

6.3: Summary And Software Solution

Summary

Two-way analysis of variance allows you to examine the effect of two factors simultaneously on the average response. The interaction of these two factors is always the starting point for two-way ANOVA. If the interaction term is significant, then you will ignore the main effects and focus solely on the unique treatments (combinations of the different levels of the two factors). If the interaction term is not significant, then it is appropriate to investigate the presence of the main effect of the response variable separately.

Software Solutions

Minitab

Minitab - 2 way ANOVA ex2.MPJ

File Edit Data Calc Stat Graph Editor Tools Window Help Assistant

Basic Statistics
Regression
ANOVA
DOE
Control Charts
Quality Tools
Reliability/Survival
Multivariate
Time Series
Tables
Nonparametrics
EDA
Power and Sample Size

One-Way...
One-Way (Unstacked)...
Two-Way...
Analysis of Means...
ADV Balanced ANOVA...
GLM General Linear Model...
Fully Nested ANOVA...
ADV Balanced MANOVA...
GLM General MANOVA...
Test for Equal Variances...
Interval Plot...
Main Effects Plot...
Interactions Plot...

Session

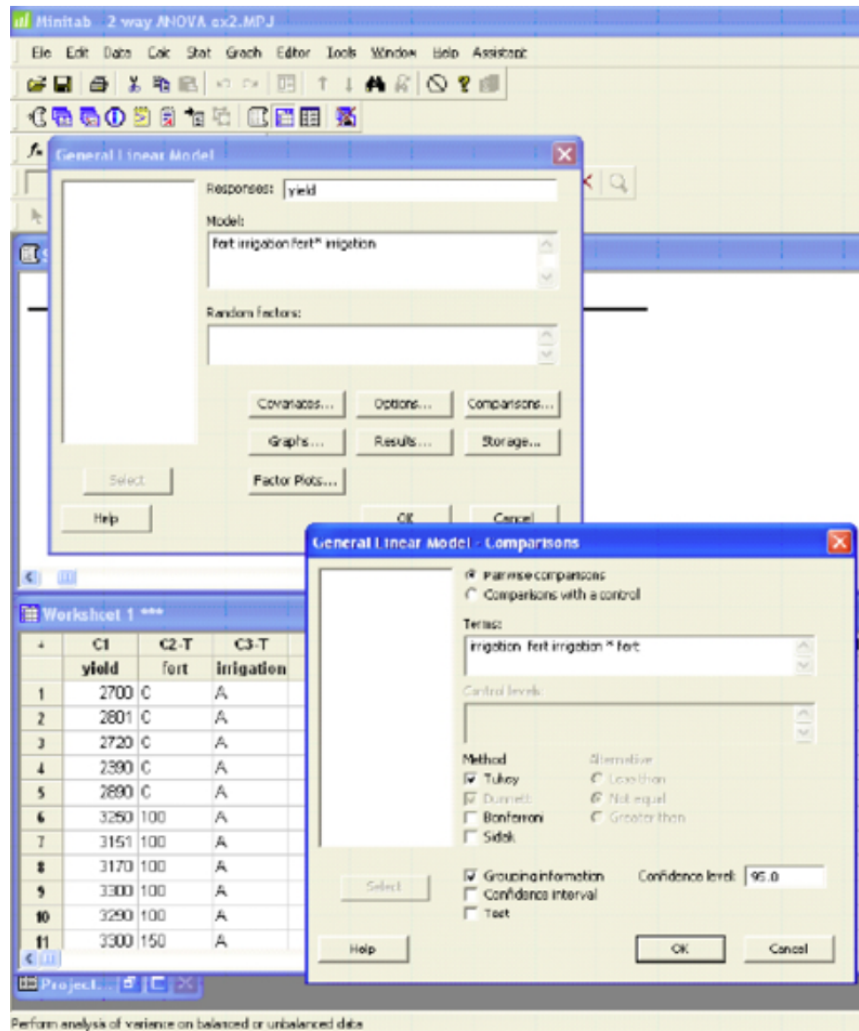
5/13/20

Worksheet 1 ***

	C1	C2-T	C3-T	C4	C5	C6	C7	C8
	yield	fert	irrigation					
1	2700	C	A					
2	2801	C	A					
3	2720	C	A					
4	2390	C	A					
5	2890	C	A					
6	3250	100	A					
7	3151	100	A					
8	3170	100	A					
9	3300	100	A					
10	3290	100	A					
11	3300	150	A					

Project...

Perform analysis of variance on balanced or unbalanced data



General Linear Model: yield vs. fert, irrigation

Factor	Type	Levels	Values			
fert	fixed	4	100,	150,	200,	C
irrigation	fixed	4	A,	B,	C,	D

Analysis of Variance for Yield, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
fert	3	1128272	1128272	376091	12.76	0.000
irrigation	3	161776127	161776127	53925376	1830.16	0.000
fert*irrigation	9	2088667	2088667	232074	7.88	0.000
Error	64	1885746	1885746	29465		
Total	79	166878812				

S = 171.653 R-Sq = 98.87% R-Sq(adj) = 98.61%

Unusual Observations for yield

Obs	yield	Fit	SE	Fit	Residual	St	Resid
	4	2390.00	2700.20	76.77	-310.20	-2.02	R
	28	2250.00	2646.00	76.77	-396.00	-2.58	R
	35	4250.00	3327.60	76.77	922.40	6.01	R

R denotes an observation with a large standardized residual.

Grouping Information Using Tukey Method and 95.0% Confidence

irrigation	N	Mean	Grouping				
A	20	3120.60	A				
B	20	3040.05	A				
C	20	352.85		B			
D	20	129.55			C		

Means that do not share a letter are significantly different.

Grouping Information Using Tukey Method and 95.0% Confidence

fert	N	Mean	Grouping				
150	20	1797.90	A				
200	20	1749.95	A				
100	20	1592.55		B			
C	20	1502.65		B			

Means that do not share a letter are significantly different.

Grouping Information Using Tukey Method and 95.0% Confidence

fert	irrigation	N	Mean	Grouping			
200	A	5	3381.00	A			
150	B	5	3327.60	A			
100	A	5	3232.20	A			
150	A	5	3169.00	A			
200	B	5	3097.00	A			
C	B	5	3089.60	A			
C	A	5	2700.20		B		
100	B	5	2646.00		B		
150	C	5	623.80			C	
100	C	5	340.60			C	D
200	C	5	338.00			C	D

200	D	5	183.80			D
100	D	5	151.40			D
C	D	5	111.80			D
C	C	5	109.00			D
150	D	5	71.20			D

Means that do not share a letter are significantly different.

Excel

The screenshot shows the Microsoft Excel interface with the 'Data Analysis' task pane open. The 'Analysis Tools' list includes:

- Anova: Single Factor
- Anova: Two-Factor With Replication** (selected)
- Anova: Two-Factor Without Replication
- Correlation
- Covariance
- Descriptive Statistics
- Exponential Smoothing
- F-Test Two-Sample for Variances
- Fourier Analysis
- Histogram


The background spreadsheet contains the following data:

	Bcontrol	B100	B150	B200
AA	2700	3250	3300	3500
AA	2801	3151	3235	3455
AA	2720	3170	3025	3100
AA	2390	3300	3165	3600
AA	2890	3290	3120	3250
AB	3101	2700	3050	3100
AB	3035	2935	3110	3235
AB	3205	2250	3033	3005
AB	3007	2495	3195	3095
AB	3100	2850	4250	3050
AC	101	400	630	400
AC	97	302	624	325
AC	106	296	595	200
AC	142	315	675	375
AC	99	390	595	390
AD	121	100	60	201
AD	174	125	28	223
AD	88	91	112	195
AD	100	222	89	120
AD	76	219	67	180

The screenshot shows the 'Anova: Two-Factor With Replication' dialog box. The 'Input Range' is set to M13:M14, and the 'Range in Rows' is set to 2. The 'Range in Columns' is set to 4. The 'Output Range' is set to A1:E1. The 'Anova: Two-Factor With Replication' dialog box is open to the 'Input Range' tab.

2	AA	2700	3250	3300	3500
3	AA	2801	3151	3235	3455
4	AA	2720	3170	3025	3100
5	AA	2390	3300	3165	3600
6	AA	2890	3290	3120	3250
7	AB	3101	2700	3050	3100
8	AB	3035	2935	3110	3235
9	AB	3205	2250	3033	3005
10	AB	3007	2495	3195	3095
11	AB	3100	2850	4250	3050
12	AC	101	400	630	400
13	AC	97	302	624	325
14	AC	106	296	595	200
15	AC	142	315	675	375
16	AC	99	390	595	390
17	AD	121	100	60	201
18	AD	174	125	28	223
19	AD	88	91	112	195
20	AD	100	222	89	120
21	AD	76	219	67	180


Input:

Input Range: 

Rows per sample:

Alpha:

Output options

☒ Output Range: 

☐ New Worksheet Ply:

☐ New workbook

OK Cancel Help

Anova: Two-Factor With Replication

SUMMARY	Bcontrol	B100	B150	B200	Total
AA					
Count	5	5	5	5	20
Sum	13501	16161	15845	16905	62412
Average	2700.2	3232.2	3169	3381	3120.6
Variance	35700.2	4679.2	11167.5	40930	87716.57
AB					
Count	5	5	5	5	20
Sum	15448	13230	16638	15485	60801
Average	3089.6	2646	3327.6	3097	3040.05
Variance	5839.8	76917.5	269901.3	7432.5	139929.4
AC					
Count	5	5	5	5	20
Sum	545	1703	3119	1690	7057
Average	109	340.6	623.8	338	352.85
Variance	351.5	2525.8	1079.7	6782.5	37326.03
AD					
Count	5	5	5	5	20
Sum	559	757	356	919	2591

Average	111.8	151.4	71.2	183.8	129.55	
Variance	1485.2	4135.3	997.7	1510.7	3590.366	
Total						
Count	20	20	20	20		
Sum	30053	31851	35958	34999		
Average	1502.65	1592.55	1797.9	1749.95		
Variance	2069464	1977134	2317478	2359637		
ANOVA						
Source of Variation	SS	df	MS	F	p-value	F crit
Sample	1.62E+08	3	53925376	1830.164	5.98E-62	2.748191
Columns	1128272	3	376090.7	12.76408	1.23E-06	2.748191
Interaction	2088667	9	232074.2	7.876325	1.02E-07	2.029792
Within	1885746	64	29464.78			
Total	1.67E+08	79				

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