## Calculation

From the given problem, $n = 400$, $x = 216$, $p_0 = q_0 = \frac{1}{2}$

Let us setup the hypothesis that the coin is unbiased. Also let $p$ be prob. of getting head then acc. to the assumption, the hypothesis are

$H_0: p = p_0 = \frac{1}{2}$ v/s $H_1: p \neq p_0 (\frac{1}{2})$

Now to test $H_0$, we use test statistic

$$Z = \frac{216 - 400 \times \frac{1}{2}}{\sqrt{400 \times \frac{1}{2} \times \frac{1}{2}}} = 1.6$$

$Z_{cal} = 1.6$

So, at 5% LOS the $Z_{tab}$ is taken from table, $Z_{tab} = 1.96$

Here, $Z_{cal} (1.6) < Z_{tab} (1.96)$, So we accept $H_0$ means that the coin is unbiased

24/09/2025

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## PRACTICAL - 1

**Aim:** Testing of hypothesis in large sample test

**Problem:** A coin tossed for 400 times and the head turned up 216 times. Test the hypothesis that the coin is unbiased.

**Theory & formula:** To test the hypothesis that the coin is unbiased and let 'p' be the prob. of getting head so we have the hypothesis-

$H_0: p = p_0 = \frac{1}{2}$ v/s $H_1: p \neq p_0 (\frac{1}{2})$

In this case, to test $H_0$, we use test statistic

$$Z = \frac{x - np_0}{\sqrt{np_0 q_0}} \sim N(0, 1)$$

this is the calculated value of $Z$ if $Z_{cal} < Z_{tab}$ then we accept $H_0$, otherwise we reject $H_0$.

**Result:** Here, $Z_{cal} (1.6) < Z_{tab} (1.96)$, So we accept $H_0$, means that the coin is unbiased.

## Calculation

From the given problem, $x = 3240$, $n = 9000$, $p = \frac{1}{3}$

Now, test statistic

$$Z = \frac{3240 - 9000\left(\frac{1}{3}\right)}{\sqrt{9000 \times \frac{1}{3} \times \frac{2}{3}}} = \frac{240}{\sqrt{2000}} = \frac{240}{44.73}$$

$$Z_{cal} = 5.36$$

Since $|Z| > 3$, $H_0$ is rejected means the die can't be regarded as unbiased.

To get probable limit we have,

$$\hat{p} \pm 3\sqrt{\frac{\hat{p}\hat{q}}{n}}, \quad \text{Here } \hat{p} = \frac{x}{n} = \frac{3240}{9000} = 0.36$$

$$\hat{q} = 1 - 0.36 = 0.64$$

The probable limit for popl^n proportion of success may be taken as

$$\hat{P} \pm 3\sqrt{\frac{\hat{P}\hat{Q}}{n}} = \hat{p} \pm 3\sqrt{\frac{\hat{p}\hat{q}}{n}}$$

$$0.36 \pm 3\sqrt{\frac{0.36 \times 0.64}{9000}} = 0.36 \pm 3 \times \frac{0.6 \times 0.8}{30\sqrt{10}}$$

$$= 0.36 \pm 0.015$$

Hence, the prob of getting 3 or 4 almost certainly lies b/w 0.345 & 0.375

24/09/2025

2

## PRACTICAL - 2

**Aim:** Testing of hypothesis in large sample test

**Problem:** A die is thrown 9000 times and a throw of 3 or 4 is observed 3240 times, show that the die can't be regarded as an unbiased one and find the limits b/w which the prob. of a throw of 3 or 4 lies.

**Theory & formula:** Here, we want to test that die is not biased one. Also let '$p$' is the prob of getting 3 or 4. So, first we set up the hypothesis

$$H_0: p = p_0 = \frac{1}{3} \quad v/s \quad H_1: p \neq p_0\left(\frac{1}{3}\right)$$

To test $H_0$, the test statistic is given by

$$Z = \frac{x - np_0}{\sqrt{np_0q_0}} \sim N(0,1)$$

If the $Z_{cal}$ is less than $Z_{tab}$, then we accept $H_0$, otherwise, we reject $H_0$.

Now to get the probable limit we have,

$$\left[\hat{p} \pm 3\sqrt{\frac{\hat{p}\hat{q}}{n}}\right]$$

Result: Since, $|Z| > 3$ so we reject $H_0$ means that the die is biased.

And the probable limit are (0.345 and 0.375)

05/10/20

## Calculation

The sample proportion from town A

$$\hat{p}_1 = \frac{400}{1000} = 0.4$$

And sample proportion from town B

$$\hat{p}_2 = \frac{400}{800} = 0.5$$

Common proportion $\hat{p}$ is given by

$$\hat{p} = \frac{400+400}{1000+800} = \frac{800}{1800} = \frac{4}{9} = 0.44$$

$$\hat{q} = 1 - 0.44 = 0.56$$

Now to test $H_0$, we use test statistic

$$Z = \frac{0.4 - 0.5}{\sqrt{0.44 \times 0.56 \left[\frac{1}{1000} + \frac{1}{800}\right]}} = \frac{-0.1}{0.0235}$$

$$Z_{cal} = -4.255 \Rightarrow |Z| = 4.255$$

Now from table, $Z_{tab}$ at 5% L.O.S is given by

$$Z_{tab} = 1.96$$

So, in this case, $|Z| > 1.96$ so we reject $H_0$ means that the consumers of wheat in town A & B are not same.



# PRACTICAL - 3

**Aim:** Testing the hypothesis in large sample test

**Problem:** In a random sample of 1000 people from town A, 400 are found to be consumers of wheat. In a sample of 800 from town B, 400 are found to be consumers of wheat. Does this data reveal a significant diff. b/w town A & B?

**Theory & Formula:** Let us set up the hypothesis that the proportion of wheat consumers in two town, say $P_1$ & $P_2$ are same. $H_0 : p_1 = p_2$ v/s $H_1 : p_1 \neq p_2$

First, we have calculated sample proportion of wheat consumers in town A is $\hat{p}_1 = \frac{x_1}{n_1}$, similarly $\hat{p}_2 = \frac{x_2}{n_2}$

Now, common proportion of wheat consumers is given by

$$\hat{p} = \frac{x_1 + x_2}{n_1 + n_2} \quad \text{and} \quad \hat{q} = 1 - \frac{x_1 + x_2}{n_1 + n_2}$$

Now to test $H_0$, we use test statistic

06/10/25

$$Z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}\hat{q}\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}}$$

If the value of Z-statistic is less than tabulated value of Z at 5% L.O.S then we accept $H_0$. Otherwise, we reject $H_0$.

**Result:** We have $|Z_{cal}| = 4.255$ & $Z_{tab} = 1.96$ thus $|Z| > 1.96$, so we reject $H_0$ means that data does not reveal that consumption of wheat in town A & B are same.

## Calculation

First of all, we calculate sample mean & S.D from the following data.

| C.I | f | x=M | fM | fM² |
|---|---|---|---|---|
| 15.5 - 20.5 | 12 | 18 | 216 | 3888 |
| 20.5 - 25.5 | 22 | 23 | 506 | 11638 |
| 25.5 - 30.5 | 20 | 28 | 560 | 15680 |
| 30.5 - 35.5 | 30 | 33 | 990 | 32670 |
| 35.5 - 40.5 | 16 | 38 | 608 | 23104 |
| | | | 2880 | 86980 |

$\bar{x} = \frac{2880}{100} = 28.8$ years, $s = \sqrt{\frac{1}{N}\Sigma f x_i^2}$ or $\sqrt{\frac{1}{N}\Sigma f_i (x_i - \bar{x})^2}$

$= 6.35$ years

Since, the sample is large, $\hat{\sigma} \simeq s = 6.35$ years

now to test Ho,

$$z = \frac{28.8 - 30.5}{6.35/\sqrt{100}} = z = -2.681$$

$|z| = 2.681$

Since the $|z_{cal}| = 2.681 >$ the critical value of z at 5% LOS. So, we reject the hypothesis means the insurance agent is correct.

24/09/2025

# PRACTICAL - 4



**Aim:** Testing the hypothesis in large sample test

**Problem:** An insurance agent has claimed that avg. age of policy holder who insured through him is less than the avg. from all agent which is 30.5 years. A random sample of 100 policy holder who had insured through him gave the following age distⁿ

| age limit | no. of person |
|---|---|
| 16 - 20 | 12 |
| 21 - 25 | 22 |
| 26 - 30 | 20 |
| 31 - 35 | 30 |
| 36 - 40 | 16 |

Calculate mean & ~~S.D~~ S.D of this distⁿ and use these value to test his claim at 5% LOS.

**Theory & formula:** First of all, we calculate mean & S.D from the given distⁿ then we set up the hypothesis i.e. $H_0: \mu = 30.5$ years v/s $H_1: \mu < 30.5$ years.

Now to test Ho, we apply the test statistic

$$z = \frac{\bar{x} - \mu}{s/\sqrt{n}} \sim N(0,1)$$

where $\bar{x}$ = sample mean

$s$ = sample S.D

If the calculated value of $Z$ is less than tabulated value of $Z$ at 5% LOS then we accept $H_0$. Otherwise, we reject $H_0$.

**Result:** Since, the $|Z_{cal}| = 2.681 >$ the critical value of $Z$ i.e. $Z > 1.645$ at 5% LOS. So we reject the hypothesis means insurance agent claim is correct.

08/10/25

## Calculation

The usual notations, we are given that $n_1 = 1000$, $\bar{x}_1 = 67.5''$
$n_2 = 2000$, $\bar{x}_2 = 68''$

From the hypothesis, we are given S.D $= 2.5''$

Then under $H_0$, we have

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{\sigma\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$Z = \frac{67.5 - 68}{2.5\sqrt{\frac{1}{1000} + \frac{1}{2000}}} = \frac{-0.5}{0.0968}$$

$$Z = -5.16$$

$$|Z| = 5.16$$

This is calculated value of Z

Thus, we have

$|Z| > 3$, so we reject $H_0$ means that the samples are certainly not from the same popl$^n$ with S.D. $2.5''$.

| | PRACTICAL - 5 | 8/10/25 <br> 7 |
|---|---|---|

**Aim:** To test the hypothesis in large sample test

**Problem:** The mean of 2 single large samples of 1000 & 2000 members are $67.5''$ and $68''$ respectively.
Can samples be regarded as drawn from the same popl$^n$ of S.D $2.5''$ at 5% LOS

**Theory & formula:** First we set up the null hypothesis

$H_0: \mu_1 = \mu_2$ and $\sigma = 2.5$

$H_1: \mu_1 \neq \mu_2$

Here, to test $H_0$, we use the test statistic

$$Z = \frac{\bar{x}_1 - \bar{x}_2}{\sigma\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim N(0,1)$$

Here if $|Z| \leq 3$ then we accept $H_0$. Otherwise, we reject $H_0$.

**Result:** $|Z|$ calculated $= 5.16$

$Z$ tabulated $= 3$

Thus, $|Z| > 3$, so we reject $H_0$ means that the samples are certainly not from the same popl$^n$ with S.D. $2.5''$.

## Calculations

As shown in excel:

PRACTICAL - 6

28/10/25

8

**Aim:** To test the goodness of fit

**Problem:** The demand for a particular spare part in a factory was found to vary day to day. In a sample study, the following information was obtained

| Days: | M | T | W | Th | F | Sat |
|---|---|---|---|---|---|---|
| Demand: | 1124 | 1125 | 1110 | 1120 | 1126 | 1115 |

Test the hypothesis that the no. of parts demanded does not depend on the day of week [Given the $\chi^2$ at 5 d.o.f. at 5% LOS is 11.07]

**Theory & formula:** First of all we set up the hypothesis

$H_0$: the no. of parts demanded does not depend on the day of the week

$H_1$: the no. of parts demand does depend on the day of the week

Now in the given case, we are have the observed frequencies

To have the expected frequencies, we have

$$\text{Expected freq. } (e_i) = \frac{\sum O_i}{n}$$

Now here we apply the test statistic

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - e_i)^2}{e_i}$$

This value is known as calculated value of $\chi^2$ i.e. $\chi^2_{cal}$

Thus, if $\chi^2_{cal} \leq \chi^2_{tab}$ then we accept $H_0$.

otherwise we reject $H_0$.

<u>Result</u>: Here, $\chi^2(cal) < \chi^2(tab)$ so we accept $H_0$ means that the no. of parts demanded does not depend on the day of the week.

## Calculation

We are given that, $\mu = 0.700$ inches, $\bar{x} = 0.742$ inches

$s = 0.040$ inches and $n = 10$

Test statistic, under $H_0$:

$$t = \frac{\sqrt{9}\,(0.742 - 0.700)}{0.040} = 3.15$$

$$t_{cal} = 3.15$$

Now tabulated value for $(10-1) = 9$ d.o.f. & at 5% LOS is 2.26

So Here, $t_{(9, 0.05)} = 2.26$

Thus, we have $t_{cal}\,(3.15) > t_{tab}\,(2.26)$. So, we reject $H_0$ means that the product is not confirming to specifications.

PRACTICAL - 10 12/11/2025

**Aim:** To test the application based on t - test

**Problem:** A machinist is making engine parts with axle diameters of 0.7 inch. A random sample of 10 parts shows a mean diameter of 0.742 inch with a St. deviation of 0.040 inch. Compute the statistic you would use to test whether the work is meeting the specification. Also state how you would proceed further.

**Theory & formula:** First of all, we set up the hypothesis

Null hypothesis ($H_0$): the product is confirming to specifications ($\mu = 0.7$)

means $H_0: \mu = 0.700$

Alternate: product is not confirming the specifications

$H_1: \mu \neq 0.700$

Now to test the hypothesis, we use the test statistic

$$t = \frac{\bar{x} - \mu}{\sqrt{S^2/n}} = \frac{\bar{x} - \mu}{\sqrt{s^2/(n-1)}} \sim t_{(n-1)}$$

This is the value of $t_{calculated}$

if $t_{cal} < t_{tabulated}$ then we accept $H_0$

if $t_{cal} > t_{tabulated}$ then we reject $H_0$

$t_{tabulated}$ can be taken from table at 5% LOS at $(n-1)$ d.o.f.

**Result:** Here, $t_{cal}\,(3.15) > t_{tab}\,(2.26)$. So, we reject $H_0$ means that the product is not confirming to specifications

PRACTICAL-11 12/11/2025

**Aim:** To test application based on t-distribution

**Problem:** A random sample of 10 boys had the following I.Q's: 70, 120, 110, 101, 88, 83, 95, 98, 107, 100. Do these data support the assumption of a popl$^n$ mean I.Q of 100? ~~Find the reasonable range in which most of the mean I.Q values of samples of 10 boys lie.~~

**Theory & Formula:** First of all we set up Null hypothesis

$H_0$: The data are consistent with assumption of mean I.Q of 100 in popl$^n$ i.e, $\mu = 100$

$H_1$: $\mu \neq 100$

Now to test hypothesis, we use test Statistic

$$t = \frac{\bar{x} - \mu}{\sqrt{s^2/n}} \sim t_{(n-1)}$$

This is value of $t_{cal}$

if $t_{cal} < t_{tab}$ then we accept $H_0$, otherwise we reject $H_0$.

$t_{tab}$ can be taken from table at 5% l.o.s at (n-1) d.o.f

**Result:** Here, $t_{cal}(0.62) < t_{tab}(2.26)$. So, we accept $H_0$ means that the data are consistent with assumption of mean I.Q of 100 in popl$^n$

## Calculation

we find $\bar{x}$, $s^2$

| $X$ | $X - \bar{x}$ | $(X - \bar{x})^2$ |
|---|---|---|
| 70 | -27.2 | 739.84 |
| 120 | 22.8 | 519.84 |
| 110 | 12.8 | 163.84 |
| 101 | 3.8 | 14.44 |
| 88 | -9.2 | 84.64 |
| 83 | -14.2 | 201.64 |
| 95 | -2.2 | 4.84 |
| 98 | 0.8 | 0.64 |
| 107 | 9.8 | 96.04 |
| 100 | 2.8 | 7.84 |
| 972 | | 1833.6 |

Here $n = 10$, $\bar{x} = \frac{972}{10} = 97.2$, $s^2 = \frac{1833.6}{9} = 203.73$

$$|t| = \frac{|97.2 - 100|}{\sqrt{203.73/10}} = \frac{2.8}{4.514} = 0.62$$

$t_{tab}$ is 2.26

& $t_{cal}$ is 0.62

Thus, we have $t_{cal}(0.62) < t_{tab}(2.26)$. So we accept $H_0$ means that the data are consistent with assumption of mean I.Q of 100 in popl$^n$

## Calculation

we find Sample mean & S.D.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $x$ | 70 | 67 | 62 | 68 | 61 | 68 | 70 | 64 | 64 | 66 | Total - 660 |
| $x-\bar{x}$ | 4 | 1 | -4 | 2 | -5 | 2 | 4 | -2 | -2 | 0 | 0 |
| $(x-\bar{x})^2$ | 16 | 1 | 16 | 4 | 25 | 4 | 16 | 4 | 4 | 0 | 90 |

$$\bar{x} = \frac{\Sigma x}{n} = \frac{660}{10} = 66$$

$$S^2 = \frac{1}{n-1} \Sigma (x-\bar{x})^2 = \frac{90}{9} = 10$$

Test statistic under $H_0$ is

$$t = \frac{66-64}{\sqrt{10/10}} = 2$$

which follows $(10-1) = 9$ d.o.f.

Since, $t_{cal}(2) > t_{tab}(1.83)$. We reject $H_0$ means that the avg. height is greater than 64 inches

PRACTICAL-12 12/11/2025

**Aim:** To test application based on t-distribution

**Problem:** The heights of 10 males of a given locality are found to be 70, 67, 62, 68, 61, 68, 70, 64, 64, 66 inches. Is it reasonable to believe that the avg. height is greater than 64 inches? Test at 5% LOS assuming that for 9 d.o.f. $P(t > 1.83) = 0.05$.

**Theory & Formula:** First of all we set up Null hypothesis

$H_0: \mu = 64$ inches, $H_1: \mu > 64$ inches

Now to test hypothesis, we use test statistic

$$t = \frac{\bar{x} - \mu}{\sqrt{S^2/n}} \sim t_{(n-1)}$$

This is $t_{cal}$.

if $t_{cal} < t_{tab}$ then we accept $H_0$. Otherwise, we reject $H_0$.

at 9 d.o.f. $t_{tab}$ for right tail test at 5% LOS is 1.83

**Result:** Here, $t_{cal}(2) > t_{tab}(1.83)$. So, we reject $H_0$ means that the avg. height is greater 64 inches.

# Calculation

Diet A

| $X$ | $X-\bar{X}$ | $(X-\bar{X})^2$ |
|---|---|---|
| 25 | -3 | 9 |
| 32 | 4 | 16 |
| 30 | 2 | 4 |
| 34 | 6 | 36 |
| 24 | -4 | 16 |
| 14 | -14 | 196 |
| 32 | 4 | 16 |
| 24 | -4 | 16 |
| 30 | 2 | 4 |
| 31 | 3 | 9 |
| 35 | 7 | 49 |
| 25 | -3 | 9 |
| Total - 336 | 0 | 350 |

Diet B

| $Y$ | $Y-\bar{Y}$ | $(Y-\bar{Y})^2$ |
|---|---|---|
| 44 | 14 | 196 |
| 34 | 4 | 16 |
| 22 | -8 | 64 |
| 10 | -20 | 400 |
| 47 | 17 | 289 |
| 31 | 1 | 1 |
| 40 | 10 | 100 |
| 30 | 0 | 0 |
| 32 | 2 | 4 |
| 35 | 5 | 25 |
| 18 | -12 | 144 |
| 21 | -9 | 81 |
| 35 | 5 | 25 |
| 29 | -1 | 1 |
| 22 | -8 | 64 |
| Total - 450 | 0 | 1410 |

Here $n_1 = 12$, $n_2 = 15$, $\bar{X} = \frac{336}{12} = 28$, $\bar{Y} = \frac{450}{15} = 30$

$\Sigma(x-\bar{x})^2 = 350$ ; $\Sigma(y-\bar{y})^2 = 1410$

$$s^2 = \frac{1}{n_1+n_2-2}\left[\Sigma(x-\bar{x})^2 + \Sigma(y-\bar{y})^2\right] = 71.6$$

$$t = \frac{28-30}{\sqrt{71.6\left(\frac{1}{12}+\frac{1}{15}\right)}} = -0.609$$

$t_{tab}$ from table at $(12+15-2)$ d.o.f $= 25$ i.e. $2.06$

Since, $t_{cal}(-0.609) < t_{tab}(2.06)$, so we accept $H_0$

means that there is no significant difference b/w the mean increment in weight



PRACTICAL - 13 20/11/25

**Aim:** To test the difference b/w mean

**Problem:** Below are given the gain in weights (in lbs) of pigs fed on two diets A and B.

Gain in weight

Diet A : 25, 32, 30, 34, 24, 14, 32, 24, 30, 31, 35, 25
Diet B : 44, 34, 22, 10, 47, 31, 40, 30, 32, 35, 18, 21, 35, 29, 22.

Test, if the two diets differ significantly as regards their effect on increase in weight.

**Theory & Formula:** First of all, we set up the hypothesis (null)

$H_0$: There is no significant difference b/w the mean increase in weight i.e. $\mu_x = \mu_y$

$H_1$: $\mu_x \neq \mu_y$

To test the $H_0$, we use test statistic

$$t = \frac{\bar{x}-\bar{y}}{\sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \sim t_{(n_1+n_2-2)}$$

This is calculated value of $t$

tabulated value of $t$ is taken from table at $(n_1+n_2-2)$ d.o.f

if $t_{cal} < t_{tab}$, we accept $H_0$. Otherwise, if $t_{cal} > t_{tab}$, we reject $H_0$.

**Result:** Here, $t_{cal}(-0.609) < t_{tab}(2.06)$. So we accept $H_0$ means that there is no significant difference b/w the mean increment in weight i.e. $\mu_x = \mu_y$

| | PRACTICAL-14 | 2/1/25 |
|---|---|---|

**Aim**: To test the difference b/w mean

**Problem**: Samples of two types of electric light bulbs were tested for length of life and following data were obtained:

| | Type 1 | Type 2 |
|---|---|---|
| Sample No. | $n_1 = 8$ | $n_2 = 7$ |
| Sample Means | $\bar{x}_1 = 1234$ hrs | $\bar{x}_2 = 1036$ hrs |
| Sample S.D.'s | $s_1 = 36$ hrs | $s_2 = 40$ hrs |

Is the difference in the means sufficient to warrant that type 1 is superior to type 2 regarding length of life?

**Theory & Formula**: First of all, we set up the Hypothesis

$H_0$: The two types 1 and 2 of electric bulbs are identical i.e. $\mu_x = \mu_y$

$H_1$: $\mu_x > \mu_y$

To test the $H_0$, we use test statistic

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{S^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t_{(n_1+n_2-2)}$$

This is t calculated

Value of t tabulated from table at $(n_1+n_2-2)$ d.o.f.

If $t_{cal} < t_{tab}$, we accept $H_0$. Otherwise, if $t_{cal} > t_{tab}$, we reject $H_0$.

**Result**: Here, $t_{cal}(9.39) > t_{tab}(1.77)$. So, we reject $H_0$ means that type 1 is superior to type 2.

## Calculation

Given, $n_1 = 8$, $\bar{x}_1 = 1234$, $s_1 = 36$, $n_2 = 7$, $\bar{x}_2 = 1036$, $s_2 = 40$

$$S^2 = \frac{1}{n_1+n_2-2}\left[\Sigma(x_1-\bar{x}_1)^2 + \Sigma(x_2-\bar{x}_2)^2\right]$$

$$= \frac{1}{n_1+n_2-2}\left[n_1 s_1^2 + n_2 s_2^2\right]$$

$$= \frac{1}{13}\left[8\times(36)^2 + 7\times(40)^2\right] = 1659.08$$

$$t = \frac{1234 - 1036}{\sqrt{1659.08\left(\frac{1}{8}+\frac{1}{7}\right)}} = 9.39$$

Value of $t_{tab}$ at $(8+7-2)$ d.o.f. is 1.77 (for right tailed test)

Since, $t_{cal}(9.39) > t_{tab}(1.77)$. So, we reject $H_0$ means that type 1 is superior to type 2.

## Calculation

| | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $d$ | 5 | 2 | 8 | -1 | 3 | 0 | -2 | 1 | 5 | 0 | 4 | 6 | 31 |
| $d^2$ | 25 | 4 | 64 | 1 | 9 | 0 | 4 | 1 | 25 | 0 | 16 | 36 | 185 |

$$S^2 = \frac{1}{n-1}\sum(d-\bar{d})^2 = \frac{1}{n-1}\left[\sum d^2 - \frac{(\sum d)^2}{n}\right]$$

$$= \frac{1}{11}\left[185 - \frac{(31)^2}{12}\right] = \frac{1}{11}(185 - 80.08) = 9.5382$$

$$\bar{d} = \frac{31}{12} = 2.58$$

$$t = \frac{2.58 \times \sqrt{12}}{\sqrt{9.5382}} = \frac{2.58 \times 3.464}{3.09} = 2.89$$

$t_{tab}$ taken from table at $(12-1)$ d.o.f. is 1.8

Since, $t_{cal}(2.89) > t_{tab}(1.8)$, so, we reject $H_0$ means that the stimulus, in general, be accompanied by an increase in blood pressure

| | | 15 |
|---|---|---|
| | PRACTICAL - 15 | 20/11/25 |

**Aim:** Application based on paired t-test

**Problem:** A certain stimulus administered to each of the 12 patients resulted in following increase of blood pressure:

5, 2, 8, -1, 3, 0, -2, 1, 5, 0, 4, 6

Can it be concluded that the stimulus will in general be accompanied by an increase in blood pressure?

**Theory & Formula:** First of all, we set up the hypothesis

$H_0$: there is no significant difference in the blood pressure readings of the patients before & after the drug i.e. $(\mu_x = \mu_y)$

$H_1$: $\mu_x < \mu_y$

To test $H_0$, we use test statistic

$$t = \frac{\bar{d}}{S/\sqrt{n}} \sim t_{(n-1)}$$

This is $t_{calculated}$

Value of $t_{tabulated}$ can be taken from table at $(n-1)$ d.o.f.

If $t_{cal} < t_{tab}$, we accept $H_0$. Otherwise if $t_{cal} > t_{tab}$, we reject $H_0$.

**Result:** Here, $t_{cal}(2.89) > t_{tab}(1.8)$. So, we reject $H_0$ means that the stimulus, in general, be accompanied by an increase in blood pressure.

## Calculation

As shown in excel:

| digits | observed | expected fre | (Oi-Ei) | $(Oi-Ei)^2$ | $\chi^2$ $(Oi-Ei)^2/Ei$ |
|---|---|---|---|---|---|
| 0 | 1026 | 1000 | 26 | 676 | 0.676 |
| 1 | 1107 | 1000 | 107 | 11449 | 11.449 |
| 2 | 997 | 1000 | -3 | 9 | 0.009 |
| 3 | 966 | 1000 | -34 | 1156 | 1.156 |
| 4 | 1075 | 1000 | 75 | 5625 | 5.625 |
| 5 | 933 | 1000 | -67 | 4489 | 4.489 |
| 6 | 1107 | 1000 | 107 | 11449 | 11.449 |
| 7 | 972 | 1000 | -28 | 784 | 0.784 |
| 8 | 964 | 1000 | -36 | 1296 | 1.296 |
| 9 | 853 | 1000 | -147 | 21609 | 21.609 |
| TOTAL | 10000 | 10000 | | | 58.542 |

| | | |
|---|---|---|
| χ2(cal) | 58.542 | |
| χ2(tab) | 16.919 | |
| | | |
| χ2(cal)>χ2(tab), so we reject Ho | | |



## PRACTICAL - 7

2/1/25

**Aim:** To test goodness of fit

**Problem:** The following figures show the distribution of digits in no. chosen at random from a telephone directory:

| Digits: | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency: | 1026 | 1107 | 997 | 966 | 1075 | 933 | 1107 | 972 | 964 | 853 | 10,000 |

Test whether the digits may be taken to occur equally frequently in directory.

**Theory & Formula:** First of all, we set up the hypothesis

$H_0$: the digits taken occur equally frequently in directory

$H_1$: the digits taken does not occur equally frequently in directory

Now in given case, we have the observed freq.

To find expected freq., we have

Expected freq. $(E_i) = \frac{\Sigma O_i}{n}$

Now, we apply test statistic

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

This is $\chi^2_{cal}$.

Thus, if $\chi^2_{cal} \le \chi^2_{tab}$ then we accept $H_0$. Otherwise we reject $H_0$.

**Result:** Here, $\chi^2(cal) > \chi^2(tab)$. So we reject $H_0$ means that the digits taken does not occur equally frequently in directory

## Calculation

As shown in excel:

| days | observed | expected fre | OI-EI | (OI-EI)² | $\chi^2$ (OI-EI)²/EI |
|---|---|---|---|---|---|
| sun | 14 | 12 | 2 | 4 | 0.333333333 |
| mon | 16 | 12 | 4 | 16 | 1.333333333 |
| tues | 8 | 12 | -4 | 16 | 1.333333333 |
| wed | 12 | 12 | 0 | 0 | 0 |
| thurs | 11 | 12 | -1 | 1 | 0.083333333 |
| fri | 9 | 12 | -3 | 9 | 0.75 |
| sat | 14 | 12 | 2 | 4 | 0.333333333 |
| TOTAL | 84 | | | | 4.166666667 |

| | | |
|---|---|---|
| χ2(cal) | 4.166666667 | |
| χ2(tab) | 12.59 | |
| | | |
| χ2(cal)<χ2(tab), so we accept Ho | | |



## PRACTICAL - 8

20/11/25

**Aim:** To test goodness of fit

**Problem:** The following table gives the no. of air craft accidents that occurs during the various days of the week. Find whether the accidents are uniformly distributed over the week.

| Days | Sun | Mon | Tue | Thurs | Fri | Sat | Wed |
|---|---|---|---|---|---|---|---|
| no. of accidents | 14 | 16 | 8 | 11 | 9 | 14 | 12 |

(Given: value of chi-square significant at 5, 6, 7, d.f. are respectively 11.07, 12.59, 14.07 at 5% LOS)

**Theory & Formula:** First of all, we set up the hypothesis

$H_0$: the accidents are uniformly distributed over week

$H_1$: the accidents are not uniformly distributed over week

To test $H_0$, we use test statistic

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E}$$

Then by $\chi^2_{cal}$

For expected freq. = $e_i = \frac{\sum O_i}{n}$

If $\chi^2_{cal} < \chi^2_{tab}$ then we accept $H_0$. Otherwise we reject $H_0$.

**Result:** Here, $\chi^2_{cal} < \chi^2_{tab}$. So we accept $H_0$ means that the accidents are uniformly distributed over week

PRACTICAL - 9 20/11/25

**Aim:** To test goodness of fit

**Problem:** A survey of 320 families with 5 children each result following:

| | | | | | | |
|---|---|---|---|---|---|---|
| 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 consistent with hypothesis that male & female births are equally probable?

**Theory & Formula:** First of all, we set up the hypothesis

$H_0$: The result is consistent with hypothesis that male & female births are equally probable

$H_1$: The result is not consistent

To test $H_0$, we use test statistic

$$\chi^2 = \sum\frac{(O_i - E_i)^2}{E_i}, \text{ this is } \chi^2_{cal}$$

For expected freq. $(E_i)$ = $10 \times {}^5C_x$, $x = 0,1,2,3,4$

or $320 *$ BINOM.DIST (x, 5, 0.5, FALSE)

x = no. of boys

if $\chi^2_{cal} \le \chi^2_{tab}$ then we accept $H_0$ otherwise we reject $H_0$.

**Result:** Here, $\chi^2_{cal} \le \chi^2_{tab}$ so we accept $H_0$ means that the result is consistent with hypothesis that male & female births are equally probable.

## Calculation

$p$ = prob. of male birth $= \frac{1}{2} = q$

$p(x)$ = prob. of '$x$' male births in family of 5

$= {}^5C_x\, p^x q^{5-x} = {}^5C_x \left(\frac{1}{2}\right)\left(\frac{1}{2}\right)^5$

The freq. of $x$ male births is given by:

$f(x) = N \cdot p(x) = 320 \times {}^5C_x \times \left(\frac{1}{2}\right)^5$

$= 10 \times {}^5C_x$

now for $x = 0,1,2,3 \Rightarrow$ we get expected freq.

further, as shown in excel:

| boys | observed | expected fre | Oi-Ei | (Oi-Ei)$^2$ | (Oi-Ei)$^2$/Ei |
|---|---|---|---|---|---|
| 5 | 14 | 10 | 4 | 16 | 1.6 |
| 4 | 56 | 50 | 6 | 36 | 0.72 |
| 3 | 110 | 100 | 10 | 100 | 1 |
| 2 | 88 | 100 | -12 | 144 | 1.44 |
| 1 | 40 | 50 | -10 | 100 | 2 |
| 0 | 12 | 10 | 2 | 4 | 0.4 |
| TOTAL | | | | | 7.16 |

| | | |
|---|---|---|
| χ2(cal) | 7.16 | |
| χ2(tab) | 11.07 | |
| | | |
| χ2(cal)<χ2(tab), so we accept Ho | | |