N-n}{N-1}\right]\frac{\sigma^2}{\cancel{N}n}$$

$$= \left[\frac{5-2}{5-1}\right]\frac{10.8}{2} = \frac{3}{4}(5.4)$$

$$\sigma_{\bar{x}}^2 = 4.05 \Rightarrow \sigma_{\bar{x}} = \sqrt{4.05} \qquad \boxed{\sigma_{\bar{x}} = 2.01}$$

NOTE:-

1) Mean of the population $= \boxed{\mu = \frac{\Sigma f}{N}}$

N - Total no. of population.

σ of the population.

$$\boxed{\sigma = \sqrt{\frac{V(x)}{N}} = \sqrt{\frac{\Sigma(x_i - \mu)^2}{N}}}$$

2) To find random sampling with replacement.

$$\boxed{\mu_{\bar{x}} = \mu} = \frac{\Sigma f(x)}{N}$$

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$$\sigma_{\bar{x}}^2 = \frac{\sigma_x^2}{n} \text{ (or) } \frac{\sigma^2}{n}$$

Here, $\sigma^2 = \frac{\Sigma (x_i - \mu)^2}{N}$

3) Sampling without replacement

$$\mu_{\bar{x}} = \mu$$

$$\sigma_{\bar{x}}^2 = \left[\frac{N-n}{N-1}\right] \frac{\sigma^2}{n}$$

2) A population consists of 4 numbers 3, 7, 11, 15,

(i) find the mean and S.D of the sampling distribution of means by considering samplings of size 2 with replacement?

(ii) If N, n denotes respectively the population size & sample size, σ and $\sigma_{\bar{x}}$ respectively denotes population S.D and S.D of the sampling distribution of means without replacement?

⇒ Given: N - size of the population = 4

n - sample size = 2

(i) Sampling with replacement,

$$\mu_{\bar{x}} = \mu$$

$$\mu = \frac{\Sigma f}{N} = \frac{3+7+11+15}{4} = 9$$

$$\therefore \boxed{\mu_{\bar{x}} = \mu = 9}$$

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$$\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n}$$

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

σ - s.d of population

$$\sigma^2 = \frac{[(3-9)^2 + (7-9)^2 + (11-9)^2 + (15-9)^2]}{4}$$

$$\sigma^2 = 20$$

$$\sigma_{\bar{x}}^2 = \frac{20}{2}$$

$$\sigma_{\bar{x}}^2 = 10 \Rightarrow \sigma_{\bar{x}} = \sqrt{10}$$

$$\boxed{\sigma_{\bar{x}} = 3.162}$$

(ii) Sampling without replacement,

$$\boxed{\mu_{\bar{x}} = \mu = 9}$$

$$\sigma_{\bar{x}}^2 = \left[\frac{N-n}{N-1}\right] \frac{\sigma^2}{n}$$

$$\sigma_{\bar{x}}^2 = \left[\frac{4-2}{4-1}\right](10) \Rightarrow \frac{4}{3}(10) = \frac{40}{3}$$

$$\sigma_{\bar{x}}^2 = 6.67$$

$$\sigma_{\bar{x}} = \sqrt{6.67}$$

$$\boxed{\sigma_{\bar{x}} = 2.58}$$

3) Certain tubes manufactured by a company have mean lifetime of 800 hours and S.D of 60 hours. Find the probability that a random sample of 16 tubes taken from the group will have a main life time,

(i) Between 790 hours to 810 hours.

(ii) < 785 hours (less than).

(iii) more than 820 hours.

(iv) Between 770 hours - 830 hours.

⇒ Given:

$\mu = 800$

$\sigma = 60$

$n = 16$

$$\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n} = \frac{(60)^2}{16}$$

$\sigma_{\bar{x}}^2 = 225$

$\boxed{\sigma_{\bar{x}} = 15}$

(i) Probability between 790 hours to 810 hours.

$P(790 < \bar{x} < 810)$

Let $\bar{x} = 790$, $z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} \Rightarrow \frac{790 - 800}{15}$

$\boxed{z = -0.67}$

Let $\bar{x} = 810$, $z = \frac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \frac{810 - 800}{15} = 0.67$

$\boxed{\sigma_{\bar{x}} = 0.67}$

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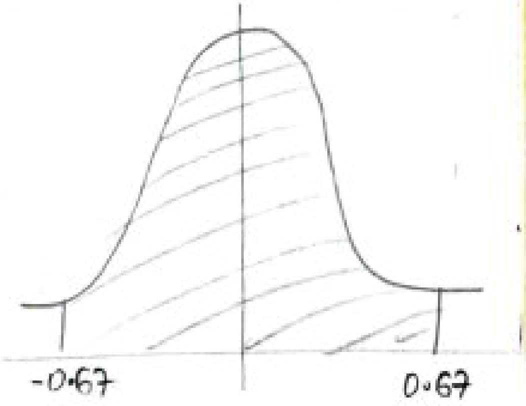
$P(-0.647 < z < 0.67)$



$z(-0.67 \text{ to } 0) + z(0 \text{ to } 0.67)$

$2z(0 \text{ to } 0.67)$

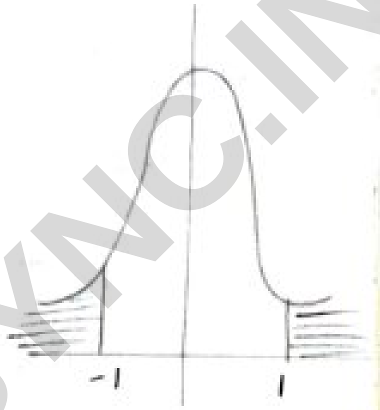
$2\phi(0.67)$

2×0.2486

$\boxed{= 0.4972}$

(ii) < 785 hours

$P(\bar{x} < 785)$



let $\bar{x} = 785$, $z = \dfrac{\bar{x} - \mu}{\sigma_{\bar{x}}} = \dfrac{785 - 800}{15} = -1$

$z(0 \text{ to } \infty) - z(0 \text{ to } \cancel{\infty}\ 1)$

$0.5 - \phi(1)$

$P(z < -1) = 0.5 - \phi(1)$

$= 0.5 - 0.3413$

$\boxed{P(z < -1) = 0.1587}$

(iii) more than 820 hours

$P(\bar{x} > 820)$

let $\bar{x} = 820$, $z = \dfrac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} = \dfrac{820 - 800}{\cancel{160}15} = \dfrac{\cancel{20}}{\cancel{60}\ 15} = \dfrac{\cancel{1}}{\cancel{3}}\ 1.33$

$z(0 \text{ to } \infty) - z(0 \text{ to } 1.33)$

$0.5 - \phi(1.33) \Rightarrow 0.5 - 0.4082$

$\boxed{P(z > 1.33) \Rightarrow 0.0918}$

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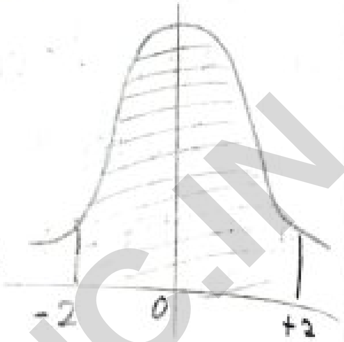
(iv) between 770 and 830 hours

$$P(770 < \bar{x} < 830)$$

Let $\bar{x} = 770$, $z = \dfrac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} \Rightarrow \dfrac{770 - 800}{15} = \dfrac{-30}{15} = -2$

$\bar{x} = 830$, $z = \dfrac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} \Rightarrow \dfrac{830 - 800}{15} = \dfrac{30}{15} = 2$



$P(-2 < z < 2)$

$z(-2 \text{ to } 0) + z(0 \text{ to } 2)$

$z(0 \text{ to } 2) + z(0 \text{ to } 2)$

$2\, z(0 \text{ to } 2)$

$2\, \phi(2)$

$$\boxed{P(-2 < z < 2) = 0.9544}$$

4) The weights of 1500 ball bearing are normally distributed with a mean of 635 gms and standard deviation of 1.36 gms. If 400 random samples of size 36 are drawn from this population, determine the expected mean and S.D of the sampling distribution of mean. If sampling is done.

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(i) with replacement

(ii) without replacement.

In the case of random sampling with replacement, find how many random samples would have been.

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(a) between 634.76 and 635.24 gms.

(b) greater than 635.5 gm

(c) less than 634.2 gms

(d) less than 634.5 gm (or) more than 635.24 gm.

Given: $N = 1500$

$\mu = 635$

$n = 36$

σ = S.D of population = 1.36

(i) Sampling distribution with replacement

$$\boxed{\mu_{\bar{x}} = \mu = 635}$$

S.D of s.d with replacement

$$\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n}$$

Now, finding for σ^2

$$\sigma^2 = \frac{\Sigma (x_i - \mu)^2}{N}$$

$$\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n} = \frac{(1.36)^2}{36} \Rightarrow 0.0514$$

$$\boxed{\sigma_{\bar{x}} = 0.2267}$$

(ii) Sampling distribution without replacement

$$\boxed{\mu_{\bar{x}} = \mu = 635}$$

$$\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n}\left[\frac{N-n}{N-1}\right] \Rightarrow 0.0514\left[\frac{1500-36}{1500-1}\right]$$

$$\sigma_{\bar{x}}^2 = 0.050 \Rightarrow \boxed{\sigma_{\bar{x}} = 0.2241}$$

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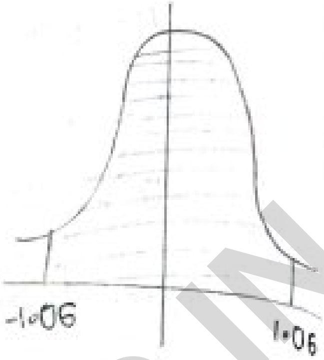
In the case of random sampling with replacement,

(a) $P(634.76 < \bar{x} < 635.24)$

If $z = \dfrac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}}$, $\boxed{z = \dfrac{\bar{x} - 635}{0.227}}$

$\bar{x} = 634.76$ $\quad z = \dfrac{634.76 - 635}{0.2267}$

$\boxed{z = -1.06}$



$\bar{x} = 635.24$, $\boxed{z = 1.06}$

$P(-1.06 < z < 1.06)$

$z(-1.06 \text{ to } 0) + z(0 \text{ to } 1.06)$

$z(0 \text{ to } 1.06) + z(0 \text{ to } 1.06)$

$2z(1.06)$

$2\phi(1.06)$

$P(-1.06 < z < 1.06) \Rightarrow 0.7108$

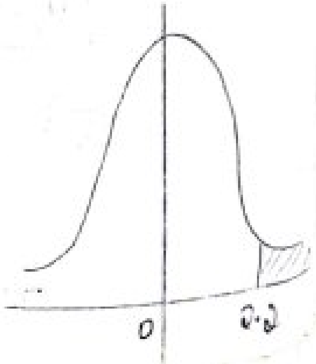
For 400 random samples, $400 \times 0.7108 \Rightarrow 284.32 \simeq 284$ samples.

(b) greater than 635.5

$P(\bar{x} > 635.5)$

let $\bar{x} = 635.5$, $z = \dfrac{635.5 - 635}{0.227}$, $\boxed{z = 2.2}$

$P(z > 2.2)$



$z(0 \text{ to } \infty) - z(0 \text{ to } 2.2)$

$0.5 - \phi(2.2)$

$\boxed{P(z > 2.2) \Rightarrow 0.0139}$

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For 400 random samples, $400 \times 0.0139 \Rightarrow 5.56 = 6$ samples

(c) $P(\bar{x} < 634.2)$ less than 634.2 gms.

let $\bar{x} = 634.2$, $z = \dfrac{634.2 - 635}{0.227}$, $\boxed{z = -3.524}$

$P(z < -3.52) \Rightarrow 0.0002$

For 400 samples, $400 \times 0.0002 \Rightarrow 0$ samples.

(d) less than 634.5 gm (or) more than 635.24 gm

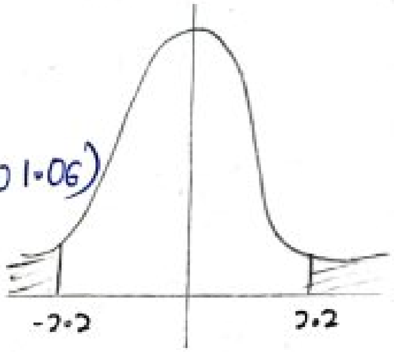
$P(\bar{x} < 634.5) + P(\bar{x} > 635.24)$ 0.456

$P(\bar{x} < 634.5)$

let $\bar{x} = 634.5$, $z = \dfrac{634.5 - 635}{0.227}$, $\boxed{z = -2.2}$

$P(\bar{x} > 635.24)$, $z = \dfrac{635.24 - 635}{0.227}$, $\boxed{z = 1.06}$

$P(z < -2.2) + P(z > 1.06)$



$z(0 \text{ to } \infty) - z(0 \text{ to } 2.2) + z(0 \text{ to } \infty) - z(0 \text{ to } 1.06)$

$0.0139 + 0.1446$

$\Rightarrow \boxed{0.1518}$

For 400 samples, $400 \times 0.1518 \Rightarrow 63.4 = 63$ samples

3 AC, shift 1, 5,

2,

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