* **Aim** :-

To check the unbiasedness of the estimators.

* **Experiment** :-

(a) A random experiment of size 3 is drawn from a population with mean $\mu$. Then find the value of k such ~~tat~~ that the estimator $T = 2x_1 + 3x_2 - kx_3$ is unbiased for $\mu$.

(b) Find the unbiased estimator of $\theta$ from $ax^2+bx+c$ for $(1+\theta)(2+\theta)$ given $x$ follow poisson distribution with parameter $\theta$.

* **Theory & Formula used** :-

Unbiased estimator : An estimator $T_n = T(x_1, x_2, \ldots, x_n)$ is said to be unbiased estimator of $\theta$ if

$$E(T_n) = \theta \quad \forall \ \theta \in \phi \qquad \phi = \text{Parameter Space}$$

* **Result** :-

(a) $k = 4$

(b) Unbiased Estimator : $x^2 + 2x + 2$

* Calculations :-

(a) $T$ is an unbiased estimator of $\mu$

$$E(T) = \mu$$

$$E(2x_1 + 3x_2 - kx_3) = \mu$$ $\{E(ax+by) = aE(x) + bE(y)\}$

$$2E(x_1) + 3E(x_2) - kE(x_3) = \mu$$ $\{E(x) = \mu\}$

$$2\mu + 3\mu - k\mu = \mu$$

$$\boxed{k = 4}$$

(b) Since $x$ follows poisson distribution with parameter $\theta$ so

$$V(x) = \theta \quad \& \quad E(x^2) = V(x) + (E(x))^2$$
$$E(x^2) = \theta + \theta^2$$

Now, let $ax^2 + bx + c$ be an unbiased estimator of $(1+\theta)(2+\theta)$

so
$$E(ax^2 + bx + c) = (1+\theta)(2+\theta)$$
$$aE(x^2) + b.E(x) + c = \theta^2 + 3\theta + 2$$

$$\cancel{a(\theta^2+\theta)+} \; a(\theta^2 + \theta) + b\theta + c = \theta^2 + 3\theta + 2$$

$$a\theta^2 + \theta(a+b) + c = \theta^2 + 3\theta + 2$$
$$a = 1, \quad a+b = 3, \quad c = 2$$
$$a = 1, \quad b = 2, \quad c = 2$$

So Estimator is $x^2 + 2x + 2$

* **Aim :-**

To check whether the given estimators are unbiased or not & find the best estimator among them.

* **Experiment :-**

A random sample $x_1, x_2, \ldots, x_5$ of size 5 is drawn from a population (normal) with unknown mean $\mu$. Consider the following estimators to estimate $\mu$.

(i) $$t_1 = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}$$

(ii) $$t_2 = \frac{x_1 + x_2}{2} + x_3$$

(iii) $$t_3 = \frac{2x_1 + x_2 + \lambda x_3}{3}$$

where $\lambda$ is such that $t_3$ is unbiased for $\mu$. Find $\lambda$. Are $t_1$ & $t_2$ unbiased? State given reason. Select the best estimator.

* **Theory & Formula used :**

Unbiasedness :- An estimator $T_n = T(x_1, x_2, \ldots x_n)$ is unbiased for $\theta$ if

$$E(T_n) = \theta \quad \forall\ \theta \in \phi$$

Instructer's Sign

Efficiency :- The concept of efficiency refers to the sampling variability of the estimators. If two estimators are unbiased then one with smaller variance is said to be relatively more efficient.

Best estimator is some kind of estimator that fulfils all the four property of estimation like unbiasedness, consistency, efficiency, sufficiency.

* Result :-

$\lambda = 4$ , $t_1 \rightarrow$ unbiased , $t_2 \rightarrow$ biased

~~$t_1$ and $t_3$ are~~ $t_1$ and $t_3$ are unbiased but $V(t_1) < V(t_3)$ so $t_1$ is the most efficient estimator. So $t_1$ is the best estimator

Instructer's Sign

* Calculations :

lets calculate Expected value & variance of the estimators.

(i) $$t_1 = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}$$

$$E(t_1) = E\left(\frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}\right)$$

$$E(t_1) = \frac{\cancel{5}\mu}{\cancel{5}} = \mu$$

$$V(t_1) = V\left(\frac{x_1 + x_2 + x_3 + x_4 + x_5}{5}\right)$$

$$V(t_1) = \frac{5\sigma^2}{25} = \frac{\sigma^2}{5}$$

(ii) $$t_2 = \frac{x_1 + x_2}{2} + x_3$$

$$E(t_2) = \frac{E(x_1 + x_2)}{2} + E(x_3)$$

$$E(t_2) = \frac{\cancel{2}\mu}{\cancel{2}} + \mu = 2\mu$$

$$V(t_2) = V\left(\frac{x_1 + x_2}{2} + x_3\right)$$

$$V(t_2) = \frac{2\sigma^2}{4} + \sigma^2 = \frac{3}{2}\sigma^2$$

(iii) $t_3$ is unbiased for $\mu$

so $E(t_3) = \mu$

$$E\left(\frac{2x_1 + x_2 + \lambda x_3}{3}\right) = \mu$$

$$2\mu + \mu + \lambda\mu = 3\mu$$

$$\lambda\mu = 0$$

$$\lambda = 0$$

$$V(t_3) = \frac{V(2x_1 + x_2 + \cancel{t})}{9}$$

$$= \frac{4\sigma^2 + \sigma^2}{9} = \frac{5}{9}\sigma^2$$

Now we have

$E(T_1) = \mu$ , $V(t_1) = \frac{\sigma^2}{5}$

$E(T_2) = 2\mu$ , $V(t_2) = \frac{3\sigma^2}{2}$

$E(T_3) = \mu$ , $V(t_3) = \frac{5\sigma^2}{9}$

$\lambda = 0$

* **Aim** :-

To construct 95 % confidence interval for the given sample.

* **Experiment** :-

An industrial designer wants to know the average amount of time it takes an ~~add~~ adult to assemble on "easy-to-assemble" toy. Use the following data (in min), a random sample, to construct 95 % confidence interval for the mean of population sampled.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 17 | 13 | 18 | 19 | 17 | 21 | 22 | 16 | 28 | 21 |
| 26 | 23 | 24 | 20 | 8 | 17 | 21 | 32 | 18 | 25 |
| 16 | 10 | 20 | 22 | 9 | 14 | 22 | 12 | 14 | 28 |
| 15 | 29 | | | | | | | | |
| 22 | 17 | | | | | | | | |
| 11 | 30 | | | | | | | | |

* **Theory & Formula used** :-

Mean :- Avg. value or most common value in a collection.

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{\Sigma fx}{n}$$

Required Confidence Interval :

$$\bar{x} - Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}} < \mu < \bar{x} + Z_{\alpha/2} \cdot \frac{\sigma}{\sqrt{n}}$$

Instructer's Sign

where $Z_{\alpha/2}$ → see from table

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

$n$ = sample size
$\sigma$ = Standard Deviation
$\mu$ = Population Mean
$\bar{x}$ = Sample Mean

$\alpha$ = level of significance

* Result :-

Required Confidence Interval :

$18.05 < \mu < 21.79$

Instructer's Sign

* <u>Calculations</u> :-

$n = 36$ , $\Sigma fx = 717$

so $\bar{x} = \frac{717}{36} = 19.92$

$\alpha = 0.05 \Rightarrow \alpha/2 = 0.025$

$Z_{0.025} = 1.96$ & $\sigma = 5.73$

$Z_{0.025} \cdot \frac{\sigma}{\sqrt{n}} = 1.96 \times \frac{5.73}{\sqrt{36}} = 1.87$

Now Required Confidence Interval

lower limit $= \cancel{Z_{0.025}}\ \bar{x} - Z_{0.025} \cdot \frac{\sigma}{\sqrt{n}}$

$= 19.92 - 1.87 = 18.05$

Upper limit $= \bar{x} + Z_{0.025} \cdot \frac{\sigma}{\sqrt{n}}$

$= 19.92 + 1.87 = 21.79$

$18.05 < \mu < 21.79$

* **Aim :-**

To construct 94 % confidence interval for the difference between mean of two samples.

* **Experiment :-**

Construct a 94 % confidence interval for the difference between the means of lifetimes of two kind of light bulbs. Given that a random sample of 40 light bulbs of first kind lasted on the average of 418 hrs of continuous use and 50 light bulbs of second kind on the average 402 hrs of continuous use. The population standard deviation are known to be $\sigma_1 = 26$ and $\sigma_2 = 22$

* **Theory & Formula used :-**

If we want to find out the difference between means of two sampled population & with known variances then we use following statistics :

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

So required confidence interval

$$(\bar{x}_1 - \bar{x}_2) - Z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < (\bar{x}_1 - \bar{x}_2) - Z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

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Practical No.



where $n_1, n_2$ = Sample size of first & second population
$\bar{x}_1, \bar{x}_2$ = Sample mean of first & second population
$\mu_1, \mu_2$ = Population mean — " —
$\sigma_1^2, \sigma_2^2$ = Variance — " —

* Result :-

Required Confidence Interval

$$6.31 < \mu_1 - \mu_2 < 25.69$$

Since the difference is positive that means first kind of light bulbs are superior to second kind.

Instructer's Sign

* **Calculations** :-

$\alpha = 0.06$ & $Z_{\alpha/2} = Z_{0.03} = 1.88$

| I | II |
|---|---|
| $n_1 = 40$ | $n_2 = 50$ |
| $x_1 = 418$ | $x_2 = 402$ |
| $\sigma_1 = 26$ | $\sigma_2 = 22$ |

So $Z_{\alpha/2} \cdot \sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}} = 1.88 \sqrt{\dfrac{576}{40} + \dfrac{484}{50}}$

$= 9.69$

So required confidence interval

lower limit $= (\bar{x}_1 - \bar{x}_2) - Z_{\alpha/2} \cdot \sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$

$= 16 - 9.69 = 6.31$

Upper limit $= (\bar{x}_1 - \bar{x}_2) - Z_{\alpha/2} \cdot \sqrt{\dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}}$

$= 16 + 9.69 = 25.69$

$6.31 < \mu_1 - \mu_2 < 25.69$

* **Aim :-**

To test the hypothesis for the parameters of a normal distribution.

* **Experiment :-**

(a) In 12 test runs over a marked course, a newly designed motorboat averaged 33.6 sec with a standard deviation of 2.3 sec. Assuming that it is reasonable to treat the data as a random sample from a normal population. Test the null hypothesis $\mu = 35$ against $\mu < 35$ at 0.05 level of significance.

(b) A study of the no. of business launches that executives in the insurance and banking industry claim as deductable expenses per month was based on random samples and yields the following result

$n_1 = 40$ , $\bar{x}_1 = 9.1$ , $s_1 = 1.9$

$n_2 = 50$ , $\bar{x}_2 = 8.0$ , $s_2 = 2.1$

Test the null hypothesis $\mu_1 - \mu_2 = 0$ against the alternative $\mu_1 - \mu_2 \neq 0$ with 0.05 level of significance.

* **Theory & Formula used :-**

Test of significance is a statistical test where we check the validity of $H_0$ (null hypothesis) against $H_1$

Instructer's Sign

(alternative hypothesis) on the basis of avaliable evidences.

Test of Significance

One tail test
$H_0 : \mu = 0$
$H_1 : \mu > 0$ or $\mu < 0$

Two tail test
$H_0 : \mu = 0$
$H_1 : \mu \neq 0$

Depends on sample size (n) & population variance($\sigma$), we use Z and t statistics and check the validity of $H_0$ with the help of critical region.

In this question we will use

$$t = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

where
$\bar{x}$ = sample mean
$\mu_0$ = population mean
$s$ = sample standard deviatio
$n$ = sample size

$$Z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

* Result :-

(a) $H_0$ must be rejected because $-2.1086 < -1.796$
(b) $H_0$ must be rejected because $2.604 > 1.96$

## * Calculations :-

(a) Given : $n = 12$, $\bar{x} = 33.6$, $s = 2.3$, $\mu_0 = 35$, $\alpha = 0.05$

Hypothesis : $H_0 : \mu = 35$

$H_1 : \mu < 35$ (left tail test)

Test Statistic :

$$t = \frac{33.6 - 35}{2.3/\sqrt{12}} = -2.1086$$

$$t = -2.1086$$

$$t_{0.05,11} = -1.796$$

So $t < t_{0.05,11}$

$H_0$ must be rejected. So we can say that the average of newly motorboat is less than 35 sec.

(b) Given : $n_1 = 40$ $\quad \bar{x}_1 = 9.1$ $\quad s_1 = 1.9$

$n_2 = 50$ $\quad \bar{x}_2 = 8.0$ $\quad s_2 = 2.1$

$\alpha = 0.05$

Hypothesis:

$H_0 : \mu_1 - \mu_2 = 0$

$H_1 : \mu_1 - \mu_2 \neq 0$ (two tail test)

Test Statistic:

$$Z = \frac{9.1 - 8.0}{\sqrt{\frac{(1.9)^2}{40} + \frac{(2.1)^2}{50}}}$$

$$Z = 2.604$$

$$Z_{0.025} = 1.96$$

So $\quad Z > Z_{0.025}$

$H_0$ must be rejected.

* **Aim :-**

To perform chi-square test of association.

* **Experiment :-**

A T.V. channel program manager wants to know whether there are any significant differences among male & female viewers between the type of program they watch. A survey condected for the purpose given the following results. Calculate chi-square statistic and determine whether type of T.V. program is independent of viewers' sex. Take 0.1 significance level and critical value as 2.706.

* **Theory & Formula used :-**

Contingency Table :- It's a two-way table for attributes. Different levels of 2 attributes are considered and the table gives frequencies ~~according~~ corresponding to $i^{th}$ level of one attribute and $j^{th}$ level of another attribute $i = 1, 2, \ldots, m$ and $j = 1, 2, \ldots, n$. This type of table is called contingency table of $m \times n$.

$$\text{Expected Frequency} = \frac{\text{Row total} \times \text{column total}}{\text{Grand Total}}$$

Test statistic :

$$\chi^2 = \sum_{i=1}^{m} \sum_{j=1}^{n} \left\{ \frac{(o_{ij} - e_{ij})^2}{e_{ij}} \right\}$$

Instructer's Sign

where $O_{ij}$ = observed frequency for $(i,j)$ in contingency table.

If $\chi^2 > \chi^2_{\alpha, n-1}$ we reject $H_0$ otherwise not.

* **Result :-**

$$16.66 > 2.706$$

i.e. $\chi^2 > \chi^2_{0.1, 1}$ so $H_0$ is rejected

Hence, there is no any relation between gender of viewers and T.V. program watched by them.

Instructer's Sign

## * Calculations :-

| Type of T.V. Programs | Viewers' Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| News | 30 | 10 | 40 |
| Serial | 20 | 40 | 60 |
| Total | 50 | 50 | 100 |

$H_0$ : There is any relation between gender and program.
$H_1$ : Both are independent.

| $O_{ij}$ | $e_{ij}$ | $(O_{ij} - e_{ij})^2$ | $\frac{(O_{ij} - e_{ij})^2}{e_{ij}}$ |
|---|---|---|---|
| 30 | 20 | 100 | 5 |
| 20 | 30 | 100 | 10/3 |
| 10 | 20 | 100 | 5 |
| 40 | 30 | 100 | 3.33 |
| | | | Total = 16.33 |

$\chi^2 = 16.33$ and $\chi^2_{0.1,1} = 2.706$

$\chi^2 > \chi^2_{0.1,1}$

$H_0$ is rejected

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## * Aim :-

To perform chi-square test of goodness of fit.

## * Experiment :-

A survey of 320 families with 5 children each revealed the following distribution :-

| | | | | | | |
|---|---|---|---|---|---|---|
| No. of boys : | 5 | 4 | 3 | 2 | 1 | 0 |
| No. of girls : | 0 | 1 | 2 | 3 | 4 | 5 |
| No. of families : | 14 | 56 | 110 | 88 | 40 | 12 |

Is this result consisted with the hypothesis that male and female births are equally probable ?

## * Theory & Formula used :-

Expected Frequency = $f(r)$ = ~~N.p(r)~~ $N \cdot P(r)$

where $P(r)$ = Probability of male birth in a family of 5

$$P(r) = {}^5C_r \, p^r q^{5-r}$$

Our test statistic will be

$$\chi^2 = \Sigma \left[ \frac{(O-e)^2}{e} \right]$$

where O = observed frequency
~~reject~~ e = expected frequency

Instructer's Sign

Reject $H_0$ if $\chi^2 > \chi^2_{0.05,4}$

* Result :-

$11.07 > 7.16$

$\chi^2_{0.05,4} > \chi^2$ $H_0$ can't be rejected

Hence the data are consistent with the hypothesis of equal probability for male & Female births.

* Calculations :-

$H_0$ : Male and Female births are equal.
$H_1$ : Both are not equal.

$$P(r) = \left(\frac{1}{2}\right)^5 \, {}^5C_r$$

Expected frequency of male birth is given by

$$f(r) = N \cdot P(r) = 320 \times \left(\frac{1}{2}\right)^5 \, {}^5C_r$$

$$f(r) = 10 \times {}^5C_r$$

| $o$ | $e$ | $(o-e)^2$ | $\frac{(o-e)^2}{e}$ |
|---|---|---|---|
| 14 | 10 | 16 | 1.6 |
| 56 | 50 | 36 | 0.72 |
| 110 | 100 | 100 | 1.0 |
| 88 | 100 | 144 | 1.44 |
| 40 | 50 | 100 | 2.0 |
| 12 | 10 | 4 | 0.4 |
| | | | Total = 7.16 |

$\chi^2 = 7.16$ , $\chi^2_{0.05,1} = 11.07$

$\chi^2 < \chi^2_{0.05,1}$

$H_0$ can't be rejected

* **Aim :-**

To perform sign test for the given distribution.

* **Experiment :-**

The grade of the result of the students of a college of the mid-term and end-term examination are given below. Then by sign test, test the hypothesis that the performance of the students in both the examination is equal. Use the binomial distribution at 5% significance level.

| Grade M.T. ($x$) | Grade E.T. ($x$) |
|---|---|
| $B^+$ | $C^+$ |
| $A^+$ | $A+$ |
| $B$ | $C+$ |
| $B^+$ | $B$ |
| $A^+$ | $B+$ |
| $C^+$ | $C+$ |
| $D$ | $D+$ |
| $B$ | $B+$ |
| $C+$ | $B$ |
| $A$ | $A$ |

* **Theory & Formula used :-**

**Sign Test** :- It is a statistical method to test for consistent difference between pair of observations such as weight of a person before and after treatment.

The sign test can also test if the median of collection is significantly greater or less than a specified value.

Since we have to use binomial distribution so

$$P(r \le r_0) = \left(\frac{1}{2}\right)^n \sum_{r=0}^{r_0} {}^nC_r$$

if $P(r \le r_0) > \alpha$, Accept $H_0$.

* **Result :-**

$\because P(r \le 3) = 0.5 > 0.05$

$H_0$ is accepted

Hence the performance of students in both exams are equal.

* Calculations :-

$H_0$ : The performance in both exams are equal
$H_1$ : Both are not equal

| ~~Grad~~ Grade M.T. (X) | Grade E.T. (Y) | Y − X |
|---|---|---|
| B + | C + | − |
| A + | A + | 0 |
| B | C + | − |
| B + | B | − |
| A + | B + | − |
| C + | C + | 0 |
| D | D + | + |
| B | B + | + |
| C + | B | + |
| A | A | 0 |

no. of (+) = 3 , no. of (−) = 4 , no. of 0 = 3

$n = 10 - 3 = 7$

$$P(r \leq 3) = \left(\frac{1}{2}\right)^7 \sum_{r=0}^{3} {}^7C_r$$

$$= \frac{64}{128} = 0.5$$

$P(r \leq 3) = 0.5 > 0.05\ (\alpha)$

$H_0$ is accepted.

* **Aim** :-

To perform wilcoxon signed rank test.

* **Experiment** :-

Generally it is claimed that there is more effect of remembering by visual than audio. Use wilcoxon test to test this hypothesis.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Visual (X) | 20 | 17 | 14 | 18 | 15 | 16 | 19 | 16 | 17 | 18 |
| Audio (Y) | 19 | 16 | 15 | 16 | 13 | 16 | 15 | 18 | 14 | 17 |

* **Theory & Formula used** :-

Wilcoxon Signed-rank test :- It is a non-paramatric test used either to test the location of a set of samples or to compare the location of two population using a set at matched samples.

$T^+$ = Total no. of ranks at + diff.
$T^-$ = Total no. of ranks at − diff.

$$\text{Mean} = \frac{n(n+1)}{4}, \quad \text{S.D.} = \sqrt{\frac{n(n+1)(2n+1)}{24}}$$

$$z = \frac{T - \text{mean}}{\text{S.D.}} \qquad \left[ T = \min(T^+, T^-) \right]$$

If $z \leq z_a$, Accept $H_0$

Instructer's Sign

* Result :-

$$-1.66 < -1.645$$

$$Z < Z_{\alpha}$$

$H_0$ is accepted

Hence, There is effect of remembering by visual than audio.

## * Calculations :-

$H_0$ : There is effect of remembering by visual than audio.

$H_1$ : No effect.

| Visual (X) | Audio (Y) | d = X − Y | Rank |
|---|---|---|---|
| 20 | 19 | 1 | 2.5 |
| 17 | 16 | 1 | 2.5 |
| 14 | 15 | -1 | 2.5 |
| 18 | 16 | 2 | 6 |
| 15 | 13 | 2 | 6 |
| 16 | 16 | 0 | 0 |
| 19 | 15 | 4 | 9 |
| 16 | 18 | -2 | 6 |
| 17 | 14 | 3 | 8 |
| 18 | 17 | 1 | 2.5 |

Revised n = higher Rank = 10 − 1 = 9

$$\text{Tie } 1 = \frac{1+2+3+4}{4} = 2.5$$

$$\text{Tie } 2 = \frac{5+6+7}{3} = 6$$

$T^+ = 36.5, \quad T^- = 8.5$

$$T = \{\min(T^+, T^-)\} = 8.5$$

$$\text{Mean} = \frac{90}{4} = 22.5$$

$$\text{S.D.} = \sqrt{\frac{9 \times 10 \times 19}{24}} = 8.44$$

Now $$Z = \frac{8.5 - 22.5}{8.44} = -1.66$$

$$Z_{0.05} = 1.645$$

* **Aim :-**

To test given hypothesis using sign test. (For Median)

* **Experiment :-**

A random sample of size 8 taken from the population is given below :

19, 18, 11, 9, 13, 15, 17, 13

Test the hypothesis that the population ~~mean~~ median is 12 using sign test. ( $Z\alpha = 1.96$ )

* **Theory & Formula used :-**

Sign Test :- It's a statistical test to check the consistent difference ~~bet~~ between pairs of observations.
The sign test can also test if the Median of collection is greater than or less than specified value.

$d = x - M$ ; $d = (+, -)$

$z = \frac{r - Mean}{S.D.}$ , $Mean = n/2$ , $S.D. = \sqrt{\frac{n}{4}} = \frac{\sqrt{n}}{2}$

* **Result :-**

$0.76 < 1.96$

$z < 1.96$ , $H_0$ is accepted

Hence, Population Median = 12

Instructer's Sign

* Calculations :-

$H_0 : M = 12$ $M_0 = 12$

$H_1 : M \neq 12$

| X | d = sign(X − $M_0$) |
|---|---|
| 19 | + |
| 18 | + |
| 11 | − |
| 9 | − |
| 13 | + |
| 12 | 0 |
| 17 | + |
| 13 | + |

(+) sign = 5, (−) sign = 2, $r = 2$

Revised $n = 8 - 1 = 7$, Mean = 3.5, S.D. = 1.32

$\because r <$ Mean

$r' = r + 0.5 = 2.5$

$$Z = \frac{2.5 - 3.5}{1.32} = -0.76$$

$Z = -0.76$

$Z_\alpha = 1.96$

* **Aim** :-

To perform sign test for median.

* **Experiment** :-

To test the claim that median of mathematics faculty in state community college at least 42 year, the result from a random sample of 32 mathematics facility give the following are in years

56, 62, 61, 54, 52, 32, 24, 35, 50, 42, 52, 49, 26, 31, 31, 54, 38, 36, 45, 53, 37, 40, 38, 31, 29, 25, 45, 32, 49, 39, 36, 38

Use the sign test at least 5% level of significance to test the claim by critical value method.

* **Theory & Formula used** :-

**Sign Test** :- It's a statistical method to test the consistent differences between pair of observations.

$d = x - M$ , $d = (+, -)$

$Z = \frac{r - \text{Mean}}{S.D.}$ , $\text{Mean} = \frac{n}{2}$ , $S.D. = \frac{\sqrt{n}}{2}$

* **Result** :-

$-0.7184 < -1.96$ so $Z < Z_{\alpha/2}$

Hence, Median of mathematics faculty is atleast 42.

Instructer's Sign

* **Calculations :-**

$H_0 : M \geq 42$ $\alpha = 0.05$

$H_1 : M < 42$ $Z_{0.025} = -1.96$

$T = \min(T^+, T^-) = 13$

$n = 32 - 1 = 31,$ $\text{Mean} = \frac{31}{2} = 15.5$

$\because$ $T < \text{Mean}$

$T = 13 + 0.5 = 13.5$

Now $Z = \dfrac{13.5 - 15.5}{\frac{\sqrt{31}}{2}} = -0.7184$

$\because$ $Z < Z_{\alpha/2}$

$H_0$ is accepted