

LATIN SQUARE:**Steps in constructing Latin Square****Step:1**

Square the Grand total (T) and divide it by the number of observations (N).

i.e), Find $\frac{T^2}{N}$ which is called the correction factor (C.F)

Step:2

Add the squares of the individual observations (X_i 's) and subtract the C.F from it to get the total sum of squares. i.e), Find Total sum of squares TSS

$$\text{i.e), TSS} = \sum_i (X_i)^2 - \frac{T^2}{N}$$

Step:3

Add the squares of the row sums (R_i) divide it by the number of items in a row and subtract the C.F from the result to get the row sum of squares.

$$\text{Row sum of squares } SSR = \frac{(\sum R_i)^2}{n_1} - C.F$$

Where n_1 is the number of items in a row.

Step:4

Add the squares of the columns sums (C_i) divide it by the number of items and subtract the C.F from the result to get the column sum of squares.

$$\text{Column sum of squares } SSC = \frac{(\sum C_j)^2}{n_2} - C.F$$

Where n_2 is the number of items in a column.

Step:5

Sum of the squares of the treatment sums (T_i) divide it by the number of treatments and subtract the C.F from it to get the treatment sum of squares, i.e., Treatment sum of squares.

$$SST = \frac{(\sum T_i)^2}{n_i} - C.F$$

Where n_i is the number of treatments.

Step:6

Subtract the sum obtained in steps 3, 4, and 5 from 2 we get residual.

i.e., Residual $SSE = TSS - (SSR + SSC + SST)$

Step:7

Prepare the ANOVA table using all these and calculate the various mean squares as follows.

Source of variation	Sum of Degrees	Degrees of Freedom	Mean Square	F - Ratio
Between Rows	SSR	$n - 1$	$MSR = \frac{SSR}{n-1}$	$F_R = \frac{MSR}{MSE}$ if $MSR > MSE$ $F_R = \frac{MSE}{MSR}$ if $MSE > MSR$
Between Columns	SSC	$n - 1$	$MSC = \frac{SSC}{n-1}$	$F_c = \frac{MSC}{MSE}$ if $MSC > MSE$ $F_c = \frac{MSE}{MSC}$ if $MSE > MSC$
Treatments	SST	$n - 1$	$MST = \frac{SST}{n-1}$	$F_T = \frac{MST}{MSE}$ if $MST > MSE$ $F_T = \frac{MSE}{MST}$ if $MSE > MST$
Residual or Error	SSE	$(n - 1)(n - 2)$	$MSE = \frac{SSE}{(n - 1)(n - 2)}$	

Step:8

Compute the F-ratio and find out whether the differences are significant or not according to the given level of significance.

1. Set up the analysis of variance for the following results of a Latin square design.

A 12	C 19	B 10	D 8
C 18	B 12	D 6	A 7
B 22	D 10	A 5	C 21
C 12	A 7	C 27	B 17

Solution:

Set the null hypothesis H_0 : There is no significance difference between the rows, columns and treatments.

Table I (To find TSS, SSR and SSC)

	C_1	C_2	C_3	C_4	Row Total R_i	$R_i^2/4$
R_1	12	19	10	8	49	600.25
R_2	18	12	6	7	43	462.25
R_3	22	10	5	21	58	841
R_4	12	7	27	17	63	992.25
Column Total C_j	64	48	48	53	213 (T)	2895.75
$C_j^2/4$	1024	576	576	702.25	2895.75	$\sum R_i^2/4$
					$\sum C_j^2/4$	

Table II (To find SST)

	1	2	3	4	Row Total T_i	$T_i^2/4$
A	12	7	5	7	31	240.25
B	10	12	22	17	61	930.25
C	19	18	21	27	85	1806.25
D	8	6	10	12	36	324
						3300.75 = $\sum T_i^2/4$

Step:1

Grand total (T) =213

Step:2

Correction factor (C.F) = $\frac{T^2}{N} = \frac{(213)^2}{16} = 2835.56$

Step:3

Sum of squares of individual observations

$$\begin{aligned}
 &= (12)^2 + (7)^2 + (5)^2 + (7)^2 + (10)^2 + (12)^2 + (22)^2 + (17)^2 + \\
 &\quad (19)^2 + (18)^2 + (21)^2 + (27)^2 + (8)^2 + (6)^2 + (10)^2 + (12)^2 \\
 &= 3483
 \end{aligned}$$

Step:4

TSS = sum of squares of individual observations – C.F

$$= \sum_i (X_i)^2 - \frac{T^2}{N} = 3486 - 2835.56 = 647.44$$

Step:5

Row sum of squares $SSR = \frac{(\sum R_i)^2}{4} - C.F = 2895.75 - 2835.56 = 60.19$

Step:6

Column sum of squares $SSC = \frac{(\sum C_j)^2}{4} - C.F = 2878.25 - 2835.56$
 $= 42.69$

Step:7

Sum of squares of Treatment

$$SST = \frac{(\sum T_i)^2}{n_i} - C.F = 3300.75 - 2835.56 = 465.19$$

Step:8

Residual $SSE = TSS - (SSR + SSC + SST)$
 $= 647.44 - (60.19 + 42.69 + 465.19) = 79.37$

Step:9

Prepare the ANOVA table using all these and calculate the various mean squares as follows.

Source of variation	Sum of Degrees	Degrees of Freedom	Mean Square	F - Ratio
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Between Rows	SSR=60.19	$4 - 1 = 3$	$MSR = \frac{SSR}{n-1} = 20.06$	$F_R = \frac{MSR}{MSE} = 1.52$
Between Columns	SSC=42.69	$4 - 1 = 3$	$MSC = \frac{SSC}{n-1} = 14.23$	$F_C = \frac{MSC}{MSE} = 1.08$
Treatments	SST=465.19	$4 - 1 = 3$	$MST = \frac{SST}{n-1} = 155.06$	$F_T = \frac{MST}{MSE} = 11.73$
Residual or Error	SSE=79.37	$(4 - 1)(4 - 2) = 6$	$MSE = \frac{SSE}{(n - 1)(n - 2)} = 13.22$	

Step: 10

d.f for (3, 6) at 5% level of significance is 4.76

Step: 11 Conclusion:

Calculated value $F_C < \text{Table value}$, then we accept null hypothesis.

There is no significance difference between the columns.

Calculated value $F_R < \text{Table value}$, then we accept null hypothesis.

There is no significance difference between the rows.

Calculated value $F_T > \text{Table value}$, then we reject null hypothesis.

There is a significance difference between the rows.