國立政治大學111學年度第二學期 期中R程式考題

Department:_____ ID:_____ Name:_____

Subject: **Regression Analysis (I)**

Date: 2023/04/20

Time: 11:00~12:00 (60 minutes)

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注意事項:

1. 本次考題以R程式(Rgui或RStudio)方式作答，其他程式不允許。
2. 考試過程中可查詢書本、教學講義或上網，禁止利用messenger, IG, Line等等通訊軟體。
3. 禁止疑似作弊行為。
4. 本答案卷上請務必於　　內複制「執行後的程式碼及結果(含圖形)」，於本答案卷貼上(Courier New, 10點字，白底黑字)，不能只有程式碼，不能只有報表。最後，將每小題之答案(不能只印出報表，要助教去找答案)，在小題最後以打字(英文)作答(Times New Roman, 12點字，白底黑字)。
5. 請依序註明題號: (1)a, (1)b, (2)a 等等。
6. 作答完請將此word檔存檔，檔名為「學號-姓名-Regression-R-Midterm.docx」(更改成自己「學號、姓名」)並上傳至http://ftp.hmwu.idv.tw:8080/login.html?lang=tchinese
   或點選教師網站首頁【作業考試上傳區】。
7. 帳號: reg111，密碼: 上課教室號碼，資料夾: 「**20230420-MidtermExam**」
8. 如果上傳網站出現「空白頁」，請將滑鼠移至「網址列」後，按「Enter」即可。若再不行，請換其它瀏覽器(IE/Edge/Firefox/Chrome)
9. 上傳檔案無法刪除，若要上傳更新檔，請於主檔名後加

「-2」，例如:「學號-姓名-Regression-R-Midterm-2.docx」。

Notes:

1. This is an Open Book exam; you are free to use any materials including laptop, tablet and internets.
2. Smart phone and the communication software/APP (e.g., Messenger, IG, LINE, WeChat,..) are prohibited.
3. Copy the R codes and the results from and paste it to this answer sheet.
4. Change the file name of this answer sheet according to your ID and Full Name. Upload the answer sheet to http://ftp.hmwu.idv.tw:8080/login.html?lang=tchinese
5. Account: **rege111**，password: classroom number.

(1) 20% Data file: Grade_Point_Average.csv

Grade point average. The director of admissions of a small college selected 120 students at random from the new freshman class in a study to determine whether a student's grade point average (GPA) at the end of the freshman year (Y) can be predicted from the ACT test score (X). The results of the study follow. Assume that first-order regression model (1.1) is appropriate.

i:	1	2	3	...	118	119	120
X_i:	21	14	28	...	28	16	28
Y_i:	3.897	3.885	3.778	...	3.914	1.860	2.948

a. Obtain the least squares estimates of β_0 and β_1, and state the estimated regression function.
b. Plot the estimated regression function and the data. Does the estimated regression function appear to fit the data well?
c. Obtain a point estimate of the mean freshman GPA for students with ACT test score $X = 30$.

```
#1
#(a)
> GPA_X <- read.csv("C:/Users/USER/Downloads/111-2-Regression-R-
Midterm/data/Grade_Point_Average.csv")
> GPA_X
     GPA ACT
1   3.897  21
2   3.885  14
3   3.778  28
4   2.540  22
5   3.028  21
6   3.865  31
7   2.962  32
8   3.961  27
9   0.500  29
10  3.178  26
11  3.310  24
12  3.538  30
13  3.083  24
14  3.013  24
15  3.245  33
16  2.963  27
```

17	3.522	25
18	3.013	31
19	2.947	25
20	2.118	20
21	2.563	24
22	3.357	21
23	3.731	28
24	3.925	27
25	3.556	28
26	3.101	26
27	2.420	28
28	2.579	22
29	3.871	26
30	3.060	21
31	3.927	25
32	2.375	16
33	2.929	28
34	3.375	26
35	2.857	22
36	3.072	24
37	3.381	21
38	3.290	30
39	3.549	27
40	3.646	26
41	2.978	26
42	2.654	30
43	2.540	24
44	2.250	26
45	2.069	29
46	2.617	24
47	2.183	31
48	2.000	15
49	2.952	19
50	3.806	18
51	2.871	27
52	3.352	16
53	3.305	27
54	2.952	26
55	3.547	24
56	3.691	30
57	3.160	21
58	2.194	20
59	3.323	30
60	3.936	29
61	2.922	25
62	2.716	23
63	3.370	25
64	3.606	23
65	2.642	30
66	2.452	21
67	2.655	24
68	3.714	32
69	1.806	18
70	3.516	23
71	3.039	20
72	2.966	23
73	2.482	18
74	2.700	18

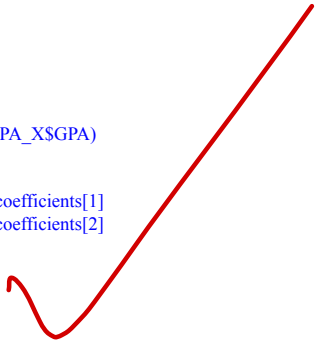
```
75  3.920  29
76  2.834  20
77  3.222  23
78  3.084  26
79  4.000  28
80  3.511  34
81  3.323  20
82  3.072  20
83  2.079  26
84  3.875  32
85  3.208  25
86  2.920  27
87  3.345  27
88  3.956  29
89  3.808  19
90  2.506  21
91  3.886  24
92  2.183  27
93  3.429  25
94  3.024  18
95  3.750  29
96  3.833  24
97  3.113  27
98  2.875  21
99  2.747  19
100 2.311  18
101 1.841  25
102 1.583  18
103 2.879  20
104 3.591  32
105 2.914  24
106 3.716  35
107 2.800  25
108 3.621  28
109 3.792  28
110 2.867  25
111 3.419  22
112 3.600  30
113 2.394  20
114 2.286  20
115 1.486  31
116 3.885  20
117 3.800  29
118 3.914  28
119 1.860  16
120 2.948  28
> GPA_X_lm <- lm(GPA~ACT, data = GPA_X)
> GPA_X_lm


Call:
lm(formula = GPA ~ ACT, data = GPA_X)


Coefficients:
(Intercept)          ACT
   2.11405      0.03883
```

beta0 = 2.11405
beta1 = 0.03883
Y = 2.11405+0.03883X

```
> plot(GPA_X$ACT, GPA_X$GPA)
> abline(GPA_X_lm)
>
> beta0 = GPA_X_lm$coefficients[1]
> beta1 = GPA_X_lm$coefficients[2]
> beta0 + beta1*30
(Intercept)
  3.278863
>
```



(2) Data file: Grade_Point_Average.csv

20% Refer to **Grade point average**

a. Set up the ANOVA table.

b. Conduct an F test of whether or not $\beta_1 = 0$. Control the α risk at .01. State the alternatives, decision rule, and conclusion.

c. What is the absolute magnitude of the reduction in the variation of Y when X is introduced into the regression model?

#2

```
> GPA_X <- read.csv("C:/Users/USER/Downloads/111-2-Regression-R-
Midterm/data/Grade_Point_Average.csv")
> GPA_X_ANOVA <- anova(lm(GPA~ACT, data = GPA_X))
>
> #H0: beta1 = 0
> alpha <- 0.01
> GPA_X_ANOVA
Analysis of Variance Table


Response: GPA
          Df Sum Sq Mean Sq F value    Pr(>F)
ACT         1  3.588  3.5878  9.2402 0.002917 **
Residuals 118 45.818  0.3883
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> F <- qf(1-alpha, 1, 118, lower.tail=TRUE)
> F
[1] 6.854641
> #F* = 9.2402
> #9.2402>6.8546, reject H0
```

(3) 30% Data file: Grade_Point_Average_X.csv

Refer to **Grade point average**

a. Prepare a box plot for the ACT scores X_i. Are there any noteworthy features in this plot?

b. Prepare a dot plot of the residuals. What information does this plot provide?

c. Plot the residual e_i against the fitted values $\hat{Y}_i$. What departures from regression model (2.1) can be studied from this plot? What are your findings?

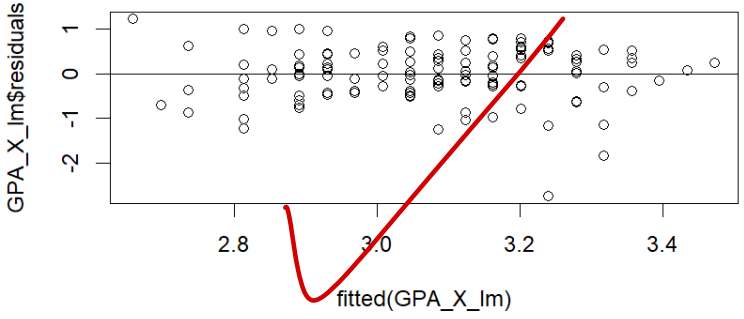
d. Prepare a normal probability plot of the residuals. Also obtain the coefficient of correlation between the ordered residuals and their expected values under normality. Test the reasonableness of the normality assumption here using Table B.6 and $\alpha = .05$. What do you conclude?

e. Conduct the Brown-Forsythe test to determine whether or not the error variance varies with the level of X. Divide the data into the two groups, $X < 26$, $X \geq 26$, and use $\alpha = .01$. State the decision rule and conclusion. Does your conclusion support your preliminary findings in part (c)?

f. Information is given below for each student on two variables not included in the model, namely, intelligence test score (X_2) and high school class rank percentile (X_3). (Note that larger class rank percentiles indicate higher standing in the class, e.g., 1% is near the bottom of the class and 99% is near the top of the class.) Plot the residuals against X_2 and X_3 on separate graphs to ascertain whether the model can be improved by including either of these variables. What do you conclude?

i:	1	2	3	...	118	119	120
X_2:	122	132	119	...	140	111	110
X_3:	99	71	75	...	97	65	85

```
#3
> #(a)
> boxplot(GPA_X$ACT, xlab = "ACT", horizontal = TRUE)
> #(b)
> plot(fitted(GPA_X_lm), GPA_X_lm$residuals)
> abline(0,0)
```




```
> #(c)
```

(4) Data file: Solution_concentration.csv

30%

Solution concentration. A chemist studied the concentration of a solution (Y) over time (X). Fifteen identical solutions were prepared. The 15 solutions were randomly divided into five sets of three, and the five sets were measured, respectively, after 1, 3, 5, 7, and 9 hours. The results follow.

i:	1	2	3	...	13	14	15
X_i:	9	9	9	...	1	1	1
Y_i:	.07	.09	.08	...	2.84	2.57	3.10

a. Prepare a scatter plot of the data. What transformation of Y might you try, using the prototype patterns in Figure 3.15 to achieve constant variance and linearity?

b. Use the Box-Cox procedure and standardization (3.36) to find an appropriate power transformation. Evaluate SSE for $\lambda = -.2, -.1, 0, .1, .2$. What transformation of Y is suggested?

c. Use the transformation $Y' = \log_{10} Y$ and obtain the estimated linear regression function for the transformed data.

d. Plot the estimated regression line and the transformed data. Does the regression line appear to be a good fit to the transformed data?

e. Obtain the residuals and plot them against the fitted values. Also prepare a normal probability plot. What do your plots show?

f. Express the estimated regression function in the original units.