

No part marks
on any question

Name Jerry
Student Number _____

STA 441s 2024 Quiz Three

1. (4 points) In a study comparing the effectiveness of different exercise programmes, volunteers were randomly assigned to either a control condition or one of four exercise programmes (1, 2, 3 or 4). Thus, there were five experimental treatments. Denote the true treatment means by $\mu_c, \mu_1, \mu_2, \mu_3$ and μ_4 .

Aerobic capacity is the body's ability to process oxygen. Using a standard treadmill test, aerobic capacity was measured before and after 6 months of participation in the program (or 6 months of elapsed time for the control condition). The response variable was improvement in aerobic capacity.

- (a) What null hypothesis would you test to determine whether experimental treatment (including the control) had any effect on average improvement in aerobic capacity? State the null hypothesis in symbols.

$$H_0: \mu_c = \mu_1 = \mu_2 = \mu_3 = \mu_4$$

- (b) For the test of whether experimental treatment had any effect on average improvement in aerobic capacity, give the contrast or contrasts you would test. Make a table. There is one column in your table for each treatment mean, and one row for each contrast.

	μ_c	μ_1	μ_2	μ_3	μ_4
1	1	-1	0	0	0
2	0	1	-1	0	0
3	0	0	1	-1	0
4	0	0	0	1	-1

← $q_1, \dots, q_5$
on H_0
Any t -tests equivalent to this

- (c) What null hypothesis would you test to determine whether the average improvement from the four exercise programs was greater than improvement from the control condition? State the null hypothesis in symbols.

$$H_0: \mu_c = \frac{1}{4}(\mu_1 + \mu_2 + \mu_3 + \mu_4) \text{ or } 4\mu_c = \mu_1 + \mu_2 + \mu_3 + \mu_4$$

- (d) For the test of whether average improvement from the four exercise programs was greater than improvement from the wait list control, give the contrast or contrasts you would test. Make a table. There is one column in your table for each treatment mean, and one row for each contrast.

	μ_c	μ_1	μ_2	μ_3	μ_4
1	-4	1	1	1	1

or equivalent

2. Please refer to your analysis of the Chick Weights data.

- (a) (1 point) What proportion of the variation in the chicks' weight is explained by type of feed? The answer is a number on your printout. Write the number in the space below. on the printout, circle the number and write "Question 2a" beside it.

$$R^2 = 0.54 \quad (\text{More decimal places okay of course})$$

- (b) (5 points) In your analysis of the Chick Weights data, you used Tukey multiple comparisons to test for all pairwise differences between means, at joint significance level 0.05. Based on this, answer each of the questions below "Yes" or "No." To get any marks for this question, you can get no more than one wrong.

- Is there sufficient evidence to conclude that sunflower is better than horsebean? *Yes*
- Is there sufficient evidence to conclude that casin is better than soybean? *Yes*
- Is there sufficient evidence to conclude that sunflower is better than casin? *No*
- Is there sufficient evidence to conclude that casin is better than meatmeal? *No*
- Is there sufficient evidence to conclude that meatmeal is better than soybean? *No*
- Is there sufficient evidence to conclude that soybean is better than linseed? *No*
- Is there sufficient evidence to conclude that linseed is better than horsebean? *No*

Attach your log file and your results file to the quiz paper. Make sure your name and student number are written clearly on both printouts.

STA441 HW3 Check: Chickwts
Q3b: Means, standard deviations and sample sizes

The MEANS Procedure

Analysis Variable : weight Weight in grams at 6 weeks						
feed	N Obs	N	Mean	Std Dev	Minimum	Maximum
casein	12	12	323.583	64.434	216.000	404.000
horsebean	10	10	160.200	38.626	108.000	227.000
linseed	12	12	218.750	52.236	141.000	309.000
meatmeal	11	11	276.909	64.901	153.000	380.000
soybean	14	14	246.429	54.129	158.000	329.000
sunflower	12	12	328.917	48.836	226.000	423.000

STA441 HW3 Check: Chickwts
Q3 c, d and f: Overall F-test, Tukey HSD and special contrast

The GLM Procedure

Class Level Information		
Class	Levels	Values
feed	6	casein horsebean linseed meatmeal soybean sunflower

Number of Observations Read	71
Number of Observations Used	71

STA441 HW3 Check: Chickwts
Q3 c, d and f: Overall F-test, Tukey HSD and special contrast

The GLM Procedure

Dependent Variable: weight Weight in grams at 6 weeks

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	231129.1621	46225.8324	15.36	<.0001
Error	65	195556.0210	3008.5542		
Corrected Total	70	426685.1831			

R-Square	Coeff Var	Root MSE	weight Mean
0.541685	20.99052	54.85029	261.3099

Question 2a

Source	DF	Type I SS	Mean Square	F Value	Pr > F
feed	5	231129.1621	46225.8324	15.36	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
feed	5	231129.1621	46225.8324	15.36	<.0001

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
All But Horsebean	4	112137.7757	28034.4439	9.32	<.0001

STA441 HW3 Check: Chickwts

Q3 c, d and f: Overall F-test, Tukey HSD and special contrast

The GLM Procedure

Level of feed	N	weight	
		Mean	Std Dev
casein	12	323.583333	64.4338397
horsebean	10	160.200000	38.6258405
linseed	12	218.750000	52.2356983
meatmeal	11	276.909091	64.9006233
soybean	14	246.428571	54.1290684
sunflower	12	328.916667	48.8363842

STA441 HW3 Check: Chickwts

Q3 c, d and f: Overall F-test, Tukey HSD and special contrast

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey-Kramer

feed	weight LSMEAN	LSMEAN Number
casein	323.583333	1
horsebean	160.200000	2
linseed	218.750000	3
meatmeal	276.909091	4
soybean	246.428571	5
sunflower	328.916667	6

Least Squares Means for effect feed Pr > t for H0: LSMean(i)=LSMean(j)						
Dependent Variable: weight						
i/j	1	2	3	4	5	6
1		<.0001	0.0002	0.3325	0.0084	0.9999
2	<.0001		0.1413	0.0001	0.0042	<.0001
3	0.0002	0.1413		0.1277	0.7933	<.0001
4	0.3325	0.0001	0.1277		0.7391	0.2207
5	0.0084	0.0042	0.7933	0.7391		0.0039
6	0.9999	<.0001	<.0001	0.2207	0.0039	

```

1      OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
72
73      /* HW3chickwts.sas */
74
75      title 'STA441 HW3 Check: Chickwts';
76
77      data cluck;
78          infile '/home/u1407221/441s24/data/ChickWeight.data.txt';
79          length feed $ 9;
80          input id weight feed $;
81          label weight = 'Weight in grams at 6 weeks';
82

```

NOTE: The infile '/home/u1407221/441s24/data/ChickWeight.data.txt' is:
 Filename=/home/u1407221/441s24/data/ChickWeight.data.txt,
 Owner Name=u1407221,Group Name=oda,
 Access Permission=-rw-r--r--,
 Last Modified=11Jan2024:12:41:54,
 File Size (bytes)=1493

NOTE: 72 records were read from the infile '/home/u1407221/441s24/data/ChickWeight.data.txt'.
 The minimum record length was 0.
 The maximum record length was 19.

NOTE: SAS went to a new line when INPUT statement reached past the end of a line.

NOTE: The data set WORK.CLUCK has 71 observations and 3 variables.

NOTE: DATA statement used (Total process time):

real time	0.00 seconds
user cpu time	0.01 seconds
system cpu time	0.00 seconds
memory	755.46k
OS Memory	30120.00k
Timestamp	01/31/2024 04:38:42 PM
Step Count	32 Switch Count 2
Page Faults	0
Page Reclaims	156
Page Swaps	0
Voluntary Context Switches	16
Involuntary Context Switches	0
Block Input Operations	0
Block Output Operations	264

```

83      proc means maxdec=3;
84          title2 "Q3b: Means, standard deviations and sample sizes";
85          class feed;
86          var weight;
87

```

NOTE: There were 71 observations read from the data set WORK.CLUCK.

NOTE: PROCEDURE MEANS used (Total process time):

real time	0.04 seconds
user cpu time	0.03 seconds
system cpu time	0.01 seconds
memory	10568.31k
OS Memory	38332.00k
Timestamp	01/31/2024 04:38:42 PM

Step Count	33	Switch Count	2
Page Faults	0		
Page Reclaims	2075		
Page Swaps	0		
Voluntary Context Switches	19		
Involuntary Context Switches	0		
Block Input Operations	0		
Block Output Operations	8		

```

88      proc glm plots=none;
89          title2 'Q3 c, d and f: Overall F-test, Tukey HSD and special contrast';
90          class feed;
91          model weight=feed;
92          contrast 'All But Horsebean' feed 1 0 -1 0 0 0,
93                      feed 1 0 0 -1 0 0,
94                      feed 1 0 0 0 -1 0,
95                      feed 1 0 0 0 0 -1;
96          means feed; /* Redundant with proc means */
97          lsmeans feed / pdiff adjust=tukey;
98      run;

99      quit;

```

NOTE: PROCEDURE GLM used (Total process time):

real time	0.10 seconds
user cpu time	0.10 seconds
system cpu time	0.00 seconds
memory	2374.90k
OS Memory	33720.00k
Timestamp	01/31/2024 04:38:42 PM
Step Count	34
Switch Count	3
Page Faults	0
Page Reclaims	286
Page Swaps	0
Voluntary Context Switches	22
Involuntary Context Switches	0
Block Input Operations	0
Block Output Operations	312

```

100
101      /* Commented out: This is sort of reasonable too. Do you really want to
102         estimate the common variance using horsebean? Also, non-parametric.
103
104      proc glm;
105          title2 'F-test for difference among 5 excluding horsebean';
106          class feed;
107          where feed ne 'horsebean';
108          model weight=feed;
109
110      proc npar1way Wilcoxon;
111          title2 'Kruskal-Wallis for difference among 5 excluding horsebean';
112          class feed;
113          where feed ne 'horsebean';
114          var weight;
115      */
116

```