

# HW3

```
#rm(list = ls())
```

## Regression model in lm function

```
lse3 <- lm(value~crime+nitox+rooms+age+dist+access+tax+prratio)
summary(lse3)
```

```
##
## Call:
## lm(formula = value ~ crime + nitox + rooms + age + dist + access +
##      tax + prratio)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -14.254  -2.898  -0.595   2.048  37.396
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  28.40666    5.36595   5.294 1.80e-07 ***
## crime        -0.18345    0.03649  -5.028 6.95e-07 ***
## nitox       -22.81088    4.16074  -5.482 6.69e-08 ***
## rooms         6.37151    0.39239  16.238 < 2e-16 ***
## age          -0.04775    0.01410  -3.386 0.000765 ***
## dist         -1.33527    0.20015  -6.671 6.77e-11 ***
## access        0.27228    0.07228   3.767 0.000185 ***
## tax          -0.01259    0.00377  -3.340 0.000901 ***
## prratio      -1.17679    0.13942  -8.441 3.47e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.43 on 497 degrees of freedom
## Multiple R-squared:  0.657, Adjusted R-squared:  0.6515
## F-statistic: 119 on 8 and 497 DF, p-value: < 2.2e-16
```

## Regression model in hand-on style

coding for Estimate

```
y3 <- as.matrix(value)

X3 <- cbind(1,crime,nitox,rooms,age,dist,access,tax,prratio)

betahat3 <- solve(crossprod(X3,X3)) %*% crossprod(X3,y3)
betahat3

##              [,1]
##      28.40665786
```

```
## crime      -0.18344901
## nitox     -22.81087877
## rooms      6.37151243
## age       -0.04774991
## dist      -1.33526931
## access     0.27228205
## tax       -0.01259209
## ptratio   -1.17678656
```

## coding for Residuals

```
u3hat <- y3 - X3%*%betahat3
summary(u3hat)
```

```
##          V1
## Min.      :-14.2543
## 1st Qu.:  -2.8979
## Median :  -0.5954
## Mean     :   0.0000
## 3rd Qu.:   2.0478
## Max.     :  37.3961
```

## coding for $R^2$ & adjusted $R^2$

```
#          y3  y yhat?

tss <- t(y3)%*%m0%*%y3
rss <- crossprod(u3hat, u3hat)
ess <- tss - rss
```

```
R2 <- ess/tss
R2
```

```
##          [,1]
## [1,] 0.6569876
```

```
k <- ncol(X3)
nmk <- n-k
nmk
```

```
## [1] 497
```

```
#AdjustedR2 <- 1-((rss/nmk)/(tss/n-1))
#AdjustedR2          0.6465898
```

```
Adjusttry <- (1-k)/nmk + (n-1)/nmk*R2
Adjusttry
```

```
##          [,1]
## [1,] 0.6514663
```

coding for t-test (including Var(beta hat) hat and the se.

```
s2 <- crossprod(u3hat, u3hat)/nmk
s2 <- as.numeric(s2)
s <- s2^0.5
s #Residual standard error

## [1] 5.429671
VCOV <- s2*solve(crossprod(X3,X3))
var <- diag(VCOV)

se <- var^0.5
se #Std. Error

##               crime          nitox          rooms          age          dist
## 5.365948055 0.036488720 4.160741151 0.392386610 0.014101810 0.200146828
##      access          tax          ptratio
## 0.072276042 0.003770155 0.139415353
```

coding for t-test(t-ratio and p-vlaue)

```
tratio <- betahat3/se
tratio

##           [,1]
##           5.293875
## crime -5.027554
## nitox -5.482408
## rooms 16.237844
## age -3.386083
## dist -6.671449
## access 3.767252
## tax -3.339939
## ptratio -8.440868

pvt <- 2*pt(-abs(tratio), df=nmk)
pvt

##           [,1]
##           1.800579e-07
## crime 6.946703e-07
## nitox 6.685498e-08
## rooms 7.073223e-48
## age 7.651452e-04
## dist 6.770208e-11
## access 1.848352e-04
## tax 9.009665e-04
## ptratio 3.470529e-16
```

combine the infos above

```
final <- cbind(betahat3,se,tratio,pvt)
colnames(final) <- c("Estimate","Std. Error","t value","Pr(>|t|)")
rownames(final) <- c("intercept","crime","nitox","rooms","age","dist","access","tax","ptratio")
final <- round(final,digits=5)
final
```

```
##           Estimate Std. Error  t value Pr(>|t|)
## intercept  28.40666    5.36595   5.29387  0.00000
## crime     -0.18345    0.03649  -5.02755  0.00000
## nitox     -22.81088    4.16074  -5.48241  0.00000
## rooms      6.37151    0.39239  16.23784  0.00000
## age       -0.04775    0.01410  -3.38608  0.00077
## dist      -1.33527    0.20015  -6.67145  0.00000
## access     0.27228    0.07228   3.76725  0.00018
## tax       -0.01259    0.00377  -3.33994  0.00090
## ptratio   -1.17679    0.13942  -8.44087  0.00000
```

coding for F-test

```
q <- ncol(X3)-1
q #

## [1] 8

# R
colvector <- matrix(0:0,q)
unitvector <- diag(q)

R <- cbind(colvector, unitvector)
#R 8 by 9

r <- matrix(0:0,q)

Rbetahat3mr <- R%*%betahat3-r

F3 <- t(Rbetahat3mr)%*%solve(R%*% VCOV %*%t(R))%*%Rbetahat3mr/q
F3

##           [,1]
## [1,] 118.9909

pvF <- 1- pf(F3, df1=q, df2=nmk)
pvF

##           [,1]
## [1,] 0
```