R PROGRAMMING

Tutorial 9

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```
> #Ques-1
> z=matrix(c(1,30,1,20,1,60,1,80,1,40,1,50,1,60,1,30,1,70,1,60),nrow = 10,ncol = 2,byrow = TRUE)
> y=matrix(c(73,50,128,170,87,108,135,69,148,132),nrow = 10,ncol = 1,byrow = TRUE)
> relation=lm(y~z)
> print(relation)

Call:
lm(formula = y ~ z)

Coefficients:
(Intercept)           z1           z2
         10           NA            2

> print(summary(relation))

Call:
lm(formula = y ~ z)


Residuals:
   Min     1Q Median     3Q    Max
  -3.0   -2.0   -0.5    1.5    5.0

Coefficients: (1 not defined because of singularities)
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 10.00000    2.50294   3.995  0.00398 **
z1                 NA         NA      NA       NA
z2           2.00000    0.04697  42.583 1.02e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.739 on 8 degrees of freedom
Multiple R-squared:  0.9956,    Adjusted R-squared:  0.9951
F-statistic:  1813 on 1 and 8 DF,  p-value: 1.02e-10

> trz=t(z)
> print(trz)

     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10]
[1,]    1    1    1    1    1    1    1    1    1     1
[2,]   30   20   60   80   40   50   60   30   70    60
> zn=trz%*%z
> print(zn)
     [,1]  [,2]
[1,]   10   500
[2,]  500 28400
> invz=solve(zn)
> print(invz)
            [,1]          [,2]
[1,]  0.83529412 -0.0147058824
[2,] -0.01470588  0.0002941176
> betah=invz%*%trz%*%y
> print(trz%*%y)
      [,1]
[1,]  1100
[2,] 61800
```

```
> print(betah)
     [,1]
[1,]   10
[2,]    2
> yhat=z%*%betah
> print(yhat)
      [,1]
 [1,]   70
 [2,]   50
 [3,]  130
 [4,]  170
 [5,]   90
 [6,]  110
 [7,]  130
 [8,]   70
 [9,]  150
[10,]  130
```

```
> error=y-yhat
> print(error)
                [,1]
 [1,]  3.000000e+00
 [2,]  1.065814e-13
 [3,] -2.000000e+00
 [4,] -8.526513e-14
 [5,] -3.000000e+00
 [6,] -2.000000e+00
 [7,]  5.000000e+00
 [8,] -1.000000e+00
 [9,] -2.000000e+00
[10,]  2.000000e+00
> #print(betah*trz)
> po=t(betah)
> po1=t(y)
> SSE=(po1%*%y)-(po%*%trz%*%y)
> print(SSE)
```

```
     [,1]
[1,]   60
> var=SSE/(10-1-1)
> print(var)
     [,1]
[1,]  7.5
```

```
> #Ques2
> z=matrix(c(1,-2,1,-1,1,0,1,1,1,2),nrow = 5,ncol = 2,byrow = TRUE)
> y1=matrix(c(5,3,4,2,1),nrow = 5,ncol = 1,byrow = TRUE)
> y2=matrix(c(-3,-1,-1,2,3),nrow = 5,ncol = 1,byrow = TRUE)
> relation=lm(y1+y2~z)
> print(relation)

Call:
lm(formula = y1 + y2 ~ z)

Coefficients:
(Intercept)           z1           z2
        3.0           NA          0.6

> print(summary(relation))

Call:
lm(formula = y1 + y2 ~ z)

Residuals:
         1          2          3          4          5
 2.000e-01 -4.000e-01 -1.318e-16  4.000e-01 -2.000e-01

Coefficients: (1 not defined because of singularities)
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   3.0000     0.1633  18.371 0.000352 ***
z1                NA         NA      NA       NA
z2            0.6000     0.1155   5.196 0.013847 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.3651 on 3 degrees of freedom
Multiple R-squared:    0.9,     Adjusted R-squared:  0.8667
F-statistic:    27 on 1 and 3 DF,  p-value: 0.01385

> trz=t(z)
> print(trz)
     [,1] [,2] [,3] [,4] [,5]
[1,]    1    1    1    1    1
[2,]   -2   -1    0    1    2
> zn=trz%*%z
> print(zn)
     [,1] [,2]
[1,]    5    0
[2,]    0   10
```

```
> invz=solve(zn)
> print(invz)
     [,1] [,2]
[1,]  0.2  0.0
[2,]  0.0  0.1
> betah=invz%*%trz%*%y1
> print(betah)
     [,1]
[1,]  3.0
[2,] -0.9
> betah2=invz%*%trz%*%y2
> print(betah2)
             [,1]
[1,] 1.110223e-16
[2,] 1.500000e+00
> newbeta=cbind(betah,betah2)
> print(newbeta)
     [,1]         [,2]
[1,]  3.0 1.110223e-16
[2,] -0.9 1.500000e+00
> yhat=z%*%newbeta
> print(yhat)
     [,1]          [,2]
[1,]  4.8 -3.000000e+00
[2,]  3.9 -1.500000e+00
[3,]  3.0  1.110223e-16
[4,]  2.1  1.500000e+00
[5,]  1.2  3.000000e+00
> temp2=cbind(y1,y2)
> e=temp2-yhat
> print(e)
     [,1]          [,2]
[1,]  0.2  4.440892e-16
[2,] -0.9  5.000000e-01
[3,]  1.0 -1.000000e+00
[4,] -0.1  5.000000e-01
[5,] -0.2 -4.440892e-16
```

```
> #Ques-3
> z=matrix(c(1,7,2.6,1,1,2.9,1,11,5.6),nrow = 3,ncol = 3,byrow = TRUE)
> y=matrix(c(78.5,74.3,104.3),nrow = 3,ncol = 1,byrow = TRUE)
> relation=lm(y~z)
> print(relation)

Call:
lm(formula = y ~ z)

Coefficients:
(Intercept)           z1           z2           z3
     52.397           NA        1.059        7.187

> print(summary(relation))

Call:
lm(formula = y ~ z)

Residuals:
ALL 3 residuals are 0: no residual degrees of freedom!

Coefficients: (1 not defined because of singularities)
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   52.397        NaN     NaN      NaN
z1                NA         NA      NA       NA
z2             1.059        NaN     NaN      NaN
z3             7.187        NaN     NaN      NaN

Residual standard error: NaN on 0 degrees of freedom
Multiple R-squared:      1,     Adjusted R-squared:    NaN
F-statistic:   NaN on 2 and 0 DF,  p-value: NA

> trz=t(z)
> print(trz)
     [,1] [,2] [,3]
[1,]  1.0  1.0  1.0
[2,]  7.0  1.0 11.0
[3,]  2.6  2.9  5.6
> zn=trz%*%z
> print(zn)
     [,1]  [,2]  [,3]
[1,]  3.0  19.0 11.10
[2,] 19.0 171.0 82.70
[3,] 11.1  82.7 46.53
> invz=solve(zn)
```

```
> print(invz)
            [,1]        [,2]       [,3]
[1,]  3.03097873  0.09195964 -0.8865017
[2,]  0.09195964  0.04443359 -0.1009115
[3,] -0.88650174 -0.10091146  0.4123264
> betah=invz%*%trz%*%y
> print(trz%*%y)
        [,1]
[1,]  257.10
[2,] 1771.10
[3,] 1003.65
> print(betah)
          [,1]
[1,] 52.396875
[2,]  1.059375
[3,]  7.187500
> yhat=z%*%betah
> print(yhat)
      [,1]
[1,]  78.5
[2,]  74.3
[3,] 104.3
> error=y-yhat
> print(error)
              [,1]
[1,] -1.421085e-13
[2,] -1.989520e-13
[3,] -1.989520e-13
> #print(betah*trz)
> po=t(betah)
> po1=t(y)
> SSE=(po1%*%y)-(po%*%trz%*%y)
> print(SSE)
              [,1]
[1,] -4.729372e-11
> var=SSE/(10-1-1)
> print(var)
              [,1]
[1,] -5.911716e-12
> P=z%*%invz%*%trz
> print(P)
             [,1]          [,2]         [,3]
[1,] 1.000000e+00  1.554312e-15 2.220446e-15
[2,] 2.886580e-15  1.000000e+00 0.000000e+00
[3,] 6.661338e-16 -1.776357e-15 1.000000e+00
```