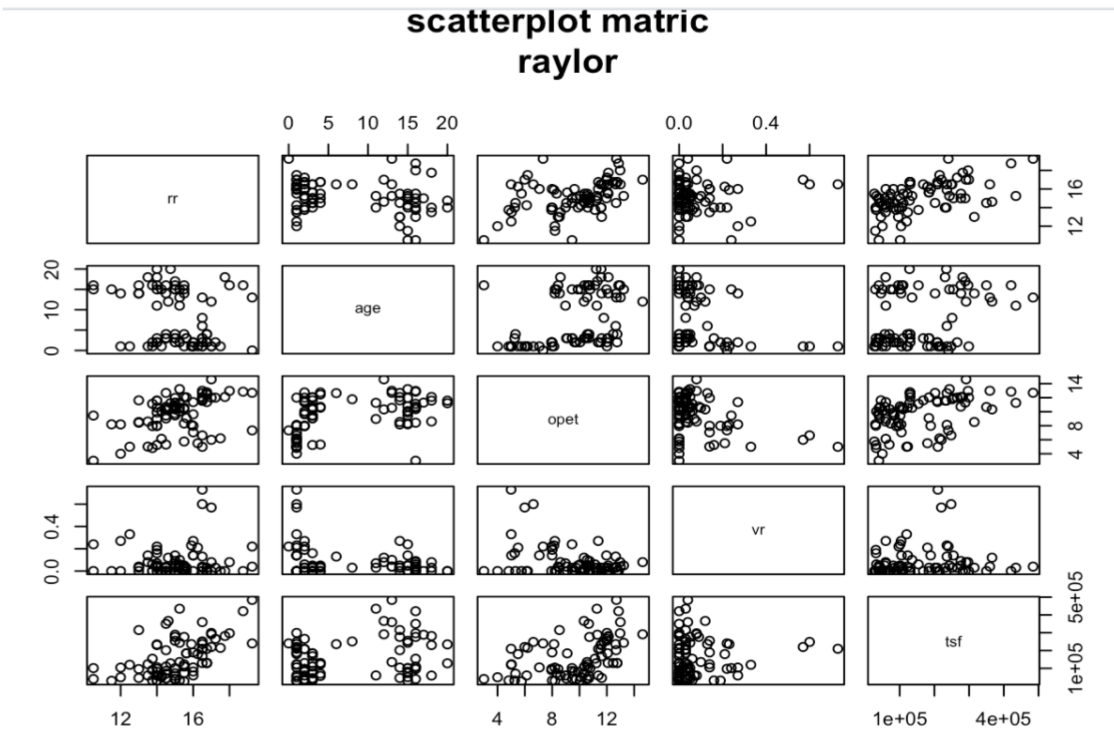
Problem1: The response variable is rental rates. The explanatory variables are age, operating expenses and taxes, vacancy rates, and total square footage.
(In this hw, I will use rr replaces rental rates, ot replaces operating expenses and taxes, vr replaces vacancy rates, and tsf replaces total square footage.)

1)



As we can see, they are all not very linearly related because the point is not like a line.

2) Find the correlation of all pairs of variables and give your comments about the association between variables.

```
> cor(p1)
              rr        age      opet          vr        tsf
rr    1.00000000 -0.2502846 0.4137872  0.06652647 0.53526237
age  -0.25028456  1.0000000 0.3888264 -0.25266347 0.28858350
opet  0.41378716  0.3888264 1.0000000 -0.37976174 0.44069713
vr    0.06652647 -0.2526635 -0.3797617  1.00000000 0.08061073
tsf   0.53526237  0.2885835 0.4406971  0.08061073 1.00000000
```

Rr and tsf have the largest correlation, and rr and tsf have second largest correlation. Then opet and age has the third largest correlation. Vr and rr have the least correlation, and vr and tsf have the second least correlation. Moreover, the correlation for rr and age, age and vr, opet and rr, vr and opet is negative. Otherwise, otis positive.

3) Run the multiple regressions with age, operating expenses and taxes, vacancy rates, and total square footage as the explanatory variables and rental rates as the response variable.

a) **Y=1.220e1 - 1.420e-1*age + 2.82e-1*ot +6.193e-1vr +7.924e-6tsf**

b) **β 0 represents the change in the mean of rental rates, per unit increase 1.22e1 when all predictor all zero.**

β1 represents the change in the mean of rental rates, per unit decrease 1.42e-1 in age when operating expenses and taxes, vacancy rates, and total square footage are held constant.

β 2 represents the change in the mean of rental rates, per unit increase 2.82e-1 in operating expenses and taxes when age, vacancy rates, and total square footage are held constant.

β 3 represents the change in the mean of rental rates, per unit increase 6.193e-1 in vacancy rates when age, operating expenses and taxes, and total square footage are held constant.

β 4 represents the change in the mean of rental rates, per unit increase 7.924e-6 in total square footage when age, operating expenses and taxes, and vacancy rates are held constant.

c) **R^2=0.5847 Adj R^2=0.5629**

d) ***H_0*: β1=β2=β3=β4=0 *H_A*: Not all βi = 0 (1, 2, 3 or 4) F-statistic: 26.76 on 4 and 76 DF p-value: 7.272e-14<0.05, so reject null hypothesis and conclude that not all βi =0.**

e) ***H_0*: β3=β4=0 *H_A*: Not all βi = 0 (3 or 4) F-statistic: 19.616 and p-value is 1.353e-07 <0.05, so reject null hypothesis and conclude that not all βi =0.**

f) ***H_0*: β3=0 *H_A*: Not β3 = 0 T=0.57 p=0.57>0.05 , so fail to reject null hypothesis and conclude that β3 =0.**

g) ***H_0*: β3=0 *H_A*: Not β3 = 0**
f=0.3248 p=0.5704>0.05 , so fail to reject null hypothesis and conclude that β3 =0.

h) **Remove vr, then get the new model below rr=12.37-0.1442age+0.2672ot+8.17e-6 tsf**

```
Call:
lm(formula = rr ~ age + ot + tsf)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.0620 -0.6437 -0.1013  0.5672  2.9583 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.237e+01  4.928e-01  25.100  < 2e-16
age         -1.442e-01  2.092e-02  -6.891 1.33e-09
ot           2.672e-01  5.729e-02   4.663 1.29e-05
tsf          8.178e-06  1.305e-06   6.265 1.97e-08

(Intercept) ***
age         ***
ot          ***
tsf         ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.132 on 77 degrees of freedom
Multiple R-squared:  0.583,     Adjusted R-squared:  0.5
667
F-statistic: 35.88 on 3 and 77 DF,  p-value: 1.295e-14
```

4) Confidence intervals for the regression coefficients for the final model.

I. Give the 90% confidence intervals for <u>each</u> of the regression coefficients. (Where 0.90 is the "statement confidence coefficient".)

```
                      5 %          95 %
(Intercept)  1.155005e+01  1.319112e+01
age         -1.789942e-01 -1.093351e-01
ot           1.717777e-01  3.625564e-01
tsf          6.004908e-06  1.035151e-05
```

Like the picture show

II. Give <u>Bonferroni Joint 90% confidence intervals</u> for each of the regression coefficients. (Where 0.90 is the "family confidence coefficient".)

```
> confint(d,level=(1-0.1/4))
                   1.25 %       98.75 %
(Intercept)  1.124390e+01 13.4972680885
age         -1.919897e-01 -0.0963396198
ot           1.361865e-01  0.3981475445
tsf          5.194017e-06  0.0000111624
```

Like the picture show

III. We would like to obtain <u>simultaneous interval estimates of the mean rental rates</u> for four typical properties specified below. Obtain the family of estimates using a 95% family confidence coefficient.

```
> predict(d,new.data,interval="confidence",level=(1-.05/4))
       fit      lwr      upr
1 15.89844 15.35022 16.44666
2 15.98463 15.41526 16.55400
3 15.87816 15.32149 16.43483
4 15.91431 15.33555 16.49308
```

simultaneous interval is ((15.35022, 16.44666), (15.41526, 16.554), (15.32149, 16.43483) and (15.33555, 16.49308).

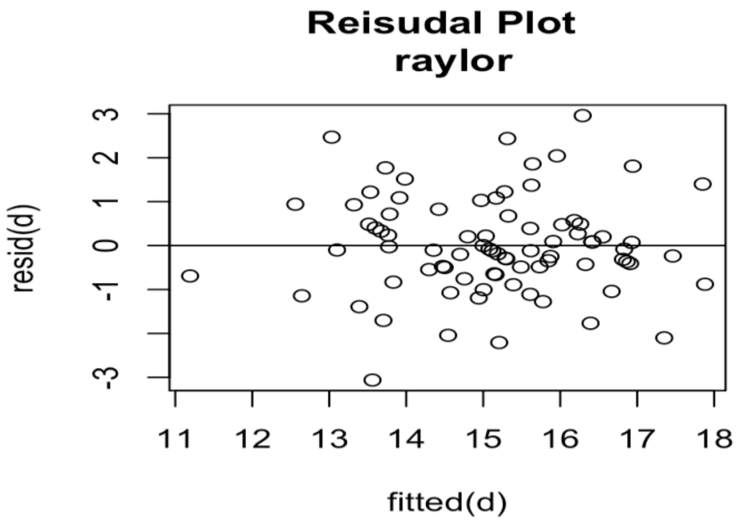
IV. Develop <u>separate prediction intervals</u> for the rental rates of these properties, using a 95% statement confidence coefficient in <u>each case</u>

```
> predict(d,nnnew.data,interval="confidence",level=(1-.05))
       fit      lwr      upr
1 14.83152 14.49011 15.17293
2 14.40608 13.98934 14.82283
3 16.76079 16.26594 17.25563
```

Intervals are (14.75475, 15.48495), (15.17685, 15. 94195) and (16.26594, 17.25563)

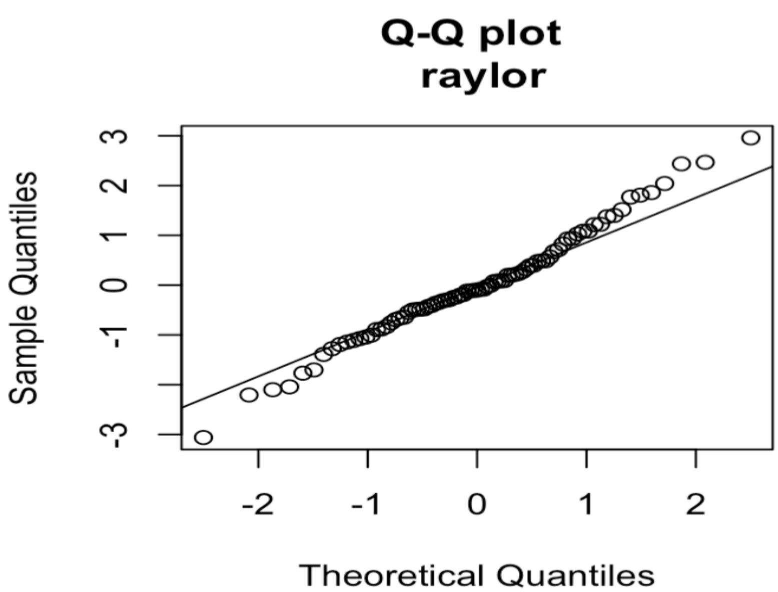
5) Diagnostic Plots and Tests:

a) Plot the residuals against the predicted (fitted) rental rate. Comment on the plot.

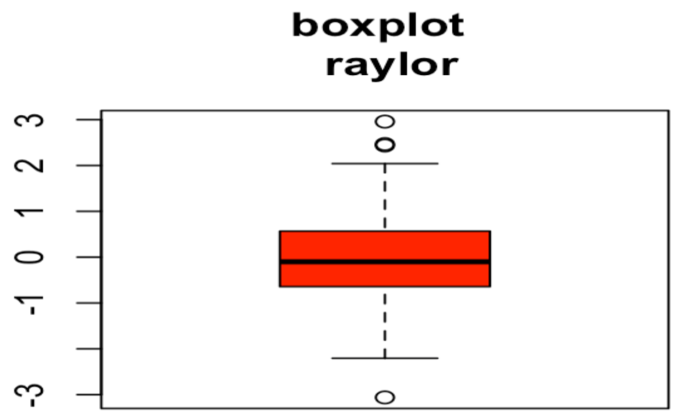


It is almost linear.

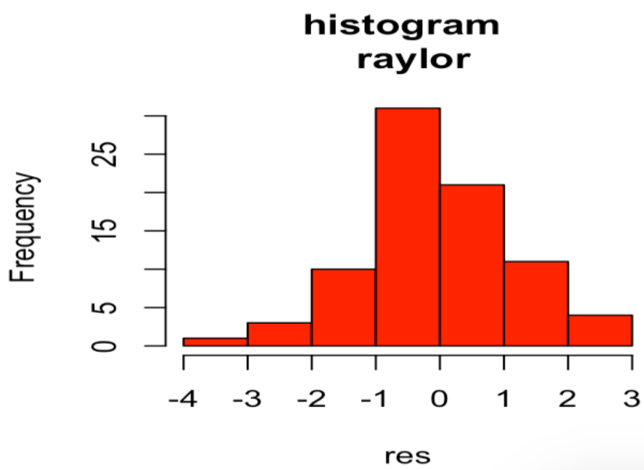
b) Give a QQ-plot, boxplot and histogram of the residuals with normal curve. State your conclusions from these plots.



It looks like be normal.



There are three outliers and look normally.

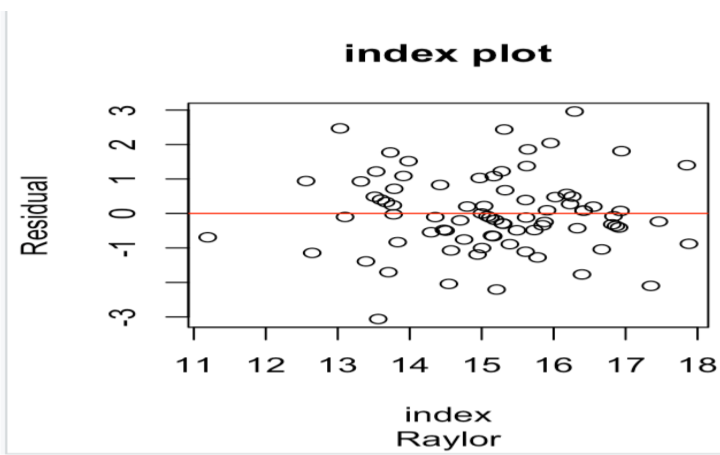


It is almost normal.

c) Conduct Breusch-Pagan Test for the constancy of the error variance.

Ho: The error variance is constant Ha: The error variance is not constant BP = 17.281, df = 3, p-value = 0.0006187<0.05, so reject null hypothesis and state that the error variance is not constant.

d) Index Plot to test for Independence of errors.

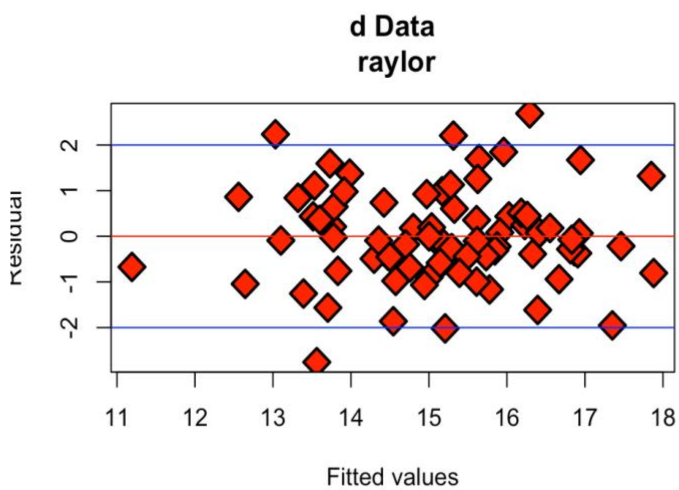


It looks like independent.

e) Conduct a Shapiro-Wilk Test on the residuals. Give the p-value for this test and explain what this means in terms of our model assumptions.
Ho: Random error comes from normal distribution Ha: Random error does not come from normal distribution. W = 0.98776, p-value = 0.6406>0.05, so fail to reject h0 and state that random error comes from normal distribution

f) Conduct Durbin-Watson Test.
Ho: The errors are uncorrelated over time Ha: The errors are positively correlated DW = 1.5867, p-value = 0.02463<0.05, so reject null hypothesis and state that the errors are uncorrelated over time.

g) Deduct any outliers.



There are five outliners.

6) Remove the outliers and refit the model to see how much difference in R^2 and adj R^2
New R^2=0.6623 and adjusted r^2=0.6462

7) Assume that a particular rental property is 5 years old, the operating expenses and taxes are 8.25, the vacancy rate is 0, and the total square footage is 250,000. Find a point estimate and 90% prediction interval for the rental rate of this property.
point estimate is 15.81573 and 90% prediction interval is (14.22162, 17.40984)

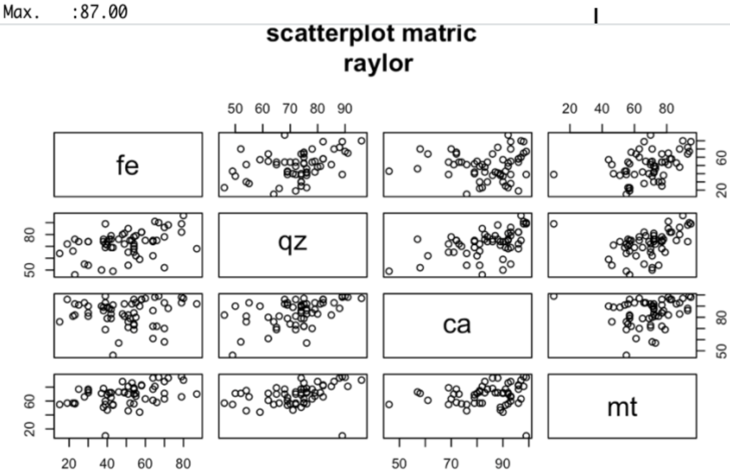
Problem2: Data from a ST430 class many years ago consist of quiz average, computer assignment average, midterm score and Final Exam score, all in percent. We seek to predict final exam score from the term work. In the data file, the quiz averages and computer averages are out of ten, but you should fix them up so they are out of 100.

Part A:

1. Start with a summary of the data frame, a correlation matrix, and a matrix of scatterplots using pairs

```
> summary(a[c('QuizAve','CompAve','MidTerm', 'FinalExam')])
    QuizAve         CompAve          MidTerm
 Min.   :4.600   Min.   :4.600   Min.   :10.00
 1st Qu.:6.800   1st Qu.:7.900   1st Qu.:57.25
 Median :7.400   Median :8.650   Median :71.00
 Mean   :7.257   Mean   :8.400   Mean   :68.88
 3rd Qu.:7.875   3rd Qu.:9.275   3rd Qu.:77.00
 Max.   :9.600   Max.   :9.900   Max.   :95.00
   FinalExam
 Min.   :15.00
 1st Qu.:39.00
 Median :51.00
 Mean   :49.45
 3rd Qu.:59.50
 Max.   :87.00
```

```
> cor(a)
            QuizAve    CompAve   MidTerm  FinalExam
QuizAve   1.0000000 0.49313970 0.3665234 0.39597772
CompAve   0.4931397 1.00000000 0.1600845 0.03312729
MidTerm   0.3665234 0.16008452 1.0000000 0.40363552
FinalExam 0.3959777 0.03312729 0.4036355 1.00000000
```



i. What is the median score on the computer assignments?
86.5

ii. What is the correlation between the computer average and the final exam score?
0.03312729

iii. Suppose you were to fit a simple regression model with quiz average as the single explanatory variable and final exam score as the response variable. Without actually fitting the model, what would R^2 be?
0.1568

2. Write the regression equation in scalar form
Final= 9.1368 + 0.5871 * QuizAve- 0.2934 * CompAve+ 0.3246* Midterm

3. What is the expected final exam score for a student with a 70% average on the quizzes,85% on the computer assignments, and 65% on the midterm?
Final= 9.13675 + 0.587096 * 70 - 0.293434 * 85 + 0.32455* 65
= 46.38733

4. For any fixed quiz average and computer average, a score one point higher on the midterm yields an expected mark on the Final Exam that is **_0.32455__**higher.

We want a hypothesis test to answer this question:

5. Are any of the term work variables useful in predicting final exam score?

   i. State the null and alternate hypothesis in terms of scalar β_j values.

Ho: β1 = β2 = β3=0 Ha: At least one βi does not equal to 0, i=1, 2, 3   F-statistic: 6.528 on 3 and 54 DF, p-value: 0.000755<0.05, so reject null hypothesis and conclude that at least one βi does not equal to 0, i=1, 2, 3.

   ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
   Y=β0=49.448

6. Controlling for computer assignment average and midterm score, is quiz average related to Final Exam score?

   i. State the null and alternate hypothesis in terms of scalar β_j values.

Ho: β1= 0 Ha: β1 does not equal to 0   F = 7.5217. p-value = 0.008253<0.05, so reject h0 and conclude that β1 does not equal to 0.

   ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
   Final=22.19359- 0.04598* xi2+ 0.45176* xi3

7. Allowing for quiz average and computer assignment average, is midterm score a predictor of Final Exam score?

   i. State the null and alternate hypothesis in terms of scalar β_j values.
   Ho: β3= 0 Ha: β3 does not equal to 0   F = 5.4909 p-value = 0.02283<0.05, so reject h0 and conclude that β3 does not equal to 0.

   ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
   Final=20.2595+0.7551* xi1-0.3048* xi2

8. Holding for quiz average and midterm score fixed, is computer assignment average connected to Final Exam score?

   i. State the null and alternate hypothesis in terms of scalar β_j values.
   Ho: β2= 0 Ha: β2 does not equal to 0   F = 2.367 p-value = 0.1298>0.05, so fail to reject h0 and conclude that β3 is equal to 0.

   ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
   Final=-4.5802+0.4313* xi1+0.33* xi3

9. Controlling for computer assignment average, is quiz average or midterm score (or both) related to Final Exam score?

i. State the null and alternate hypothesis in terms of scalar β_j values.
Ho: β1= β3=0 Ha: one of β1,3 does not equal to 0 F = 9.7522 p-value= 0. 0002422<0.05, so reject h0 and conclude that one of β1,3 does not equal to 0.

ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
Final=45.4889+0.04714* xi2

10. The professor thinks that the quizzes and midterm should have equal weight, and should be worth twice as much as the computer assignments. If this idea is correct, it should be reflected in the relationship of the term marks to the final exam. Also, it makes sense that if a student got zero on all three components of the term mark, he or she should also expect a zero on the final exam - even though this extreme case is outside the range of the data. Taken together, these ideas represent an unusual but testable null hypothesis. If it is rejected, we could say that the professor's ideas are not supported by the data.

i. State the null and alternate hypothesis in terms of scalar β_j values.
Ho: β0= 0 Ha: β0 does not equal to 0

ii. The null hypothesis could be tested using the full-reduced model approach. Give the regression equation for the reduced model.
Final=0.4xi1+0.2xi2+0.4xi3

Part B:

1. Write the regression equation in matrix form

Y1		**1**	**x1 1.**				**e1**
Y2		**1**	**x2 1**		**β0**		**.**
.	=	**.**	**.**	*	**β1**	+	**.**
.		**.**	**.**		**β2**		**.**
.		**.**	**.**		**β3**		**.**
Y58		**1**	**x58 1**				**e58**

i. What are the dimensions of the X matrix?
58 rows and 4 columns 58*4

ii. What are the dimensions of $\widehat{\beta} = b$?
4 rows and 1 column 4*1

iii. What are the dimensions of $\widehat{\varepsilon} = e$?
58 rows and 1 column 58*1

iv. What are the dimensions of $e'e$?
1 row and 1 column 1*1

v. What are the dimensions of the $\hat{y}$ matrix?
58 rows and 1 column 58*1

vi. What are the dimensions of the hat matrix H?
58 rows and 58 columns 58*58

vii. What is $e'e$
Sse

2. Calculate:

$\hat{\beta} = (X'X)^{-1}X'Y$

```
> b
           [,1]
[1,]  9.1367509
[2,]  0.5870963
[3,] -0.2934339
[4,]  0.3245532
```

$\hat{Y} = Xb = X(X'X)^{-1}X'y$

```
          [,1]
 [1,] 42.25694
 [2,] 51.40981
 [3,] 63.43346
 [4,] 60.09480
 [5,] 48.48723
 [6,] 57.03233
 [7,] 47.56108
 [8,] 35.12579
 [9,] 52.69078
[10,] 60.72272
[11,] 31.64672
[12,] 53.06346
[13,] 60.89836
[14,] 52.92403
[15,] 44.78210
[16,] 45.10529
[17,] 53.83590
[18,] 35.58390
[19,] 55.72236
[20,] 60.31012
[21,] 46.69436
[22,] 49.54066
[23,] 41.41330
[24,] 65.16249
[25,] 51.79477
[26,] 42.61649
[27,] 40.46978
[28,] 35.55821
[29,] 41.83024
[30,] 61.26717
[31,] 47.43500
[32,] 51.30172
[33,] 56.04691
```

```
[33,] 56.04691
[34,] 50.86582
[35,] 52.76889
[36,] 45.68987
[37,] 63.46435
[38,] 66.24470
[39,] 54.08463
[40,] 45.15274
[41,] 49.18293
[42,] 30.58113
[43,] 49.01117
[44,] 57.53001
[45,] 54.83674
[46,] 55.27241
[47,] 33.46842
[48,] 42.26036
[49,] 50.86999
[50,] 41.73756
[51,] 45.88024
[52,] 51.33192
[53,] 52.70574
[54,] 53.35644
[55,] 39.95897
[56,] 43.01847
[57,] 44.93513
[58,] 49.97307
```

$$H = X(X'X)^{-1}X'$$

	[,1]	[,2]	[,3]	[,4]
[1,]	0.2126898843	-0.031154549	-7.329939e-02	-0.0662934493
[2,]	-0.0311545486	0.038098010	3.410654e-02	0.0435725942
[3,]	-0.0732993882	0.034106539	9.261622e-02	0.0731529675
[4,]	-0.0662934493	0.043572594	7.315297e-02	0.0709096805
[5,]	0.0402577283	0.025180604	-3.048806e-03	0.0153278296
[6,]	0.0658051056	0.006916066	1.965547e-02	0.0155586971
[7,]	0.0439815858	0.011625867	1.654318e-03	0.0046723760
[8,]	0.0123159653	-0.010770813	-8.735204e-04	-0.0260580856
[9,]	0.0884107970	-0.010049865	7.179298e-03	-0.0076549243
[10,]	0.1323943193	0.000804899	-1.191990e-03	0.0051280722
[11,]	0.0108375277	0.019699285	-3.056986e-02	-0.0142599405
[12,]	-0.0273797701	0.032006671	4.086523e-02	0.0423345277
[13,]	-0.0411216220	0.028660825	7.222925e-02	0.0583022942
[14,]	0.0136071171	0.013696179	3.125747e-02	0.0225808070
[15,]	-0.0140174963	0.015704821	2.187276e-02	0.0138536662
[16,]	0.0448068529	-0.001256932	3.179046e-03	-0.0079248258
[17,]	0.0024978579	0.017092595	3.736284e-02	0.0286839705

	[,5]	[,6]	[,7]	[,8]
[1,]	0.0402577283	0.065805106	0.043981586	0.0123159653
[2,]	0.0251806036	0.006916066	0.011625867	-0.0107708130
[3,]	-0.0030488061	0.019655468	0.001654318	-0.0008735204
[4,]	0.0153278296	0.015558697	0.004672376	-0.0260580856
[5,]	0.0409545352	0.024626915	0.022029866	-0.0268601712
[6,]	0.0246269148	0.052157143	0.021849600	-0.0231345378
[7,]	0.0220298662	0.021849600	0.021234357	0.0165740922
[8,]	-0.0268601712	-0.023134538	0.016574092	0.1636493910
[9,]	0.0101472885	0.047687988	0.024436305	0.0255289900
[10,]	0.0478182503	0.084994115	0.030720920	-0.0803072400
[11,]	0.0196574488	-0.027739555	0.020774031	0.0794144134
[12,]	0.0175067894	0.011444158	0.011104820	-0.0006973893
[13,]	0.0047590373	0.024750303	0.006677375	-0.0049524603
[14,]	0.0096332110	0.023767914	0.015420903	0.0196410049
[15,]	-0.0001283099	-0.005878190	0.013256488	0.0688135637
[16,]	0.0028591781	0.014398065	0.020427466	0.0661093380
[17,]	0.0092676384	0.022313256	0.013857212	0.0160332623

	[,9]	[,10]	[,11]	[,12]
[1,]	8.841080e-02	0.1323943193	0.0108375277	-2.737977e-02
[2,]	-1.004986e-02	0.0008048990	0.0196992849	3.200667e-02
[3,]	7.179298e-03	-0.0011919900	-0.0305698595	4.086523e-02
[4,]	-7.654924e-03	0.0051280722	-0.0142599405	4.233453e-02
[5,]	1.014729e-02	0.0478182503	0.0196574488	1.750679e-02
[6,]	4.768799e-02	0.0849941149	-0.0277395551	1.144416e-02
[7,]	2.443630e-02	0.0307209196	0.0207740307	1.110482e-02
[8,]	2.552899e-02	-0.0803072400	0.0794144134	-6.973893e-04
[9,]	6.317565e-02	0.0699089191	-0.0143043314	-8.574677e-05
[10,]	6.990892e-02	0.1617378563	-0.0565619135	3.495469e-03
[11,]	-1.430433e-02	-0.0565619135	0.1017694101	1.021554e-02
[12,]	-8.574677e-05	0.0034954688	0.0102155400	2.991556e-02
[13,]	1.395264e-02	0.0156665614	-0.0248328654	3.388759e-02
[14,]	2.613515e-02	0.0225899450	0.0009091208	1.789246e-02
[15,]	7.158495e-03	-0.0359984994	0.0436066327	1.773303e-02
[16,]	3.515975e-02	0.0054028574	0.0296105632	4.543532e-03
[17,]	2.215340e-02	0.0188560522	-0.0009492762	2.093938e-02

	[,13]	[,14]	[,15]	[,16]
[1,]	-0.0411216220	0.0136071171	-0.0140174963	0.0448068529
[2,]	0.0286608249	0.0136961786	0.0157048214	-0.0012569320
[3,]	0.0722292454	0.0312574670	0.0218727632	0.0031790464
[4,]	0.0583022942	0.0225808070	0.0138536662	-0.0079248258
[5,]	0.0047590373	0.0096332110	-0.0001283099	0.0028591781
[6,]	0.0247503031	0.0237679144	-0.0058781902	0.0143980646
[7,]	0.0066773754	0.0154209026	0.0132564877	0.0204274662
[8,]	-0.0049524603	0.0196410049	0.0688135637	0.0661093380
[9,]	0.0139526432	0.0261351467	0.0071584950	0.0351597463
[10,]	0.0156665614	0.0225899450	-0.0359984994	0.0054028574
[11,]	-0.0248328654	0.0009091208	0.0436066327	0.0296105632
[12,]	0.0338875862	0.0178924599	0.0177330347	0.0045435316
[13,]	0.0583649910	0.0281516825	0.0161291394	0.0055197669
[14,]	0.0281516825	0.0225804662	0.0174786783	0.0198349075
[15,]	0.0161291394	0.0174786783	0.0401217715	0.0295306476
[16,]	0.0055197669	0.0198349075	0.0295306476	0.0389532839
[17,]	0.0324340045	0.0228982039	0.0178680218	0.0170274772

	[,17]	[,18]	[,19]	[,20]
[1,]	0.0024978579	-0.049312496	-0.0488316527	0.0091125955
[2,]	0.0170925948	0.089521331	0.0293186706	0.0137312843
[3,]	0.0373628411	-0.035405768	0.0614653194	0.0541645411
[4,]	0.0286839705	0.047568858	0.0503291373	0.0377731368
[5,]	0.0092676384	0.096940145	0.0024784786	0.0067133659
[6,]	0.0223132562	-0.030704607	0.0094851146	0.0399173755
[7,]	0.0138572117	0.018626375	0.0067779034	0.0129549036
[8,]	0.0160332623	-0.102198857	0.0188932127	-0.0027234553
[9,]	0.0221534016	-0.095113600	0.0040018836	0.0370107736
[10,]	0.0188560522	-0.014854242	-0.0120141369	0.0470435958
[11,]	-0.0009492762	0.106319496	0.0006490717	-0.0328391785
[12,]	0.0209393763	0.047250540	0.0324590787	0.0220185573
[13,]	0.0324340045	-0.024178628	0.0479455055	0.0473875962
[14,]	0.0228982039	-0.024953223	0.0241018735	0.0296281053
[15,]	0.0178680218	-0.005078928	0.0265720497	0.0087930408
[16,]	0.0170274772	-0.051614321	0.0104185065	0.0148344290
[17,]	0.0239563955	-0.019319646	0.0280433939	0.0310398538

	[,21]	[,22]	[,23]	[,24]
[1,]	6.762014e-02	-0.0116156313	0.0471655070	-2.230233e-02
[2,]	1.567576e-02	0.0211445495	-0.0141459664	2.460656e-02
[3,]	-1.604808e-02	0.0301256178	0.0004561502	7.688780e-02
[4,]	4.884244e-04	0.0257708063	-0.0232279444	6.017229e-02
[5,]	4.005541e-02	0.0089511485	-0.0154365957	7.405168e-03
[6,]	2.914066e-02	0.0072709016	0.0045345349	4.147015e-02
[7,]	2.563843e-02	0.0131414416	0.0201561403	8.140538e-03
[8,]	-1.593246e-02	0.0318962192	0.1186428317	-2.519039e-02
[9,]	2.194163e-02	0.0088524776	0.0441758467	2.788515e-02
[10,]	5.734305e-02	-0.0077364447	-0.0231871310	4.708115e-02
[11,]	2.190045e-02	0.0220823726	0.0439731637	-4.845641e-02
[12,]	9.758501e-03	0.0220285456	-0.0027936459	3.226918e-02
[13,]	-4.246478e-03	0.0247805624	0.0009034597	6.450215e-02
[14,]	9.843902e-03	0.0186010010	0.0229801173	3.188375e-02
[15,]	-5.886952e-04	0.0265597895	0.0468956662	5.296886e-03
[16,]	1.089239e-02	0.0181581393	0.0581524068	3.428458e-03
[17,]	7.631977e-03	0.0198909617	0.0187186319	3.576642e-02

	[,25]	[,26]	[,27]	[,28]
[1,]	0.0379575901	0.0402654385	-6.190088e-03	-0.0045395536
[2,]	0.0157122414	0.0143152395	2.719848e-02	0.0014328773
[3,]	0.0138357787	-0.0119689855	-2.118824e-03	0.0009306326
[4,]	0.0165279457	-0.0024750420	1.077337e-02	-0.0144210315
[5,]	0.0249075409	0.0248301578	2.187445e-02	-0.0164669273
[6,]	0.0304011775	0.0089197000	-1.172916e-02	-0.0266322286
[7,]	0.0197592012	0.0221480479	1.687588e-02	0.0152620981
[8,]	-0.0060505797	0.0292298273	3.981228e-02	0.1388827739
[9,]	0.0256130912	0.0131445077	-1.135569e-02	0.0100911965
[10,]	0.0463202823	0.0107541077	-3.005857e-02	-0.0806946956
[11,]	0.0027556385	0.0449439824	6.472253e-02	0.0823955906
[12,]	0.0155082569	0.0101849569	1.946432e-02	0.0063417465
[13,]	0.0171697099	-0.0052002696	-1.198391e-03	-0.0035136083
[14,]	0.0177447394	0.0100646879	6.791949e-03	0.0156199589
[15,]	0.0057503010	0.0194421063	3.107673e-02	0.0636250476
[16,]	0.0130024031	0.0216629848	1.639751e-02	0.0534491423
[17,]	0.0172134942	0.0081930614	7.169515e-03	0.0135100464

	[,29]	[,30]	[,31]	[,32]
[1,]	-0.0166969820	0.0105326328	0.1317526563	-0.004723158
[2,]	0.0244996245	0.0245740136	-0.0073835635	0.022504139
[3,]	0.0090762935	0.0486728950	-0.0322307217	0.030444636
[4,]	0.0139757233	0.0457955121	-0.0252340509	0.028538293
[5,]	0.0123803353	0.0240077596	0.0362439933	0.014278018
[6,]	-0.0127452125	0.0442991188	0.0515330109	0.014280410
[7,]	0.0145793150	0.0142315903	0.0328239224	0.013965987
[8,]	0.0536511847	-0.0424454892	-0.0055650109	0.014605299
[9,]	-0.0077122354	0.0265526095	0.0581996592	0.011077015
[10,]	-0.0391959143	0.0661979398	0.0981630496	0.008198173
[11,]	0.0594983429	-0.0354295488	0.0039467079	0.013050437
[12,]	0.0201734751	0.0267660714	-0.0062980054	0.022696509
[13,]	0.0063682720	0.0450283868	-0.0130877879	0.026398350
[14,]	0.0106023045	0.0246865795	0.0151276170	0.018668282
[15,]	0.0367256290	-0.0042734551	-0.0080607473	0.019413136
[16,]	0.0210244927	-0.0003155097	0.0267887932	0.013537389
[17,]	0.0113283927	0.0269310024	0.0091591033	0.020036730

	[,33]	[,34]	[,35]	[,36]
[1,]	-0.0491054759	0.071007747	0.0174367295	0.1521677618
[2,]	0.0286428044	0.019757524	0.0191132719	-0.0297564241
[3,]	0.0629747629	-0.009023959	0.0250984960	-0.0326313437
[4,]	0.0506081397	0.010257652	0.0247174509	-0.0462156535
[5,]	0.0012697709	0.047592362	0.0198826857	0.0120947048
[6,]	0.0100698472	0.041047222	0.0255915348	0.0517417180
[7,]	0.0065774584	0.025658055	0.0167007249	0.0338070675
[8,]	0.0201654515	-0.047307076	-0.0009083750	0.0532764276
[9,]	0.0052285368	0.024381579	0.0203681845	0.0835005445
[10,]	-0.0118874256	0.082586600	0.0329422011	0.0840915441
[11,]	-0.0009529196	0.002698280	0.0020810240	0.0045660011
[12,]	0.0323717471	0.013103459	0.0196136525	-0.0185265632
[13,]	0.0490790320	0.003213299	0.0244845891	-0.0148172357
[14,]	0.0247718966	0.011037475	0.0191927400	0.0228550341
[15,]	0.0269140320	-0.012375854	0.0104206166	0.0077117964
[16,]	0.0110949293	0.001546031	0.0121162671	0.0529618576
[17,]	0.0287166058	0.009522230	0.0197377154	0.0143849439

	[,37]	[,38]	[,39]	[,40]
[1,]	-0.0681554935	-0.0692545838	-0.025298852	-0.0411608047
[2,]	0.0313945318	0.0436014645	0.014396737	0.0333325265
[3,]	0.0918277020	0.0918124174	0.054625020	0.0252539599
[4,]	0.0705198893	0.0833960935	0.033353088	0.0307568767
[5,]	-0.0046790814	0.0132828989	-0.008670126	0.0135254847
[6,]	0.0212598957	0.0292961633	0.012175239	-0.0125847374
[7,]	0.0021354961	0.0027419423	0.009106641	0.0109821378
[8,]	0.0028387091	-0.0454242980	0.050370307	0.0366224876
[9,]	0.0110101499	0.0015133615	0.021563188	-0.0159410030
[10,]	0.0008650233	0.0263097969	-0.012841594	-0.0404999816
[11,]	-0.0320436480	-0.0424821717	0.001720174	0.0495353868
[12,]	0.0392107792	0.0456847356	0.022989598	0.0280810817
[13,]	0.0717883741	0.0740795092	0.042607084	0.0184497339
[14,]	0.0321036328	0.0283596510	0.027700290	0.0117653007
[15,]	0.0221910649	0.0062588873	0.033169726	0.0342966519
[16,]	0.0055973958	-0.0122519991	0.026170357	0.0120337531
[17,]	0.0378435632	0.0353465096	0.029568221	0.0143833618

	[,41]	[,42]	[,43]	[,44]
[1,]	0.0820112513	0.0555482723	0.0880823707	0.0003619904
[2,]	-0.0026107223	-0.0121659445	0.0156766990	0.0042386662
[3,]	-0.0042672378	-0.0354745031	-0.0204461855	0.0575470191
[4,]	-0.0086376085	-0.0446691147	0.0006844037	0.0285731817
[5,]	0.0187837913	-0.0071407986	0.0499537829	-0.0119479804
[6,]	0.0379009444	-0.0181931138	0.0423521101	0.0285991875
[7,]	0.0251464147	0.0242946049	0.0283042588	0.0111198868
[8,]	0.0202843100	0.1431870709	-0.0438038202	0.0462022958
[9,]	0.0484193026	0.0262055784	0.0285142169	0.0420451289
[10,]	0.0588709064	-0.0545647679	0.0879973726	0.0147197146
[11,]	0.0045013554	0.0935795728	0.0078888622	-0.0203349750
[12,]	0.0019333805	-0.0082095273	0.0086640820	0.0177282961
[13,]	0.0045164087	-0.0286504310	-0.0049104736	0.0470536110
[14,]	0.0198951555	0.0113848187	0.0095558342	0.0330910527
[15,]	0.0076776617	0.0567370739	-0.0134728428	0.0265474028
[16,]	0.0296403894	0.0624702272	0.0047425418	0.0312261216
[17,]	0.0162141002	0.0055991247	0.0069251248	0.0337892001

	[,45]	[,46]	[,47]	[,48]
[1,]	7.554536e-02	0.009664155	0.0772662679	0.064944453
[2,]	1.909575e-02	0.019128050	0.0020632865	0.009560169
[3,]	7.101426e-05	0.036172416	-0.0486638517	-0.022791487
[4,]	1.656806e-02	0.031172455	-0.0351398551	-0.011149713
[5,]	4.841819e-02	0.015803216	0.0252205973	0.029767239
[6,]	5.222292e-02	0.028738032	-0.0011115884	0.016576300
[7,]	2.534570e-02	0.014882202	0.0287037844	0.025553027
[8,]	-6.377953e-02	-0.002529897	0.0662342315	0.022257127
[9,]	3.199342e-02	0.023151286	0.0178940756	0.021474301
[10,]	1.021733e-01	0.034663959	-0.0021177309	0.029207706
[11,]	-1.666570e-02	-0.008379221	0.0794614988	0.041822723
[12,]	1.428532e-02	0.021694671	-0.0033438844	0.005375658
[13,]	1.169036e-02	0.032918265	-0.0338825699	-0.011764374
[14,]	1.438362e-02	0.022295462	0.0040739052	0.009391602
[15,]	-1.958742e-02	0.010379386	0.0279856603	0.013315269
[16,]	-1.718757e-03	0.011730304	0.0371150227	0.022941319
[17,]	1.316674e-02	0.023428952	-0.0011035277	0.006282249

	[,49]	[,50]	[,51]	[,52]
[1,]	-0.0174167249	-0.0321286662	-0.033662169	0.029969823
[2,]	0.0184433919	0.0326356467	0.013686451	0.011649188
[3,]	0.0387420634	0.0114418590	0.036715780	0.019554534
[4,]	0.0279299866	0.0218749579	0.018863357	0.014876468
[5,]	0.0017866761	0.0172711614	-0.013072999	0.014745840
[6,]	0.0079323401	-0.0175584969	-0.010833961	0.025730600
[7,]	0.0115922688	0.0131357813	0.009665582	0.018132876
[8,]	0.0413601482	0.0425144961	0.090130175	0.016329296
[9,]	0.0131275094	-0.0192047922	0.008312131	0.028295166
[10,]	-0.0120516937	-0.0453669543	-0.054906742	0.030892509
[11,]	0.0162662986	0.0639197083	0.041168224	0.005379609
[12,]	0.0222084586	0.0251368420	0.019587998	0.014490967
[13,]	0.0308309471	0.0076908857	0.025594833	0.020086029
[14,]	0.0218462250	0.0080638070	0.021749274	0.020357551
[15,]	0.0300682048	0.0357707239	0.049709663	0.014264884
[16,]	0.0218244778	0.0137694444	0.035402505	0.020328845
[17,]	0.0233168241	0.0098862266	0.022819717	0.019760574

	[,53]	[,54]	[,55]	[,56]
[1,]	6.624711e-02	-0.0032484018	0.002619149	-0.0014333659
[2,]	8.251399e-03	0.0258998688	0.033289127	0.0346595662
[3,]	6.472379e-03	0.0330616200	-0.012365910	-0.0026419238
[4,]	7.926113e-03	0.0342178611	0.011587843	0.0191475884
[5,]	2.733943e-02	0.0200264549	0.035662273	0.0354549452
[6,]	4.207420e-02	0.0202702235	-0.008812779	-0.0027462598
[7,]	2.310979e-02	0.0141089085	0.019103541	0.0178977348
[8,]	-1.230930e-02	-0.0051256122	0.013615690	0.0020764689
[9,]	3.948108e-02	0.0106973532	-0.017717721	-0.0150490041
[10,]	7.010282e-02	0.0222024894	-0.015010932	-0.0054485763
[11,]	-7.365477e-03	0.0038902980	0.066904529	0.0535303075
[12,]	9.820392e-03	0.0249315957	0.020743607	0.0232459388
[13,]	1.362343e-02	0.0295905345	-0.007515290	0.0005937533
[14,]	1.918661e-02	0.0185594202	0.002169068	0.0046354073
[15,]	-1.149093e-03	0.0122901622	0.021536198	0.0175796572
[16,]	1.602578e-02	0.0071747118	0.007041797	0.0036690352
[17,]	1.726251e-02	0.0203749879	0.002602800	0.0056937089

	[,57]	[,58]
[1,]	-0.0180698955	-0.0284711502
[2,]	0.0360306910	0.0333482398
[3,]	0.0105704524	0.0319297708
[4,]	0.0271309298	0.0374078604
[5,]	0.0291336079	0.0193443924
[6,]	-0.0041242122	0.0037732107
[7,]	0.0149853162	0.0118294475
[8,]	0.0066604165	0.0071296021
[9,]	-0.0159823706	-0.0065853158
[10,]	-0.0136244295	-0.0081239003
[11,]	0.0474578278	0.0250635498
[12,]	0.0265600998	0.0290676813
[13,]	0.0097929335	0.0262194144
[14,]	0.0075283458	0.0145799550
[15,]	0.0211354337	0.0213712733
[16,]	0.0038515206	0.0054979435
[17,]	0.0095045510	0.0173677457

$$\hat{Y} = X(X'X)^{-1}X'y = Hy$$

```
> Yhat
          [,1]
 [1,] 42.25694
 [2,] 51.40981
 [3,] 63.43346
 [4,] 60.09480
 [5,] 48.48723
 [6,] 57.03233
 [7,] 47.56108
 [8,] 35.12579
 [9,] 52.69078
[10,] 60.72272
[11,] 31.64672
[12,] 53.06346
[13,] 60.89836
[14,] 52.92403
[15,] 44.78210
[16,] 45.10529
[17,] 53.83590
[18,] 35.58390
[19,] 55.72236
[20,] 60.31012
[21,] 46.69436
[22,] 49.54066
[23,] 41.41330
[24,] 65.16249
[25,] 51.79477
[26,] 42.61649
[27,] 40.46978
[28,] 35.55821
[29,] 41.83024
[30,] 61.26717
[31,] 47.43500
[32,] 51.30172
[33,] 56.04691
[34,] 50.86582
[35,] 52.76889
[36,] 45.68987
[37,] 63.46435
[38,] 66.24470
[39,] 54.08463
[40,] 45.15274
[41,] 49.18293
[42,] 30.58113
[43,] 49.01117
[44,] 57.53001
[45,] 54.83674
[46,] 55.27241
[47,] 33.46842
[48,] 42.26036
[49,] 50.86999
[50,] 41.73756
[51,] 45.88024
[52,] 51.33192
[53,] 52.70574
[54,] 53.35644
[55,] 39.95897
[56,] 43.01847
[57,] 44.93513
[58,] 49.97307
```

$$Var(\hat{\beta}) = MSE(X'X)^{-1}$$

```
> var
            [,1]         [,2]          [,3]          [,4]
[1,] 260.8936587 -1.000599069 -1.6695697647 -0.6454847451
[2,]  -1.0005991  0.044991612 -0.0189632577 -0.0097486757
[3,]  -1.6695698 -0.018963258  0.0357155755  0.0006621061
[4,]  -0.6454847 -0.009748676  0.0006621061  0.0188346709
```

$$SSTO = Y'Y - \left(\frac{1}{n}\right)Y'JY$$

15548.34

$$SSE = Y'Y - b'X'Y$$

11410.04

$$SSR = b'X'Y - \left(\frac{1}{n}\right)Y'JY$$

4138.305

$$E(Y_h) = X_h{}'\beta$$

49.44828

$\hat{Y}_h = X_h'b$ where $X_h' = (1, X_h)$

49.44828

$$\sigma^2(\hat{Y}_h) = \sigma^2 X_h'(X'X)^{-1}X_h$$

$\mathbf{3.576815}$

$$S^2(\hat{Y}_h) = MSE\, X_h'(X'X)^{-1}X_h$$

211.0321

3. What is the predicted final exam score for a student with a 70% average on the quizzes, 85% on the computer assignments, and 65% on the midterm?
46.38757 and confident interval is (42.29514, 50.48)

4. For any fixed quiz average and computer average, a score one point higher on the midterm yields a predicted mark on the Final Exam that is **__0.3246___**higher.

5. What is the largest e_i in absolute value?
42.2179

6. For each of the following null hypotheses, give the value of the test statistic and the p-value. The answers are numbers that appear in the output from summary table. Also state whether you reject H0 at α = 0.05.

H0	Test Statistic	p-value	Reject H0?
$\beta_1 = \beta_2 = \beta_3 = 0$	**6.528**	**0.000755**	**Reject**
$\beta_0 = 0$	**0.56**	**0.57746**	**Not reject**
$\beta_1 = 0$	**2.743**	**0.00825**	**Reject**
$\beta_2 = 0$	**-1.538**	**0.12977**	**Not reject**
$\beta_3 = 0$	**2.343**	**0.02283**	**reject**

7. What proportion of the variation (sum of squares) in final exam mark is explained by the term work?
26.62%

8. Controlling for computer assignment average and midterm score, is quiz average related to Final Exam score?

i. State the null and alternate hypothesis in terms of scalar β_j values.
Ho: β1= 0 Ha: β1 does not equal to 0

ii. A nice 2-sided t-test is part of the default output. Give the value of the t statistic, the degrees of freedom, and the p-value.
t=2.743 df= 54 p-value = 0.00825<0.05

iii. Do you reject the null hypothesis at α = 0.05? Answer Yes or No.
reject h0 and conclude that β1 is equal to 0.

iv. Are the results statistically significant at the α = 0:05 level? Answer Yes or No.
Yes

v. Carry out the same test using the full-reduced model approach.
F=7.5217 p=0.008253<0.05, so reject h0 and conclude that β1 is equal to 0.

9. Give a 95% confidence interval for β_1. Why does this confidence interval provide one more way of testing H0 : β_1= 0?
(0.15791733, 1.01627535), yes because it can look cl of $\boldsymbol{\beta_1}$ is include or not. This cl doesn't include 0 and reject h0 and conclude that β1 is equal to 0.

10. Consider a student who is "average" on all three explanatory variables. The expected final exam score for such a student would be

$$E(y/x_1 = \bar{x}_{1,}\ x_2 = \bar{x}_{2,}\ x_3 = \bar{x}_3\,) = \beta_0 + \beta_1\bar{x}_1 + \beta_2\bar{x}_2 + \beta_3\bar{x}_3$$

i. Give a point estimate of the expected value.
   49.44828
ii. Give a 95% confidence interval for the expected value.
   (45.62161,53.27495)

11. For each of the following questions, give the null and alternate hypothesis, test statistic and p-value.
i. Controlling for quiz average and computer average, is mark on the midterm test related to mark on the final exam?
Ho: β3= 0 Ha: β3 does not equal to 0 F = 5.4909 p-value = 0.02283<0.05, so we reject null hypothesis and conclude that β3 does not equal to 0.

ii. Allowing for mark on the midterm test and quiz average, is computer average a useful predictor of mark on the final exam?
Ho: β2= 0 Ha: β2 does not equal to 0 F = 2.367 p-value = 0.1298>0.05, so we fail to reject null hypothesis and conclude that β2 is equal to 0.

iii. Considering mark on the midterm test and computer average, is quiz average related connected to mark on the final exam?
Ho: β1= 0 Ha: β1 does not equal to 0 F = 7.5217 p-value = 0.008253<0.05, so we reject null hypothesis and conclude that β1 does not equal to 0.

iv. Are any of the predictor variables useful?
Controlling for mark on the midterm test, are the other two variables (either or both) related to mark on the Final exam?
Ho: β1=beta2=0 Ha: β1 and 2 does not equal to 0 F = 3.7983 p-value = 0.02862<0.05, so we reject null hypothesis and conclude that β1 or 2 does not equal to 0.

Q1

```
> p1 = read.table (file.choose(), header = TRUE)
> p1
       rr age  opet   vr    tsf
1  13.500   1  5.02 0.14 123000
2  12.000  14  8.19 0.27 104079
3  10.500  16  3.00 0.00  39998
4  15.000   4 10.70 0.05  57112
5  14.000  11  8.97 0.07  60000
6  10.500  15  9.45 0.24 101385
7  14.000   2  8.00 0.19  31300
8  16.500   1  6.62 0.60 248172
9  17.500   1  6.20 0.00 215000
10 16.500   8 11.78 0.03 251015
11 17.000  12 14.62 0.08 291264
12 16.500   2 11.55 0.03 207549
13 16.000   2  9.63 0.00  82000
14 16.500  13 12.99 0.04 359665
15 17.225   2 12.01 0.03 265500
16 17.000   1 12.01 0.00 299000
17 16.000   1  7.99 0.14 189258
18 14.625  12 10.33 0.12 366013
19 14.500  16 10.67 0.00 349930
20 14.500   3  9.45 0.03  85335
21 16.500   6 12.65 0.13 235932
22 16.500   3 12.08 0.00 130000
23 15.000   3 10.52 0.05  40500
24 15.000   3  9.47 0.00  40500
25 13.000  14 11.62 0.00  45959
26 12.500   1  5.00 0.33 120000
27 14.000  15  9.89 0.05  81243
28 13.750  16 11.13 0.06 153947
29 14.000   2  7.96 0.22  97321
30 15.000  16 10.73 0.09 276099
31 13.750   2  7.95 0.00  90000
32 15.625   3  9.10 0.00 184000
33 15.625   3 12.05 0.03 184718
34 13.000  16  8.43 0.04  96000
35 14.000  16 10.60 0.04 106350
36 15.250  13 10.55 0.10 135512
37 16.250   1  5.50 0.21 180000
38 13.000  14  8.53 0.03 315000
39 14.500   3  9.04 0.04  42500
40 11.500  15  8.20 0.00  30005
41 14.250   1  6.13 0.00  60000
42 15.500  15  8.32 0.00  73521
```

```
43 12.000   1  4.00 0.00  50000
44 14.250  15 10.10 0.00  50724
45 14.000   3  5.25 0.16  31750
46 16.500   3 11.62 0.00 168000
47 14.500   4  5.31 0.00  70000
48 15.500   1  5.75 0.00  27000
49 16.750   4 12.46 0.03 129614
50 16.750   4 12.75 0.00 129614
51 16.750   2 12.75 0.00 130000
52 16.750   2 11.38 0.00 209000
53 17.000   1  5.99 0.57 220000
54 16.000   2 11.37 0.27  60000
55 14.500   3 10.38 0.00 110000
56 15.000  15 10.77 0.05 101206
57 15.000  17 11.30 0.00 288847
58 16.000   1  7.06 0.14 105000
59 15.500  14 12.10 0.05 276425
60 15.250   2 10.04 0.06  33000
61 16.500   1  4.99 0.73 210000
62 19.250   0  7.33 0.22 240000
63 17.750  18 12.11 0.00 281552
64 18.750  16 12.86 0.00 421000
65 19.250  13 12.70 0.04 484290
66 14.000  20 11.58 0.00 234493
67 14.000  18 11.58 0.03 230675
68 18.000  16 12.97 0.08 296966
69 13.750   1  4.82 0.00  32000
70 15.000   2  9.75 0.03  38533
71 15.500  16 10.36 0.02 109912
72 15.900   1  8.13 0.23 236000
73 15.250  15 13.23 0.05 243338
74 15.500   4 10.57 0.04 122183
75 14.750  20 11.22 0.00 128268
76 15.000   3 10.34 0.00  72000
77 14.500   3 10.67 0.00  43404
78 13.500  18  8.60 0.08  59443
79 15.000  15 11.97 0.14 254700
80 15.250  11 11.27 0.03 434746
81 14.500  14 12.68 0.03 201930
> summary(p1[c('rr','age','opet','vr','tsf')])
       rr             age              opet              vr         
 Min.   :10.50   Min.   : 0.000   Min.   : 3.000   Min.   :0.00000  
 1st Qu.:14.00   1st Qu.: 2.000   1st Qu.: 8.130   1st Qu.:0.00000  
 Median :15.00   Median : 4.000   Median :10.360   Median :0.03000  
 Mean   :15.14   Mean   : 7.864   Mean   : 9.688   Mean   :0.08099  
 3rd Qu.:16.50   3rd Qu.:15.000   3rd Qu.:11.620   3rd Qu.:0.09000  
```

```
 Max.   :19.25   Max.   :20.000   Max.   :14.620   Max.   :0.73000
      tsf
 Min.   : 27000
 1st Qu.: 70000
 Median :129614
 Mean   :160633
 3rd Qu.:236000
 Max.   :484290
> pairs(~rr+age+opet+vr+tsf, data=p1,main="scatterplot matric \n raylor")
> rr=p1$rr
> age=p1$age
> ot=p1$opet
> vr=p1$vr
> tsf=p1$tsf
> cor(p1)
              rr        age       opet          vr        tsf
rr    1.00000000 -0.2502846  0.4137872  0.06652647 0.53526237
age  -0.25028456  1.0000000  0.3888264 -0.25266347 0.28858350
opet  0.41378716  0.3888264  1.0000000 -0.37976174 0.44069713
vr    0.06652647 -0.2526635 -0.3797617  1.00000000 0.08061073
tsf   0.53526237  0.2885835  0.4406971  0.08061073 1.00000000
> model <- lm(rr~age+ot+vr+tsf)
> summary(model)

Call:
lm(formula = rr ~ age + ot + vr + tsf)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.1872 -0.5911 -0.0910  0.5579  2.9441 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.220e+01  5.780e-01  21.110  < 2e-16 ***
age         -1.420e-01  2.134e-02  -6.655 3.89e-09 ***
ot           2.820e-01  6.317e-02   4.464 2.75e-05 ***
vr           6.193e-01  1.087e+00   0.570     0.57    
tsf          7.924e-06  1.385e-06   5.722 1.98e-07 ***
---
Signif. codes:  
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 

Residual standard error: 1.137 on 76 degrees of freedom
Multiple R-squared:  0.5847,  Adjusted R-squared:  0.5629 
F-statistic: 26.76 on 4 and 76 DF,  p-value: 7.272e-14
> anova(model)
```

```
Analysis of Variance Table

Response: rr
          Df Sum Sq Mean Sq F value    Pr(>F)
age        1 14.819  14.819 11.4649  0.001125 **
ot         1 72.802  72.802 56.3262 9.699e-11 ***
vr         1  8.381   8.381  6.4846  0.012904 *
tsf        1 42.325  42.325 32.7464 1.976e-07 ***
Residuals 76 98.231   1.293
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> model1 <- lm(rr~vr+tsf)
> summary(model1)

Call:
lm(formula = rr ~ vr + tsf)

Residuals:
    Min      1Q  Median      3Q     Max
-4.1886 -0.7879  0.3140  0.9820  3.4021

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.376e+01  3.027e-01  45.469  < 2e-16 ***
vr          3.007e-01  1.226e+00   0.245    0.807
tsf         8.407e-06  1.512e-06   5.561 3.63e-07 ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.47 on 78 degrees of freedom
Multiple R-squared:  0.2871,  Adjusted R-squared:  0.2688
F-statistic:  15.7 on 2 and 78 DF,  p-value: 1.859e-06
> a=lm(rr~age+ot)
> anova(a,model)
Analysis of Variance Table

Model 1: rr ~ age + ot
Model 2: rr ~ age + ot + vr + tsf
  Res.Df     RSS Df Sum of Sq      F    Pr(>F)
1     78 148.937
2     76  98.231  2    50.706 19.616 1.353e-07 ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> d=lm(rr~age+ot+tsf)
> summary(d)

Call:
lm(formula = rr ~ age + ot + tsf)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0620 -0.6437 -0.1013  0.5672  2.9583

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.237e+01  4.928e-01  25.100  < 2e-16
age         -1.442e-01  2.092e-02  -6.891 1.33e-09
ot           2.672e-01  5.729e-02   4.663 1.29e-05
tsf          8.178e-06  1.305e-06   6.265 1.97e-08

(Intercept) ***
age         ***
ot          ***
tsf         ***
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.132 on 77 degrees of freedom
Multiple R-squared:  0.583,    Adjusted R-squared:  0.5667
F-statistic: 35.88 on 3 and 77 DF,  p-value: 1.295e-14
> confint(d,level=0.9)
                       5 %         95 %
(Intercept)  1.155005e+01  1.319112e+01
age         -1.789942e-01 -1.093351e-01
ot           1.717777e-01  3.625564e-01
tsf          6.004908e-06  1.035151e-05
> confint(d,level=(1-0.1/4))
                    1.25 %       98.75 %
(Intercept)  1.124390e+01 13.4972680885
age         -1.919897e-01 -0.0963396198
ot           1.361865e-01  0.3981475445
tsf          5.194017e-06  0.0000111624
>
new.data=data.frame(age=c(5,6,14,12),ot=c(8.25,8.5,11.5,10.25),tsf=c(250000,270000,3
00000,310000))
> predict(d,new.data,interval="confidence",level=(1-.05/4))
       fit      lwr      upr
1 15.89844 15.35022 16.44666
```

```
2 15.98463 15.41526 16.55400
3 15.87816 15.32149 16.43483
4 15.91431 15.33555 16.49308
>
>
nnew.data=data.frame(age=c(6,14,12),ot=c(10,11.5,12.5),tsf=c(80000,120000,340000))
> predict(d,nnew.data,interval="confidence",level=(1-.05/4))
       fit      lwr      upr
1 14.83152 14.39298 15.27006
2 14.40608 13.87078 14.94139
3 16.76079 16.12517 17.39640
> plot(fitted(d), resid(d),main="Reisudal Plot \n raylor")
> abline(h=0)
>
> qqnorm(resid(d),main= "Q-Q plot \n raylor")
> qqline(resid(d))
> plot (d$fitted.values, d$residuals, main="Index Plot", sub= "raylor",xlab="Fitted
values",ylab="Residual")
>  abline(h=0, col="red")
> bptest(d, studentize = FALSE)

	Breusch-Pagan test

data:  d
BP = 17.281, df = 3, p-value = 0.0006187

> plot(d$fitted.values,d$residuals,main="index plot", sub=
"Raylor",xlab="index",ylab="Residual")
> abline(h=0,col="red")
> shapiro.test(resid(d))

	Shapiro-Wilk normality test

data:  resid(d)
W = 0.98776, p-value = 0.6406
> dwtest(d)

	Durbin-Watson test

data:  d
DW = 1.5867, p-value = 0.02463
alternative hypothesis: true autocorrelation is greater than 0

> rstandard(d)
          1           2           3           4           5
-0.97755761 -1.25401611 -0.67191935 -0.10784521  0.29435399
```

```
          6           7           8           9          10 
-2.75734430 -0.42746706  0.43454717  1.69420847  0.07399060 
         11          12          13          14          15 
 0.06506769 -0.32948755  0.60461995 -0.37163043 -0.21543236 
         16          17          18          19          20 
-0.80591580  0.08189521 -1.61432640 -1.16507694 -0.59099078 
         21          22          23          24          25 
-0.28349894  0.24536238 -0.07221777  0.18038226 -0.75846965 
         26          27          28          29          30 
-1.86090930  0.43783689 -0.49137300 -0.89871942 -0.17007734 
         31          32          33          34          35 
-1.06666638 -0.22250001 -0.94070474 -0.09179945  0.21147055 
         36          37          38          39          40 
 0.73903240  0.98700409 -2.01833988 -0.18030785 -1.04344579 
         41          42          43          44          45 
-0.09457136  2.23542440 -1.56396092  0.84233923  0.36262270 
         46          47          48          49          50 
 0.07508971  0.64753002  1.37328967  0.51342789  0.44454389 
         51          52          53          54          55 
 0.18085669 -0.07374863  1.25591023  0.35371952 -0.99497514 
         56          57          58          59          60 
 0.97916007 -0.27212934  0.92338213 -0.31056246  0.19479994 
         61          62          63          64          65 
 1.12771528  2.69207186  2.20586445  1.67146835  1.32044244 
         66          67          68          69          70 
-0.45321947 -0.68237999  1.84718053 -0.02356378 -0.00203972 
         71          72          73          74          75 
 1.59571850 -0.38729516 -0.43540397 -0.10473058  1.11051846 
         76          77          78          79          80 
-0.26011939 -0.58210287  0.86254288 -0.43922831 -1.95155044 
         81 
-0.80086111 
 > shapiro.test(resid(d))

	Shapiro-Wilk normality test

data:  resid(d)
W = 0.98776, p-value = 0.6406

> plot(d$fitted.values, rstandard(d),main="d Data\n raylor",xlab="Fitted values",ylab="Residual", pch=23,bg="red",cex=2,lwd=2)
> abline(h=0,col="red")
> abline(h=2,col="blue")
> abline(h=-2,col="blue")
>(1:length(rstandard(d)))[rstandard(d)>2]
> (1:length(rstandard(d)))[rstandard(d)< -2]
```

```
> p2 = read.table (file.choose(), header = TRUE)
> rr=p2$rr
>  age=p2$age
> ot=p2$opet
> vr=p2$vr
> tsf=p2$tsf
> e=lm(rr~age+ot+tsf)
> summary(e)

Call:
lm(formula = rr ~ age + ot + tsf)

Residuals:
     Min       1Q   Median       3Q      Max 
-2.00369 -0.58142 -0.06623  0.54297  2.06131 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept)  1.232e+01  4.170e-01  29.536  < 2e-16 ***
age         -1.381e-01  1.823e-02  -7.578 9.38e-11 ***
ot           2.697e-01  4.862e-02   5.547 4.54e-07 ***
tsf          7.860e-06  1.128e-06   6.970 1.26e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9383 on 72 degrees of freedom
Multiple R-squared:  0.6603,  Adjusted R-squared:  0.6462 
F-statistic: 46.66 on 3 and 72 DF,  p-value: < 2.2e-16
nnnew.data=data.frame(age=c(6,14,12),ot=c(10,11.5,12.5),tsf=c(80000,120000,340000))
> predict(d,nnnew.data,interval="confidence",level=(1-.05))
       fit      lwr      upr
1 14.83152 14.49011 15.17293
2 14.40608 13.98934 14.82283
3 16.76079 16.26594 17.25563
```

Q2

```
> a = read.table (file.choose(), header = TRUE)
> summary(a[c('QuizAve','CompAve','MidTerm', 'FinalExam')])
    QuizAve         CompAve         MidTerm     
 Min.   :4.600   Min.   :4.600   Min.   :10.00  
 1st Qu.:6.800   1st Qu.:7.900   1st Qu.:57.25  
 Median :7.400   Median :8.650   Median :71.00  
 Mean   :7.257   Mean   :8.400   Mean   :68.88  
```

```
 3rd Qu.:7.875   3rd Qu.:9.275   3rd Qu.:77.00
 Max.   :9.600   Max.   :9.900   Max.   :95.00
   FinalExam
 Min.   :15.00
 1st Qu.:39.00
 Median :51.00
 Mean   :49.45
 3rd Qu.:59.50
 Max.   :87.00
> qz= a$QuizAve*10
> ca= a$CompAve*10
> mt= a$MidTerm
> fe= a$FinalExam
> pairs(~fe+qz+ca+mt, data=a,main="scatterplot matric \n raylor")
> cor(a)
            QuizAve    CompAve   MidTerm  FinalExam
QuizAve   1.0000000 0.49313970 0.3665234 0.39597772
CompAve   0.4931397 1.00000000 0.1600845 0.03312729
MidTerm   0.3665234 0.16008452 1.0000000 0.40363552
FinalExam 0.3959777 0.03312729 0.4036355 1.00000000
> median(ca)
[1] 86.5
> b=lm(fe~qz+ca+mt)
> summary(b)

Call:
lm(formula = fe ~ qz + ca + mt)

Residuals:
    Min      1Q  Median      3Q     Max
-27.260 -10.293   1.302   7.221  42.218

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   9.1368    16.3011   0.560  0.57746
qz            0.5871     0.2141   2.743  0.00825 **
ca           -0.2934     0.1907  -1.538  0.12977
mt            0.3246     0.1385   2.343  0.02283 *
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.54 on 54 degrees of freedom
Multiple R-squared:  0.2662,  Adjusted R-squared:  0.2254
F-statistic: 6.528 on 3 and 54 DF,  p-value: 0.000755
> c=lm(fe~qz)
```

```
> summary(c)

Call:
lm(formula = fe ~ qz)

Residuals:
    Min      1Q  Median      3Q     Max 
-30.109 -10.253   1.209  11.164  40.275 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)   
(Intercept)   6.1938    13.5537   0.457  0.64945   
qz            0.5960     0.1847   3.227  0.00209 **
---
Signif. codes: 
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 

Residual standard error: 15.3 on 56 degrees of freedom
Multiple R-squared:  0.1568,  Adjusted R-squared:  0.1417 
F-statistic: 10.41 on 1 and 56 DF,  p-value: 0.002092
> d=lm(fe~ca+mt)
> summary(d)

Call:
lm(formula = fe ~ ca + mt)

Residuals:
    Min      1Q  Median      3Q     Max 
-28.546  -9.482   0.522  10.623  37.413 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)   
(Intercept) 22.19359   16.48882   1.346  0.18383   
ca          -0.04598    0.17772  -0.259  0.79681   
mt           0.45176    0.13803   3.273  0.00184 **
---
Signif. codes: 
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 

Residual standard error: 15.37 on 55 degrees of freedom
Multiple R-squared:  0.1639,  Adjusted R-squared:  0.1335 
F-statistic: 5.392 on 2 and 55 DF,  p-value: 0.00727

>  e= lm(fe~1)
> anova(e, b)
Analysis of Variance Table
```

```
Model 1: fe ~ 1
Model 2: fe ~ qz + ca + mt
  Res.Df   RSS Df Sum of Sq      F   Pr(>F)
1     57 15548
2     54 11410  3    4138.3 6.5284 0.000755 ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>  summary(e)

Call:
lm(formula = fe ~ 1)

Residuals:
    Min      1Q  Median      3Q     Max
-34.448 -10.448   1.552  10.052  37.552

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   49.448      2.169    22.8   <2e-16 ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 16.52 on 57 degrees of freedom
> f= lm(fe~ca+mt)
> anova(f, b)
Analysis of Variance Table

Model 1: fe ~ ca + mt
Model 2: fe ~ qz + ca + mt
  Res.Df   RSS Df Sum of Sq      F   Pr(>F)
1     55 12999
2     54 11410  1    1589.3 7.5217 0.008253 **
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> summary(f)

Call:
lm(formula = fe ~ ca + mt)

Residuals:
    Min      1Q  Median      3Q     Max
-28.546  -9.482   0.522  10.623  37.413
```

```
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 22.19359   16.48882   1.346  0.18383
ca          -0.04598    0.17772  -0.259  0.79681
mt           0.45176    0.13803   3.273  0.00184 **
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 15.37 on 55 degrees of freedom
Multiple R-squared:  0.1639,  Adjusted R-squared:  0.1335
F-statistic: 5.392 on 2 and 55 DF,  p-value: 0.00727

> g=lm(fe~qz+ca)
> summary(g)

Call:
lm(formula = fe ~ qz + ca)

Residuals:
    Min      1Q  Median      3Q     Max
-30.417 -10.213   0.108  11.509  43.440

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  20.2595    16.2189   1.249 0.216906
qz            0.7551     0.2098   3.599 0.000685 ***
ca           -0.3048     0.1983  -1.537 0.129952
---
Signif. codes:
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 15.12 on 55 degrees of freedom
Multiple R-squared:  0.1915,  Adjusted R-squared:  0.1621
F-statistic: 6.515 on 2 and 55 DF,  p-value: 0.002888

> anova(g,b)
Analysis of Variance Table

Model 1: fe ~ qz + ca
Model 2: fe ~ qz + ca + mt
  Res.Df   RSS Df Sum of Sq      F  Pr(>F)
1     55 12570
2     54 11410  1    1160.2 5.4909 0.02283 *
---
```

```
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> h=lm(fe~qz+mt)
> summary(h)

Call:
lm(formula = fe ~ qz + mt)

Residuals:
    Min      1Q  Median      3Q     Max
-27.745 -10.068  -0.087   8.411  39.152

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -4.5802    13.8153  -0.332   0.7415
qz            0.4313     0.1909   2.259   0.0279 *
mt            0.3300     0.1402   2.354   0.0222 *
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.72 on 55 degrees of freedom
Multiple R-squared:  0.234,	Adjusted R-squared:  0.2061
F-statistic:   8.4 on 2 and 55 DF,  p-value: 0.0006553

> anova(h,b)
Analysis of Variance Table

Model 1: fe ~ qz + mt
Model 2: fe ~ qz + ca + mt
  Res.Df   RSS Df Sum of Sq     F Pr(>F)
1     55 11910
2     54 11410  1    500.14 2.367 0.1298
> i=lm(fe~ca)
> summary(i)

Call:
lm(formula = fe ~ ca)

Residuals:
    Min      1Q  Median      3Q     Max
-34.071 -10.590   1.787   9.451  37.175

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 45.48890   16.11186   2.823  0.00657 **
```

```
ca          0.04714    0.19003   0.248  0.80501
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 16.65 on 56 degrees of freedom
Multiple R-squared:  0.001097,          Adjusted R-squared:  -0.01674
F-statistic: 0.06152 on 1 and 56 DF,  p-value: 0.805

> anova(i,b)
Analysis of Variance Table

Model 1: fe ~ ca
Model 2: fe ~ qz + ca + mt
  Res.Df   RSS Df Sum of Sq      F    Pr(>F)
1     56 15531
2     54 11410  2    4121.2 9.7522 0.0002422 ***
---
Signif. codes:
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> data= read.table (file.choose(), header = TRUE)
> quiz<- data[, 1]
> comp<- data[, 2]
> mid<- data[, 3]
> final<- data[, 4]
> X=matrix(c( rep(1, 58), data[, 1],data[, 2], data[, 3]), ncol=4)
> Y=matrix(data[ ,4])
> b=solve(t(X)%*%X)%*%(X)%*%Y
b
          [,1]
[1,]  9.1367509
[2,]  0.5870963
[3,] -0.2934339
[4,]  0.3245532
> yhat=X%*%b
> yhat
         [,1]
 [1,] 42.25694
 [2,] 51.40981
 [3,] 63.43346
 [4,] 60.09480
 [5,] 48.48723
 [6,] 57.03233
 [7,] 47.56108
 [8,] 35.12579
 [9,] 52.69078
```

[10,] 60.72272
[11,] 31.64672
[12,] 53.06346
[13,] 60.89836
[14,] 52.92403
[15,] 44.78210
[16,] 45.10529
[17,] 53.83590
[18,] 35.58390
[19,] 55.72236
[20,] 60.31012
[21,] 46.69436
[22,] 49.54066
[23,] 41.41330
[24,] 65.16249
[25,] 51.79477
[26,] 42.61649
[27,] 40.46978
[28,] 35.55821
[29,] 41.83024
[30,] 61.26717
[31,] 47.43500
[32,] 51.30172
[33,] 56.04691
[34,] 50.86582
[35,] 52.76889
[36,] 45.68987
[37,] 63.46435
[38,] 66.24470
[39,] 54.08463
[40,] 45.15274
[41,] 49.18293
[42,] 30.58113
[43,] 49.01117
[44,] 57.53001
[45,] 54.83674
[46,] 55.27241
[47,] 33.46842
[48,] 42.26036
[49,] 50.86999
[50,] 41.73756
[51,] 45.88024
[52,] 51.33192
[53,] 52.70574
[54,] 53.35644
[55,] 39.95897

```
[56,] 43.01847
[57,] 44.93513
[58,] 49.97307
> H=X%*%solve(t(X)%*%X)%*%t(X)
> H
              [,1]         [,2]          [,3]          [,4]
 [1,]  0.2126898843 -0.031154549 -7.329939e-02 -0.0662934493
 [2,] -0.0311545486  0.038098010  3.410654e-02  0.0435725942
 [3,] -0.0732993882  0.034106539  9.261622e-02  0.0731529675
 [4,] -0.0662934493  0.043572594  7.315297e-02  0.0709096805
 [5,]  0.0402577283  0.025180604 -3.048806e-03  0.0153278296
 [6,]  0.0658051056  0.006916066  1.965547e-02  0.0155586971
 [7,]  0.0439815858  0.011625867  1.654318e-03  0.0046723760
 [8,]  0.0123159653 -0.010770813 -8.735204e-04 -0.0260580856
 [9,]  0.0884107970 -0.010049865  7.179298e-03 -0.0076549243
[10,]  0.1323943193  0.000804899 -1.191990e-03  0.0051280722
[11,]  0.0108375277  0.019699285 -3.056986e-02 -0.0142599405
[12,] -0.0273797701  0.032006671  4.086523e-02  0.0423345277
[13,] -0.0411216220  0.028660825  7.222925e-02  0.0583022942
[14,]  0.0136071171  0.013696179  3.125747e-02  0.0225808070
[15,] -0.0140174963  0.015704821  2.187276e-02  0.0138536662
[16,]  0.0448068529 -0.001256932  3.179046e-03 -0.0079248258
[17,]  0.0024978579  0.017092595  3.736284e-02  0.0286839705
              [,5]         [,6]        [,7]          [,8]
 [1,]  0.0402577283  0.065805106 0.043981586  0.0123159653
 [2,]  0.0251806036  0.006916066 0.011625867 -0.0107708130
 [3,] -0.0030488061  0.019655468 0.001654318 -0.0008735204
 [4,]  0.0153278296  0.015558697 0.004672376 -0.0260580856
 [5,]  0.0409545352  0.024626915 0.022029866 -0.0268601712
 [6,]  0.0246269148  0.052157143 0.021849600 -0.0231345378
 [7,]  0.0220298662  0.021849600 0.021234357  0.0165740922
 [8,] -0.0268601712 -0.023134538 0.016574092  0.1636493910
 [9,]  0.0101472885  0.047687988 0.024436305  0.0255289900
[10,]  0.0478182503  0.084994115 0.030720920 -0.0803072400
[11,]  0.0196574488 -0.027739555 0.020774031  0.0794144134
[12,]  0.0175067894  0.011444158 0.011104820 -0.0006973893
[13,]  0.0047590373  0.024750303 0.006677375 -0.0049524603
[14,]  0.0096332110  0.023767914 0.015420903  0.0196410049
[15,] -0.0001283099 -0.005878190 0.013256488  0.0688135637
[16,]  0.0028591781  0.014398065 0.020427466  0.0661093380
[17,]  0.0092676384  0.022313256 0.013857212  0.0160332623
              [,9]         [,10]         [,11]         [,12]
 [1,]  8.841080e-02  0.1323943193  0.0108375277 -2.737977e-02
 [2,] -1.004986e-02  0.0008048990  0.0196992849  3.200667e-02
 [3,]  7.179298e-03 -0.0011919900 -0.0305698595  4.086523e-02
 [4,] -7.654924e-03  0.0051280722 -0.0142599405  4.233453e-02
```

```
 [5,]  1.014729e-02  0.0478182503  0.0196574488  1.750679e-02
 [6,]  4.768799e-02  0.0849941149 -0.0277395551  1.144416e-02
 [7,]  2.443630e-02  0.0307209196  0.0207740307  1.110482e-02
 [8,]  2.552899e-02 -0.0803072400  0.0794144134 -6.973893e-04
 [9,]  6.317565e-02  0.0699089191 -0.0143043314 -8.574677e-05
[10,]  6.990892e-02  0.1617378563 -0.0565619135  3.495469e-03
[11,] -1.430433e-02 -0.0565619135  0.1017694101  1.021554e-02
[12,] -8.574677e-05  0.0034954688  0.0102155400  2.991556e-02
[13,]  1.395264e-02  0.0156665614 -0.0248328654  3.388759e-02
[14,]  2.613515e-02  0.0225899450  0.0009091208  1.789246e-02
[15,]  7.158495e-03 -0.0359984994  0.0436066327  1.773303e-02
[16,]  3.515975e-02  0.0054028574  0.0296105632  4.543532e-03
[17,]  2.215340e-02  0.0188560522 -0.0009492762  2.093938e-02
              [,13]         [,14]         [,15]         [,16]
 [1,] -0.0411216220  0.0136071171 -0.0140174963  0.0448068529
 [2,]  0.0286608249  0.0136961786  0.0157048214 -0.0012569320
 [3,]  0.0722292454  0.0312574670  0.0218727632  0.0031790464
 [4,]  0.0583022942  0.0225808070  0.0138536662 -0.0079248258
 [5,]  0.0047590373  0.0096332110 -0.0001283099  0.0028591781
 [6,]  0.0247503031  0.0237679144 -0.0058781902  0.0143980646
 [7,]  0.0066773754  0.0154209026  0.0132564877  0.0204274662
 [8,] -0.0049524603  0.0196410049  0.0688135637  0.0661093380
 [9,]  0.0139526432  0.0261351467  0.0071584950  0.0351597463
[10,]  0.0156665614  0.0225899450 -0.0359984994  0.0054028574
[11,] -0.0248328654  0.0009091208  0.0436066327  0.0296105632
[12,]  0.0338875862  0.0178924599  0.0177330347  0.0045435316
[13,]  0.0583649910  0.0281516825  0.0161291394  0.0055197669
[14,]  0.0281516825  0.0225804662  0.0174786783  0.0198349075
[15,]  0.0161291394  0.0174786783  0.0401217715  0.0295306476
[16,]  0.0055197669  0.0198349075  0.0295306476  0.0389532839
[17,]  0.0324340045  0.0228982039  0.0178680218  0.0170274772
              [,17]        [,18]         [,19]         [,20]
 [1,]  0.0024978579 -0.049312496 -0.0488316527  0.0091125955
 [2,]  0.0170925948  0.089521331  0.0293186706  0.0137312843
 [3,]  0.0373628411 -0.035405768  0.0614653194  0.0541645411
 [4,]  0.0286839705  0.047568858  0.0503291373  0.0377731368
 [5,]  0.0092676384  0.096940145  0.0024784786  0.0067133659
 [6,]  0.0223132562 -0.030704607  0.0094851146  0.0399173755
 [7,]  0.0138572117  0.018626375  0.0067779034  0.0129549036
 [8,]  0.0160332623 -0.102198857  0.0188932127 -0.0027234553
 [9,]  0.0221534016 -0.095113600  0.0040018836  0.0370107736
[10,]  0.0188560522 -0.014854242 -0.0120141369  0.0470435958
[11,] -0.0009492762  0.106319496  0.0006490717 -0.0328391785
[12,]  0.0209393763  0.047250540  0.0324590787  0.0220185573
[13,]  0.0324340045 -0.024178628  0.0479455055  0.0473875962
[14,]  0.0228982039 -0.024953223  0.0241018735  0.0296281053
```

```
[15,]  0.0178680218 -0.005078928  0.0265720497  0.0087930408
[16,]  0.0170274772 -0.051614321  0.0104185065  0.0148344290
[17,]  0.0239563955 -0.019319646  0.0280433939  0.0310398538
             [,21]         [,22]         [,23]         [,24]
 [1,]  6.762014e-02 -0.0116156313  0.0471655070 -2.230233e-02
 [2,]  1.567576e-02  0.0211445495 -0.0141459664  2.460656e-02
 [3,] -1.604808e-02  0.0301256178  0.0004561502  7.688780e-02
 [4,]  4.884244e-04  0.0257708063 -0.0232279444  6.017229e-02
 [5,]  4.005541e-02  0.0089511485 -0.0154365957  7.405168e-03
 [6,]  2.914066e-02  0.0072709016  0.0045345349  4.147015e-02
 [7,]  2.563843e-02  0.0131414416  0.0201561403  8.140538e-03
 [8,] -1.593246e-02  0.0318962192  0.1186428317 -2.519039e-02
 [9,]  2.194163e-02  0.0088524776  0.0441758467  2.788515e-02
[10,]  5.734305e-02 -0.0077364447 -0.0231871310  4.708115e-02
[11,]  2.190045e-02  0.0220823726  0.0439731637 -4.845641e-02
[12,]  9.758501e-03  0.0220285456 -0.0027936459  3.226918e-02
[13,] -4.246478e-03  0.0247805624  0.0009034597  6.450215e-02
[14,]  9.843902e-03  0.0186010010  0.0229801173  3.188375e-02
[15,] -5.886952e-04  0.0265597895  0.0468956662  5.296886e-03
[16,]  1.089239e-02  0.0181581393  0.0581524068  3.428458e-03
[17,]  7.631977e-03  0.0198909617  0.0187186319  3.576642e-02
             [,25]         [,26]         [,27]         [,28]
 [1,]  0.0379575901  0.0402654385 -6.190088e-03 -0.0045395536
 [2,]  0.0157122414  0.0143152395  2.719848e-02  0.0014328773
 [3,]  0.0138357787 -0.0119689855 -2.118824e-03  0.0009306326
 [4,]  0.0165279457 -0.0024750420  1.077337e-02 -0.0144210315
 [5,]  0.0249075409  0.0248301578  2.187445e-02 -0.0164669273
 [6,]  0.0304011775  0.0089197000 -1.172916e-02 -0.0266322286
 [7,]  0.0197592012  0.0221480479  1.687588e-02  0.0152620981
 [8,] -0.0060505797  0.0292298273  3.981228e-02  0.1388827739
 [9,]  0.0256130912  0.0131445077 -1.135569e-02  0.0100911965
[10,]  0.0463202823  0.0107541077 -3.005857e-02 -0.0806946956
[11,]  0.0027556385  0.0449439824  6.472253e-02  0.0823955906
[12,]  0.0155082569  0.0101849569  1.946432e-02  0.0063417465
[13,]  0.0171697099 -0.0052002696 -1.198391e-03 -0.0035136083
[14,]  0.0177447394  0.0100646879  6.791949e-03  0.0156199589
[15,]  0.0057503010  0.0194421063  3.107673e-02  0.0636250476
[16,]  0.0130024031  0.0216629848  1.639751e-02  0.0534491423
[17,]  0.0172134942  0.0081930614  7.169515e-03  0.0135100464
             [,29]         [,30]         [,31]        [,32]
 [1,] -0.0166969820  0.0105326328  0.1317526563 -0.004723158
 [2,]  0.0244996245  0.0245740136 -0.0073835635  0.022504139
 [3,]  0.0090762935  0.0486728950 -0.0322307217  0.030444636
 [4,]  0.0139757233  0.0457955121 -0.0252340509  0.028538293
 [5,]  0.0123803353  0.0240077596  0.0362439933  0.014278018
 [6,] -0.0127452125  0.0442991188  0.0515330109  0.014280410
```

```
 [7,]  0.0145793150  0.0142315903  0.0328239224  0.013965987
 [8,]  0.0536511847 -0.0424454892 -0.0055650109  0.014605299
 [9,] -0.0077122354  0.0265526095  0.0581996592  0.011077015
[10,] -0.0391959143  0.0661979398  0.0981630496  0.008198173
[11,]  0.0594983429 -0.0354295488  0.0039467079  0.013050437
[12,]  0.0201734751  0.0267660714 -0.0062980054  0.022696509
[13,]  0.0063682720  0.0450283868 -0.0130877879  0.026398350
[14,]  0.0106023045  0.0246865795  0.0151276170  0.018668282
[15,]  0.0367256290 -0.0042734551 -0.0080607473  0.019413136
[16,]  0.0210244927 -0.0003155097  0.0267887932  0.013537389
[17,]  0.0113283927  0.0269310024  0.0091591033  0.020036730
              [,33]        [,34]         [,35]         [,36]
 [1,] -0.0491054759  0.071007747  0.0174367295  0.1521677618
 [2,]  0.0286428044  0.019757524  0.0191132719 -0.0297564241
 [3,]  0.0629747629 -0.009023959  0.0250984960 -0.0326313437
 [4,]  0.0506081397  0.010257652  0.0247174509 -0.0462156535
 [5,]  0.0012697709  0.047592362  0.0198826857  0.0120947048
 [6,]  0.0100698472  0.041047222  0.0255915348  0.0517417180
 [7,]  0.0065774584  0.025658055  0.0167007249  0.0338070675
 [8,]  0.0201654515 -0.047307076 -0.0009083750  0.0532764276
 [9,]  0.0052285368  0.024381579  0.0203681845  0.0835005445
[10,] -0.0118874256  0.082586600  0.0329422011  0.0840915441
[11,] -0.0009529196  0.002698280  0.0020810240  0.0045660011
[12,]  0.0323717471  0.013103459  0.0196136525 -0.0185265632
[13,]  0.0490790320  0.003213299  0.0244845891 -0.0148172357
[14,]  0.0247718966  0.011037475  0.0191927400  0.0228550341
[15,]  0.0269140320 -0.012375854  0.0104206166  0.0077117964
[16,]  0.0110949293  0.001546031  0.0121162671  0.0529618576
[17,]  0.0287166058  0.009522230  0.0197377154  0.0143849439
              [,37]         [,38]        [,39]         [,40]
 [1,] -0.0681554935 -0.0692545838 -0.025298852 -0.0411608047
 [2,]  0.0313945318  0.0436014645  0.014396737  0.0333325265
 [3,]  0.0918277020  0.0918124174  0.054625020  0.0252539599
 [4,]  0.0705198893  0.0833960935  0.033353088  0.0307568767
 [5,] -0.0046790814  0.0132828989 -0.008670126  0.0135254847
 [6,]  0.0212598957  0.0292961633  0.012175239 -0.0125847374
 [7,]  0.0021354961  0.0027419423  0.009106641  0.0109821378
 [8,]  0.0028387091 -0.0454242980  0.050370307  0.0366224876
 [9,]  0.0110101499  0.0015133615  0.021563188 -0.0159410030
[10,]  0.0008650233  0.0263097969 -0.012841594 -0.0404999816
[11,] -0.0320436480 -0.0424821717  0.001720174  0.0495353868
[12,]  0.0392107792  0.0456847356  0.022989598  0.0280810817
[13,]  0.0717883741  0.0740795092  0.042607084  0.0184497339
[14,]  0.0321036328  0.0283596510  0.027700290  0.0117653007
[15,]  0.0221910649  0.0062588873  0.033169726  0.0342966519
[16,]  0.0055973958 -0.0122519991  0.026170357  0.0120337531
```

```
[17,]  0.0378435632  0.0353465096  0.029568221  0.0143833618
             [,41]         [,42]         [,43]         [,44]
 [1,]  0.0820112513  0.0555482723  0.0880823707  0.0003619904
 [2,] -0.0026107223 -0.0121659445  0.0156766990  0.0042386662
 [3,] -0.0042672378 -0.0354745031 -0.0204461855  0.0575470191
 [4,] -0.0086376085 -0.0446691147  0.0006844037  0.0285731817
 [5,]  0.0187837913 -0.0071407986  0.0499537829 -0.0119479804
 [6,]  0.0379009444 -0.0181931138  0.0423521101  0.0285991875
 [7,]  0.0251464147  0.0242946049  0.0283042588  0.0111198868
 [8,]  0.0202843100  0.1431870709 -0.0438038202  0.0462022958
 [9,]  0.0484193026  0.0262055784  0.0285142169  0.0420451289
[10,]  0.0588709064 -0.0545647679  0.0879973726  0.0147197146
[11,]  0.0045013554  0.0935795728  0.0078888622 -0.0203349750
[12,]  0.0019333805 -0.0082095273  0.0086640820  0.0177282961
[13,]  0.0045164087 -0.0286504310 -0.0049104736  0.0470536110
[14,]  0.0198951555  0.0113848187  0.0095558342  0.0330910527
[15,]  0.0076776617  0.0567370739 -0.0134728428  0.0265474028
[16,]  0.0296403894  0.0624702272  0.0047425418  0.0312261216
[17,]  0.0162141002  0.0055991247  0.0069251248  0.0337892001
             [,45]        [,46]         [,47]        [,48]
 [1,]  7.554536e-02  0.009664155  0.0772662679  0.064944453
 [2,]  1.909575e-02  0.019128050  0.0020632865  0.009560169
 [3,]  7.101426e-05  0.036172416 -0.0486638517 -0.022791487
 [4,]  1.656806e-02  0.031172455 -0.0351398551 -0.011149713
 [5,]  4.841819e-02  0.015803216  0.0252205973  0.029767239
 [6,]  5.222292e-02  0.028738032 -0.0011115884  0.016576300
 [7,]  2.534570e-02  0.014882202  0.0287037844  0.025553027
 [8,] -6.377953e-02 -0.002529897  0.0662342315  0.022257127
 [9,]  3.199342e-02  0.023151286  0.0178940756  0.021474301
[10,]  1.021733e-01  0.034663959 -0.0021177309  0.029207706
[11,] -1.666570e-02 -0.008379221  0.0794614988  0.041822723
[12,]  1.428532e-02  0.021694671 -0.0033438844  0.005375658
[13,]  1.169036e-02  0.032918265 -0.0338825699 -0.011764374
[14,]  1.438362e-02  0.022295462  0.0040739052  0.009391602
[15,] -1.958742e-02  0.010379386  0.0279856603  0.013315269
[16,] -1.718757e-03  0.011730304  0.0371150227  0.022941319
[17,]  1.316674e-02  0.023428952 -0.0011035277  0.006282249
             [,49]         [,50]        [,51]        [,52]
 [1,] -0.0174167249 -0.0321286662 -0.033662169  0.029969823
 [2,]  0.0184433919  0.0326356467  0.013686451  0.011649188
 [3,]  0.0387420634  0.0114418590  0.036715780  0.019554534
 [4,]  0.0279299866  0.0218749579  0.018863357  0.014876468
 [5,]  0.0017866761  0.0172711614 -0.013072999  0.014745840
 [6,]  0.0079323401 -0.0175584969 -0.010833961  0.025730600
 [7,]  0.0115922688  0.0131357813  0.009665582  0.018132876
 [8,]  0.0413601482  0.0425144961  0.090130175  0.016329296
```

```
 [9,]  0.0131275094 -0.0192047922  0.008312131  0.028295166
[10,] -0.0120516937 -0.0453669543 -0.054906742  0.030892509
[11,]  0.0162662986  0.0639197083  0.041168224  0.005379609
[12,]  0.0222084586  0.0251368420  0.019587998  0.014490967
[13,]  0.0308309471  0.0076908857  0.025594833  0.020086029
[14,]  0.0218462250  0.0080638070  0.021749274  0.020357551
[15,]  0.0300682048  0.0357707239  0.049709663  0.014264884
[16,]  0.0218244778  0.0137694444  0.035402505  0.020328845
[17,]  0.0233168241  0.0098862266  0.022819717  0.019760574
             [,53]         [,54]        [,55]         [,56]
 [1,]  6.624711e-02 -0.0032484018  0.002619149 -0.0014333659
 [2,]  8.251399e-03  0.0258998688  0.033289127  0.0346595662
 [3,]  6.472379e-03  0.0330616200 -0.012365910 -0.0026419238
 [4,]  7.926113e-03  0.0342178611  0.011587843  0.0191475884
 [5,]  2.733943e-02  0.0200264549  0.035662273  0.0354549452
 [6,]  4.207420e-02  0.0202702235 -0.008812779 -0.0027462598
 [7,]  2.310979e-02  0.0141089085  0.019103541  0.0178977348
 [8,] -1.230930e-02 -0.0051256122  0.013615690  0.0020764689
 [9,]  3.948108e-02  0.0106973532 -0.017717721 -0.0150490041
[10,]  7.010282e-02  0.0222024894 -0.015010932 -0.0054485763
[11,] -7.365477e-03  0.0038902980  0.066904529  0.0535303075
[12,]  9.820392e-03  0.0249315957  0.020743607  0.0232459388
[13,]  1.362343e-02  0.0295905345 -0.007515290  0.0005937533
[14,]  1.918661e-02  0.0185594202  0.002169068  0.0046354073
[15,] -1.149093e-03  0.0122901622  0.021536198  0.0175796572
[16,]  1.602578e-02  0.0071747118  0.007041797  0.0036690352
[17,]  1.726251e-02  0.0203749879  0.002602800  0.0056937089
             [,57]         [,58]
 [1,] -0.0180698955 -0.0284711502
 [2,]  0.0360306910  0.0333482398
 [3,]  0.0105704524  0.0319297708
 [4,]  0.0271309298  0.0374078604
 [5,]  0.0291336079  0.0193443924
 [6,] -0.0041242122  0.0037732107
 [7,]  0.0149853162  0.0118294475
 [8,]  0.0066604165  0.0071296021
 [9,] -0.0159823706 -0.0065853158
[10,] -0.0136244295 -0.0081239003
[11,]  0.0474578278  0.0250635498
[12,]  0.0265600998  0.0290676813
[13,]  0.0097929335  0.0262194144
[14,]  0.0075283458  0.0145799550
[15,]  0.0211354337  0.0213712733
[16,]  0.0038515206  0.0054979435
[17,]  0.0095045510  0.0173677457
 [ reached getOption("max.print") -- omitted 41 rows ]
```

```
> Yhat= H%*%Y
> Yhat
          [,1]
 [1,] 42.25694
 [2,] 51.40981
 [3,] 63.43346
 [4,] 60.09480
 [5,] 48.48723
 [6,] 57.03233
 [7,] 47.56108
 [8,] 35.12579
 [9,] 52.69078
[10,] 60.72272
[11,] 31.64672
[12,] 53.06346
[13,] 60.89836
[14,] 52.92403
[15,] 44.78210
[16,] 45.10529
[17,] 53.83590
[18,] 35.58390
[19,] 55.72236
[20,] 60.31012
[21,] 46.69436
[22,] 49.54066
[23,] 41.41330
[24,] 65.16249
[25,] 51.79477
[26,] 42.61649
[27,] 40.46978
[28,] 35.55821
[29,] 41.83024
[30,] 61.26717
[31,] 47.43500
[32,] 51.30172
[33,] 56.04691
[34,] 50.86582
[35,] 52.76889
[36,] 45.68987
[37,] 63.46435
[38,] 66.24470
[39,] 54.08463
[40,] 45.15274
[41,] 49.18293
[42,] 30.58113
[43,] 49.01117
```

```
[44,] 57.53001
[45,] 54.83674
[46,] 55.27241
[47,] 33.46842
[48,] 42.26036
[49,] 50.86999
[50,] 41.73756
[51,] 45.88024
[52,] 51.33192
[53,] 52.70574
[54,] 53.35644
[55,] 39.95897
[56,] 43.01847
[57,] 44.93513
[58,] 49.97307
> sse=(t(Y)%*%Y) - t(b)%*%t(X)%*%Y
>  n = nrow(Y)
> mse = as.vector(sse/(n-3))
>
> var = mse*solve(t(X)%*%X)
> var
            [,1]         [,2]          [,3]          [,4]
[1,] 260.8936587 -1.000599069 -1.6695697647 -0.6454847451
[2,]  -1.0005991  0.044991612 -0.0189632577 -0.0097486757
[3,]  -1.6695698 -0.018963258  0.0357155755  0.0006621061
[4,]  -0.6454847 -0.009748676  0.0006621061  0.0188346709
>
> J = matrix(1, n, n)
> SSTO = t(Y)%*%Y-(1/n)*t(Y)%*%J%*%Y
> SSTO
         [,1]
[1,] 15548.34
>
> sse
         [,1]
[1,] 11410.04
> SSR = t(b)%*%t(X)%*%Y-(1/n)*t(Y)%*%J%*%Y
> SSR
         [,1]
[1,] 4138.305
<xh=matrix(c(1,50))
<s_sqyh=mse*t(xh)%*%xtrxinv%*%xh
<s_sqyh
<s_yh=sqrt(s_sqyh)
<s_yh
<s_sqp=mse*(1+t(xh)%*%xtrxinv%*%xh)
```

```
<s_sqp
<s_p = sqrt(s_sqp)
<s_p
> newmodel=lm(final~quiz+comp+mid)
> new.data=data.frame(quiz=70, comp= 85, mid= 65)
> predict(newmodel,new.data,interval="confidence",level=(1-.05), se.fit=TRUE)
$fit
       fit      lwr   upr
1 46.38757 42.29514 50.48

$se.fit
[1] 2.041236

$df
[1] 54

$residual.scale
[1] 14.53606
> summary(newmodel)

Call:
lm(formula = final ~ quiz + comp + mid)

Residuals:
    Min      1Q  Median      3Q     Max
-27.260 -10.293   1.302   7.221  42.218

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   9.1368    16.3011   0.560  0.57746
quiz          0.5871     0.2141   2.743  0.00825 **
comp         -0.2934     0.1907  -1.538  0.12977
mid           0.3246     0.1385   2.343  0.02283 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.54 on 54 degrees of freedom
Multiple R-squared:  0.2662,  Adjusted R-squared:  0.2254
F-statistic: 6.528 on 3 and 54 DF,  p-value: 0.000755
> e=Y-yhat
> max(e)
[1] 42.2179
> n=lm(final~quiz+comp+mid)
> summary(n)

Call:
```

```
lm(formula = final ~ quiz + comp + mid)

Residuals:
    Min      1Q  Median      3Q     Max
-27.260 -10.293   1.302   7.221  42.218

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   9.1368    16.3011   0.560  0.57746
quiz          0.5871     0.2141   2.743  0.00825 **
comp         -0.2934     0.1907  -1.538  0.12977
mid           0.3246     0.1385   2.343  0.02283 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 14.54 on 54 degrees of freedom
Multiple R-squared:  0.2662,  Adjusted R-squared:  0.2254
F-statistic: 6.528 on 3 and 54 DF,  p-value: 0.000755
> o= lm(final~comp+mid)
> anova(n, o)
Analysis of Variance Table

Model 1: final ~ quiz + comp + mid
Model 2: final ~ comp + mid
  Res.Df   RSS Df Sum of Sq      F   Pr(>F)
1     54 11410
2     55 12999 -1   -1589.3 7.5217 0.008253 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> confint (n, level = 0.95)
                   2.5 %      97.5 %
(Intercept) -23.54493534 41.81843706
quiz          0.15791733  1.01627535
comp         -0.67581953  0.08895166
mid           0.04686867  0.60223776
> mean (quiz)
[1] 72.56897
> mean (comp)
[1] 84
> mean (mid)
[1] 68.87931
> average= data.frame(quiz=72.56897, comp=84, mid=68.87931)
> predict(n, average, interval="confidence", level=(1-.05))
       fit      lwr      upr
1 49.44828 45.62161 53.27495
>
```

```
> k= lm(final~ mid)
> anova(k, n)
Analysis of Variance Table

Model 1: final ~ mid
Model 2: final ~ quiz + comp + mid
  Res.Df   RSS Df Sum of Sq      F  Pr(>F)
1     56 13015
2     54 11410  2    1605.1 3.7983 0.02862 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> v= lm(final~quiz+mid)
> anova(v, n)
Analysis of Variance Table

Model 1: final ~ quiz + mid
Model 2: final ~ quiz + comp + mid
  Res.Df   RSS Df Sum of Sq     F Pr(>F)
1     55 11910
2     54 11410  1    500.14 2.367 0.1298
> h= lm(final~quiz+comp)
> anova(h, n)
Analysis of Variance Table

Model 1: final ~ quiz + comp
Model 2: final ~ quiz + comp + mid
  Res.Df   RSS Df Sum of Sq      F  Pr(>F)
1     55 12570
2     54 11410  1    1160.2 5.4909 0.02283 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> s= lm(final~comp+mid)
> anova(s, n)
Analysis of Variance Table

Model 1: final ~ comp + mid
Model 2: final ~ quiz + comp + mid
  Res.Df   RSS Df Sum of Sq      F   Pr(>F)
1     55 12999
2     54 11410  1    1589.3 7.5217 0.008253 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```