PLSC 724 – EXAMINATION 2

November 15, 2023
Show all work

Name: Key

1. The JMP output in the accompanying material for Question #1 shows the output from an experiment analyzed as a Latin Square Design with a 2 x 4 factorial arrangement across two squares. Assuming that squares, A, and B are fixed effects:

   a. Provide the correct *F*-values for the A, Square x B, and Square x A x B sources of variation (20)?

Since all factors are fixed, the f-values given in the JMP output are correct

$F_A = 227.08$

$F_{Sq \times B} = 1.194$

$F_{Sq \times A \times B} = 0.700$

b. Assuming the *F*-test for B is significant, indicate which means for the B main effect are significantly different at the 95% level of confidence using an *F*-protected LSD and lowercase letters (15).

$$LSD_B \; t_{\frac{.05}{2}; \text{Error df}} \sqrt{\frac{2 \text{ Error MS}}{S_f \cdot r \cdot a}}$$

$$= 1.99 \sqrt{\frac{2(5.512)}{2(8)(2)}}$$

$$= 1.99 \sqrt{\frac{11.024}{32}}$$

$$= 1.99 \sqrt{0.3445}$$

$$= 1.168 \cong 1.17$$

Trt B		
3	72.05	a
4	73.12	a
1	75.31	b
2	79.74	c

c. Assuming the F-test for the AxB interaction is significant, indicate which means for the AxB interaction are significantly different at the 95% level of confidence using an F-protected LSD and lowercase letters (15).

$$LSD_{AB} = t_{\frac{.05}{2};\ \text{Error df}} \sqrt{\frac{2\ \text{Error MS}}{r \cdot s}}$$

$$= 1.99 \sqrt{\frac{2(5.512)}{8 \times 2}}$$

$$1.99 \sqrt{\frac{11.024}{16}}$$

$$= 1.99 \sqrt{0.689}$$

$$= 1.65$$

A	B	Mean	
1	1	59.03	a
1	4	64.02	b
0	3	66.85	c
0	2	72.07	d
1	3	77.25	e
0	4	82.22	f
1	2	87.42	g
0	1	91.59	h

2. The JMP output in the accompanying material for Question #2 shows the output from an experiment analyzed as a Randomized Complete Block Design. In the randomization there were 10 treatments and 5 replicates. When data were collected, there was missing data. 10 = trts rep = 5

a. How many missing values are there in this analysis (15)? Justify your answer.

Total df should = 49 & Error df should = 36 if there are no missing values. In the output there are 46 df for total and 33 for error. ∴ 3 observations are missing.

or

Observations (or Sum wgts) = 47 on output. If there were no missing values there should be 50 observations. ∴ There are 3 missing values

b. Which treatments have missing values (15)? Justify your answer.

G-1, G-6, & G-9 have missing values

LS Sq MN ≠ mean when there are missing values

3. Treatments in an experiment were assigned to experimental units using a Randomized Complete Block Design with a 5 x 3 factorial arrangement. A was a random effect and B was a fixed effect, and there were four replicates. Given this information, please provide sources of variation, degrees of freedom, and indicate how to make all valid *F*-tests (20).

RCBD A=5 B=3 rep=4
random (A) fixed (B)

SOV	df		
Rep	3	$\sigma^2 + ab\sigma^2_R$	Rep MS / Error MS
A	4	$\sigma^2 +$ ~~$r\sigma^2_{AB}$~~ $+ rb\sigma^2_A$	A ms / Error MS
B	2	$\sigma^2 + r\sigma^2_{AB} + ra\frac{\sum \beta^2}{b-1}$	B ms / AxB MS
AxB	8	$\sigma^2 + r\sigma^2_{AB}$	AxB ms / Error MS
Error	42	σ^2	
Total	59		

Upon my honor, I have neither given nor received aid in writing this exam."

Signed______________________________

2023 PLSC 724 Exam #2 – Question 1 Output

Response YIELD

Summary of Fit

RSquare	0.970395
RSquare Adj	0.955241
Root Mean Square Error	2.347865
Mean of Response	75.05438
Observations (or Sum Wgts)	128

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	43	15178.050	352.978	64.0326
Error	84	463.048	5.512	**Prob > F**
C. Total	127	15641.098		<.0001*

Effect Tests

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
SQUARE	1	13.611	13.611	2.4692	0.1199
ROW[SQUARE]	14	66.159	4.726	0.8573	0.6064
COLUMN[SQUARE]	14	74.150	5.296	0.9608	0.4996
A	1	1251.751	1251.751	227.0761	<.0001*
A*SQUARE	1	0.018	0.018	0.0032	0.9551
B	3	1114.694	371.565	67.4043	<.0001*
B*SQUARE	3	19.744	6.581	1.1939	0.3171
A*B	3	12626.347	4208.782	763.5018	<.0001*
A*B*SQUARE	3	11.578	3.859	0.7001	0.5546

Effect Details

A
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
0	78.181563	0.29348319	78.1816
1	71.927188	0.29348319	71.9272

2023 PLSC 724 Exam #2 – Question 1 Output

B
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
1	75.305625	0.41504790	75.3056
2	79.744063	0.41504790	79.7441
3	72.049375	0.41504790	72.0494
4	73.118438	0.41504790	73.1184

A*B
Least Squares Means Table

Level	Least Sq Mean	Std Error
0,1	91.585000	0.58696637
0,2	72.071250	0.58696637
0,3	66.852500	0.58696637
0,4	82.217500	0.58696637
1,1	59.026250	0.58696637
1,2	87.416875	0.58696637
1,3	77.246250	0.58696637
1,4	64.019375	0.58696637

2023 PLSC 724 Exam #2 – Question 2 Output

Response YIELD
Summary of Fit

RSquare	0.983672
RSquare Adj	0.977239
Root Mean Square Error	1.279926
Mean of Response	55.41404
Observations (or Sum Wgts)	47

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	13	3256.7896	250.522	152.9243
Error	33	54.0610	1.638	**Prob > F**
C. Total	46	3310.8505		<.0001*

Effect Tests

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
REP	4	1.6070	0.4017	0.2452	0.9105
TREATMENT	9	3239.0977	359.8997	219.6907	<.0001*

Effect Details
TREATMENT
Least Squares Means Table

Level	Least Sq Mean	Std Error	Mean
G-1	56.147850	0.64714047	56.1875
G-2	50.584000	0.57240039	50.5840
G-3	67.972000	0.57240039	67.9720
G-4	42.352000	0.57240039	42.3520
G-5	54.766000	0.57240039	54.7660
G-6	44.535850	0.64714047	44.4950
G-7	62.074000	0.57240039	62.0740
G-8	64.658000	0.57240039	64.6580
G-9	47.357564	0.64714047	47.3650
G-10	60.048000	0.57240039	60.0480

II. Percentage Points of the t Distribution[a]

ν \ α	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
1	.325	1.000	3.078	6.314	12.706	31.821	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.920	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.541	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.727	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.019	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.587
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

ν = degrees of freedom.

[a]Adapted with permission from *Biometrika Tables for Statisticians*, Vol. 1, 3rd edition, by E. S. Pearson and H. O. Hartley, Cambridge University Press, Cambridge, 1966.