online

Math 583 Final Fall 2008 Name_____

I	A	B	C	AB	AC	BC	ABC	y
+	−	−	−	+	+	+	−	86.8
+	+	−	−	−	−	+	+	85.9
+	−	+	−	−	+	−	+	79.4
+	+	+	−	+	−	−	−	60.0
+	−	−	+	+	−	−	+	94.6
+	+	−	+	−	+	−	−	85.4
+	−	+	+	−	−	+	−	84.5
+	+	+	+	+	+	+	+	80.3

1) The above table of 2^3 contrasts is for 2^{5-2}_{III} data.

a) Estimate the B effect.

$$\frac{-86.8 - 85.9 + 79.4 + 60 - 94.6 - 85.4 + 84.5 + 80.3}{4}$$

$$= \frac{-48.5}{4} = -12.125$$

b) Estimate the D effect.

$$\frac{86.8 - 85.9 - 79.4 + 60 + 94.6 - 85.4 - 84.5 + 80.3}{4}$$

$$\frac{-13.5}{4} = -3.375$$

2) Suppose that for 2^3 data with $m = 2$, the MSE = 407.5625. Find SE(effect).

$$SE(\text{effect}) = \sqrt{\frac{MSE}{m\,2^{n-2}}} = \sqrt{\frac{407.5625}{2(2)}} = \sqrt{101.8906}$$

$$= \boxed{10.094}$$

test	df	T	p-value
matched pairs	19	1.98	0.062
pooled 2 sample t	38	2.47	0.018

Let μ_1 = initial chicken weight, μ_2 = weight after 3 weeks. If appropriate, $\mu_D = \mu_1 - \mu_2$.

3) A farmer wants to test whether a new chicken feed will change the weight of his chickens in just 3 weeks. The weights from a SRS of 20 chickens are recorded. Then these chickens are fed the product for 3 weeks and the weights recorded again. The chickens gained 36.65 grams on the average. The output is shown above.

a) Which test should be used? **Explain briefly.**

matched pairs

E 0.25

2 measurements per chicken

or before and after

or block on initial weight

b) Test whether $\mu_D \neq 0$ or $\mu_1 \neq \mu_2$.

H_0 $\mu_D = 0$ H_A $\mu_D \neq 0$

$T_0 = 1.98$

$pval = 0.062$

fail to reject H_0, the mean weight after the feed is the same as the mean weight before the feed

or the mean weight does not depend on product

or the mean weights are the same

not significantly ~1

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4) Arthoscopic surgery is one of the most common surgical procedures performed for osteoarthritis of the knee. In five studies all of the patients were given the surgery and the studies concluded that the surgery resulted in pain relief. Another study performed the surgery on half of the patients. The remaining half were put to sleep and received surgical incisions (placebo) but not the surgery. The patients were randomly assigned to the two groups (surgery vs placebo) and did not know whether they received the surgery or the placebo. The pain relief reported by the two groups was about the same. Is the surgery a useful procedure? Explain briefly.

E 0.25

NO the good expt said surgery did not help

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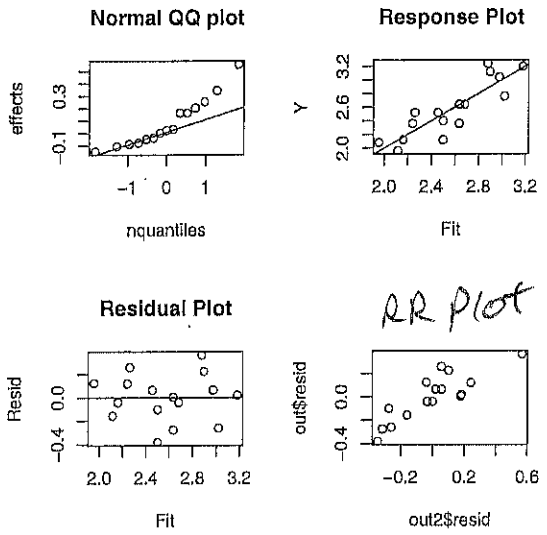
Coef	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	2.56750	0.06933	37.035	3.1e-10
ca	0.17250	0.06933	2.488	0.03763
cb	0.08250	0.06933	1.190	0.26816
cc	0.00250	0.06933	0.036	0.97212
cd	0.01750	0.06933	0.252	0.80708
ce	0.08250	0.06933	1.190	0.26816
cf	-0.02250	0.06933	-0.325	0.75385
cg	0.27750	0.06933	4.003	0.00393



5) Ledolter and Swersey (2007, p, 240) give 2^{7-3}_{IV} data and the above least squares model corresponds to the main effects model with no interactions. Here "ca" is the coefficient related to the A effect, "cb" is related to the B effect, et cetera.

a) The response and residual plots above correspond to the main effects model. Do the plots look ok? Yes

b) Let the reduced model $\hat{Y} = \hat{\beta}_0 + \hat{\beta}_{r1}x_{r1} + \cdots + \hat{\beta}_{rj}x_{rj}$ where j is the number of significant terms found in a). Write down the reduced model.

$\hat{Y} = 2.5675 + 0.1725 X_a + 0.2775 X_g$

c) Want large Y. Using the model in b), choose the x values that will give large Y, and predict Y.

$\hat{Y} = 2.5675 + 0.1725(1) + 0.2755(1)$

$= 3.0175$

A	B	C
9.5	8.5	7.7
3.2	9.0	11.3
4.7	7.9	9.7
7.5	5.0	11.5
8.3	3.2	12.4

Analysis of Variance for Time

Source	DF	SS	MS	F	P
Design	2	49.168	24.584	4.4625	0.0356
Error	12	66.108	5.509		

6) Ledolter and Swersey (2007, p. 49) describe a one way Anova design used to study the effectiveness of 3 product displays (A, B and C). Fifteen stores were used and each display was randomly assigned to 5 stores. The response Y was the sales volume for the week during which the display was present compared to the base sales for that store.

a) Find $\hat{\mu}_2 = \hat{\mu}_B$.

$$\frac{8.5+9+7.9+5+3.2}{5} = \frac{33.6}{5} = 6.72$$

b) Perform a 4 step Anova F test.

H_0 $\mu_1 = \mu_2 = \mu_3$ H_A not H_0

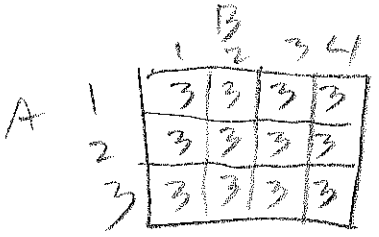
$F_0 = 4.4625$

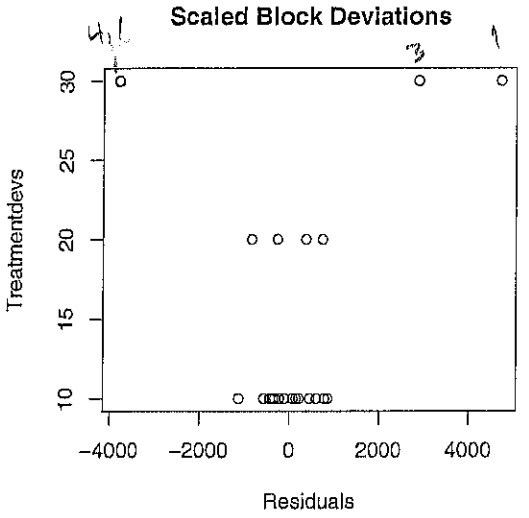
pval $= 0.0356$

reject H_0, the mean sales volume depends on the display

7) Suppose the response variable is tensile strength of paper. One factor is preparation method with 3 levels (1, 2, 3). Another factor is temperature with 4 levels (200, 225, 250, 275). Suppose the pilot plant can make 36 runs in one day and that the units are 36 batches of material to be made into pulp. Each of the 12 method temperature combinations is to be replicated 3 times. What type of experimental design should be used?

2 way Anova





E8025

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3				
treatment	3	1917416	639139	1.313	0.3292
Residuals	9	4380871	486763		

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> ganova2(x,block,y)
block deviations -3790.377  4720.488  2881.483 -3811.594
block                   1          2          3          4

treatment deviations -266.0863 -833.7660  733.3070  366.5453
Treatments                "A"       "B"       "C"       "D"
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8) Ledolter and Swersey (2007, p. 60) give completely randomized block design data. The block variable = market had 4 levels (1 Binghamton, 2 Rockford, 3 Albuquerque, 4 Chattanooga) while the treatment factor had 4 levels (A no advertising, B \$6 million, C \$12 million, D \$18 million advertising dollars in 1973). The response variable was average cheese sales (in pounds per store) sold in a 3 month period.

a) From the graphical Anova above, were blocks useful? yes

b) Perform an appropriate 4 step test for whether advertising helped cheese sales.

Ho $\mu_1 = \mu_2 = \mu_3 = \mu_4$ Ha not Ho

$F_0 = 1.313$

$p\text{val} = 0.3292$

Fail to reject Ho, the mean sales does not depend on advertising level

(18)

Source	df	SS	MS	F	pvalue
block	1	0.1334	0.1334	4.85	0.0379
L	3	0.0427	0.0142	0.5164	0.6751
M	2	0.0526	0.0263	0.9564	0.3990
P	1	0.5355	0.5355	19.47	0.0002
LM	6	0.2543	0.0424	1.54	0.2099
LP	3	0.2399	0.0800	2.91	0.0562
MP	2	0.0821	0.0410	1.49	0.2463
LMP	6	0.0685	0.0114	0.4145	0.8617
error	23	0.6319	0.0275		

9) Snedecor and Cochran (1967, p. 361-364) describe a block design (2 levels) with three factors: food supplements Lysine (4 levels), Methionine (3 levels) and Protein (2 levels). Male pigs were fed the supplements in a $4 \times 3 \times 2$ factorial arrangement and the response was average daily weight gain. The Anova table is shown above. The model could be described as $Y_{ijkl} = \mu_{ijkl} + e_{ijkl}$ for $i = 1, 2, 3, 4$; $j = 1, 2, 3$; $k = 1, 2$ and $l = 1, 2$ where i, j, k are for L,M,P and l is for block. Note that μ_{i000} is the mean corresponding to the ith level of L.

a) There were 24 pigs in each block. How were they assigned to the $24 = 4 \times 3 \times 2$ runs (a run is a L,M,P combination forming a pig diet)?

randomly

ex 7.2 b) Was blocking useful? yes .0379 < .05

c) Perform a 4 step test for the significant main effect.

Ho $\mu_{0010} = \mu_{0020}$ HA not Ho

$F_{OP} = 19.47$

pval = .0002

the mean weight gain depends on protein

d) Which, if any, of the interactions were significant?

none

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Source	df	SS	MS	F	p-value
Block	1	0.051	0.051		
Nitrogen	3	37.32	12.44	29.62	0.010
Block*Nitrogen	3	1.26	0.42		
Thatch	2	3.82	1.91	9.10	0.009
Nitrogen*Thatch	6	4.15	0.69	3.29	0.065
error(S)	12	1.72	0.21		

10) The Anova table above is for the Kuehl (1994, p. 473-481) split plot data where the whole plots are assigned to factor A and to blocks in a completely randomized block design. The response variable is the average chlorophyll content (mg/gm of turf grass clippings). Factor A is nitrogen fertilizer with 4 levels (1, 2, 3, 4). Factor B is length of time that thatch was allowed to accumulate with 3 levels (2, 5, or 8 years).

There were 2 blocks of 4 whole plots to which the levels of Factor A were assigned. The 2 blocks formed a golf green which was seeded with turf grass. The 8 whole plots were plots of golf green. Each whole plot had 3 subplots to which the levels of Factor B were randomly assigned.

a) Perform the test corresponding to A.

H_0 $\mu_{100} = \mu_{111} = \mu_{400}$ H_A not H_0

$F_A = 29.62$

pval = .010

reject H_0, the mean chlorophyll content depends on nitrogen fertilizer.

b) Perform the test corresponding to B.

H_0 $\mu_{010} = \cdots = \mu_{030}$ H_A not H_0

$F_B = 9.10$

pval = .009

reject H_0 the mean chlorophyll content depends on length of time

c) Perform the test corresponding to AB.

H_0 no interaction H_A there is an interaction

$F_{AB} = 3.29$

pval = .065

fail to reject H_0, there is NO nitrogen fertilizer length of time interaction