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Testing Hypothesis

Solⁿ : 7) Given : $n = 14$, $\alpha = 5\% = 0.05$, $\bar{X} = 17.85$ and $S = 1.955$
$\mu = 18.5$

Solution : $H_0 : \mu = 18.5$
$H_1 : \mu \neq 18.5$

$\therefore t = \dfrac{\bar{X} - \mu}{S/\sqrt{n-1}}$ ... $(n < 30)$

$\therefore t = \dfrac{17.85 - 18.5}{1.955/\sqrt{13}}$

$\therefore t = -1.199$

$\therefore |t| = 1.99$

$\nu = n - 1 = 14 - 1 = 13$

$t_{(\alpha, \nu)} = 2.16$

$\therefore |t| < t_{(\alpha, \nu)}$

H_0 is accepted

$\therefore \mu = 18.5$

There is no significant result of the experiment.

Solⁿ : 11) Given : $n = 100$, $\bar{X} = 16.5$, $\sigma = 37.21$, $\mu = 15$
$\alpha_1 = 5\% = 0.05$, $\alpha_2 = 1\% = 0.01$

Solution : $H_0 : \mu = 15$
$H_1 : \mu \neq 15$

$Z = \dfrac{\bar{X} - \mu}{\sigma/\sqrt{n}}$ ... $(n > 30)$

$\therefore Z = \dfrac{16.5 - 15}{37.21/\sqrt{100}}$

$\therefore Z = 0.403$

$\therefore |Z| = 0.403$

(i) $\alpha_1 = 0.05$, $Z_\alpha = 0.019$

$|Z| > Z_\alpha$

H_0 is rejected

$\therefore \mu \neq 15$

The sample is not considered to be drawn from the population with mean 15 at 5% L.O.S

(ii) For $\alpha = 0.01$, $Z_\alpha = 0.004$

$|Z| > Z_\alpha$

H_0 is rejected

$\therefore \mu \neq 15$

The population is not considered to be drawn from the population with mean 15 at 1% L.O.S

Sol^n:17) Given :

Pig	1	2	3	4	5	6	7	8	T
Food A	49	53	51	62	47	50	52	53	407
Food B	52	55	52	53	50	54	54	53	423
X	-3	-2	-1	-1	-3	-4	-2	0	-16
$X+2$	-1	0	1	1	-1	-2	0	2	
$(X+2)^2$	1	0	1	1	1	4	0	4	12

Solution : $H_0: \mu = 0$

$H_1: \mu > 0$

$\mu < 0$

$t = \dfrac{\bar{X} - \mu}{S/\sqrt{n-1}}$ ... $(n < 30)$

$t = \dfrac{-2-0}{S/\sqrt{7}}$

$t = \dfrac{-2\sqrt{7}}{S}$

$S = \sqrt{\dfrac{\Sigma(x-\bar{x})^2}{n}}$

$S = \sqrt{\dfrac{12}{8}} = 1.225$

$\therefore t = \dfrac{-2\sqrt{7}}{1.225} = -4.319$

$|t| = 4.319$

$\alpha = 0.05$, $\nu = n - 1 = 7$

$t_{(0.05, 7)} = 2.998$ ... (one-tailed)

$|t| > t_{(\alpha, \nu)}$

H_0 is rejected

Food B is better than Food A

Sol^n: 21) $n = 220$, $\alpha = 5\% = 0.05$

	I	II	III	T
Y	43	20	37	100
N	23	57	40	120
T	66	77	77	220

Observed

	I	II	III	T
Y	30	35	35	100
N	36	42	42	120
T	66	77	77	220

Expected

O	43	20	37	23	57	40	
E	30	35	35	36	42	42	
$O-E$	13	-15	2	-13	15	-2	
$(O-E)^2$	169	225	4	169	225	4	
$\frac{(O-E)^2}{E}$	5.634	6.429	0.114	4.695	5.357	0.095	$\Sigma = 22.234$

H_0 : There is no association between opinion and class

H_1 : There is an association between opinion and class

$$\chi^2 = \Sigma\left[\frac{(O-E)^2}{E}\right] = 22.234$$

$\alpha = 0.05$, $\nu = (r-1)(c-1) = (2-1)(3-1) = 2$

$$\chi^2_{(\alpha,\nu)} = 5.991$$

$$\chi^2 > \chi^2_{(\alpha,\nu)}$$

H_0 is rejected.

There is an association between opinion and class in college.

Large Sample Test :

Sol^n: 5) Given : $n_1 = 1000$, $n_2 = 2000$

$\overline{X_1} = 67.5$, $\overline{X_2} = 68$

$\sigma = 2.5$, $\alpha = 1\% = 0.01$

Solution : $H_0 : \mu = 0$

$H_1 : \mu \neq 0$

$$Z = \frac{\overline{X_1} - \overline{X_2}}{\cancel{\sigma / \sqrt{n_1 + n_2 - 2}}\ S.E}$$

$$Z = \frac{67.5 - 68}{\cancel{2.5 / \sqrt{1000 + 2000 - 2}}\ S.E}$$

$$S.E. = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$= \sigma \times \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

$$= 2.5 \times \sqrt{\frac{1}{1000} + \frac{1}{2000}}$$

$$= 0.097$$

$$Z = \frac{67.5 - 68}{0.097} = -5.15$$

$\therefore |z| = 5.15$

$\alpha = 0.01$, ~~$z = n_1$~~

$Z_\alpha = 0.004$

$|z| > Z_\alpha$

H_0 is rejected

The two samples are not drawn from population with $\sigma = 2.5$ inches.

Sol^n: 8) Given : $n_1 = 8$, $n_2 = 10$

$\overline{X_1} = 950$, $\overline{X_2} = 1000$

$\sigma_1 = 80$, $\sigma_2 = 100$

Solution : $H_0 : \mu = 0$

$H_1 : \mu \neq 0$

$$Z = \frac{\overline{X_1} - \overline{X_2}}{S.E.}$$

$$S.E. = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

$$= \sqrt{\frac{(80)^2}{8} + \frac{(100)^2}{10}}$$

$$S.E. = 42.426$$

$$Z = \frac{950 - 1000}{42.426}$$

$$Z = -1.179$$

$\therefore |Z| = 1.179$

$\alpha = 0.05$

$Z_{0.05} = 0.019$

$|Z| > Z_\alpha$

H_0 is rejected

The population does not have same mean

Small Sample Test :

Solⁿ : 16) Given : $n_1 = 8$, $\bar{X}_1 = 166.9$, $S_1 = 8.29$

$n_2 = 6$, $X_2 = 170.3$, $S_2 = 8.5$

$\alpha = 5\% = 0.05$

Solution : $H_0 : \mu = 0$

$H_1 : \mu > 0$, $\mu < 0$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{S.E.} \quad \ldots (n < 30)$$

$$S.E. = S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

$$S_p = \sqrt{\frac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2}}$$

$$S_p = \sqrt{\frac{8(8.29)^2 + 6(8.5)^2}{12}}$$

$$S_p = 9.062$$

$$S.E. = 9.062\sqrt{\frac{1}{8} + \frac{1}{6}}$$

$$S.E. = 4.889$$

$$t = \frac{166.9 - 170.3}{4.889} = -0.695$$

$\therefore |t| = 0.695$

$\alpha = 0.05$, $\nu = n_1 + n_2 - 2 = 12$

$\therefore t_{(\alpha, \nu)} = 2.681$ ... (One-tailed)

$|t| < t_{(\alpha, \nu)}$

$\therefore$ H_0 is accepted

The soldiers and sailors are equal in height in general

Confidence limit at 95% = $0 \pm 4.889 \times 2.681$

Confidence limit at 95% = $(-13.107, 13.107)$

Sol: 17) $n_1 = 6, \quad n_2 = 6$

$\overline{X_1} = 13.55, \overline{X_2} = 10.1$

$S_1 = 3.2, \quad S_2 = 2.8$

$\alpha = 5\% = 0.05$

Solution : $H_0 : \mu = 0$

$H_1 : \mu \neq 0$

$$t = \frac{\overline{X_1} - \overline{X_2}}{S.E.}$$

$$S.E. = S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

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

$$S_p = \sqrt{\frac{5(3.2)^2 + 5(2.8)^2}{8}}$$

$S_p = 3.362$

$$S.E. = 3.362 \sqrt{\frac{1}{6} + \frac{1}{6}}$$

$\therefore S.E. = 1.941$

$$t = \frac{13.55 - 10.1}{1.941} = 1.777$$

$\therefore |t| = 1.777$

$\nu = n_1 + n_2 - 2 = 8$

$t_{(\alpha, \nu)} = 2.306$

$|t| < t_{(\alpha, \nu)}$

H_0 is accepted

There is no significant difference in mean period of two drugs

Sol^n:20) Given : $n = 8$, $\alpha = 0.05$

X	-4	-2	-2	0	2	2	3	3	$\Sigma = 2$
$X - 0.25$	-4.25	-2.25	-2.25	-0.25	1.75	1.75	2.75	2.75	
$(X-0.25)^2$	18.0625	5.0625	5.0625	0.0625	3.0625	3.0625	7.5625	7.5625	$\Sigma = 49.5$

Solution : $H_0 : \mu = 0$

$H_1 : \mu \neq 0$, $\mu > 0$

$t = \dfrac{\bar{X} - \mu}{S/\sqrt{n-1}}$ ... $(n < 30)$

$S = \sqrt{\dfrac{\Sigma (X - \bar{X})^2}{n}}$

$\therefore S = \sqrt{\dfrac{49.5}{8}} = 2.487$

$\therefore t = \dfrac{2 - 0}{2.487} = 0.804$

$\therefore |t| = 0.804$

$\nu = n - 1 = 7$

$t_{(\alpha, \nu)} = 2.365$

$|t| < t_{(\alpha, \nu)}$

H_0 is accepted

There is no significant difference

Sol^n:19) Given : $n = 12$, $\alpha = 0.05$

X	5	2	8	-1	3	0	6	-2	1	5	0	4	
$X - 2.584$	2.416	-0.584	5.416	-3.584	0.416	-2.584	3.416	-4.584	-1.584	2.416	-2.584	1.416	
$(X-2.584)^2$	5.837	0.341	29.333	12.845	0.173	6.677	11.669	21.013	2.509	5.837	6.677	2.005	$\Sigma = 104.916$

Solution : $H_0 : \mu = 0$

$H_1 : \mu \neq 0$

$$t = \frac{\bar{x} - \mu}{s/\sqrt{n-1}} \quad \ldots (n<30)$$

$$S = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n}}$$

$$S = \sqrt{\frac{104.916}{12}} = 2.957$$

$$t = \frac{2.584 - 0}{\frac{2.987}{\sqrt{11}}} = 2.869$$

$$\nu = n - 1 = 11$$

$$t_{(\alpha,\nu)} = 2.206$$

$$|t| > t_{(\alpha,\nu)}$$

H_0 is rejected

There will be an increase in the blood pressure.

Non-parametric test :

Soln : 27)

	Favorable	Non-favourable	Total
New	60	30	90
Conventional	40	70	110
Total	100	100	200

	Favorable	Non-favorable	Total
New	45	45	90
Conventional	55	55	110
Total	100	100	200

O	60	30	40	70	
E	45	45	55	55	
O-E	15	-15	-15	15	
$(O-E)^2$	225	225	225	225	
$\frac{(O-E)^2}{E}$	5	5	4.091	4.091	$\Sigma = 18.182$

H_0 : There is no association

H_1 : There is an association

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

$\therefore \chi^2 = 18.182$

$\alpha = 0.05$, $\gamma = (r-1)(c-1) = 1$

$\chi^2_{(0.05,1)} = 3.841$

$\chi^2 > \chi^2_{(\alpha,\gamma)}$

H_0 is rejected

There is an association between conventional and new treatment

Soln: 24)

	Attacked	Not-attacked	Total
Inoculated	20	300	320
Non-Inoculated	80	600	680
Total	100	900	1000

	Attacked	Non-Attacked	Total
Inoculated	32	288	320
Non-Inoculated	68	612	680
Total	100	900	1000

O	20	300	80	600	
E	32	288	68	612	
O-E	-12	12	12	-12	
$(O-E)^2$	144	144	144	144	
$\frac{(O-E)^2}{E}$	4.5	0.5	2.118	0.235	$\Sigma = 7.353$

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

$\chi^2 = 7.353$

$\alpha = 0.05$, $\nu = (r-1)(c-1) = 1$

$\chi^2_{(0.05,1)} = 3.841$

$\chi^2 > \chi^2_{(\alpha,\nu)}$

H_0: There is no effect

H_1: There is an effect

H_0 is rejected

There is an effect of inoculation.

Goodness of fit

Sol^n: 29) Given:

No. of mistakes	0	1	2	3	4
No. of pages	211	90	19	5	0

Solution:

(x)	No. of mistakes	0	1	9	
(f)	No. of pages	211	90	24	
	xf	0	90	216	
	E	126.7	119.35	56.21	
	$f-E$	84.3	-29.35	-32.21	
	$(f-E)^2$	7106.49	861.42	1037.48	
	$\frac{(f-E)^2}{E}$	56.09	7.22	18.46	81.77

$$m = \frac{\Sigma xf}{\Sigma f} = 0.942$$

By Poisson's distribution

$$P(x) = \frac{e^{-m} \cdot m^x}{x!}$$

$$E = \Sigma f \times \frac{e^{-m} \cdot m^x}{x!} = 325 e^{-0.942} \frac{(0.942)^x}{x!} = 126.7 \frac{(0.942)^x}{x!}$$

$$\chi^2 = \Sigma \left[\frac{(O-E)^2}{E}\right] = 81.77$$

$\alpha = 0.05$, $\nu = 5-(2+2) = 1$

$\chi^2_{(0.05, 1)} = 3.841$

H_0 : There is goodness of fit

H_1 : There is no goodness of fit

$\chi^2 > \chi^2_{(\alpha,\nu)}$, H_0 is rejected.

There is no goodness of fit

Sol^n: 28)

Given:

O	1	12	66	220	495	792	924	792	945	220	66	12	1
E	2	15	66	210	484	799	943	799	484	210	66	15	2

Solution:

O	13	66	220	495	792	924	792	220	66	13
E	17	66	210	484	799	943	799	210	66	17
O−E	-4	0	10	11	−7	−19	−7	10	0	-4
$(O-E)^2$	16	0	100	121	49	361	49	100	0	16
$\frac{(O-E)^2}{E}$	0.941	0	0.476	0.25	0.061	0.382	0.624	0.476	0	0.941

H_0 : There is a goodness of fit

H_1 : There is no goodness of fit

$\chi^2 = \sum\left[\frac{(O-E)^2}{E}\right] = 4.151$

$\alpha = 0.05$, $\nu = 12-(3+2) = 7$

$\chi^2_{(0.05,7)} = 14.067$

$\chi^2 < \chi^2_{(0.05,7)}$

H_0 is accepted

There is goodness of fit