Alexandr Martinez

Hw 4 Ch. 7-8

7.1 (1) 1
(2) 1
(3) 2
(4) 3

7.4 a. Done in R
$SSR(x_1) = 136,366$
$SSR(x_3 | x_1) = 2,033,566$
$SSR(x_2 | x_1, x_3) = 6674$

b. Done in R
$H_0: \beta_2 = 0$
$H_a: \beta_2 \neq 0$

Pval = .5712.

Fail to reject H_0.

c. Done in R
$SSR(x_1) + SSR(x_2 | x_1) = 142092.2$
$SSR(x_2) + SSR(x_1 | x_2) = 142092.2$

Yes, this is the same and will always be the case

7.25 a. $\hat{Y} = 4879.87 + .000935X_2$ (Done in R)
b. In 6.10 a. $\hat{\beta}_1 = .0007871$. More weight is attached to β_1 in SLR compared to the corresponding coefficient in MLR.
c. $SSR(x_1) = 136,366$
$SSR(x_1 | x_2) = 130,697$ (Done in R)
They dont equal.

d) (Done in R)
They have ~ corr. of .84996639

7.28 b. for $\beta_2 = \beta_4 = 0$ test using $SSR(X_2, X_4 \mid X_1, X_3, X_5)$ and $SSE(X_1, X_2, X_3, X_4, X_5)$

, for $\beta_5 = 0$ Test using $(X_5 \mid X_1, X_2, X_3, X_4)$ and $(X_1, X_2, X_3, X_4, X_5)$

7.29 a $SSR(X_1, X_2, X_3, X_4) = SSR(X_1) + SSR(X_2 \mid X_1) + SSR(X_3 \mid X_1, X_2) + SSR(X_4 \mid X_1, X_2 X_3)$

$SSR(X_2, X_3 \mid X_1) = SSR(X_2 \mid X_1) + SSR(X_3 \mid X_1, X_2)$

$SSR(X_1) + SSR(X_2, X_3 \mid X_1 + SSR(X_4 \mid X_1, X_2 X_3) = SSR(X_1, X_2, X_3, X_4)$

b. $SSR(X_1, X_2, X_3, X_4) = SSR(X_2) + SSR(X_3 \mid X_1) + SSR(X_1 \mid X_2, X_3) + SSR(X_4 \mid X_1, X_2, X_3)$

$SSR(X_2, X_3) = SSR(X_2) + SSR(X_3 \mid X_1)$

$\therefore SSR(X_2, X_3) + SSR(X_1 \mid X_2, X_3) + SSR(X_4 \mid X_1, X_2, X_3)$

$SSR(X_1, X_2, X_3, X_4) = SSR(X_2, X_3) + SSR(X_1 \mid X_2, X_3) + SSR(X_4 \mid X_1, X_2, X_3)$

8.4a Done in R

$\hat{y} = 82.9357 - 1.18396 + .01484$

The Model seems like a good fit (Done in R)

$R^2 = .7632$ (Done in R)

b. Done in R

$F(.95; 2, 57) = 3.158843$

$H_0: \beta_1 = \beta_{11} = 0$

$H_a:$ Not both $= 0$

In R model summary

$F^* = 91.84 > 3.158843$

Reject Null conclude H_a.

c. Done in R

$Fit = 99.25461$

$95.83983 \leq E\{y_h\} \leq 102.6694$

d. Done in R

$Fit = 99.25461$

$80.46568 \leq E\{y_{hnew}\} \leq 118.0435$

e. Done in R

Just by looking at the anova the pval is greater than .05.

$H_0: \beta_{11} = 0$

$H_a: \beta_{11} \neq 0$

Conclude H_0.

f. $\hat{Y} = 207.350 - 2.96432X + .0148405X^2$

g. $r_{x,x^2} = -.03635$

$r_{X,x^2} = .99609392$

8.5 a. Done in R
The first 2 residual plots do not have any real pattern and the NPP follows a positive diagonal line pretty consistently.

b. Done in R

$H_0: E\{Y\} = \beta_0 + \beta_1 x + \beta_2 x^2$
$H_a: E\{Y\} \neq \beta_0 + \beta_1 x + \beta_2 x^2$

Giant p-value = No significant deviation from fit, Fail to reject Null

C. Done in R
$\hat{Y} = 62.927344 - 1.2678894X + .0150390x^2 + .0003369x^3$

$SSR(x^3 \mid x, x^2) = 8.3$
$SSE(x, x^2, x^3) = 3662.78$

$F(.95, 1, 56) = 4.012973$

$H_0: \beta_{111} = 0$
$H_a: \beta_{111} \neq 0$

$F^* = 8.6 / (3662.78/56)$
$= 8.6 / 65.407429 \approx .13148$

$F^* < 4.012973$

Conclude H_0

8.15 b. $\hat{y} = -.9225 + 15.0461 x_1 + .7567 x_2$ (In R)

c. (In · R)

$-4.051254 \leq \beta_2 \leq 6.368698$

At a 95% CI, β_2 does not depart from $\emptyset$. Cannot conclude if β_2 has any effect on the model

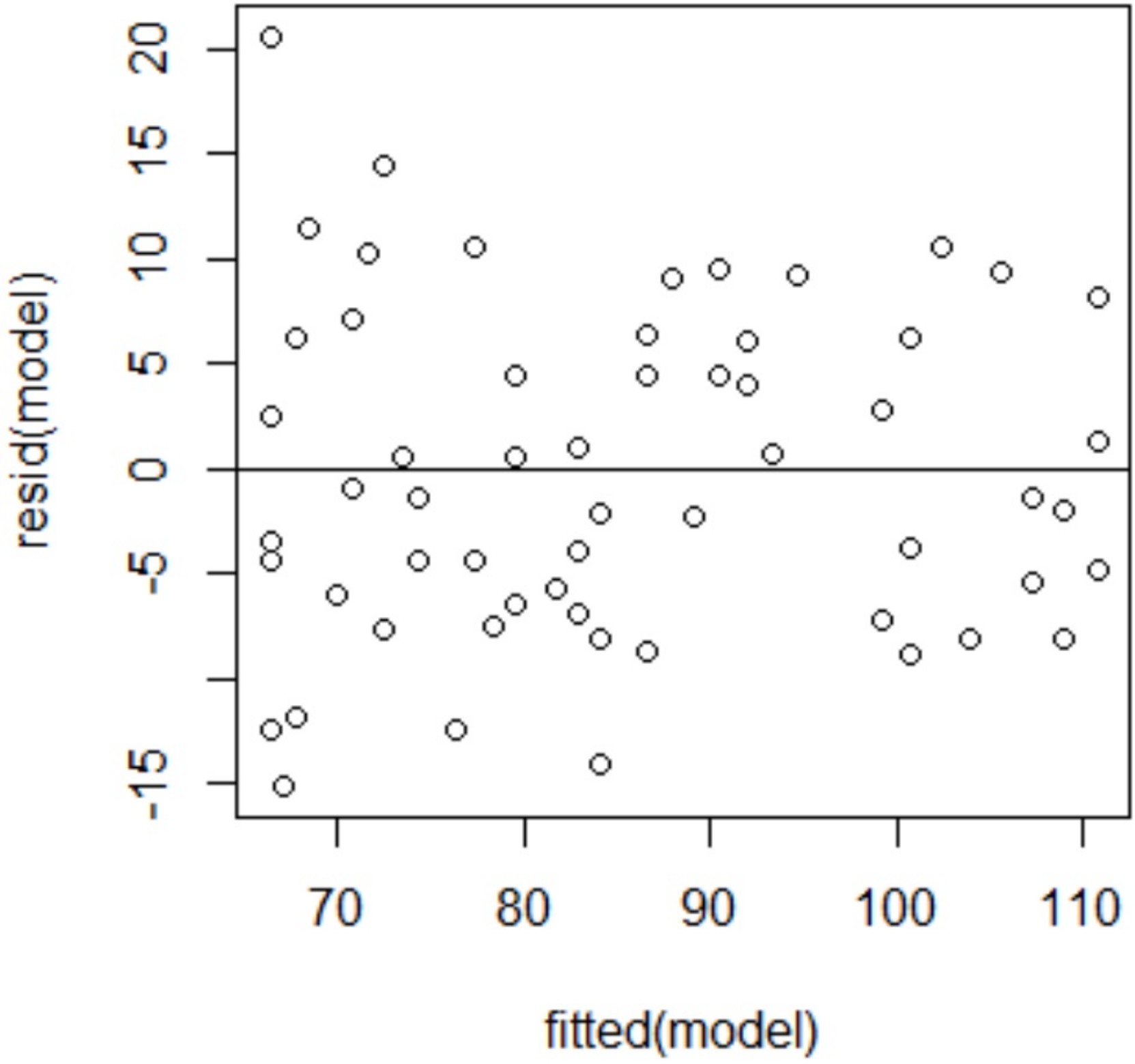
8.19 a. $\hat{y} = 2.813 + 14.339 x_1 + -8.141 x_2 + 1.777 x_3$

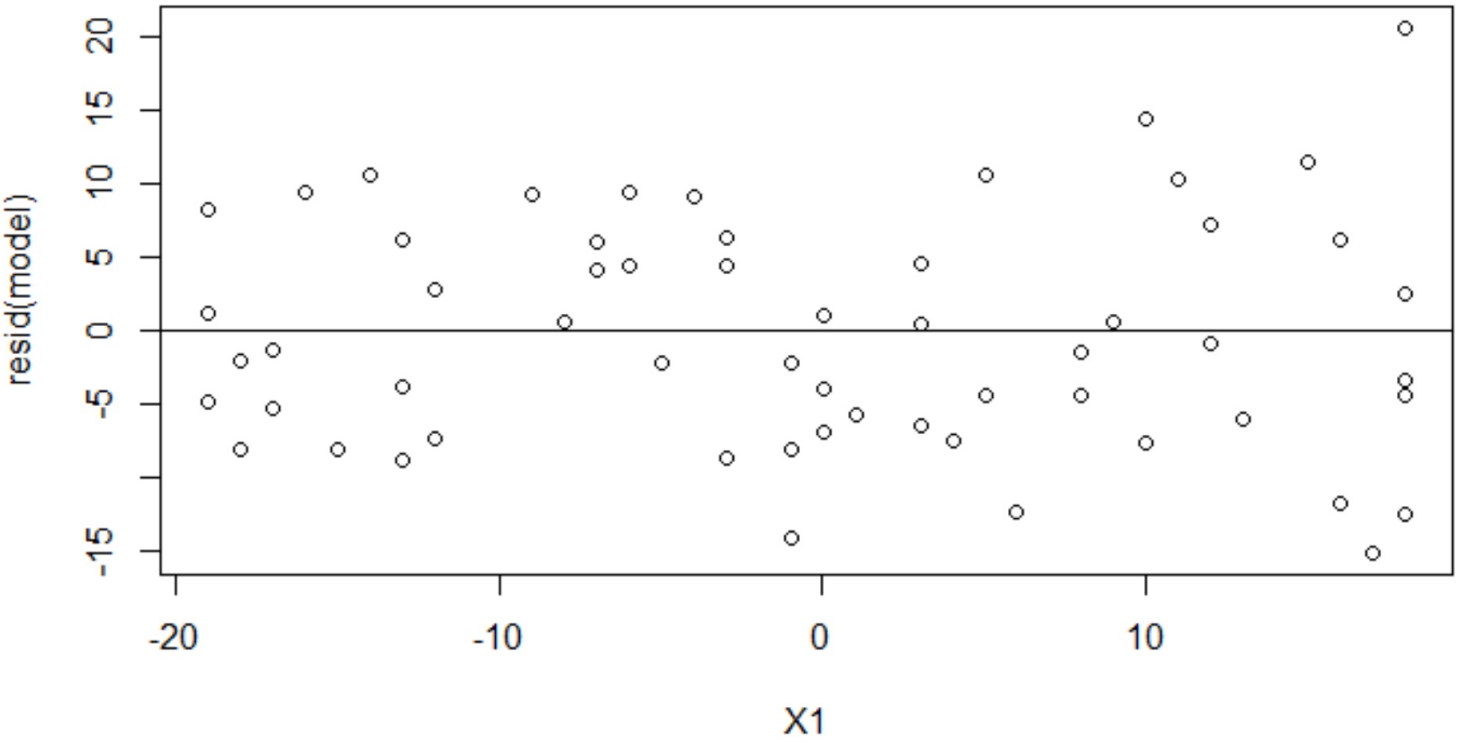
b. $t^* = 1.824$
$t(.93, 41) = 1.682878$ (Both Done in R)

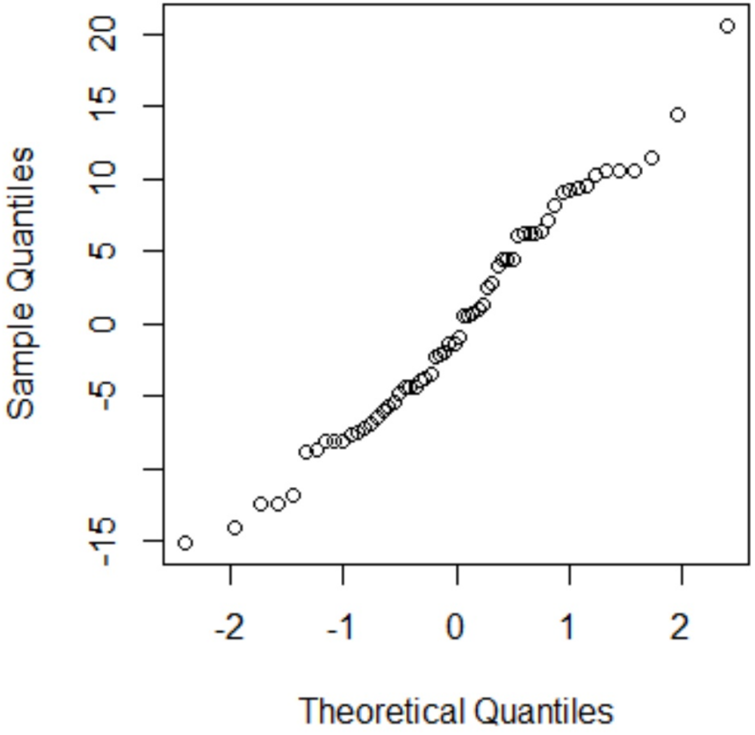
$|t^*| \geq t$

$H_0: \beta_3 = 0$ Conclude H_a.
$H_a: \beta_3 \neq 0$

View a larger version of the plot in a new window




resid(model)
20
15
10
5
0
-5
-15
-20
-10
0
10
X1


Sample Quantiles
Theoretical Quantiles
-15
-5
0
5
10
15
20
-2
-1
0
1
2

```
> ##7.4
> #a.
> grocery <- read.delim(file = "https://www.math.arizona.edu/~piegorsch/571A/Data/Chapter06/CH06PR09.txt",
+                       header = F, sep = "")
> head(grocery)
    V1     V2   V3 V4
1 4264 305657 7.17  0
2 4496 328476 6.20  0
3 4317 317164 4.61  0
4 4292 366745 7.02  0
5 4945 265518 8.61  1
6 4325 301995 6.88  0
> X1_Cases <- grocery$V2
> head(X1_Cases)
[1] 305657 328476 317164 366745 265518 301995
> X2_Costs_Of_Labor <- grocery$V3
> head(X2_Costs_Of_Labor)
[1] 7.17 6.20 4.61 7.02 8.61 6.88
> X3_Holiday_Week <- grocery$V4
> head(X3_Holiday_Week)
[1] 0 0 0 0 1 0
> Y_Total_Labor <- grocery$V1
> head(Y_Total_Labor)
[1] 4264 4496 4317 4292 4945 4325
> lm.grocery <- lm(Y_Total_Labor ~ X1_Cases + X2_Costs_Of_Labor + X3_Holiday_Week)
> ##SRR(X_1)
> anova(lm.grocery)
Analysis of Variance Table

Response: Y_Total_Labor
                Df  Sum Sq Mean Sq F value    Pr(>F)
X1_Cases         1  136366  136366  6.6417   0.01309 *
X2_Costs_Of_Labor  1    5726    5726  0.2789   0.59987
X3_Holiday_Week    1 2034514 2034514 99.0905 2.941e-13 ***
Residuals       48  985530   20532
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> ##SSR(X_3|X_1)
> anova(lm(Y_Total_Labor ~ X1_Cases + X3_Holiday_Week))
Analysis of Variance Table

Response: Y_Total_Labor
                Df  Sum Sq Mean Sq  F value    Pr(>F)
X1_Cases         1  136366  136366   6.7344   0.01244 *
X3_Holiday_Week  1 2033565 2033565 100.4276 1.875e-13 ***
Residuals       49  992204   20249
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> ##SSR(X_2|X_1, X_3)
> anova(lm(Y_Total_Labor ~ X3_Holiday_Week + X1_Cases), lm.grocery)
Analysis of Variance Table

Model 1: Y_Total_Labor ~ X3_Holiday_Week + X1_Cases
Model 2: Y_Total_Labor ~ X1_Cases + X2_Costs_Of_Labor + X3_Holiday_Week
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1     49 992204
2     48 985530  1    6674.6 0.3251 0.5712
> ##SSE(X_1, X_2, X_3)
> anova(lm.grocery)
Analysis of Variance Table

Response: Y_Total_Labor
                 Df  Sum Sq Mean Sq F value    Pr(>F)
X1_Cases          1  136366  136366  6.6417   0.01309 *
X2_Costs_Of_Labor 1    5726    5726  0.2789   0.59987
X3_Holiday_Week   1 2034514 2034514 99.0905 2.941e-13 ***
Residuals        48  985530   20532
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
> #b.
> anova(lm(Y_Total_Labor ~ X3_Holiday_Week + X1_Cases), lm.grocery)
Analysis of Variance Table

Model 1: Y_Total_Labor ~ X3_Holiday_Week + X1_Cases
Model 2: Y_Total_Labor ~ X1_Cases + X2_Costs_Of_Labor + X3_Holiday_Week
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1     49 992204
2     48 985530  1    6674.6 0.3251 0.5712
> #c.
> anova(lm(Y_Total_Labor ~ X1_Cases))
Analysis of Variance Table

Response: Y_Total_Labor
          Df  Sum Sq Mean Sq F value Pr(>F)
X1_Cases   1  136366  136366  2.2534 0.1396
Residuals 50 3025770   60515
> anova(lm(Y_Total_Labor ~ X1_Cases + X2_Costs_Of_Labor))
Analysis of Variance Table

Response: Y_Total_Labor
                 Df  Sum Sq Mean Sq F value Pr(>F)
X1_Cases          1  136366  136366  2.2125 0.1433
X2_Costs_Of_Labor  1    5726    5726  0.0929 0.7618
Residuals         49 3020044   61634
> ## add them together
> anova(lm(Y_Total_Labor ~X1_Cases))[1,2] + anova(lm(Y_Total_Labor ~ X1_Cases + X2_Costs_Of_Labor))[2,2]
[1] 142092.2
> anova(lm(Y_Total_Labor ~ X2_Costs_Of_Labor))[1,2]+ anova(lm(Y_Total_Labor ~ X2_Costs_Of_Labor + X1_Cases))[2,2]
[1] 142092.2
> ################################################################################
> ##7.25
> #a.
> summary(lm(Y_Total_Labor ~ X1_Cases))
```

```
Call:
lm(formula = Y_Total_Labor ~ X1_Cases)

Residuals:
    Min      1Q  Median      3Q     Max
-356.18 -164.64  -56.07  111.23  619.01

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 4.080e+03  1.917e+02  21.283   <2e-16 ***
X1_Cases    9.355e-04  6.232e-04   1.501     0.14
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 246 on 50 degrees of freedom
Multiple R-squared:  0.04312,   Adjusted R-squared:  0.02399
F-statistic: 2.253 on 1 and 50 DF,  p-value: 0.1396

> #c.
> anova(lm(Y_Total_Labor ~ X1_Cases))
Analysis of Variance Table

Response: Y_Total_Labor
          Df  Sum Sq Mean Sq F value Pr(>F)
X1_Cases   1  136366  136366  2.2534 0.1396
Residuals 50 3025770   60515
> anova(lm(Y_Total_Labor ~ X2_Costs_Of_Labor + X1_Cases))
Analysis of Variance Table

Response: Y_Total_Labor
                 Df  Sum Sq Mean Sq F value Pr(>F)
X2_Costs_Of_Labor  1   11395   11395  0.1849 0.6691
X1_Cases           1  130697  130697  2.1206 0.1517
Residuals         49 3020044   61634
```

```
> #d.
> grocery.df <- data.frame(Y_Total_Labor ,X1_Cases , X2_Costs_Of_Labor, X3_Holiday_Week)
> grocery.df
   Y_Total_Labor X1_Cases X2_Costs_Of_Labor X3_Holiday_Week
1           4264   305657              7.17               0
2           4496   328476              6.20               0
3           4317   317164              4.61               0
4           4292   366745              7.02               0
5           4945   265518              8.61               1
6           4325   301995              6.88               0
7           4110   269334              7.23               0
8           4111   267631              6.27               0
9           4161   296350              6.49               0
10          4560   277223              6.37               0
11          4401   269189              7.05               0
12          4251   277133              6.34               0
13          4222   282892              6.94               0
14          4063   306639              8.56               0
15          4343   328405              6.71               0
16          4833   321773              5.82               1
17          4453   272319              6.82               0
18          4195   293880              8.38               0
19          4394   300867              7.72               0
20          4099   296872              7.67               0
21          4816   245674              7.72               1
22          4867   211944              6.45               1
23          4114   227996              7.22               0
24          4314   248328              8.50               0
25          4289   249894              8.08               0
26          4269   302660              7.26               0
27          4347   273848              7.39               0
28          4178   245743              8.12               0
29          4333   267673              6.75               0
30          4226   256506              7.79               0
31          4121   271854              7.89               0
```

```
32          3998   293225              9.01                0
33          4475   269121              8.01                0
34          4545   322812              7.21                0
35          4016   252225              7.85                0
36          4207   261365              6.14                0
37          4148   287645              6.76                0
38          4562   289666              7.92                0
39          4146   270051              8.19                0
40          4555   265239              7.55                0
41          4365   352466              6.94                0
42          4471   426908              7.25                0
43          5045   369989              9.65                1
44          4469   472476              8.20                0
45          4408   414102              8.02                0
46          4219   302507              6.72                0
47          4211   382686              7.23                0
48          4993   442782              7.61                1
49          4309   322303              7.39                0
50          4499   290455              7.99                0
51          4186   411750              7.83                0
52          4342   292087              7.77                0
> cor(grocery.df)
                 Y_Total_Labor   X1_Cases X2_Costs_Of_Labor X3_Holiday_Week
Y_Total_Labor        1.0000000 0.20766494        0.06002960      0.81057940
X1_Cases             0.2076649 1.00000000        0.08489639      0.04565698
X2_Costs_Of_Labor    0.0600296 0.08489639        1.00000000      0.11337076
X3_Holiday_Week      0.8105794 0.04565698        0.11337076      1.00000000
> ##############################################################################
> ####################CHAPTER 8
> ##8.4
> #a.
> muscle <- read.delim(file = "https://www.math.arizona.edu/~piegorsch/571A/Data/Chapter01/CH01PR27.txt",
+                      header = F, sep = "")
> X <- muscle$V2
```

```
> X
 [1] 43 41 47 46 45 41 47 41 48 48 42 47 43 44 42 55 57 56 59 57 54 53 52 53 54 60 59 51 59 57 68 63 60 63 63 64 66 65 60 65 65 69 61 70 68 78 78 78
[49] 72 70 73 76 78 78 71 75 77 76 72 76
> Y <- muscle$V1
> Y
 [1] 106 106  97 113  96 119  92 112  92 102 107 107 102 115 101  87  91  97  82  78  95  98  94  96 100  84  70 104  76  93  73  73  76  80  84  71
[37]  64  88  79  88  73  74  76  87  70  69  54  62  78  65  64  74  87  63  82  80  52  56  70  74
> X1 <- (X - mean(X))
> X1sq <- (X1*X1)
> model<- lm(Y ~ X1 + X1sq)
> model

Call:
lm(formula = Y ~ X1 + X1sq)

Coefficients:
(Intercept)           X1         X1sq
   82.93575     -1.18396      0.01484

> #b.
> f <- qf(.95,2,57)
> f
[1] 3.158843
> summary(model)

Call:
lm(formula = Y ~ X1 + X1sq)

Residuals:
    Min      1Q  Median      3Q     Max
-15.086  -6.154  -1.088   6.220  20.578

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 82.935749   1.543146  53.745   <2e-16 ***
```

```
X1          -1.183958   0.088633 -13.358   <2e-16 ***
X1sq         0.014840   0.008357   1.776   0.0811 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.026 on 57 degrees of freedom
Multiple R-squared:  0.7632,    Adjusted R-squared:  0.7549
F-statistic: 91.84 on 2 and 57 DF,  p-value: < 2.2e-16

> anova(model)
Analysis of Variance Table

Response: Y
          Df  Sum Sq Mean Sq  F value  Pr(>F)
X1         1 11627.5 11627.5 180.5258 < 2e-16 ***
X1sq       1   203.1   203.1   3.1538 0.08109 .
Residuals 57  3671.3    64.4
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> #c.
> t <- qt(.975,57)
> newdata.df = data.frame(X1 = 48 - mean(X), X1sq = (48-mean(X))^2)
> predict(model, newdata=newdata.df,se.fit=T, interval= "confidence",level = 1-(.05/2))
$fit
       fit      lwr      upr
1 99.25461 95.83983 102.6694

$se.fit
[1] 1.483295

$df
[1] 57

$residual.scale
[1] 8.025521
```

```
> #d.
> predict(model, newdata=newdata.df,se.fit=T, interval= "prediction",level = 1-(.05/2))
$fit
       fit      lwr      upr
1 99.25461 80.46568 118.0435

$se.fit
[1] 1.483295

$df
[1] 57

$residual.scale
[1] 8.025521

> #e.
> f1 <- qf(.95,1,57)
> f1
[1] 4.009868
> summary(model)

Call:
lm(formula = Y ~ X1 + X1sq)

Residuals:
    Min      1Q  Median      3Q     Max
-15.086  -6.154  -1.088   6.220  20.578

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 82.935749   1.543146  53.745   <2e-16 ***
X1          -1.183958   0.088633 -13.358   <2e-16 ***
X1sq         0.014840   0.008357   1.776   0.0811 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Residual standard error: 8.026 on 57 degrees of freedom
Multiple R-squared:  0.7632,    Adjusted R-squared:  0.7549
F-statistic: 91.84 on 2 and 57 DF,  p-value: < 2.2e-16

> anova(model)
Analysis of Variance Table

Response: Y
          Df  Sum Sq Mean Sq  F value  Pr(>F)
X1         1 11627.5 11627.5 180.5258 < 2e-16 ***
X1sq       1   203.1   203.1   3.1538 0.08109 .
Residuals 57  3671.3    64.4
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> #f
> X
 [1] 43 41 47 46 45 41 47 41 48 48 42 47 43 44 42 55 57 56 59 57 54 53 52 53 54 60 59 51 59 57 68 63 60 63 63 64 66 65 60 65 65 69 61 70 68 78 78 78
[49] 72 70 73 76 78 78 71 75 77 76 72 76
> Xsq <- X*X
> model1 <- lm(Y ~ X + Xsq)
> model1

Call:
lm(formula = Y ~ X + Xsq)

Coefficients:
(Intercept)            X          Xsq
  207.34961     -2.96432      0.01484

> #g
> cor(cbind(X1,X1sq,X,Xsq))
              X1        X1sq           X        Xsq
X1    1.00000000 -0.03835694  1.00000000 0.99609392
X1sq -0.03835694  1.00000000 -0.03835694 0.05002801
X     1.00000000 -0.03835694  1.00000000 0.99609392
Xsq   0.99609392  0.05002801  0.99609392 1.00000000
> ################################################################################
> ##8.5
```

```
> ##8.5
> #a.
> plot(resid(model) ~ fitted(model))
Error in plot.new() : figure margins too large
> abline(h=0)
Error in int_abline(a = a, b = b, h = h, v = v, untf = untf, ...) :
  invalid graphics state
> plot(resid(model)~ X1)
> abline(h=0)
Error in int_abline(a = a, b = b, h = h, v = v, untf = untf, ...) :
  invalid graphics state
In addition: Warning messages:
1: In doTryCatch(return(expr), name, parentenv, handler) :
  display list redraw incomplete
2: In doTryCatch(return(expr), name, parentenv, handler) :
  invalid graphics state
3: In doTryCatch(return(expr), name, parentenv, handler) :
  invalid graphics state
> qqnorm(resid(model), main = "")
Error in plot.new() : figure margins too large
> #b.
> fmmodel <- lm(Y ~ factor(X1)+ X1sq)
> rmmodel <- lm(Y ~ X1)
> anova(rmmodel)
Analysis of Variance Table

Response: Y
          Df  Sum Sq Mean Sq F value    Pr(>F)
X1         1 11627.5 11627.5  174.06 < 2.2e-16 ***
Residuals 58  3874.4    66.8
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> anova(fmmodel)
Analysis of Variance Table

Response: Y
           Df  Sum Sq Mean Sq F value    Pr(>F)
factor(X1) 31 13652.3  440.40  6.6666 1.207e-06 ***
```

```
factor(X1) 31 13652.3  440.40  6.6666 1.207e-06 ***
Residuals  28  1849.7   66.06
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> anova(rmmodel, fmmodel)
Analysis of Variance Table

Model 1: Y ~ X1
Model 2: Y ~ factor(X1) + X1sq
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1     58 3874.4
2     28 1849.7 30    2024.8 1.0217 0.4789
> #c.
> X1cu <- (X1*X1*X1)
> model2 <- lm(Y ~ X1 + X1sq + X1cu)
> model2

Call:
lm(formula = Y ~ X1 + X1sq + X1cu)

Coefficients:
(Intercept)           X1         X1sq         X1cu
 82.9273444   -1.2678894    0.0150390    0.0003369

> summary(model2)

Call:
lm(formula = Y ~ X1 + X1sq + X1cu)

Residuals:
     Min       1Q   Median       3Q      Max
-15.3671  -5.8483  -0.6755   6.1376  20.0637

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 82.9273444  1.5552264  53.322  < 2e-16 ***
X1          -1.2678894  0.2489231  -5.093 4.28e-06 ***
X1sq         0.0150390  0.0084390   1.782   0.0802 .
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.087 on 56 degrees of freedom
Multiple R-squared:  0.7637,    Adjusted R-squared:  0.7511
F-statistic: 60.34 on 3 and 56 DF,  p-value: < 2.2e-16

> anova(model2)
Analysis of Variance Table

Response: Y
          Df  Sum Sq Mean Sq  F value  Pr(>F)
X1         1 11627.5 11627.5 177.7720 < 2e-16 ***
X1sq       1   203.1   203.1   3.1057 0.08348 .
X1cu       1     8.5     8.5   0.1305 0.71928
Residuals 56  3662.8    65.4
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> qf(.95,1,56)
[1] 4.012973
> ##########################################################################
> ##8.15
> #b.
> X.8.15<- c(2,4,3,2,1,10,5,5,1,2,9,10,6,3,4,8,7,8,10,4,5,7,7,5,
+        9,7,2,5,7,6,8,5,2,2,1,4,5,9,7,1,9,2,2,4,5)
> length(X.8.15)
[1] 45
> Y.8.15<- c(20,60,46,41,12,137,68,89,4,32,144,156,93,36,72,100,105,
+        131,127,57,66,101,109,74,134,112,18,73,111,96,123,90,20,
+        28,3,57,86,132,112,27,131,34,27,61,77)
> length(Y.8.15)
[1] 45
> type <- read.delim(file = "https://www.math.arizona.edu/~piegorsch/571A/Data/Chapter08/CH08PR15.txt",
+                    header = F, sep = "")
> X1.8.15 <- type$V1
> head(X1.8.15)
[1] 1 0 0 0 0 0
> length(X1.8.15)
```

```
[1] 45
> copy.lm <- lm(Y.8.15 ~ X.8.15 + X1.8.15)
> coef(copy.lm)
(Intercept)      X.8.15     X1.8.15
 -0.9224729  15.0461435   0.7587218
> anova(copy.lm)
Analysis of Variance Table

Response: Y.8.15
          Df Sum Sq Mean Sq  F value Pr(>F)
X.8.15     1  76960   76960 947.8084 <2e-16 ***
X1.8.15    1      6       6   0.0745 0.7862
Residuals 42   3410      81
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> summary(copy.lm)

Call:
lm(formula = Y.8.15 ~ X.8.15 + X1.8.15)

Residuals:
     Min       1Q   Median       3Q      Max
-22.5390  -4.2515   0.5995   6.5995  14.9330

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -0.9225     3.0997  -0.298    0.767
X.8.15       15.0461     0.4900  30.706   <2e-16 ***
X1.8.15       0.7587     2.7799   0.273    0.786
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 9.011 on 42 degrees of freedom
Multiple R-squared:  0.9576,    Adjusted R-squared:  0.9556
F-statistic: 473.9 on 2 and 42 DF,  p-value: < 2.2e-16

> #c.
> confint(copy.lm)
```

```
> confint(copy.lm)
                2.5 %    97.5 %
(Intercept) -7.177891  5.332945
X.8.15      14.057283 16.035004
X1.8.15     -4.851254  6.368698
> ############################################################
> ##8.19
> #a.
> copy2.lm <- lm(Y.8.15 ~ X.8.15*X1.8.15)
> copy2.lm

Call:
lm(formula = Y.8.15 ~ X.8.15 * X1.8.15)

Coefficients:
   (Intercept)          X.8.15         X1.8.15  X.8.15:X1.8.15
         2.813          14.339          -8.141           1.777

> #b.
> summary(copy2.lm)

Call:
lm(formula = Y.8.15 ~ X.8.15 * X1.8.15)

Residuals:
     Min       1Q   Median       3Q      Max
-19.2072  -6.7887  -0.1708   7.1504  14.7441

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)      2.8131     3.6468   0.771   0.4449
X.8.15          14.3394     0.6146  23.333   <2e-16 ***
X1.8.15         -8.1412     5.5801  -1.459   0.1522
X.8.15:X1.8.15   1.7774     0.9746   1.824   0.0755 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.771 on 41 degrees of freedom
```

```
Residual standard error: 8.771 on 41 degrees of freedom
Multiple R-squared:  0.9608,    Adjusted R-squared:  0.9579
F-statistic: 334.6 on 3 and 41 DF,  p-value: < 2.2e-16

> anova(copy2.lm)
Analysis of Variance Table

Response: Y.8.15
              Df Sum Sq Mean Sq   F value  Pr(>F)
X.8.15         1  76960   76960 1000.2987 < 2e-16 ***
X1.8.15        1      6       6    0.0786 0.78059
X.8.15:X1.8.15  1    256     256    3.3260 0.07549 .
Residuals      41   3154      77
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> qt(.95,41)
[1] 1.682878
>
```