

Completely randomized design (CRD)

The complete random design (CRD) is one of the simplest and easiest experimental designs for planning and analysis. CRD is often used when the experimental units are homogeneous, that is, the differences between them are very small, and the levels of the treatments to be studied must be distributed in a completely random way, that is, without a specific system. For the CRD, any difference among experimental units receiving the same treatment is considered as experimental error. Hence, CRD is appropriate only for experiments with homogeneous experimental units, such as laboratory experiments, where environmental effects are relatively easy to control. For field experiments, where there is generally large variation among experimental units in such environmental factors as soil, the CRD is rarely used.

Advantages of a CRD

- 1) Its layout is very easy.
- 2) There is complete flexibility in this design.
- 3) This design yields maximum degrees of freedom for experimental error.
- 4) If some values are missing the analysis can be done.

Disadvantages of a CRD

- 1) It is difficult to find homogeneous experimental units in all respects.
- 2) It is less accurate than other designs.

Layout of a CRD

Completely randomized Design is the one in which all the experimental units are taken in a single group which are homogeneous as far as possible. The randomization procedure for allotting the treatments to various units will be as follows:

Step 1: Determine the total number of experimental units.

Step 2: Assign a number to each of the experimental units starting from left to right for all rows.

Step 3: Assign the treatments to the experimental units by using random numbers.

The statistical model for CRD

$$Y_{ij} = \mu + t_i + e_{ij}$$

Y_{ij} = an observation

μ = overall mean effect

t_i = true effect of the (T_i) treatment

e_{ij} = error term of the (Y_j) unit receiving (i) treatment

i = a particular treatment

j = a particular replicate

	Y1	Y2	Y3	ΣT
T1	y11	y12	y13	$\Sigma T 1$
T2	y21	y22	y23	$\Sigma T 2$
T3	Y31	Y32	Y33	$\Sigma T 3$
Total				Y..

The null hypothesis will be

- $H_0: \mu_1 = \mu_2 = \dots = \mu_j$ or There is no significant difference between the treatments.

And the alternative hypothesis is

- $H_1: \mu_1 \neq \mu_2 \neq \dots \neq \mu_j$. There is significant difference between the treatments.

The ANOVA TABLE

The analysis of variance (ANOVA) is the most widely used method of statistical analysis of quantitative data. It calculates the probability that differences among the characteristics studied appeared by the chance. Every scientist should know how to use it.

It is closely related to Student's t-test, but while the t-test is only suitable for comparing two treatment means, but the ANOVA can be used both for comparing several means and in more complex situations.

The ANOVA OF CRD partitions the total variation into a number of parts such as Treatment, Error and Total.

The steps in forming the analysis of variance table for a CRD are:

1) Correction Factor (CF)

$$CF = \frac{Y_{..}}{N}$$

2) Sum of Squares for treatments (SSt)

$$SSt = \sum \frac{T_i^2}{r} - CF$$

3) Total Sum of Squares (TSS)

$$TSS = \sum y_{ij}^2 - CF$$

4) Sum of Squares for Error (SSe)

$$SSe = TSS - SSt$$

5) degree of freedom (df)

$$dft = T-1$$

$$dfT = N-1$$

$$dfe = dfT - dft$$

6) Mean Sum of Squares for treatment (MSt)

$$MSt = SSt / dft$$

7) Mean Sum of Squares for Error (MSe)

$$MSe = SSe / dfe$$

8) F calculated : The test statistic, used in testing the equality of treatment

$$F \text{ cal.} = MSt / MSe$$

9) We make a comparison between the value of (f cal) and the value of (f tab), If the (f cal) value is greater than the (f tab) value that means there are significant differences between the treatments. And vice versa.

* A Significant Difference between two groups or two points in time means that there is a different between the groups. Statistically, the probability of difference by chance is very small (usually less than 5%).

Ex. / In the following table, the weights of a animals group, they were given a feed containing five levels of a particular vitamin. Find if there are any significant differences between these levels? (f table(5%)= 3.84).

treatment	R1	R2	R3	T_i
T1	29	28	29	86
T2	33.5	31.5	29	94
T3	26.5	30	-----	56.5
T4	48.5	46.5	49	144
T5	34.5	31	-----	65.5
Total				(Y..) 446

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<i>Source of variation</i>	<i>Degree of freedom (df)</i>	<i>Sum of squares (SS)</i>	<i>Mean square</i>	<i>F cal.</i>
Treatment	t - 1	SSt	MST	$\frac{MST}{MSE}$
Error	dfT- dft	SSE	MSE	
Total	n - 1	SST		

$$CF = \frac{Y..}{N}$$

$$\frac{(446)^2}{13} = 15301.23$$

$$TSS = \sum y_{ij}^2 - CF$$

$$\left[\frac{(86)^2}{3} + \frac{(94)^2}{3} + \dots + \frac{(65.5)^2}{2} \right] - 15301.23$$

$$= 762.69$$

$$\begin{aligned} \text{TSS} &= \sum y_{ij}^2 - \text{CF} \\ &= [(29.0)^2 + (28.0)^2 + \dots + (31.0)^2] - 15301.23 \\ &= 789.27 \end{aligned}$$

$$\begin{aligned} \text{SSe} &= \text{TSS} - \text{SSt} \\ &= 789.27 - 762.69 = 26.58 \end{aligned}$$

Source of variation	Degree of freedom	Sum of squares	Mean square	<i>F</i> cal	<i>F</i> table 5%
Treatment	4	762.69	190.67	57.38*	3.84
Error	8	26.58	3.32		
Total	12	789.27			