Week-03-L-03

Agricultural Statistics in Practice

Analysis of Variance (ANOVA)

Two – Way ANOVA with one observation per cell

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Two – Way ANOVA

- N-Way ANOVA is used when analyzing the influence of multiple assignable causes (factors) on the response variable, where N represents the number of factors being considered (N>=2).
- Two-Way ANOVA specifically examines the impact of two factors, each with multiple categories, on the dependent (response) variable.

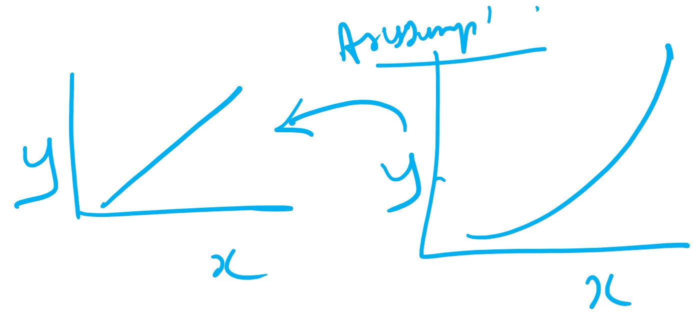
Two way classification with one observation per cell

A	B				
	B1	B2	....	Bj	....
A1	(A1B1)	(A1B2)	....	(A1Bj)	....
A2	(A2B1)	(A2B2)	....	(A2Bj)	....
:	....	....	....	:	....
:				:	....
Ai	(AiB1)	(AiB2)	....	(AiBj)	....
:	:	:	....	:	....
:	:	:	....	:	....

Two way classification with more than one observation per cell

A	B				
	B1	B2	....	Bj	....
A1	(A1B1)1 (A1B1)2 (A1B1)3	(A1B2)1 (A1B2)2 (A1B2)3	....	(A1Bj)1 (A1Bj)2 (A1Bj)3	....
A2	(A2B1)1 (A2B1)2 (A2B1)3	(A2B2)1 (A2B2)2 (A2B2)3	....	(A2Bj)1 (A2Bj)2 (A2Bj)3	....
:	....	....	....	:	....
:				:	....
Ai	(AiB1)1 (AiB1)2 (AiB1)3	(AiB2)1 (AiB2)2 (AiB2)3	....	(AiBj)1 (AiBj)2 (AiBj)3	....
:	:	:	....	:	....
:	:	:	....	:	....

ANOVA



- The Analysis of Variance (ANOVA) is based on the fundamental concept of the "Linear Model."
- Observable quantities, denoted as X1, X2, ..., Xn, can be expressed as a sum of true values (μi) and error terms (ei).
- The error terms (e_i) are assumed to be independent and normally distributed with a mean of zero and a common variance (σe_2).
- The true values (μ_i) are assumed to be composed of linear functions of t_1, t_2, ..., $t_{k,}$ referred to as "effects."
- In a linear model, if the effects (tj's) are unknown constants, the model is considered a "fixed-effect model." If the effects are random variables, it is a "random-effect model."

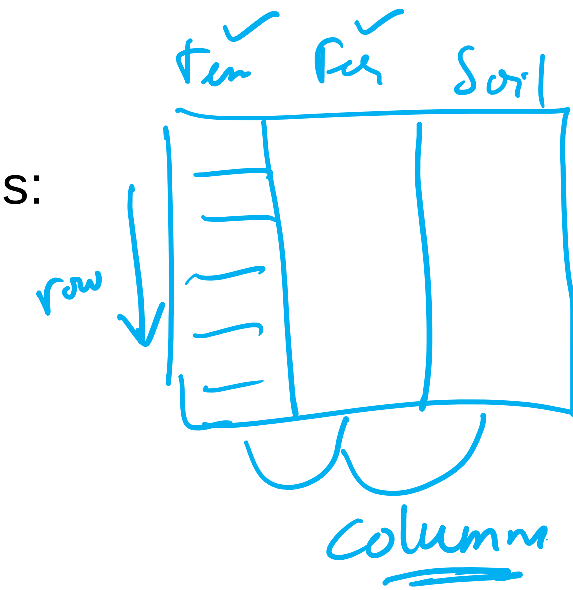
Main Effect

- The effect that an independent variable has on the dependent variable
- There is always two main effects since there will always be two independent variables or Factors of the experiment
- The Main Effect of the COL & ROW
- The null hypothesis for the Main Effect of the column is:

H_0 col: µcol 1 = µcol 2 = …. µcol k

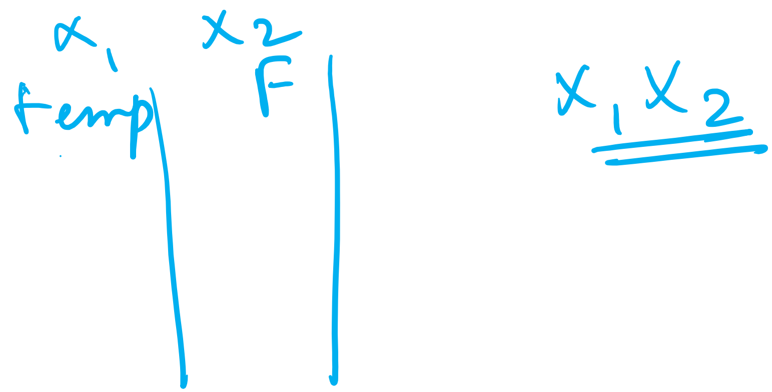
- The null hypothesis for the Main Effect of the row is:

H_0 row: µrow 1 = µrow 2 = …. µrow k



Main Effect & Interaction

- The research hypothesis for the Main Effect of the columns is: H1 col : At least one of the column samples comes from a different population distribution than the others
- The research hypothesis for the Main Effect of the rows is: H 1 row : At least one of the row samples comes from a different population distribution than the others
- Interaction is the effect of the combination of the two independent variables on the dependent variable.
- It is best seen by graphing the means of all levels of both factors.



Interaction & Source Table

- The significant interaction can be more interesting than significant Main Effects. The null hypothesis for the interaction is:
  ***H_{0rxc}* :** The effect of one independent variable (IV) on the dependent variable is unaffected by the other IV.
- The research hypothesis for the interaction is:
  ***H_{1rxc}* :** The effect of one independent variable (IV) on the dependent variable is affected by the other IV.

Variance Source	*Sum of Squares*	*Degrees of Freedom*	*Mean Square*	*F-Ratio*
Rows	SS_r	df_r	MS_r	F_r
Columns	SS_c	df_c	MS_c	F_c
Interaction	$SS_{r \times c}$	$df_{r \times c}$	$MS_{r \times c}$	$F_{r \times c}$
Within	SS_{wg}	df_{wg}	MS_{wg}	
Total	Ss_{total}	df_{total}		

Calculations

- The formulas and tabulations for Two-Way ANOVA involve calculating sums of squares, degrees of freedom, mean squares, and conducting hypothesis tests.
- Here are the steps:

a) Calculate the overall mean of the dependent variable.

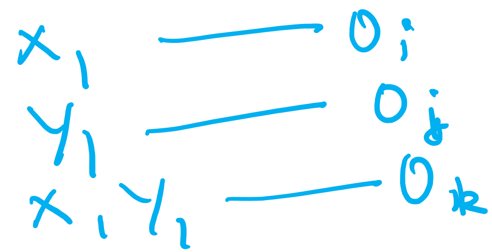
b) Compute the sum of squares for each factor and interaction, as well as the total sum of squares.

c) Determine the degrees of freedom for each sum of squares.

d) Calculate the mean squares by dividing the sum of squares by their respective degrees of freedom.

e) Conduct hypothesis tests using F-tests to assess the significance of main effects and interactions.

f) Interpret the results, considering the significance of each effect and their interactions.



Thank You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