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Meaning and Application of Analysis of Variance

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Abstract:
This paper presents the meaning and application of Analysys of Variance developed by R.A. Fisher. ANOVA is a statistical method that separates observed variance data into difference non-negative components. The basic purpose of ANOVA is to test the homogeneity of several means by making the use of F-test.

Keywords: Assignable causes, Chance causes, Variation, Treatments and Yield.

Meaning of Analysis of Variance

Variation is inherent in nature. The total variation in any set of numerical data is due a number of causes may be classified as:

(1) Assignable causes and (2) Chance causes

The variation due to assignable causes can be detected measured whereas the variation due to chance causes is beyond the control of human hand and cannot be traced separately.

For example,

Let us consider a field divided into 20 identical plots and we apply four type fertilizers to these plots. Then two yield of these different plots is recorded fertilizers wise. Thus we shall have four samples of five items each giving different yield values. The sample means i.e. the average yield of each fertilizer will differ and this variation between fertilizers or classes is called due to assignable causes (Fertilizers). Also the yield of the plots will vary even under the same fertilizer. This variation within fertilizers or classes is called due to chance causes.

Now, According to Prof. R.A. Fisher Analysis of variance is the technique by which the total variation in the sample data is expressed as the sum of its non-negative components where each of these components is measure of variation due to same specific independent sources or causes. The ANOVA consists in estimation of the amount of variation due to each of the independent factors (causes) separately and then comparing these estimates due to assignable causes with estimate due to chance causes, the latter being known as experimental error.

Total Variation = Variation due to assignable causes + Variation due to chance causes

Application of Analysis of Variance:

In statistical inference we have seen the test of significance of two means i.e. whether two samples differ significantly with respect to same property or not. In actual practice, however it often happens that move than two samples are involved in a study. For example in an agricultural experiment, five fertilizers are applied to four plots each of wheat and yield of wheat on each of plot is recorded. We are interested in finding out whether the effect these fertilizers on the yield is significantly different or in other words, whether the samples have come from the same normal population. The answer to this problem is provided by the technique of analysis of variance. Thus basic purpose of the analysis of variance is to test the homogeneity of several means (Treatments).

For the validity of F-test in ANOVA, the following assumptions are made:

(1) The observations are independent.
(2) Parent population from which observations are taken is normal.
(3) Various treatments and environmental effects are additive in nature.

Example:

The following figures relate to the production in kg of three varieties of wheat A,B and C used in 15 plots.

Variety of Wheat	**Yield (Kg)**					

A-RR-21	**14**	**17**	**16**	**16**		
B-K-68	**15**	**11**	**13**	**15**	**13**	**14**
C-SONALIKA	**18**	**16**	**18**	**19**	**15**	

Test, whether there is any significant difference in the production of three varieties or not.

H_o: There is no significant difference between the mean production of three varieties.

Table for Calculation

Variety of Wheat	Yield (kg)						Total
A-RR-21	**14**	**17**	**16**	**16**			**63**
B-K-68	**15**	**11**	**13**	**15**	**13**	**14**	**81**
C-SONALIKA	**18**	**16**	**18**	**19**	**15**		**86**

Grand Total = 63+ 81+86 = 230

Correction Factor (CF)

$= \frac{(Grand\ Total)^2}{N} = \frac{(230)^2}{15} = 3526.67$

Raw Sum of Squares (RSS)

$= 14^2 + 17^2 + \ldots\ldots\ldots + 19^2 + 15^2$

= 196 + 289 + 256 + …..+ 225

= 3592

Total Sum of Squares (TSS)

= RSS – CF

= 3592 – 3526.67

= 65.33

Variety sum of Squares (VSS)

$= \frac{63^2}{4} + \frac{81^2}{6} + \frac{86^2}{5} - CF$

= 992.25 + 1093.5 + 1479.2 – 3526.67

= 3564.95 – 3526.67

= 38.28

Sum of Square of Error (SSE)

= TSS-VSS

= 65.28 – 38.28

= 27.05

ANOVA TABLE

Sources of Variation	DF	SS	MSS	F or Variance ratio Calculated	F or Variance ratio Tabulated
Varieties	2	38.28	38.28/2 = 19.14	19.14/2.25=8.50	3.89
Error	12	27.05	27.05/12 = 2.25		
Total	14	65.33			

Conclusion: Since CalF > TabF at 5% l.o.s., we reject null hypothesis H_0. We conclude that there is a significant difference between the mean production of three varieties of Wheat.

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