

Randomized ANOVA Table / Two way classification

Source of variation	Sum of Square	Dof	Mean Square	F Ratio
Between column	SSC	$\gamma_1 = C-1$	$MSC = \frac{SSC}{C-1}$	$F_C = \frac{MSC}{MSE} \Rightarrow \frac{MSE}{MSC}$
Between Row	SSR	$\gamma_2 = R-1$	$MSR = \frac{SSR}{R-1}$	$F_R = \frac{MSR}{MSE} \Rightarrow \frac{MSE}{MSR}$
Between Error	SSE	$\gamma = (C-1)(R-1)$	$MSE = \frac{SSE}{(C-1)(R-1)}$	

$$T = \sum x_1 + \sum x_2 + \sum x_3 + \sum x_4$$

$$CF = \frac{T^2}{N}$$

$$TSS = \sum x_1^2 + \sum x_2^2 + \sum x_3^2 + \sum x_4^2 - CF$$

$$SSC = \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} + \frac{(\sum x_3)^2}{n_3} + \frac{(\sum x_4)^2}{n_4} - CF$$

$$SSR = \frac{(\sum y_1)^2}{n'_1} + \frac{(\sum y_2)^2}{n'_2} + \frac{(\sum y_3)^2}{n'_3} + \frac{(\sum y_4)^2}{n'_4} - CF$$

$$SSE = TSS - SSC - SSR$$

J. Three varieties A, B, C of a crop are tested by a randomized block design with 4 replications. The plot yields in pounds are as follows.

A	6	C	5	A	8	B	9
C	8	A	4	B	6	C	9
B	7	B	6	C	10	A	6

Analysis the experimental yield and state your conclusion.

Soln.

varieties

A	6	4	8	6			
B	7	6	6	9			
C	8	5	10	9			
x_1	x_2	x_3	x_4	x_1^2	x_2^2	x_3^2	x_4^2
y_1	6	4	8	36	16	64	36
y_2	7	6	6	49	36	36	81
y_3	8	5	10	64	25	100	81

Σx_1	15	24	24	149	77	200	198
Σx_2				Σx_1^2	Σx_2^2	Σx_3^2	Σx_4^2

Step 1:

H_0 : There is no significant difference b/w yields and varieties.

H_1 : There is a significant difference b/w yields and varieties.

Step 2:

To find N & T

$$N = n_1 + n_2 + n_3 + n_4 = 3 + 3 + 3 + 3 = 12$$

$$T = \sum x_1 + \sum x_2 + \sum x_3 + \sum x_4 = 21 + 15 + 24 + 24 = 84$$

Step 3:

Correction factor

$$CF = \frac{T^2}{N} = \frac{84^2}{12} = 588$$

Step 4:

$$TSS = \sum x_1^2 + \sum x_2^2 + \sum x_3^2 + \sum x_4^2 - CF$$

$$= 149 + 97 + 200 + 198 - 588$$

$$= 36$$

Step 5:

$$SSC = \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} + \frac{(\sum x_3)^2}{n_3} + \frac{(\sum x_4)^2}{n_4} - CF$$

$$= \frac{(21)^2}{3} + \frac{(15)^2}{3} + \frac{(24)^2}{3} + \frac{(24)^2}{3} - 588$$

$$= 18$$

$$SSR = \frac{(\sum y_1)^2}{h_1'} + \frac{(\sum y_2)^2}{h_2'} + \frac{(\sum y_3)^2}{h_3'} - CF$$

$$= \frac{(24)^2}{4} + \frac{(28)^2}{4} + \frac{(32)^2}{4} - 588$$

$$= 8$$

Step 6:

$$SSE = TSS - SSC - SSR$$

$$= 36 - 18 - 8$$

$$= 10$$

Step 7:

ANOVA Table

Source of variation	Sum of Squares	Degrees of freedom	Mean sum of squares	F-ratio
Between column	SSC = 18	C-1 = 4-1 = 3	MSC = $\frac{18}{3} = 6$	$F_c = \frac{6}{1.6} = 3.75$ $F_{\alpha}(3,6) = 4.7$
Between row	SSR = 8	R-1 = 3-1 = 2	MSR = $\frac{8}{2} = 4$	$F_R = \frac{4}{1.6} = 2.5$ $F_{\alpha}(2,6) = 5$
Error	SSE = 10	(C-1)(R-1) = 3*2 = 6	MSE = $\frac{10}{6} = 1.6$	

Step 8:

Conclusion:

$F_c = 3.75 < 4.76 = F_{\alpha}$, H_0 is accepted

$F_R = 2.5 < 5.14 = F_{\alpha}$, H_0 is accepted.

\therefore There is no significance difference b/w yields & varieties.

Q7. A Tea Company appoints 4 Salesman A, B, C, D observe their sales in 3 seasons Summer, winter and monsoon.

Seasons	Salesman				Season Total
	A	B	C	D	
Summer	38 max (36)	35	21 min	35	128
Winter	28	29	31	32	120
Monsoon	26	28	29	29	112
Salesman Total	90	93	81	96	360

i). Do the Salesman Performance

ii). Is the significance difference b/w Season

Soln.

Disguise: $x_{ij} - 29$

	A	B	C	D	Season total
Summer	7	7	-8	6	12
winter	-1	0	2	3	4
monsoon	-3	-1	0	0	-4
Salesman total	3	6	-6	9	12

	x_1	x_2	x_3	x_4	total	x_1^2	x_2^2	x_3^2	x_4^2
y_1	7	7	-8	6	12	49	49	64	36
y_2	-1	0	2	3	4	1	0	4	9
y_3	-3	-1	0	0	-4	9	0	0	0
	3	6	-6	9	12	59	50	68	45
	Σx_1	Σx_2	Σx_3	Σx_4		Σx_1^2	Σx_2^2	Σx_3^2	Σx_4^2

Step 1:

H_0 : There is no significance difference b/w Salesman

H_1 : There is a significance difference b/w Season

Step 2:

$$T = \Sigma x_1 + \Sigma x_2 + \Sigma x_3 + \Sigma x_4$$

$$T = 12$$

$$N = n_1 + n_2 + n_3 + n_4 = 3 + 3 + 3 + 3 = 12$$

Step 3:

$$CF = \frac{T^2}{N} = \frac{(12)^2}{12} = 12$$

Step 4:

$$TSS = \sum x_1^2 + \sum x_2^2 + \sum x_3^2 + \sum x_4^2 - CF$$

$$= 59 + 50 + 68 + 45 - 12$$

$$= 210$$

Step 5:

$$SSC = \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} + \frac{(\sum x_3)^2}{n_3} + \frac{(\sum x_4)^2}{n_4} - CF$$

$$= \frac{3^2}{3} + \frac{6^2}{3} + \frac{(6)^2}{3} + \frac{9^2}{3} - 12$$

$$= 42$$

Step 6:

$$SSR = \frac{(\sum y_1)^2}{n_1'} + \frac{(\sum y_2)^2}{n_2'} + \frac{(\sum y_3)^2}{n_3'} - CF$$

$$= \frac{(12)^2}{4} + \frac{(4)^2}{4} + \frac{(4)^2}{4} - 12$$

$$= 32$$

Step 7:

$$SCE = TSS - SSC - SSR$$

$$= 210 - 42 - 32$$

$$= 136$$

Step 7: ANNOVA Table

Source of Variation	Sum of Squares	df	Mean Square	F-ratio
Between columns	SSC = 42	C-1 = 4-1 = 3	MSC = $\frac{42}{3} = 14$	$F_C = \frac{22.6}{14} = 1.61$ $F_{\alpha}(6, 3) = 8.94$
Between Row	SSR = 32	R-1 = 3-1 = 2	MSR = $\frac{32}{2} = 16$	$F_R = \frac{22.6}{16} = 1.41$ $F_{\alpha}(6, 2) = 19.33$
Between Error	SCE = 136	(C-1)*(R-1) = 3*2 = 6	MSE = $\frac{136}{6} = 22.6$	

Step 8:

Conclusion:

$F_c = 1.61 < F_{\alpha} = 8.94$, H_0 is accepted

$F_R = 1.41 < F_{\alpha} = 19.33$, H_0 is accepted

\therefore There is no significance difference
Sales mans. good seasons

HW. The yield of 4 strains of a particular variety of wheat was planted in 5 random blocks in tgs per plots is gm. below.

		Blocks				
		1	2	3	4	5
Strains	A	32	34	34	35	36
	B	33	33	36	37	34
	C	30	35	35	32	35
	D	29	22	30	28	28

Test for difference b/w blocks & difference b/w strains. (Take $x_{ij} - 30$)

$T = 48, N = 20, CF = 115.2, TSS = 252.8$

$BSS = 27.9, BSR = 170.4, SSE = 55.1 \rightarrow H_0$ is accepted

Row $\rightarrow H_0$ is accepted

Q. 5 doctors each test treatments for a certain disease & observe the no. of days each takes to recover. The results are as follows.

Doctors	Treatments				
	1	2	3	4	5
A	10	14	23	19	20
B	11	15	24	17	21
C	9	12	20	16	19
D	8	13	17	17	20
E	12	15	19	15	22

Discuss the diff. b/w a) doctors b) Treatment

$$DF = 2.56,$$

$$TSS = 471.44$$

$$SSC = 407.44$$

$$SSR = 27.44$$

$$SSE = 36.56$$

$$MSC = 101.86 \quad F_C = 3$$

$$MSR = 6.86 \quad F_R = 44.58$$

$$MSE = 2.285$$

b].

	Det A	Det B	Det C
water temp			
cold	57	55	67
warm	49	52	<u>68</u>
hot	54	<u>46</u>	58