

```
In [ ]: # 1a  
# formula: solve ( t (X ) %*% X ) %*% t (X ) %*% y
```

```
In [81]: XX=matrix(c(8, 16.2, 4, 28, 16.2, 33.88, 8.6, 58.6, 4, 8.6, 4, 15, 28, 58.6, 15, 102), 4, 4)  
XY=matrix(c(1840.33, 3848.139, 1012.83, 6694.71), 4, 1)  
YY=c(441446.7)
```

```
In [82]: solve(XX)%*%XY
```

13.142261

3.566183

16.678340

57.525228

```
In [78]: #lb
XX=matrix(c(8, 16.2, 4, 28, 16.2, 33.88, 8.6, 58.6, 4, 8.6, 4, 15, 28, 58.6, 15, 102), 4, 4)
XY=matrix(c(1840.33, 3848.139, 1012.83, 6694.71), 4, 1)
YY=c(441446.7)
n = 8
y_mean = 1840.330/n
SST = YY - n*(y_mean)^2
SSE = YY-t(XY)%*%solve(XX)%*%XY
SSR = SST-SSE
r_square = SSR/SST
Fstat = r_square*4/((1-r_square)*3)
Fstat
r_square
SSE
```

14.43159

0.9154241

1530.392

In [160]: XX

8.0	16.20	4.0	28.0
16.2	33.88	8.6	58.6
4.0	8.60	4.0	15.0
28.0	58.60	15.0	102.0

```
In [79]: #lc
n = 8
y_mean = 1840.330 / n
SSE = YY-t(XY)%*%solve(XX)%*%XY
sigma2 = SSE / 4
16.678340/sqrt(sigma2*solve(XX)[3,3])
```

1.126809

```
In [163]: #ld
XXd = matrix(c(8, 28, 28, 102), 2, 2)
XYd = matrix(c(1840.33, 6694.71), 2, 1)
YY=c(441446.7)
SSEd = YY-t(XYd)%*%solve(XXd)%*%XYd
n = 8
y_mean = 1840.330/n
SST = YY - n*(y_mean)^2
SSRd = SST-SSEd
r_square = SSRd/SST

((SSEd-SSE)/2)/(SSE/4)
```

10.5966

0.6429203

```
In [83]: #le
x = c(765.196, 382.598, 1147.794)
x1 = matrix(c(1, 2, 1, 3), 1, 4)
unew = 13.142261+ 3.566183*2+16.67834*1+57.525228*3
xnew = matrix(c(382.598, x), 1, 4)
Vnew = xnew%*%solve(XX)%*%t(x1)
unew + 2.777*sqrt(Vnew +sigma2)
unew - 2.777*sqrt(Vnew +sigma2)
sigma2
```

279.3326

139.7247

382.598

```
In [59]: t(xnew)
xnew
```

1	765.196	382.598	1147.794
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1	765.196	382.598	1147.794
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```
In [131]: XX=matrix(c(8, 16.2, 4, 28, 16.2, 33.88, 8.6, 58.6, 4, 8.6, 4, 15, 28, 58.6, 15, 102), 4, 4)
XY=matrix(c(1840.33, 6694.71), 2, 1)
XXd = matrix(c(8, 28, 28, 102), 2, 2)
XXd
XY
```

8	28
28	102

1840.33

6694.71

In [12]: *#2b*

$$SSE = YY - t(XY) \%* \% solve(XX) \%* \% XY$$

 SSE

1530.392

In []: SST = YY -

In [14]: $t(XY)$
 YY

1840.33	3848.139	1012.83	6694.71
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441446.7

In [15]: *# 2a*

$$((208-100)/8)/(100/(36-8-1))$$

3.645

In [16]: *#2b*

$$((140-100)/3)/(100/(36-8-1))$$

3.6

In [133]: *#3a*

$$XX = \text{matrix}(c(10, 29, 48, 29, 105, 178, 48, 178, 304), 3, 3)$$

$$XY = \text{matrix}(c(549.45, 1759.22, 2946.19), 3, 1)$$

$$YY = c(31517.33)$$

$$\text{solve}(XX) \%* \% XY$$

32.3095732

6.7493902

0.6379573

In [175]: XX
XY

10	29	48
29	105	178
48	178	304

549.45
1759.22
2946.19

In [228]: *#3b*
 XXb=matrix(c(10), 1, 1)
 XYb=matrix(c(549.45), 1, 1)
 YY=c(31517.33)
 SSEb = YY-t(XYb)%*%solve(XXb)%*%XYb
 SSE = YY-t(XY)%*%solve(XX)%*%XY
 ((SSEb-SSE)/2)/(SSE/7)
 SSE
 SSEb

396.1216

11.62925

1327.8

```
In [145]: #3c formula beta1_bar +/- t(alpha/2) (n-p-1)*sigma2*solve(XXb)[2, 2]  
6.7493902+1.895*sqrt(sigma2*2.2439024)  
6.7493902-1.895*sqrt(sigma2*2.2439024)
```

10.40818

3.090596

```
In [134]: #3d  
XX=matrix(c(10, 29, 48, 29, 105, 178, 48, 178, 304), 3, 3)  
XY=matrix(c(549.45, 1759.22, 2946.19), 3, 1)  
YY=c(31517.33)  
SSE = YY-t(XY)%*%solve(XX)%*%XY  
sigma2 = SSE/7  
0.6379573-5/sqrt(sigma2*solve(XX)[3, 3])
```

-4.221715

```
In [225]: #3e  
XX=matrix(c(10, 29, 48, 29, 105, 178, 48, 178, 304), 3, 3)  
XY=matrix(c(549.45, 1759.22, 2946.19), 3, 1)  
YY=c(31517.33)  
SSE = YY-t(XY)%*%solve(XX)%*%XY  
sigma2 = SSE/7  
6.7493902/sqrt(sigma2*solve(XX)[2, 2])
```

3.495713

```
In [91]: #3f
x = c(2*1.661321, 1.661321*4)
x1 = matrix(c(1, 2, 4), 1, 3)
unew = 32.3095732+ 6.7493902*2+0.6379573*4
xnew = matrix(c(1.661321, x), 1, 3)
Vnew = xnew%*%solve(XX)%*%t(x1)
unew + 1.895*sqrt(Vnew +sigma2)
unew - 1.895*sqrt(Vnew +sigma2)
```

51.47086

45.24951

```
In [89]: sigma2
```

1.661321

```
In [200]: XX
sigma2
solve(XX)
```

10	29	48
29	105	178
48	178	304

1.661321

0.7195122	-0.8292683	0.3719512
-0.8292683	2.2439024	-1.1829268
0.3719512	-1.1829268	0.6371951


```
In [118]: #4a
XX=matrix(c(15, 155.9333, 155.9333, 1693.913), 2, 2)
XY=matrix(c(-9.424582, -83.04267), 2, 1)
YY=c(17.23803)
solve(XX)%*%XY
```

-2.7574776

0.2048157

```
In [94]: #4c
SSE = YY-t(XY)%*%solve(XX)%*%XY
SSE
```

8.258396

```
In [95]: #4d
SSR = SST-SSE
SSR
```

3.058118

```
In [96]: #4e
r_square = SSR/SST
r_square
```

0.270235

```
In [97]: #4f
sigma = sqrt(SSE/13)
sigma
```

0.7970327

```
In [98]: #4g
XX=matrix(c(15, 155.9333, 155.9333, 1693.913), 2, 2)
SSE = YY-t(XY)%*%solve(XX)%*%XY
sigma2 = SSE/13
sigma = sqrt(sigma2)
solve(XX)
sigma2*1.5490732
sigma2*0.01371741
sigma2*-0.14260006
```

1.5490732	-0.14260006
-0.1426001	0.01371741

0.9840661

0.008714138

-0.09058829

```
In [99]: #4h
Fstat = (0.270235*13)/(1-0.270235)
Fstat
#numerator d.f.:1
#denominator d.f. :13
```

4.81395380704747

```
In [3]: #4i
XX=matrix(c(15, 155.9333, 155.9333, 1693.913), 2, 2)
XY=matrix(c(-9.424582, -83.04267), 2, 1)
YY=c(17.23803)
SSEi = YY
# Since Y = elipscon, SSE = sum(y-0)^2 = sum(y)^2 = YY
SSE = YY-t(XY)%*%solve(XX)%*%XY
((SSEi-SSE)/2)/(SSE/13)
```

7.067671

```
In [132]: #4j
XX=matrix(c(15, 155.9333, 155.9333, 1693.913), 2, 2)
XY=matrix(c(-9.424582, -83.04267), 2, 1)
YY=c(17.23803)
SSE = YY-t(XY)%*%solve(XX)%*%XY
sigma2 = SSE/13
xnew = c(1, 9)
unew = -2.7574776+0.2048157*9
Vnew = sigma2*t(xnew)%*%solve(XX)%*%xnew
unew + 2.161*sqrt(Vnew)
unew - 2.161*sqrt(Vnew)
unew
```

-0.3878002

-1.440472

-0.9141363

```
In [131]: sigma2
xnew
```

0.6352612

0.6352612 5.717351