ASSIGNMENT : 04

Course : Computational Statistics And Probability

Submitted By,

Group A

Section : K

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Q.2 let, $x_1 \sim N(\mu_1, \sigma_1^2)$, $x_2 \sim N(\mu_2, \sigma_2^2)$
Also, let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0: \mu_1 - \mu_2$ vs $H_1: \mu_1 \neq \mu_2$
Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is not known

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

$\bar{x}_1 = \frac{1}{n_1} \Sigma x_1 = \frac{114}{7} = 16.29$; $s_1^2 = \frac{1}{n_1 - 1}\left[\Sigma x_1^2 - \frac{(\Sigma x_1)^2}{n_1}\right]$
$= \frac{1}{6}\left(1898 - \frac{114^2}{7}\right)$
$= 6.905$

$\bar{x} = \frac{1}{n_2} \Sigma x_2 = \frac{163}{11} = 14.82$; $s_2^2 = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.364$

$t = \dfrac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$

$s^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \dfrac{6(6.905)+10(15.364)}{16}$
$= 12.192$

Since $|t| < t_{16} = 2.12$, H_0 is accepted. Employment facility for both university is same

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9.4 We need to test $H_0: P = P_0 = 0.10$ vs $H_1: P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

test statistics $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}}$

$= 0.39$

Since, $|Z| < 1.96$, H_0 is accepted. It can be considered that 10% students got A

9.5 ~~test stat~~

We need to test, $H_0: P_1 = P_2$ Vs $H_1: P_1 \neq P_2$

test statistic $z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$

$P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$p_1 = \frac{34}{85} = 0.4$, $p_2 = \frac{14}{70} = 0.2$ $p = \frac{48}{155} = 0.31$ $q = 0.69$

$$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|z| > 1.96$, H_0 is rejected. We conclude that gender does make ~~a~~ difference for drug use

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9.6 We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1
H_1: At least one of them does not hold

Test statistic $\chi^2 = \Sigma \frac{O_i^2}{E_i} - n$

$$= \frac{1}{10}[8^2 + 15^2 + 5^2 + 12^2] - 40$$
$$= 45.8 - 40 = 5.8$$

$E_i = \frac{n}{k} = \frac{40}{4} = 10$

Since, $\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$, H_0 is accepted. Hence the proportions of defective computers of different labnotories are similar

Test of Independence:

Here, a, b, c are observed frequencies in different cell

$n = \Sigma\Sigma O_{ij}$

O_{ij} = Observation of ith row and jth column recorded from the experiment.

$E_{ij} = \frac{R_i C_j}{n}$ = expected frequency corresponding to ith row and jth column under H_0

We need to test, H_0: the charactors A and B are independent vs H_1: they are not independent

Test statistic : $\chi^2 = \Sigma\Sigma \frac{O_{ij}^2}{E_{ij}} - n \sim \chi^2 (r-1)(c-1)$.

Here r = no. of rows and c = no. of columns

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9.1 H_0: Job satisfaction does not depend on good result

H_1: The good result and Job ~~sta~~satisfaction are associated

Test statistics : $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$= \frac{150(22\times 50 - 22\times 58)^2}{80\times 70\times 70\times 108} = 0.02$

Since $\chi^2 < \chi_1^2 = 3.84$, H_0 is accepted. So, Job satisfaction does not depend on good result.

Ex 9.2 We need to test H_0: $P_1 = P_2 = P_3 = P_4$ vs

H_1: At least one of them not hold

$E_i = \frac{n}{k} = \frac{206}{4} = 51.5$; $\cancel{\chi^2 = \Sigma \frac{O_i}{E_i} - n}$

$\chi^2 = \Sigma \frac{O_i^2}{E_i} - n$

$= \frac{1}{51.5}[50^2 + 42^2 + 32^2 + 82^2] - 206 = 27.24$

Since, $\chi^2 > \chi^2_{k-1} = \chi_3^2 = 7.81$.

So, H_1 accepted

the proportion of road accidents not similar

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107 We need to test, $H_0: P_0 = 0.40$ vs $H_1: P_0 \neq 0.40$

$P = \frac{a}{n} = \frac{8}{25} = 0.32$

$P_0 = 0.40 \therefore Q = 0.60$

$\therefore z = \frac{P - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = 0.816$

Since $|z| < 1.96$, So H_0 accepted

the overall proportion of female students are 0.40

109 We need to test, $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$P_1 = \frac{25}{100} = 0.25$ $\qquad P = \frac{25+18}{100+125} = 0.191$

$P_2 = \frac{18}{125} = 0.144$ $\qquad Q = 1 - 0.191 = 0.808$

$\therefore z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{0.25 - 0.144}{\sqrt{0.19 \times 0.808\left(\frac{1}{100} + \frac{1}{125}\right)}}$

$= 2.011$

Since, $|z| > 1.96$ H_0 rejected

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10.11

B.P	Heart problem		Total
	Yes	No	
High	150	120	270
Not high	122	158	280
	272	278	550

H0: High BP not associated with Heart problem
H1: High BP associated with Heart problem

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)} = \frac{550[(150\times158)-(120\times122)]^2}{270\times280\times272\times278}$$
$$= 7.89 \sim 7.90$$

$\chi^2 > \chi_1^2 = 3.84$, 'H1 is accepted

10.14 We need to test,
$H_0: \mu_1 = \mu_2$ vs $H_1: \mu_2 \neq \mu_2$
both n_1 and n_2 are small and σ^2 is unknown

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

$\bar{x}_1 = \frac{1}{n_1}\Sigma x_1 = \frac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\bar{x}_2 = \frac{26500}{20} = 1325$ and $s_2^2 = 50625$

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$$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \frac{(14\times 5625)+(19\times 50625)}{14+19}$$

$$= 31534.09$$

$$t = \frac{1125-1325}{\sqrt{31534.09\left(\frac{1}{15}+\frac{1}{20}\right)}} = -3.297$$

$t\ (n_1-1)+(n_2-1) = \cancel{20.0}\ 2.035$

Since, $|t| > t_3 = 2.035$, H_0 is rejected

Salary information not similar.

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Examples:

19.2

let. $x_1 \sim N(\mu_1 . \sigma_1^2)$

$x_2 \sim N(\mu_2 , \sigma_2^2)$

Also, $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$ and

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and

σ^2 is unknown

Test statistic $t = \dfrac{\overline{x_1} - \overline{x_2}}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1 - 1) + (n_2 - 1)$

$$\bar{x}_1 = \frac{1}{n_1} \Sigma x_1 = \frac{114}{7} = 16.29$$

$$s_1^2 = \frac{1}{n_1 - 1}\left[\Sigma x_1^2 - \frac{(\Sigma_1 x_{1i})^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$$

$$\bar{x}_2 = \frac{1}{n_2} \Sigma x_2 = \frac{163}{11} = 14.82$$

$$s_2^2 = \frac{1}{n_2 - 1}\left[\Sigma x_2^2 - \frac{(\Sigma x_{2i})^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.364$$

Now

$$s_2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)} = \frac{6(6.905) + 10(15.364)}{16} = 12.192$$

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$$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7}+\frac{1}{11}\right)}} = 0.87$$

Since $|t| < t_{16} = 2.12$

H_0 is accepted. Employment facility for students of both university are same.

9.4 we need to test

$H_0: P = P_0 = 0.10$ vs $H_1: P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic $Z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

Since $|z| < 1.96$, H_0 is accepted. it can be considered that 10% students got grade A.

9.5 we need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

Test statistic $z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \sim N(0,1)$

$$P = \frac{a_1 + a_2}{n_1 + n_2}, \quad Q = 1 - P$$

$p_1 = \frac{34}{85} = 0.4 \quad p_2 = \frac{14}{70} = 0.2 \quad P = \frac{48}{155} = 0.31$

$q = 0.69$

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9.7 H_0: Job satisfaction does not depends on good result

H_1: The good result and Job satisfaction are associated.

Test statistic: $x^2 = \dfrac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{150(22\times50 - 22\times58)^2}{80\times70\times42\times108} = 0.02$$

Since $x^2 < x_1^2 = 3.84$ H_0 is accepted. So Job satisfaction does not depend on good result.

Exercise

9.2 we need to test,

$H_0: P_1 = P_2 = P_3 = P_4$ Vs H_1: At least one of them doesn't hold

here, $E_i = \dfrac{n}{k} = \dfrac{206}{4} = 51.5$

$$x^2 = \Sigma \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206$$

$$= 27.24$$

Since $x^2 > x^2_{k-1} = x_3^2 = 7.81$. So, H_1 is accepted hence the proportions of road accidents doesn't Similar.

$$Z = \frac{0.4-0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{35}+\frac{1}{70}\right)}} = 2.68$$

Since $|z|>1.96$ H_0 is rejected we conclude that gender does make a difference for drug use.

9.6

we need to test $H_0: P_1=P_2=P_3=P_4$ vs H_1: At least on of them doesn't hold

Test statistic, $$\chi^2 = \Sigma\frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2+15^2+5^2+12^2\right]-40$$

$$= 45.8-40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 20$$

Since $\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$. Ho is accepted

Hence the proportion of defective computers of different laboratories are similar.

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9.7

we need to test

$H_0: P_0 = 0.40$ vs $H_1: P_0 \neq 0.40$

$p = \frac{a}{n} = \frac{8}{25} = 0.32$

$P_0 = 0.40 \quad \therefore Q = 0.60$

$$\therefore z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = -0.816$$

Since $|z| < 1.96$. so H_0 in accepted

Hence the overall proportion of female students are 0.40

9.9

we need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$p_1 = \frac{25}{100} = 0.25$

$P = \frac{25+18}{100+125} = 0.191$

$Q = 1 - 0.191 = 0.808$

$$\therefore z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

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$$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808\left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.011$$

Since $|z| > 1.96$. H_0 in rejected.

Sol 11

H_0: High blood pressure isn't associated with heart problem

H_1: High blood pressure in associated with heart problem

$$\chi_1^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550\left[(150 \times 158) - (120 \times 122)\right]^2}{270 \times 280 \times 272 \times 278}$$

$= 7.897 \sim 7.9$

Since $\chi^2 > \chi_1^2 = 3.84$ So. H_1 in accepted

High blood pressure in associated with heart problems.

Sub: Date: / /

9.14 We need to test

$H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

both n_1 and n_2 are sample (<30) and σ^2 is unknown

Test statistic: $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \sim t(n_1-1)+t(n_2-1)$

$\bar{x}_1 = \frac{1}{n_1}\sum x_1 = \frac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{26500}{20} = 1325$ and $s_2^2 = 50625$

$s^2 = \dfrac{(n_1-1)s_1^2+(n_2-1)s_2^2}{(n_1-1)+(n_2-1)}$

$= \dfrac{(14\times5625)+(19\times50625)}{14+19}$

$= 31534.09$

$\therefore t = \dfrac{1125-1325}{\sqrt{31534.09\left(\frac{1}{15}+\frac{1}{20}\right)}}$

$= -3.297$

$\therefore t(n_1-1)+t(n_2-1)$

$t_{33} = 2.04$

since $|t| > t_{33}$

So, H_0 are rejected

$\therefore$ salary information are not similar.

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10.14

We need to test

$H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both n_1 and n_2 are small (<30) and σ^2 is unknown

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

$\bar{x}_1 = \frac{1}{n_1} \Sigma x_1 = \frac{16875}{15} = 1125$ and $S_1^2 = 5625$

$\bar{x}_2 = \frac{1}{n_2} \Sigma x_2 = \frac{2650}{20} = 1325$ and $S_2^2 = 50625$

$$S^2 = \frac{(n_1-1) S_1^2 + (n_2-1) S_2^2}{(n_1-1) + (n_2-1)}$$

$$= \frac{14 \times 5625 + (19 \times 50625)}{14 + 19} = \cancel{315.34.0} = 31534.09$$

$$\therefore t = \frac{1125 - 1325}{\sqrt{31534.09\left(\frac{1}{15} + \frac{1}{21}\right)}}$$

$= -3.297$

$t_{(n_1-1)+(n_2-1)}$

$t_{33} = 2.035$

10.11

H_0 : High blood pressure isn't associated with heart Problem

H_1 : High " " is " " " "

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550[(150 \times 158) - 120 \times 122)]^2}{270 \times 280 \times 272 \times 278}$$

$$= 7.897 \sim 7.90$$

B.P	Heart Problem Yes	Heart Problem No	Total
High	150	120	270
Not High	122	158	280
Total	272	278	550

Since, $\chi^2 > \chi_1^2 = 3.84$

So H_2 is accepted

Since $|t| > t_{3} = 2.035$

So, H_0 is rejected

$\therefore$ Salary information are not similar

10.6

We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs: At least one of them dosn't hold

Test statistics $\chi^2 = \Sigma_i \frac{O_i^2}{E_i} - n$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40$$

$$= 45.8 - 40 = 5.8$$

$E_i = \frac{n}{K} = \frac{40}{4} = 10$

Science $\chi^2 < \chi^2_{k-1} = \chi^2 = 7.81$ H_0 is accepted

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By Ove Islam

10.9

We need to test $H_0 : P_1 = P_2$ vs $H_1 : P_1 \neq P_2$

$P_1 = \frac{25}{100} = 0.25$ $\qquad$ $P_2 = \frac{18}{125} = 0.144$

$P = \frac{25+18}{100+125} = 0.191$

$Q = 1 - 0.191 = 0.808$

$\therefore Z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.011$

Here $|Z| > 1.96$ So

H_0 is rejected

10.7

H_0 : Job satisfaction dosent depend on good result

H_1 : the good result and job satisfaction are associated

Test statistics $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(c+d)}$

$= \frac{150(22\times50-22-58)^2}{80\times70\times72\times108}$

$= 0.02$

So, H_0 is accepted

So, job satisfaction dosent depend on good result

10.5 We need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

Test statistics $Z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n} + \frac{1}{n}\right)}} \sim N(0,1)$;

$P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$P_1 = \frac{34}{85} = 0.4$ $P_2 = \frac{14}{70} = 0.2$

$P = \frac{48}{155} = 0.31$ $Q = 0.69$

$\therefore Z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}}$

Since $(|Z| > 1.96)$, H_0 is rejected

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Example 9.2

Let, $x_1 \sim N(\mu_1, \sigma_1^2)$

$x_2 \sim N(\mu_2, \sigma_2^2)$ and let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 isn't known

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

$\bar{x}_1 = \dfrac{1}{n_1}\sum x_1 = \dfrac{114}{7} = 16.29$

$\bar{x}_2 = \dfrac{1}{n_2}\sum x_2 = \dfrac{163}{11} = 14.82$

$s_1^2 = \dfrac{1}{n_1-1}\left[\sum x_1^2 - \dfrac{(\sum x_{1i})^2}{n_1}\right] = \dfrac{1}{6}\left(1898 - \dfrac{114^2}{7}\right) = 6.905$

$s_2^2 = \dfrac{1}{n_2-1}\left[\sum x_2^2 - \dfrac{(\sum x_{2i})^2}{n_2}\right] = \dfrac{1}{10}\left(2569 - \dfrac{163^2}{11}\right) = 15.364$

$t = \dfrac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$

$s^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \dfrac{6(6.905) + 10(15.364)}{16}$

$= 12.192$

9.4

We need to test, $H_0: P = P_0 = 0.10$ vs $H_1: P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic: $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.1 \times 0.9}{15}}} = 0.39$

Since $|z| < 1.96$, H_0 is accepted, it can be considered that 10% students got grade A.

9.5

We need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$.

Test statistic, $z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$.

$P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$p_1 = \frac{34}{85} = 0.4$, $p_2 = \frac{14}{70} = 0.2$, $P = \frac{48}{155} = 0.31$,

$Q = 0.69$. $z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$

Since, $|z| > 1.96$. H_0 is rejected. We conclude that gender does make a difference for drug use.

9.6

We need to test $H_0 : P_1 = P_2 = P_3 = P_4$ vs H_1 : at least one of them doesn't hold.

Test statistic, $\chi^2 = \sum \frac{O_1^2}{E_1} - n$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 90$$

$$= 45.8 - 90 = 5.8$$

$$E_1 = \frac{n}{k} = \frac{90}{4} = 10$$

Since $\chi^2 < \chi^2_{k-1} = \chi_3^2 = 7.81$, H_0 is accepted

Hence, the proportions of defective computers of different laboratories are similiar.

9.7

H_0 : Job satisfaction doesn't depend on good result

H_1 : The good result and job satisfaction are associated.

Test statistic : $X^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)} = \frac{150(22 \times 50 - 22 \times 58)^2}{80 \times 70 \times 92 \times 108}$

$= 0.02$

since, $X^2 < X_1^2 = 3.84$, H_0 is accepted. So, job satisfaction does not depend on good result.

Exercise

9.2

We need to test, $H_0 : P_1 = P_2 = P_3 = P_4$ vs H_1 : at least one of them doesn't hold

Here $E_i = \frac{n}{k} = \frac{206}{4} = 51.5$

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206 = 27.24$$

Since, $\chi^2 > \chi^2_{k-1} = \chi^2_3 = 7.81$, so H_1 is accepted.

Hence, the proportions of road accidents aren't similiar.

9.7

We need to test, $H_0 : P_0 = 0.4$ vs $H_1 : P_0 \neq 0.4$

$$P = \frac{a}{n} = \frac{8}{25} = 0.32$$

$P_0 = 0.4$, so, $Q = 1 - 0.4 = 0.6$

$$\therefore Z = \frac{-P_0 + P}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.4}{\sqrt{\frac{0.4 \times 0.6}{25}}} = -0.816$$

since $|Z| < 1.96$, so H_0 is accepted. Hence the overall Proportion of female students are 0.4.

9.9

We need to test, $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$p_1 = \frac{25}{100} = 0.25$ $\quad$ $p_2 = \frac{18}{125} = 0.144$

Here, $a_1 = 25$, $a_2 = 18$

$n_1 = 100$, $n_2 = 125$

$P = \frac{25+18}{100+25} = 0.191$

$Q = 1 - 0.191 = 0.808$

$$\therefore Z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} = \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808\left(\frac{1}{100}+\frac{1}{125}\right)}} = 2.011$$

Since $|z| > 1.96$, H_0 is rejected.

9.11

H_0: High blood pressure isn't associated with heart problem

H_1: High blood pressure is associated with heart problem

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550\left[(150 \times 158)-(120 \times 122)\right]^2}{270 \times 280 \times 272 \times 278}$$

$= 7.897 \sim 7.90$

B.P	Heart Problem		Total
	Yes	No	
High	150	120	270
Normal	122	158	280
Total	272	278	550

Since $\chi^2 > \chi_1^2 = 3.84$, so, H_1 is accepted

Hence, High blood pressure is associated with heart problem.

9.14

We need to test

$H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

both n_1 and n_2 are small (< 30) and σ^2 is unknown

Test statistic : $t = \dfrac{\overline{x_1} - \overline{x_2}}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1 - 1) + t(n_2 - 1)$

$\overline{x_1} = \frac{1}{n_1} \sum x_1 = \frac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\overline{x_2} = \frac{1}{n_2} \sum x_2 = \frac{26500}{20} = 1325$ and $s_2^2 = 50625$

$$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)}$$

$$= \frac{(14 \times 5625) + (19 \times 50625)}{14 + 19} = 31534.09$$

$$\therefore t = \frac{1125 - 1325}{\sqrt{31534.09\left(\frac{1}{15} + \frac{1}{20}\right)}}$$

$$= -3.297$$

$t(n_1 - 1) + t(n_2 - 1)$

$t_{33} = 2.035$

Since $|t| > t_{33} = 2.035$

so, H_0 is rejected

Hence, Salary information aren't similiar

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P: 1

Example:

9.2 $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is not known.

$$\bar{x}_1 = \frac{114}{7} = 16.29$$

$$s_1^2 = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$$

$$\bar{x}_2 = \frac{163}{11} = 14.82$$

$$s_2^2 = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.364$$

$$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$$

$$s^2 = \frac{6(6.905) + 10(15.364)}{16}$$

$$= 12.192$$

$\therefore |t| < t_{16}$. H_0 accepted

9.4 $H_0: P = P_0 = 0.1$ vs $H_1: P \neq P_0$

$$p = \frac{a}{n} = \frac{2}{15} = 0.13$$

$$z = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.9}{15}}} = 0.39$$

$|z| < 1.96$. H_0 is accepted.

9.5 $H_0: P_1 = P_2$ vs $H_1: P_2 \neq P_1$

$$P = \frac{a_1 + a_2}{n_1 + n_2}, \quad Q = 1 - P$$

~~than 0.4 ...~~

$$p_1 = \frac{34}{85} = 0.4, \quad P_2 = \frac{14}{70} = 0.2$$

$$P = \frac{48}{155} = 0.31, \quad q = 0.69$$

$$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

$|z| > 1.96$. H_0 is rejected.

9.6 $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At least one of them doesn't same.

$$\chi^2 = \frac{1}{10}(8^2 + 15^2 + 5^2 + 12^2) - 40$$

$$= 45.8 - 40 = 5.8$$

$$E_i = \frac{n}{K} = \frac{40}{4} = 10$$

Since, $\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$.

H_0 is accepted.

9.7 H_0: Job satisfaction does not depend on good result.

H_1: The good result and job satisfaction are associated.

$$\chi^2 = \frac{150(22 \times 50 - 22 \times 58)^2}{80 \times 70 \times 42 \times 108} = 0.02$$

$\chi^2 < \chi^2_1 = 3.84$. H_0 is accepted.

Saikat P:4

Exercise:

9.2 $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At least one of them doesn't hold.

$$E_i = \frac{n}{K} = \frac{206}{4} = 51.5$$

$$\chi^2 = \frac{1}{51.5}\left(50^2 + 42^2 + 32^2 + 82^2\right) - 206$$

$$= \cancel{229.24}\ 27.24$$

Since $\chi^2 > \chi^2_3 = 7.81$.

H_0 is rejected.

Saikat

9.7 $H_0: P = P_0 = 0.4$ vs $H_1: P \neq P_0$

$$P = \frac{8}{25} = 0.32$$

$$Z = \frac{P - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.4}{\sqrt{\frac{0.4 \times 0.6}{25}}}$$

$$= -0.816$$

$|Z| = 0.816$

$|Z| < 1.96$. Ho is accepted.

9.9 $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$$P_1 = \frac{25}{100} = 0.25, \quad P_2 = \frac{18}{125} = 0.144$$

$$P = \frac{43}{225} = 0.1911, \quad q = 0.8089$$

$$Z = \frac{0.25 - 0.144}{\sqrt{0.1911 \times 0.8089 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.009$$

$|Z| > 1.96$. Ho is rejected.

Saikat

P: 6

9.11 Ho: blood pressure is not associated with heart problem

H₁: associated.

$$\cancel{\chi^2 = 278}\quad \chi^2 = \frac{550\left[(150\times158-122\times120)\right]^2}{272\times270\times280\times278}$$

$$= 7.89$$

$\chi^2 > \chi_1^2 = 3.84$.

H_1 is accepted.

9.14 $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

$$\bar{x}_1 = \frac{16875}{15} = 1125,\ \bar{x}_2 = \frac{26500}{20} = 1325$$

$$s^2 = \frac{5625\times14+50625\times19}{33} = 31534.1$$

$$t = \frac{1125-1325}{\sqrt{31534.1\left(\frac{1}{15}+\frac{1}{20}\right)}} = -3.29$$

$\therefore |t| > t_{33} = 2.035.$ ← value from random table

H_0 is rejected.

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Assignment - 4

Example:
9.2

Let, $x_1 \sim N(\mu_1, \sigma_1^2)$, $x_2 \sim N(\mu_2, \sigma_2^2)$.

Also,
Let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We Need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is not known.

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

$\bar{x}_1 = \frac{1}{n_1}\Sigma x_1 = \frac{114}{7} = 16.29$	$s_1^2 = \frac{1}{n_1-1}\left[\Sigma x_1^2 - \frac{(\Sigma x_{1i})^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$
$\bar{x}_2 = \frac{1}{n_2}\Sigma x_2 = \frac{163}{11} = 14.82$	$s_2^2 = \frac{1}{n_2-1}\left[\Sigma x_2^2 - \frac{(\Sigma x_{2i})^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.364$
$t = \dfrac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$	$s^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \dfrac{6(6.905) + 10(15.364)}{16} = 12.192$

Since $|t| < t_{16} = 2.12$, H_0 is accepted. Emplyoment facility for students for both universities is same.

9.4

We need to test, $H_0 : P = P_0 = 0.10$ vs $H_1 : P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test stastic : $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

Since $|z| < 1.96$, H_0 is accepted. It can be considered that 10% students got grade A.

9.5

We need to test $H_0 : P_1$ vs $H_1 : P_1 \neq P_2$

Test stastic, $z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$; $P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$p_1 = \frac{34}{85} = 0.4$, $p_2 = \frac{14}{70} = 0.2$, $P = \frac{48}{155} = 0.31$, $q = 0.69$

$$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|z| > 1.96$, H_0 is rejected. we conclude that gender does make a difference for drug use.

Q.6

We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At least one of them doesn't hold test statistic.

$$\chi^2 = \Sigma \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40 = 45.8 - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

Since $\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$, H_0 is accepted. Hence, the proprotions of defective computers of different laborationies are similar.

Q.7

H_0: Job ~~stati~~ statisfaction does not depend on good result.

H_1 : The good result and job statisfaction are associated.

Test statistic : $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)} = \frac{150(22\times50 - 22\times58)^2}{80\times70\times42\times108} = 0.02$

Since, $\chi^2 < \chi^2_1 = 3.84$, H_0 is accepted. So, Job statisfaction does not depend on good result.

Exercise:

Q.2 We need to test, $H_0: P_1 = P_2 = P_3 = P_4$ Vs H_1: At least one of them doesn't hold.

Here,

$$E_i = \frac{n}{K} = \frac{206}{4} = 51.5$$

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n = \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206 = 27.24$$

Since $\chi^2 > \chi^2_{K-1} = \chi^2_3 = 7.81$, H_1 is accepted.

Hence the proportion of road accidents ~~doesn't simi~~ aren't similar.

Q.7

We need to test,

$H_0: P_0 = 0.40$ Vs $H_1: P_0 \neq 0.40$.

$$P = \frac{a}{n} = \frac{8}{25} = 0.32$$

$P_0 = 0.40$

$\therefore Q_0 = 0.60$

$$\therefore z = \frac{P - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = -0.816$$

Since $|z| < 1.96$, ~~so H_0~~ H_0 is accepted

Hence, the overall proportion of female students are 0.40.

Q.9

We need to test, $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$p_1 = \frac{29}{100} = 0.25$ $\quad p_2 = \frac{18}{125} = 0.144$

$p = \frac{25+18}{100+125} = 0.191$

$Q = 1 - 0.191 = 0.808$

Here,
$a_1 = 25$
$n_1 = 100$
$n_2 = 125$
$a_2 = 18$

$$\therefore z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808 \left(\frac{1}{100} + \frac{1}{125}\right)}}$$

Since $|z| > 1.96$, H_0 is rejected.

Q.11

H_0: High blood pressure isn't associated with heart problem
H_1: High blood pressure is associated with heart problem.

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550\left[(150\times158)-(120\times122)\right]^2}{270 \times 280 \times 272 \times 278}$$

$$= 7.897 \sim 7.90$$

Blood Pressure	Heart problem Yes	Heart problem No	Total
High	150	120	270
Not high	122	158	280
Total	272	278	550

Since, $\chi^2 > \chi_1^2 = 3.84$, H_1 is accepted.

High blood pressure associated with heart.

Q.14

We need to test

~~$H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$~~

$H_0 : n_1 = n_2$ vs $H_1 : n_1 \neq n_2$

both n_1 and n_2 are small (<30) and σ^2 is unknown.

Test statistic : $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1 - 1) + t(n_2 - 1)$

$\bar{x}_1 = \dfrac{1}{n_1} \sum x_1 = \dfrac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\bar{x}_2 = \dfrac{1}{n_2} \sum x_2 = \dfrac{26500}{20} = 1325$ and $s_2^2 = 50625$

$s^2 = \dfrac{(n_1 - 1) s_1^2 + (n_2 - 1) s_2^2}{(n_1 - 1)(n_2 - 1)} = \dfrac{(14 \times 5625) + (19 \times 50625)}{14 + 19} = 31534.09$

$\therefore t = \dfrac{1125 - 1325}{\sqrt{31534.09\left(\frac{1}{15} + \frac{1}{20}\right)}}$

$= -3.207$

$\therefore t(n_1 - 1) + t(n_2 - 1)$

$t_{33} = 2.035$

since, $|t| > t_{33} = 2035$

So, H_0 is rejected

$\therefore$ Salary information are not similar.

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Examples

10.2 Let, $x_1 \sim N(\mu_1, \sigma_1^2)$

$x_2 \sim N(\mu_2, \sigma_2^2)$

Also let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is known.

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

$\bar{x}_1 = \frac{1}{x_1} \sum_1 = \frac{114}{7} = 16.29$

$s_1^2 = \frac{1}{n_1 - 1}\left[\sum n_1^2 - \frac{(\sum x_{i1})^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right)$

$= 6.905$

$\bar{x}_2 = \frac{1}{n_2} \sum n_2 \quad \frac{163}{11} = 14.82$

$s_2^2 = \frac{1}{n_2 - 1}\left[\Sigma x_2^2 - \frac{(\Sigma x_{2i})^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right)$

Now

$= 15.369$

$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \frac{6(6.905)+10(15.369)}{16}$

$= 12.192$

$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7}+\frac{1}{11}\right)}} = 0.87$

since, $|t| < t_{16} = 2.12$

H_0 is accepted Employement faulty for students to both university are same.

10.4 We need to test

$H_0 \; P = P_0 = 0.10$ vs $H_1 \; P \neq P_0$

Now $= \frac{a}{n} = \frac{2}{15} = 0.13$

Test static $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

since $|z| < 1.96$

H_0 is accepted It can be considered that 10% student got grade A.

10.5

We need to test $H_0: P_1 = P_2$ Vs $H_1: P_1 \neq P_2$

Test statistics $\Rightarrow Z = \dfrac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$;

$P = \dfrac{a_1 + a_2}{n_1 + n_2} \Rightarrow Q = 1 - P$

$P_1 = \dfrac{34}{85} = 0.4$ $\quad P_2 = \dfrac{14}{70} = 0.2$ $\quad P = \dfrac{48}{155} = 0.31, q = 0.69$

$$Z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|Z| > 1.96$ Ho is regected

We conclude that gendar dose does make a diff erence for drug use

10.6 We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs

H_1: At least one of them doesn't hold

Test statistics

$$x^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}[8^2 + 15^2 + 5^2 + 12^2] - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

since,

$x^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$ H_0 is accepted

Hence the properties of defective computer of different laboratories are similar

10.7

H_0: Job satisfaction doesn't depend on good result.

H_1: The good result and job satisfaction are associated.

Test statistics $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{150(22 \times 50 - 22 - 58)^2}{80 \times 70 \times 92 \times 108} = 0.02$$

Since $\chi^2 < \chi_1^2 = 3.84$ Ho is accepted.

So, job satisfaction doesn't depend on good result.

Exercise

10.2

We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At least one of them doesn't hold

Here,

$E_1 = \frac{n}{k} = \frac{206}{4} = 51.5$

$$x^2 = \sum \frac{O_i^2}{E_1} - n$$

$$= \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206 = 27.29$$

Since $x^2 > x^2_{k-1} = x_3^2 = 7.81$. So H_1 is accepted.

Hence the proportions of road accident are not similar.

10.7:

We need to test

$H_0: P_0 = 0.40$ vs $H_1: P_0 \neq 0.40$

$$P = \frac{a}{n} = \frac{8}{25} = 0.32$$

$P = = 0.40 \therefore Q = 0.60$

$$\therefore\ Z = \frac{p_x - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.4 \times 0.6}{25}}} = 0.816$$

Since $|Z| < 1.96$ so H_0 is accepted

Hence the overall proportion of female students are 0.40. (Ans)

10.9 We need to test $H_0 : P_1 = P_2 : P_1 \neq P_2$

$P_1 = \frac{25}{100} = 0.25$ $\quad P_2 = \frac{18}{125} = 0.144$

$P = \frac{25+18}{100+125} = 0.191$

Hence $a_1 = 25$, $n_1 = 100$, $n_2 = 125$, $a_2 = 18$

$Q = 1 - 0.191 = 0.808$

$$Z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808\left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.011$$

since $|Z| > 1.96$ H_0 is are jected.

10.14 We need to test

$H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

both n_1 and n_2 are small (<30) and σ is unknown

Test statistic: $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \sim t(n_1-1)+t(n_2-1)$

$\bar{x}_1 = \frac{1}{n_1} \sum x_1 = \dfrac{16875}{15} = 1125$ and $s_1^2 = 5625$

$s^2 = \dfrac{(n_1-1)s_1^2+(n_2-1)s_2^2}{(n_1-1)+(n_2-1)}$

$= \dfrac{(14 \times 5625)+(19 \times 50625)}{14+19}$

$\therefore t = \dfrac{1125-1325}{\sqrt{31534.09\left(\frac{1}{15}+\frac{1}{20}\right)}}$

$= -3.297$

$\therefore t(n_1-1)+t(n_2-1)$

$t_{33} = 2.035$

since $|t| > t_{33} = 2.035$

So H_0 is rejected

$\therefore$ Salary information are not similar

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P-1

Example 9.2

Let $x_1 \sim N(\mu_1, \sigma_1^2)$, $(x_2 \sim N(\mu_2, \sigma_2^2)$.

Also, let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

we need to test, $H_0\ \mu_1 = \mu_2$ vs

$H_1: \mu_1 \neq \mu_2$.

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is not known.

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

$\bar{x} = \frac{1}{n_1}\sum x_1 = \frac{114}{7} = 16.29$	$s_1^2 = \frac{1}{n_1-1}\left[\sum x_1^2 - \frac{(\sum x_1)^2}{n_1}\right] = \frac{1}{6}\left(18.98 - \frac{114^2}{7}\right) = 6.905$
$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{163}{11} = 14.82$	$s_2^2 = \frac{1}{n_2-1}\left[\sum x_2^2 - \frac{(\sum x_2)^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.364$
$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$	$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \frac{6(6.905) + 10(15.364)}{16} = 12.192$
Since $\lvert t \rvert < t_{16} = 2.12$, H_0 is accepted. Employment facility for student of both universities is same.	

Q.4

We need to test, $H_0: P = P_0 = 0.10$ VS $H_1: P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic, $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.1 \times 0.9}{15}}} = 0.387$

Since $|Z| < 1.96$, H_0 is accepted. It can be considered that 10% students get grad A

Q.5

We need to test $H_0: P_1 = P_2$ VS $H_1: P_1 \neq P_2$

Test statistic, $z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$

; $P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$p_1 = \frac{34}{85} = 0.4$. $p_2 = \frac{14}{70} = 0.2$, $P = \frac{48}{155} = 0.31$

, $Q = 0.69$

$$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.679$$

P-3

Q. 6

We need to test $H_0: P_1 = P_2 = P_3 = P_4$

vs H_1: At

least one of them doesn't hold

Test statics,

$$x = \Sigma \frac{O_i^2}{E_i^2} - n$$

$$= \frac{1}{10}[8^2 + 15^2 + 5^2 + 12^2] - 40$$

$$= 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

Since $\chi^2 < \chi^2_{k-1} = \chi_3^2 = 7.81$, H_0 is accepted. Hence, the proportion of defective computer of different laboratories are similar

P-4

9.7

Ho : Job satifacton does not depend on good result.

H1 : The good result and job satis- are associated.

Test statistic : $\chi^2 = \frac{n(ad-bc)}{(a+b)(a+c)(b+d)(c}$

$= \frac{150(22\times 50 - 22\times 58)^2}{80\times 70\times 42\times 108}$

$= 0.02$

since $\chi^2 < \chi^2_1 = 3.84$, Ho is accep

So Job satisfaction does not on good result.

P5 Exercise

9.2

we need to test H_0: $P_1 = P_2 = P_3 = P_4$

vs H_1 - At least one of them doesn't hold.

Test statistic

$$\chi^2 = \frac{\Sigma O_i^2}{E} - n$$

$$= \frac{\Sigma O_i^2}{n/k} - n = \frac{50^2 + 42^2 + 32^2 + 82^2}{206/4} - 206$$

$$= 27.24$$

As $\chi^2 > \chi^2_{k-1} = \chi^2_3 = 7.81$, H_0 is rejected

Hence the proportion of road accidents are not similar in various highways of Bangladesh

9.7

We need to test, $H_0: P = P_0 = 0.4$ vs.

$H_1: P \neq P_0$

$$p = a/n = \frac{8}{25} = 0.32$$

Test statistic: $$Z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.4}{\sqrt{\frac{0.4 \times 0.6}{25}}}$$

$$= -0.82$$

As, $|Z| < 1.96$, H_0 is accepted. It can be considered that 0.40 in the overall proportion of female student in ATUB.

9.9

We need to test $H_0: P_1 = P_2$ Vs $H_1: P_1 \neq P_2$

Test statistic, $$Z = \cancel{\frac{P_1 - P_2}{\sqrt{PQ \ldots}}} \quad \frac{P_1 - P_2}{\sqrt{PQ\,(1/n_1 + 1/n_2)}}$$

$$\sim N(0, 1)$$

$$P = \frac{a_1 + a_2}{n_1 + n_2} = \frac{25 + 18}{100 + 25} = 0.19 \;; \; P_1 = \frac{25}{100}$$

$$= 0.25$$

$q = 1 - p = 1 - 0.19 = 0.81$; $P_2 = \frac{18}{125} = 0.14$

$$Z = \frac{0.25 - 0.4}{\sqrt{0.19 \times 0.81 \times (1/100 + 1/125)}} = 2.09$$

As, $|Z| > 1.96$, Ho is rejected. We conclude that probation in not same for boys and girls at AIUB.

Q. 11)

Ho : High blood pressure does not associated with heart problem.

H_1 : High pressure and Heart problem are assaciated

Test statistic : $\chi^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{550(150 \times 158) - (22 \times 120)^2}{272 \times 270 \times 280 \times 278}$$

$= 7.897$

As $\chi^2 < \chi^2_1 = 3.84$. He is accepted so High blood pressure does not associate with Heart problem.

P-8

Q.117

Institution 1: $n_1 = 15$ $\Sigma x_1 = 16875$ $s_1^2 = 5625$

Institution 2: $n_2 = 20$ $\Sigma x_2 = 26500$ $s_2^2 = 50625$

We need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

$\bar{x}_1 = \frac{\Sigma x_1}{n_1} = \frac{16875}{15} = 1125$; $s_1^2 = 5625$

$\bar{x}_2 = \frac{\Sigma x_2}{n_2} = \frac{26500}{20} = 1325$; $s_2^2 = 50625$

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

$= \frac{1125 - 1325}{\sqrt{31534.09(1/15 + 1/20)}} = -3.29$

$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \frac{(14 \times 5625) + (19 \times 50625)}{14 + 19}$

$= 31534.09$

As $|t| > t_{33} = 2.035$. H_1 is accepted.

The salary information of both institution are not similar.

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Ex : 10.2

$X_1 \sim N(\mu_1, \sigma_1^2)$

$X_2 \sim N(\mu_2, \sigma_2^2)$

Also, let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is unknown

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

$\bar{x}_1 = \frac{1}{n_1} \sum x_1 = \frac{114}{7} = 16.29$

$s_1^2 = \frac{1}{n_1 - 1}\left[\sum x_1^2 - \frac{(\sum x_{1i})^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$

$\bar{x}_2 = \frac{1}{n_2} \sum_i x_2 = \frac{163}{11} = 14.82$

$s_2^2 = \frac{1}{n_2 - 1}\left[\sum_i x_2^2 - \frac{(\sum x_{2i})^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.369$

Now,

$s^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1) + (n_2-1)} = \dfrac{6(6.905) + 10(15.369)}{16} = 12.192$

$t = \dfrac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$

Since, $|t| < t_{16} = 2.12$

H_0 is accepted. Employment facility for student of both universities are same

10.4

We need to test,

$$H_0 : P = P_0 = 0.10 \quad vs \quad H_1 : P \neq P_0$$

Now, $P = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic : $Z = \dfrac{P - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \dfrac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

Since $|Z| < 1.96$

H_0 is accepted. It can be considered that 10% students got grade it.

10.5

We test $H_0 : P_1 = P_2$ vs $H_1 : P_1 \neq P_2$

Test statistics, $Z = \dfrac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$;

$$P = \frac{a_1 + a_2}{n_1 + n_2}, \quad Q = 1 - P$$

$P_1 = \frac{34}{85} = 0.4$, $P_2 = \frac{14}{70} = 0.2$, $P = \frac{48}{155} = 0.31$,

$q = 0.69$

$$Z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|Z| > 1.96$, H_0 is rejected.

We conclude that gender does make a difference for drug use.

10.6

We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: at least one of them doesn't hold.

Test statistics,

$$\chi^2 = \Sigma_i \frac{O_i^2}{E_i} - n$$
$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40$$
$$= 45.8 - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

Since,
$\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$. H_0 is accepted.

Hence, the proportion of defective computer of different laboratories are similar.

10.7

H_0: Job satisfaction doesn't depend on good result.

H_1: The good result and job satisfaction are associated

Test statistics. $\chi^2 = \dfrac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{150(22\times 50 - 22\text{-}58)^2}{30\times 70\times 42\times 108} = 0.02$$

Since, $\chi^2 < \chi_1^2 = 3.84$. H_0 is accepted.

So, Job satisfaction doesn't depend on good result.

10.2

We need to test, $H_0: P_1 = P_2 = P_3 = P_4$ Vs H_1: at least one of them doesnt hold.

Here, $E_i = \frac{n}{k} = \frac{206}{4} = 51.5$

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206 = 27.29$$

Since, $\chi^2 > \chi^2_{k-1} = \chi^2_3 = 7.81$. So, H_1 is accepted

Hence the proportions of road accidents aren't similar.

10.7

We need to test,

$H_0: P_0 = 0.40$ Vs $H_1: P_0 \neq 0.40$

$P = \frac{a}{n} = \frac{8}{25} = 0.32$

$P_0 = 0.40$

$\therefore Q = 0.60$

$$\therefore Z = \frac{P_0 - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = -0.816$$

Since $|Z| < 1.96$. So H_0 is accepted.

Hence, the overall proportion of female students are 0.40 (Ans)

10.9

We need to test, $H_0: P_1 = P_2$ Vs $H_1: P_1 \neq P_2$

$$P_1 = \frac{25}{100} = 0.25 \qquad P_2 = \frac{18}{125} = 0.144$$

Here,
$a_1 = 25$
$n_1 = 100$
$n_2 = 125$
$a_2 = 18$

$$P = \frac{25+18}{100+125} = 0.191$$

$$Q = 1 - 0.191 = 0.808$$

$$\therefore Z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.011$$

Since $|z| > 1.96$, H_0 is rejected.

10.11

H_0 = High blood pressure isn't associated with heart proble

H_1 = High blood pressure is associated with heart problem

$$\chi^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550\left[(150 \times 158) - (120 \times 122)\right]^2}{270 \times 280 \times 272 \times 278}$$

$$= 7.897 \sim 7.90$$

Since,
$\chi^2 > \chi_1^2 = 3.84$, so, H_1 is accepted

High blood pressure is associated with heart Problem.

10.14

We need to test

$H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

both n_1 and n_2 are small (<30) and σ^2 is unknown

Test statistics: $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}} \sim t(n_1-1)+t(n_2-1)$

$\bar{x}_1 = \frac{1}{n_1}\sum x_1 = \frac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{26500}{20} = 1325$ and $s_2^2 = 50625$

$$s^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{(n_1-1)+(n_2-1)}$$

$$= \frac{(14\times5625)+(19\times50625)}{14+19} = 31534.09$$

$$\therefore t = \frac{1125-1325}{\sqrt{31534.09\left(\frac{1}{15}+\frac{1}{20}\right)}}$$

$$= -3.297$$

$\therefore t\,(n_1-1)+(n_2-1)$

$t_{33} = 2.035$

Since, $|t| > t_{33} = 2.035$

So, H_0 is rejected

$\therefore$ Salary information are not similar.

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Pg: 01

Assignment : 04

Example 10.2 :

Let,

$x_1 \sim N(\mu_1, \sigma_1^2), x_2 \sim N(\mu_2, \sigma_2^2)$. Also let $\sigma^2 = \sigma^2 = \sigma^2$

We need to test,

$H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both,

$n_1 = 7$ and $n_2 = 11$ are (<30) and σ^2 is not known.

Test statistics $t = \frac{\bar{x} - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1 - 1) + (n_2 - 1)$

~~From~~

For x_1,

$\bar{x}_1 = \frac{1}{n_1} \Sigma x_1 = \frac{114}{7} = 16.29$

$s_1^2 = \frac{1}{n_1 - 1}\left[\Sigma x_1^2 \frac{(\Sigma x_i)^2}{n}\right] = \frac{1}{6}\left[1898 - \frac{114^2}{7}\right.$

$= 6.905.$

For x_2,

$$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{163}{11} = 14.82$$

$$s_2^2 = \frac{1}{n_2 - 1}\left[\sum x_2^2 - \frac{(\sum x)^2}{n_2}\right]$$

$$= \frac{1}{10}\left(2569 - \frac{163^2}{11}\right)$$

$$= 15.364$$

Now,

$$s^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)}$$

$$= \frac{6(6.905)+10(15.369)}{16}$$

$$= 12.192$$

$$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{4}{7}+\frac{1}{11}\right)}}$$

$$= 0.87$$

Since,

$|t| t_{18} = 2.12$

H_0 is accepted Employment Isacity for students of both universities is same.

Example 10.4:

We need to test $H_0: P = P_0 = 0.10$ vs $P \neq P$.

Now,

$$p = \frac{a}{n} = \frac{2}{15} = 0.13$$

$$\text{Test statistic}: Z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}}$$

$$= 0.39$$

Since,

$|Z| < 1.96$, H_0 is accepted. It can be considered that 10% students got grade A.

Example 10·5:

we need to test $H_0: P_1 - P_2$ Vs $H_1: P_1 \neq P_2$

Test statistic,

$$Z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$$

$$P = \frac{a_1 + a_2}{n_1 + n_2}, \quad Q = 1 - P$$

$$P_1 = \frac{a}{n} = \frac{34}{85}, \quad P_2 = \frac{14}{70}$$

$$P = \frac{34 + 14}{85 + 70} = \frac{48}{155} = 0.31$$

$$q = 1 - P \Rightarrow 0.69$$

$$Z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since,

$|Z| > 1.96$, Ho is rejected, we conclude that gender does make a difference for drug use.

Example 10.6 :

We need to test

$H_0: P_1 = P_2 = P_3 = P_4$ Vs H_1: at least one of them doesn't hold.

Test statistics,

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40$$

$$= 45.8 - 40$$

$$= 5.8$$

$$E_i = \frac{n}{K} = \frac{40}{4} = 10$$

Since,

$\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$ H_0 is accepted.

Hence,

The proportion of defective computers of different laboratories are similar.

Example 10.7:

H_0: job statification does not depend on good result.

H_1: The good result and good job satisfaction are associated.

Test statistic:

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(b+c)(b+d)(c+d)}$$

$$= \frac{150(22\times 562 - 20\times 58)^2}{80\times 70\times 92\times 108}$$

$$= 0.02$$

Since,

$\chi^2 < \chi_1^2 = 3.84$ H_0 is accepted.

So, job satisfaction does not depend on good result.

Exercise: 10.4

We need to test,

$H_0: P_1 = P_2 = P_3 = P_4$ Vs H_1: at least one of the does not hold.

$$E_i = \frac{n}{K} = \frac{1000}{4} = 250$$

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{(250^2 + 450^2 + 150^2 + 150^2)}{250} - 1000$$

$$= 1290 - 1000$$

$$= 290$$

Since,

$\cancel{\chi^2 > \chi^2}$ $\chi^2 > \chi^2_{K-1} = \chi^2_3 = 7.81$, H_0 is not accepted. Hence, The proportion of Female students is not similar in various department in AIUB.

Exercise 10.7:

We need to test,

$H_0: P = P_0 = 0.40$ vs $H_1: P \neq P_0$

Now,

$$p = \frac{8}{25} = 0.32$$

Test statistic,

$$Z = \frac{p - P_0}{\sqrt{\frac{P_0 q_0}{n}}}$$

$$= \frac{0.32 - 0.40}{\sqrt{\frac{(0.40)(0.60)}{25}}}$$

$$= -0.81$$

Since,

$|Z| < 1.96$, H_0 is accepted. It can be considered that the overall proportion of female students are 0.40 in AIUB.

19-41829-3

Exercise 10.9:

We need to test,

$H_0 : P_1 = P_2$ vs $H_1 : P_1 \neq P_2$

$p_1 = \frac{25}{100} = 0.25$

$p_2 = \frac{18}{125} = 0.144$

$p = \frac{43}{225} = 0.191$

$q = 1 - p = 0.808$

$$\therefore z = \frac{0.25 - 0.144}{\sqrt{(0.191)(0.808)\left(\frac{1}{100} + \frac{1}{125}\right)}}$$

$$= 2.011$$

Since,

$|z| > 1.96$. Ho is rejected. We conclude that the probation problem is different for boys and girls at AIUB.

Exercise: 10.12

H_0: learning does not depend residential origin

H_1: Residential origin and full attention is associated with learning.

Test statistic: $\chi^2 = \dfrac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{350(138\times 89)-(64\times 69)^2}{(130+64)(138+69)(69+89)(64+89)}$$

$$= 22.003$$

Since, $\chi^2 > \chi^2 = 3.84$, H_0 is rejected.

So residential origin and full attention is associated with learning.

Exercise 10.14:

We need to test, $H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

Here,

$n_1 = 15$ and $n_2 = 20$ are small (< 30) and

σ^2 is not Known.

$$\bar{x}_1 = \frac{1}{n_1} \sum x_1 = \frac{1}{15} \times 16875 = 1125$$

$$\bar{x}_2 = \frac{1}{n_2} \sum x_2 = \frac{1}{20} \times 26500 = 1325$$

$$S^2 = \frac{14(5625) + 19(50625)}{14+19}$$

$$= -3.297 \sim t(33)$$

Since,

$H_1 > t_{33}$, H_0 is rejected, salary information of both institute are not Similar.

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Example

9.2) Let, $x_1 \sim N(\mu_1, \sigma_1^2)$

$x_2 \sim N(\mu_2, \sigma_2^2)$

Also,

$$\sigma_1^2 = \sigma_2^2 = \sigma^2$$

We need to test, $H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (< 30) and σ^2 is unknown.

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

$$\bar{x} = \frac{1}{n_1}\sum x_1 = \frac{119}{7} = 16.29$$

$$s_1^2 = \frac{1}{n_1 - 1}\left[\sum x_1^2 - \frac{(\sum x_{1i})^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{119^2}{7}\right) = 6.905$$

$$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{163}{11} = 14.82$$

$$s_2 = \frac{1}{n_2 - 1}\left[\sum x_2^2 - \frac{(\sum x_{2i})}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.369$$

So,

$$s_2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)} = \frac{6(6.905) + 10(15.369)}{16} = 12.192$$

$$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}}$$

$$= 0.87$$

Since $|t| < t_{16} = 2.12$

(Ans)

9.4| We need to test,

H_0 $P = P_0 = 0.10$ vs $H_1 : P \neq P_0$

Now, $P = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic : $z = \frac{P - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}}$

$= 0.39$

Since $|z| < 1.96$

H_0 is accepted. It can be considere that 10% student got grade A.

9.5| We know, $H_0 : P_1 = P_2$ vs $H_1 : P_1 \neq P_2$

Test statistic; $z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$;

$P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$P_1 = \frac{34}{85} = 0.4$, $P_2 = \frac{19}{70} = 0.2$, $P = \frac{48}{155} = 0.31$, $q = 0.69$

$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$

Since $(|z| > 1.96$, H_0 is rejected$)$.

9.6| We know, $H_0 : P_1 = P_2 = P_3 = P_4$ vs H_1: At lest one of them doesn't hold.

Test statistics,

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40$$

$$= 45.8 - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

Since,

$\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$ Ho is accepted.

Hence the propenties of defective computers of different Machinies are similar.

9.7|

Ho: Job setisfaction doesn't depend on good result.

H_1: The good result and job satifiction are asociated

We know,

$$\chi^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)} = \frac{150(22\times50 - 22\times58)^2}{80\times70\times42\times108} = 0.02$$

Since, $\chi^2 < \chi^2_1 = 3.84$. Ho is accepted.

So, Job satisfaction doesn't depend on good result.

Exercise

9.21 We need to test, $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At lest one of them doesn't hold

Here, $E_i = \frac{n}{k} = \frac{206}{4} = 51.5$

$$\chi^2 = \Sigma \frac{O_i}{E_i} - n$$

$$= \frac{1}{51.5}[50^2 + 42^2 + 32^2 + 82^2] - 206 = 27.24$$

Since, $\chi^2 > \chi^2_{k-1} = \chi^2_3 = 7.81$, so, H_1 is accepted.

Hence, the proportions of need accidents anent similar.

9.7 We need to test, $H_0: P_0 = 0.40$ vs $H_1: P_0 \neq 0.40$

$$P = \frac{a}{n} = \frac{8}{25} = 0.32$$

$P_0 = 0.40 \therefore Q = 0.60$

$$\therefore Z = \frac{P_0 - P_0}{\sqrt{\frac{P_0 q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}}$$

$$= 0.816$$

Since, $|z| < 1.96$. So H_0 is accepted.

Hence, the overall proportion of female students are 0.40 (Ans).

9.21 We need to test, $H_0: P_1 = P_2$ vs $H_1: P \neq P_2$

$P_1 = \frac{25}{100} = 0.25$

$P_2 = \frac{18}{125} = 0.144$

$P = \frac{25+18}{100+125} = 0.191$

Here,

$a_1 = 25$

$n_1 = 100$

$n_2 = 125$

$a_2 = 18$

$q = 1 - 0.191 = 0.808$

$$\therefore z = \frac{P_1 - P_2}{\sqrt{pq\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{0.25 - 0.199}{\sqrt{0.191 \times 0.808 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.018$$

Since, $|z| > 1.96$. H_0 is rejected.

9.31 H_0 : High blood pressure isn't associated with heart problem.

H_1 : High blood pressure is associated with heart problem.

$$\chi^2 = \frac{n(ad - bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550[(150 \times 158) - (120 \times 122)]^2}{270 \times 280 \times 272 \times 278}$$

B.P	Heart Problem		
	Yes	No	Total
High	150	120	270
Not High	122	158	280
Total	272	278	550

Since,

$\chi^2 > \chi^2_1 = 3.84$. So, H_1 is accepted.

9.141 We need to test,

$H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

both n_1 and n_2 are small (<30) and σ^2 is unknown.

Test statics : $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1 - 1) + t(n_2 - 1)$

$\bar{x}_1 = \dfrac{1}{n_1} \Sigma x_1 = \dfrac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\bar{x}_2 = \dfrac{1}{n_2} \Sigma x_2 = \dfrac{26500}{20} = 1325$ and $s_2^2 = 50523$

$$s_2 = \frac{(n_1 - 1) s_1^2 + (n_2 - 1) s_2^2}{(n_2 - 1) + (n_2 - 1)}$$

$$= \frac{(19 \times 5625) + (19 \times 50623)}{19 + 19}$$

$$= 31539.09$$

$$\therefore t = \frac{1125 - 1325}{\sqrt{31539.09\left(\frac{1}{15} + \frac{1}{20}\right)}}$$

$$= -3.297$$

Here,

$t = (n_1 - 1) + t(n_2 - 1)$

$t_{33} = 2.035$

Since, $|t| > t_{33} = 2.035$

So, H_0 is rejected.

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Examples.

10.2

Let, $x_1 \sim N(\mu_1, \sigma_1^2)$

$x_2 \sim N(\mu_2, \sigma_2^2)$

Also, let $\sigma_1^2 = \sigma_2^2 = \sigma^2$

We need to test, $H_0: \mu_1 = \mu_2$ vs $H_1: \mu_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is unknown.

Test statistic: $t = \dfrac{\overline{x_1} - \overline{x_2}}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t\,(n_1-1)+(n_2-1)$

$$\overline{x_1} = \frac{1}{n_1}\sum x_1 = \frac{114}{7} = 16.29$$

$$s_1^2 = \frac{1}{n_1-1}\left[\sum x_1^2 - \frac{\left(\sum x_{1i}\right)^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$$

$$\overline{x_2} = \frac{1}{n_2}\sum x_2 = \frac{163}{11} = 14.82$$

$$s_2^2 = \frac{1}{n_2-1}\left[\sum x_2^2 - \frac{\left(\sum x_{2i}\right)^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.369$$

Now,

$$s_2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)} = \frac{6(6.905)+10(15.369)}{16} = 12.192$$

$$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$$

since, $|t| < t_{16} = 2.12$,

H_0 is accepted. Employment facility for students of both universities are same.

<u>10.4</u>

We need to test,

$H_0 : P = P_0 = 0.10$ vs $H_1 : P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic : $Z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

Since $|Z| < 1.96$

H_0 is accepted. It can be considered that 10% students got grade A.

10.5

We need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

Test statistics, $Z = \dfrac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$;

$$P = \frac{a_1 + a_2}{n_1 + n_2}, \quad Q = 1 - P$$

$P_1 = \dfrac{34}{85} = 0.4 \quad P_2 = \dfrac{14}{70} = 0.2, \; P = \dfrac{48}{155} = 0.31, \; q = 0.69$

$$Z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|Z| > 1.96$, H_0 is rejected.

We conclude that gender does make a difference for drug use.

10.6

We need to test $H_0 : P_1 = P_2 = P_3 = P_4$ Vs H_1: At least one of them doesn't hold

Test statistics,

$$\chi^2 = \Sigma_i \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2 + 15^2 + 5^2 + 12^2\right] - 40$$

$$= 45.8 - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

since,

$\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$. H_0 is accepted.

Hence the properties of defective computers of different labratories are similar.

10.7

H_0: Job satisfaction doesn't depend on good result.

H_1: The good result and job satisfaction are associated.

Test statistics, $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$ ~~$= 150(22\times50)$~~

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$$= \frac{150\,(22\times 50 - 22 - 58)^2}{80\times 70\times 42\times 108} = 0.02$$

since, $\chi^2 < \chi_1^2 = 3.84$. H_0 is accepted.

So, job satisfaction doesn't depend on good result.

Exercise

10.2

We need to test, $H_0 : P_1 = P_2 = P_3 = P_4$ vs H_1 : At least one of them doesn't hold

Here, $E_i = \frac{n}{k} = \frac{206}{4} = 51.5$

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n$$

$$= \frac{1}{51.5}\left[50^2 + 42^2 + 32^2 + 82^2\right] - 206 = 27.29$$

since, $\chi^2 > \chi^2_{k-1} = \chi_3^2 = 7.81$. So, H_1 is accepted.

Hence the proportions of road accidents aren't similar.

10.7

We need to test,

$H_0 : P_0 = 0.40$ vs $H_1 : P_0 \neq 0.40$

$p = \frac{a}{n} = \frac{8}{25} = 0.32$

$P_0 = 0.40 \quad \therefore Q = 0.60$

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$$\therefore Z = \frac{p_o - P_o}{\sqrt{\frac{P_o Q_o}{n}}} = \frac{0.32-0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = -0.816$$

since $|Z| < 1.96$. So H_0 is accepted.

Hence, the overall proportion of female students are 0.40

(Ans)

<u>10.9</u>

We need to test, $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

$p_1 = \frac{25}{100} = 0.25$ $\qquad p_2 = \frac{18}{125} = 0.144$

Here,
$a_1 = 25$
$n_1 = 100$
$n_2 = 125$
$a_2 = 18$

$P = \frac{25+18}{100+125} = 0.191$

$Q = 1 - 0.191 = 0.808$

$$\therefore Z = \frac{p_1 - p_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

$$= \frac{0.25 - 0.144}{\sqrt{0.191 \times 0.808 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.011$$

Since $|Z| > 1.96$. H_0 is rejected.

10.11

H_0 : High blood pressure isn't associated with heart problem

H_1 : High blood pressure is associated with heart problem.

$$\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$$

$$= \frac{550\left[(150\times158)-(120\times122)\right]^2}{270\times280\times272\times278}$$

$= 7.897 \sim 7.90$

~~= 7.~~

B.P	Heart Problem Yes	Heart Problem No	Total
High	150	120	270
Not high	122	158	280
Total	272	278	550

since,

$\chi^2 > \chi_1^2 = 3.84$. So, H_1 is accepted.

High ~~blt~~ blood pressure is associated with heart problems.

10.14

We need to test

$H_0 : \mu_1 = \mu_2$ vs $H_1 : \mu_1 \neq \mu_2$

both n_1 and n_2 are small (<30) and σ^2 is unknown.

Test statistic : $t = \dfrac{\overline{x_1} - \overline{x_2}}{\sqrt{s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim t(n_1-1) + t(n_2-1)$

$\overline{x_1} = \frac{1}{n_1} \Sigma x_1 = \frac{16875}{15} = 1125$ and $s_1^2 = 5625$

$\overline{x_2} = \frac{1}{n_2} \Sigma x_2 = \frac{26500}{20} = 1325$ and $s_2^2 = 50625$

$s^2 = \dfrac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{(n_1-1)+(n_2-1)}$

$= \dfrac{(14 \times 5625) + (19 \times 50625)}{14+19} = 31534.09$

$\therefore t = \dfrac{1125 - 1325}{\sqrt{31534.09\left(\frac{1}{15} + \frac{1}{20}\right)}}$

$= -3.297$

$\therefore t(n_1-1)+t(n_2-1)$

$t_{33} = 2.035$

Since, $|t| > t_{33} = 2.035$

So, H_0 is rejected.

$\therefore$ Salary information are not similar.

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Example 9.2:

Let, $x_1 \sim N(\mu_1, \sigma_1^2)$, $x_2 \sim N(\mu_2, \sigma_2^2)$. ~~Also~~

Also let, $\sigma_1^2 = \sigma_2^2 = \sigma^2$.

We need to test, $H_0 : \mu_1 = \mu_2$ vs $H_1 \neq \mu_2$

Both $n_1 = 7$ and $n_2 = 11$ are small (<30) and σ^2 is not known.

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

$\bar{x}_1 = \frac{1}{n_1}\sum x_1 = \frac{114}{7} = 16.29$	$S_1^2 = \frac{1}{n_1-1}\left[\sum x_1^2 - \frac{(\sum x_1)^2}{n_1}\right] = \frac{1}{6}\left(1898 - \frac{114^2}{7}\right) = 6.905$
$\bar{x}_2 = \frac{1}{n_2}\sum x_2 = \frac{163}{11} = 14.82$	$S_2^2 = \frac{1}{n_2-1}\left[\sum x_2^2 - \frac{(\sum x_2)^2}{n_2}\right] = \frac{1}{10}\left(2569 - \frac{163^2}{11}\right) = 15.36$
$t = \frac{16.29 - 14.82}{\sqrt{12.192\left(\frac{1}{7} + \frac{1}{11}\right)}} = 0.87$	$S^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{(n_1-1)+(n_2-1)} = \frac{6(6.905)+10(15.36)}{16} = 12.19$

Since $|t| < t_{16} = 2.12$, H_0 is accepted. Employment facility for students of both universities is same.

Example 9.4

We need to test, $H_0: P = P_0 = 0.10$ vs $H_1: P \neq P_0$

Now, $p = \frac{a}{n} = \frac{2}{15} = 0.13$

Test statistic: $z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.13 - 0.10}{\sqrt{\frac{0.10 \times 0.90}{15}}} = 0.39$

Since $|z| < 1.96$, H_0 is accepted. It can be considered that 10% students got grade A.

Example: 9.5

We need to test $H_0: P_1 = P_2$ vs $H_1: P_1 \neq P_2$

Test statistic, $z = \frac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \sim N(0,1)$;

$P = \frac{a_1 + a_2}{n_1 + n_2}$, $Q = 1 - P$

$P_1 = \frac{34}{85} = 0.4$, $P_2 = \frac{14}{70} = 0.2$, $p = \frac{48}{155} = 0.31$, $q = 0.69$.

$$z = \frac{0.4 - 0.2}{\sqrt{(0.31)(0.69)\left(\frac{1}{85} + \frac{1}{70}\right)}} = 2.68$$

Since $|z| > 1.96$, H_0 is rejected. We conclude that gender does make a different for drug use.

Example 9.6:

We need to test $H_0: P_1 = P_2 = P_3 = P_4$ vs H_1: At least one of them doesn't hold.

Test statistics.

$$\chi^2 = \Sigma \frac{O^2}{E_i} - n$$

$$= \frac{1}{10}\left[8^2+15^2+5^2+12^2\right] - 40 = 5.8$$

$$E_i = \frac{n}{k} = \frac{40}{4} = 10$$

Since, $\chi^2 < \chi^2_{k-1} = \chi^2_3 = 7.81$. H_0 is accepted. Hence, the proportions of defective computers of different laboratories are similar.

Example 9.7

H_0: Job satisfaction does not depend on good result.

H_1: The good result and job satisfaction are associated.

Test statistic: $\chi^2 = \frac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)} = \frac{150(22\times50-22\times58)^2}{80\times70\times42\times108}$

$= 0.02$

Since $\chi^2 < \chi_1^2 = 3.84$, H_0 is accepted. So, job satisfaction does not depend on good result.

Exercise 9.2:

$$\chi^2 = \sum \frac{O_i^2}{E_i} - n = \frac{50^2+42^2+32^2+82^2}{\frac{206}{4}} - 206$$

$$= 27.24$$

Since $\chi^2 > \chi^2_{k-1}$ So, H_0 is not accepted.
Hence, the proportion of road accident is not similar in various highways of Bangladesh

Exercise 9.7

We need to test, $H_0: P = P_0 = 0.40$ vs $H_1: P \neq P_0$

$P = \frac{a}{n} = \frac{8}{25} = 0.32$ $\quad Q_0 = 1 - 0.40 = 0.6$

Test statistic $\left(z = \frac{p - P_0}{\sqrt{\frac{P_0 Q_0}{n}}} = \frac{0.32 - 0.40}{\sqrt{\frac{0.40 \times 0.60}{25}}} = -0.82 \right.$

Since, $|z| < 1.96$. H_0 is accepted. It can be considered that 0.40 is the overall proportion of female students in AIUB.

Exercise 9.9 :

We need to test $H_0 : P_1 = P_2$ vs $H_1 : P_1 \neq P_2$

Here, $P_1 = \frac{25}{100} = 0.25$ $\quad P_2 = \frac{18}{125} = 0.144$

$$P = \frac{25+18}{100+125} = 0.19 \quad Q = 1 - 0.19 = 0.81$$

Test statistic, $Z = \dfrac{P_1 - P_2}{\sqrt{PQ\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

$$= \frac{0.25 - 0.14}{\sqrt{0.19 \times 0.81 \left(\frac{1}{100} + \frac{1}{125}\right)}} = 2.089$$

Since, $|Z| > 1.96$, H_0 is rejected.

Exercise 9.11

Test statistic, $\chi^2 = \dfrac{n(ad-bc)^2}{(a+b)(a+c)(b+d)(c+d)}$

$$= \frac{550\left[(150 \times 158) - (120 \times 122)\right]^2}{270 \times 280 \times 272 \times 278}$$

$$= 7.89$$

Since, $\chi^2 > \chi^2 = 3.84$, H_0 is rejected

Exercise 9.14

Here, $n_1 = 15$. $n_2 = 20$

$$\bar{x}_1 = \frac{1}{n_1} \sum x_1 = \frac{16875}{15} = 1125 \quad S_1^2 = 5625$$

$$\bar{x}_2 = \frac{1}{n_2} \sum x_2 = \frac{26500}{20} = 1325 \quad S_2^2 = 50625$$

$$S^2 = \frac{(n_1-1) S_1^2 + (n_2-1) S_2^2}{(n_1-1) + (n_2-1)} = \frac{(14 \times 5625) + (19 \times 50625)}{14 + 19}$$

$$= 31534.09$$

Test statistic, $t = \dfrac{\bar{x}_1 - \bar{x}_2}{\sqrt{S_1^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$

$$= \frac{1125 - 1325}{\sqrt{31534.09\left(\frac{1}{15} + \frac{1}{20}\right)}}$$

$$= -3.29$$

$|t| > t_{33} = 2.035$,

H_1 is accepted.