

Math 484 HW 9 Fall 2022, due Wednesday, Nov. 9.
 Exam 3 is Wednesday, Nov. 30. Lab 4: Monday, Nov. 14.
 The Final is Friday, Dec. 16, 10:15-12:15. 4 pages: A)-E)

A) This is like HW8 C) with the BigMac data. Assume that a multiple linear regression model holds for $Y = t(Z)$ and for some terms (usually powers or logs of the predictors). Using the techniques learned in class, find such a model. Do parts a), b) and c) below.

student	file	Z
1 Felicia	paddle.lsp	Weight
2 Sanjuka	highway.lsp	rate (from the menu Highway, select "Add a variate" and type sigsp1 = sigs + 1. Then you can transform sigsp1.)
3 Itria, Lakni	allomet.lsp	BRAIN
4 Bethany	evaporat.lsp	Evap (log rule is bad for Z = Evap)
5 Maryam, Yunjia	sniffer.lsp	Y
6 Kasun	casuarin.lsp	W
7 Mina	ozone.lsp	ozone
8 Jie Shi	ais.lsp	%Bfat
9 Howard	water.lsp	Y
10 Yangge	fuel90.lsp	inc
11 Dianqui	bodfat.lsp	y (Do not use x1 as a predictor. (The file is at (http://parker.ad.siu.edu/Olive/lregbk.htm).))
12 Aziz, Zander	haystack.lsp	Vol
13 Wyatt	hald.lsp	Y
14 Kuan	landrent.lsp	Y
15 Dhanushka	boston2.lsp	y (The file is at (http://parker.ad.siu.edu/Olive/lregbk.htm).))

a) Write down the full model that you use and include a response plot for the full model. (This plot should be linear). Also give R^2 for the full model.

b) Write down the final submodel that you use.

c) Include the least squares output for your model and 5 more plots that justify that your multiple linear regression model is reasonable. Use the residual plot for the full model, the RR plot, the FF plot, the residual plot for your model, and the response plot for your model. Below or beside each plot, give a brief explanation for how the plot gives support for your model. I do not want to see intermediate steps or competing models.

B) 5.1.

Output for Problem 5.1.

A	B	C	D	E
9.8	9.8	8.5	7.9	7.6
10.3	12.3	9.6	6.9	10.6
13.6	11.1	9.5	6.6	5.6
10.5	10.6	7.4	7.6	10.1
8.6	11.6	7.6	8.9	10.5
11.1	10.9	9.9	9.1	8.6

Analysis of Variance for Time

Source	DF	SS	MS	F	P
Design	4	44.88	11.22	5.82	0.002
Error	25	48.17	1.93		
Total	29	93.05			

In a psychology experiment on child development, the goal was to study how different designs of mobiles vary in their ability to capture the infants' attention. Thirty 3-month-old infants were randomly divided into five groups of six each. Each group was shown a mobile with one of five designs A, B, C, D, or E. The time that each infant spent looking at the design was recorded in the output above along with the ANOVA table. Data is taken from McKenzie and Goldman (1999, p. 234). See the above output.

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

b) Perform a 4 step ANOVA F test.

C) 5.16 Read all of the one way Anova in SAS on p. 209 (end of this HW).

Cut and paste the SAS program for this problem into the SAS Editor.

To execute the program, use the top menu commands "Run>Submit". An output window will appear if successful.

(If you were not successful, look at the *log window* for hints on errors. A single typo can cause failure. Reopen your file in *Word* or *Notepad* and make corrections. Occasionally you can not find your error. Then find your instructor or wait a few hours and reenter the program.)

Data is from SAS Institute (1985, pp. 126-129). See Example 5.6.

a) In SAS, use the menu commands "Edit>Select All" then "Edit>Copy." In *Word*, use the menu command "Paste." Highlight the first page of output and use the menu command "Cut." (SAS often creates too much output. These commands reduce the output from 4 pages to 3 pages.)

You may want to save your SAS output as the file HW5d16.doc on your flash drive.

b) Perform the 4 step test for $H_0: \mu_1 = \mu_2 = \dots = \mu_6$.

c) From the residual and response plots, does the assumption of equal population standard deviations ($\sigma_i = \sigma$ for $i = 1, \dots, 6$) seem reasonable?

D) 5.17 To get in ARC, you need to find the ARC icon. Suppose the ARC icon is in a *math progs* folder. Move the cursor to the math progs folder, click the right mouse button twice, move the cursor to ARC, double click, move the cursor to ARC, double click. These menu commands will be written “math progs > ARC > ARC.” To quit ARC, move cursor to the **x** in the northeast corner and click.

This Cook and Weisberg (1999a, p. 289) data set contains IQ scores on 27 pairs of identical twins, one raised by foster parents *IQf* and the other by biological parents *IQb*. *C* gives the social class of the biological parents: $C = 1$ for upper class, 2 for middle class and 3 for lower class. Hence the Anova test is for whether mean IQ depends on class.

a) Activate *twins.lsp* dataset with the menu commands “File > Load > Data > twins.lsp”.

b) Use the menu commands “Twins>Make factors”, select *C* and click on *OK*. The line “{F}C Factor 27 Factor—first level dropped” should appear on the screen.

c) Use the menu commands “Twins>Description” to see a description of the data.

d) Enter the menu commands “Graph&Fit>Fit linear LS” and select {F}C as the term and IQb as the response. Highlight the output by pressing the left mouse key and dragging the cursor over the output. Then use the menu commands “Edit> Copy.” Enter *Word* and use the menu command “Paste.”

e) Enter the menu commands “Graph&Fit>Boxplot of” and enter *IQb* in the *selection box* and *C* in the *Condition on* box. Click on *OK*. When the boxplots appear, click on the *Show Anova* box. Click on the plot, hit the *Ctrl* and *c* keys at the same time. Enter *Word* and use the menu command “Paste.” Include the output in *Word*. Notice that the regression and Anova *F* statistic and p-value are the same.

f) Residual plot: Enter the menu commands “Graph&Fit>Plot of,” select “L1:Fit-Values” for the “H” box and “L1:Residuals” for the “V” box, and click on “OK.” Click on the plot, hit the *Ctrl* and *c* keys at the same time. Enter *Word* and use the menu command “Paste.”

g) Response plot: Enter the menu commands “Graph&Fit>Plot of,” select “L1:Fit-Values” for the “H” box and “IQb” for the “V” box, and click on “OK.” When the plot appears, move the OLS slider bar to 1 to add the identity line. Click on the plot, hit the *Ctrl* and *c* keys at the same time. Enter *Word* and use the menu command “Paste.”

h) Perform the 4 step test for $H_0: \mu_1 = \mu_2 = \mu_3$.

E) 5.18 a)-f) (Part g) was done in B.)

a) In Minitab, use the menu command “File>Open Worksheet” and double click on *Baby.mtw*. A window will appear. Click on “OK.”

b) Choose “Stat>Basic Statistics>Display Descriptive Statistics,” select “C1 Time” as the “Variable,” click the “By variable” option and press *Tab*. Select “C2 Design” as the “By variable.”

c) From the window in b), click on “Graphs” the “Boxplots of data” option, and “OK” twice. Click on the plot and then click on the *printer* icon to get a plot of the boxplots.

d) Select “Stat>ANOVA>One-way,” select “C1-time” as the response and “C2-Design” as the factor. Click on “Store residuals” and click on “Store fits.” Then click on “OK.” Click on the output and then click on the *printer* icon.

e) To make a residual plot, select “Graph>Plot.” Select “Res1” for “Y” and “Fits1” for “X” and click on “OK.” Click on the plot and then click on the *printer* icon to get the residual plot.

f) To make a response plot, select “Graph>Plot.” Select “C1 Time” for “Y” and “Fits1” for “X” and click on “OK.” Click on the plot and then click on the *printer* icon to get the response plot.

(In the online Multiple Linear and 1D Regression, 5.16, 5.17, and 5.18 a)-f) are 5.15, 5.16, and 5.17 a)-f).)

One Way Anova in SAS

To get into *SAS*, often you click on a *SAS* icon, perhaps something like *The SAS System for* A window with a split screen will open. The top screen says *Log-(Untitled)* while the bottom screen says *Editor-Untitled1*. Press the spacebar and an asterisk appears: *Editor-Untitled1**.

For Problem 5.16, consider saving your file as *hw5d16.sas* on your flash drive (J, say). (On the top menu of the editor, use the commands “File > Save as”. A window will appear. Use the upper right arrow to locate “Removable Disk (J:),” and then type the file name in the bottom box. Click on OK.) From the top menu in SAS, use the “File> Open” command. A window will open. Use the arrow in the NE corner of the window to navigate to “Removable Disk (J:)”. (As you click on the arrow, you should see My Documents, C: etc, then “Removable Disk (J:)”.) Double click on **hw5d16.sas**.

This point explains the SAS commands. The semicolon “;” is used to end SAS commands and the “options ls = 70;” command makes the output readable. (An “*” can be used to insert comments into the SAS program. Try putting an * before the options command and see what it does to the output.) The next step is to get the data into SAS. The command “data clover;” gives the name “clover” to the data set. The command “input strain \$ nitrogen @ @;” says the first entry is variable strain and the \$ means it is categorical, the second variable is nitrogen and the @@ means read 2 variables, then 2, ..., until the end of the data. The command “cards;” means that the data is entered below. Then the data is entered and the isolated semicolon indicates that the last case has been entered.

The commands “proc glm; class = strain; model nitrogen = strain;” tells SAS to perform one way Anova with nitrogen as the response variable and strain as the factor.