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Praktikum 4

ANALISIS REGRESI SEDERHANA DAN BERGANDA

DESKRIPSI MODUL : Melakukan pemodelan linier sederhana dan berganda.

No	Elemen Kompetensi	Indikator Kinerja	Jml Jam	hlm
1	Mampu melakukan pemodelan linier sederhana dan berganda.	Dapat melakukan pemodelan linier sederhana dan berganda.	2	

TEORI SINGKAT

Dalam praktikum ini akan dipelajari dan dipraktekkan bagaimana melakukan pemodelan linier sederhana dan berganda dengan menggunakan library sebagai berikut :

```
> library(olsrr)
> library(car)
> library(lmtest)
> library(ggpubr)
```

Regresi Linier Sederhana

Pada regresi linier akan dibicarakan masalah pendugaan atau peramalan sebuah variabel dependen Y dengan sebuah variabel independen X yang telah diketahui nilainya. Model persamaan linier yang digunakan di sini adalah : $\hat{y} = a + bx$.

Nilai a dan b dapat diperoleh dari rumus :

$$b = \frac{n\sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{n\sum_{i=1}^{n} x_i - \left(\sum_{i=1}^{n} x_i\right)^2}$$

dan

$$a = \bar{y} - b\bar{x}$$

LAB SETUP

Untuk dapat menjalankan praktikum ini maka yang harus disiapkan adalah :

1. Aplikasi RStudio
2. Xampp

ELEMEN KOMPETENSI I

Deskripsi : Dapat melakukan pemodelan linier sederhana dan berganda.

Kompetensi Dasar : Mampu melakukan pemodelan linier sederhana dan berganda.

PRAKTIKUM

Dalam praktikum ini akan dipelajari dan dipraktekkan bagaimana melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data houseprices, directmarketing, dan mtcars.

Data latihan : Houseprices.csv

```
> library(RMySQL)
> con = dbConnect(MySQL(), user = 'root', password = '', dbname =
+                 'houseprices', host = 'localhost')
> myQuery <- "select * from tabel1;"
> df <- dbGetQuery(con, myQuery)
> View(df)
>  relasi = lm(df$Price ~ df$SqFt)
>  relasi
```

OUTPUT

```
> con = dbConnect(MySQL(), user = 'root', password = '', dbname = 'houseprices', host = 'localhost')
> myQuery <- "select * from houseprices_1;"
> df <- dbGetQuery(con, myQuery)
> View(df)
> relasi = lm(df$Price ~ df$SqFt)
> relasi

Call:
lm(formula = df$Price ~ df$SqFt)

Coefficients:
(Intercept)       df$SqFt
  -10197.29         70.27
```

Data latihan : DirectMarketing.csv

```
> library(RMySQL)
> con = dbConnect(MySQL(), user = 'root', password = '', dbname =
+                 'directmarketing', host = 'localhost')
> myQuery <- "select * from tabel1;"
> DirectMarketing <- dbGetQuery(con, myQuery)
> View(DirectMarketin)
>  regresi = lm (DirectMarketing$AmountSpent ~ DirectMarketing$Salary)
>  regresi
```

OUTPUT

```
> con = dbConnect(MySQL(), user = 'root', password = '', dbname = 'houseprices', host = 'localhost')
> myQuery <- "select * from market_1;"
> DirectMarketing <- dbGetQuery(con, myQuery)
> regresi = lm (DirectMarketing$AmountSpent ~ DirectMarketing$Salary)
> regresi

Call:
lm(formula = DirectMarketing$AmountSpent ~ DirectMarketing$Salary)

Coefficients:
           (Intercept)  DirectMarketing$Salary
             -15.31783                 0.02196
```

> summary(regresi)

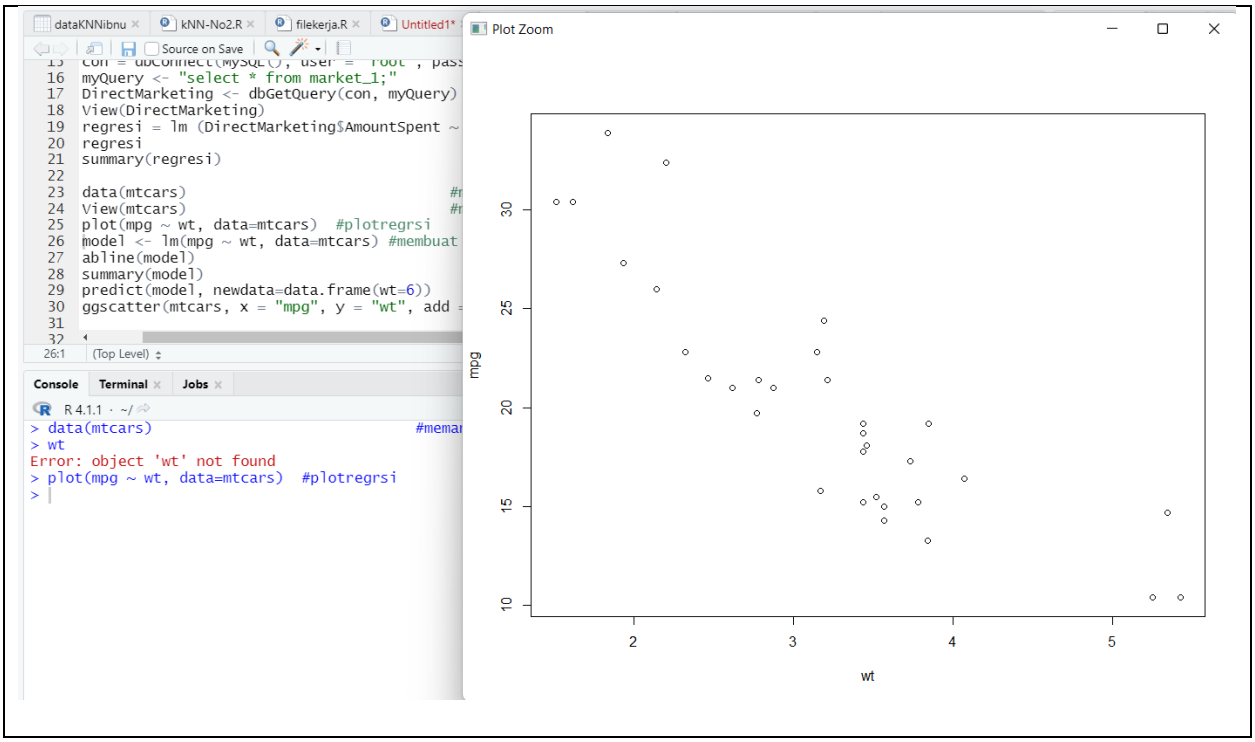
OUTPUT

```
> summary(regresi)

Call:
lm(formula = DirectMarketing$AmountSpent ~ DirectMarketing$Salary)

Residuals:
    Min      1Q  Median      3Q     Max
-2179.7  -315.2   -53.5   279.7  3752.9

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)            -15.31783   45.37416  -0.338    0.736
DirectMarketing$Salary   0.02196    0.00071  30.930   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 687.1 on 998 degrees of freedom
Multiple R-squared:  0.4894,    Adjusted R-squared:  0.4889
F-statistic: 956.7 on 1 and 998 DF,  p-value: < 2.2e-16
```

Data latihan : mtcars.csv

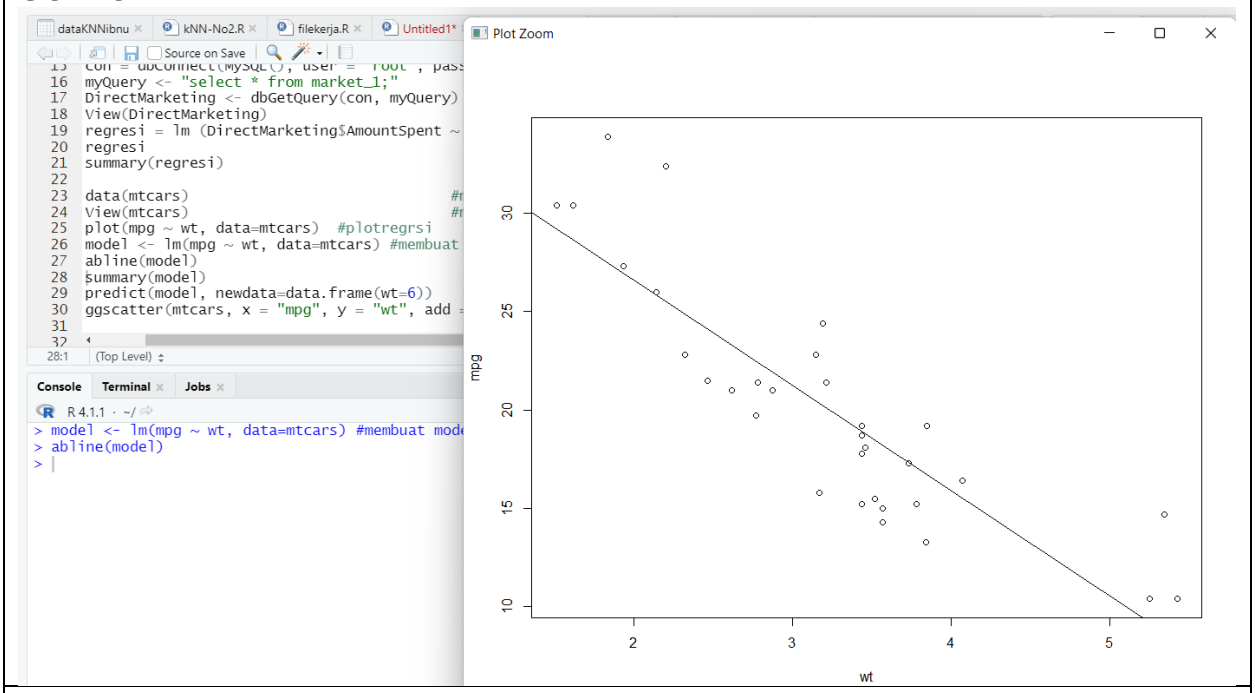
```
>data(mtcars)                    #memanggil data mtcars
>View(mtcars)                    #melihat data mtcars
> plot(mpg ~ wt, data=mtcars)  # membuat plot regresi
```

OUTPUT



> model <- lm(mpg ~ wt, data=mtcars) #membuat model regresi
> abline(model) # membuat garis pada plot regresi

OUTPUT



> summary(model) #melihat model regresi

OUTPUT

```
> summary(model)

Call:
lm(formula = mpg ~ wt, data = mtcars)

Residuals:
    Min      1Q  Median      3Q     Max
-4.5432 -2.3647 -0.1252  1.4096  6.8727

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  37.2851     1.8776  19.858  < 2e-16 ***
wt           -5.3445     0.5591  -9.559 1.29e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.046 on 30 degrees of freedom
Multiple R-squared:  0.7528,    Adjusted R-squared:  0.7446
F-statistic: 91.38 on 1 and 30 DF,  p-value: 1.294e-10
```

$$b_0 = 37.285 \qquad b_1 = -5.345$$

$$y = 37.285 + (-5.345)x$$

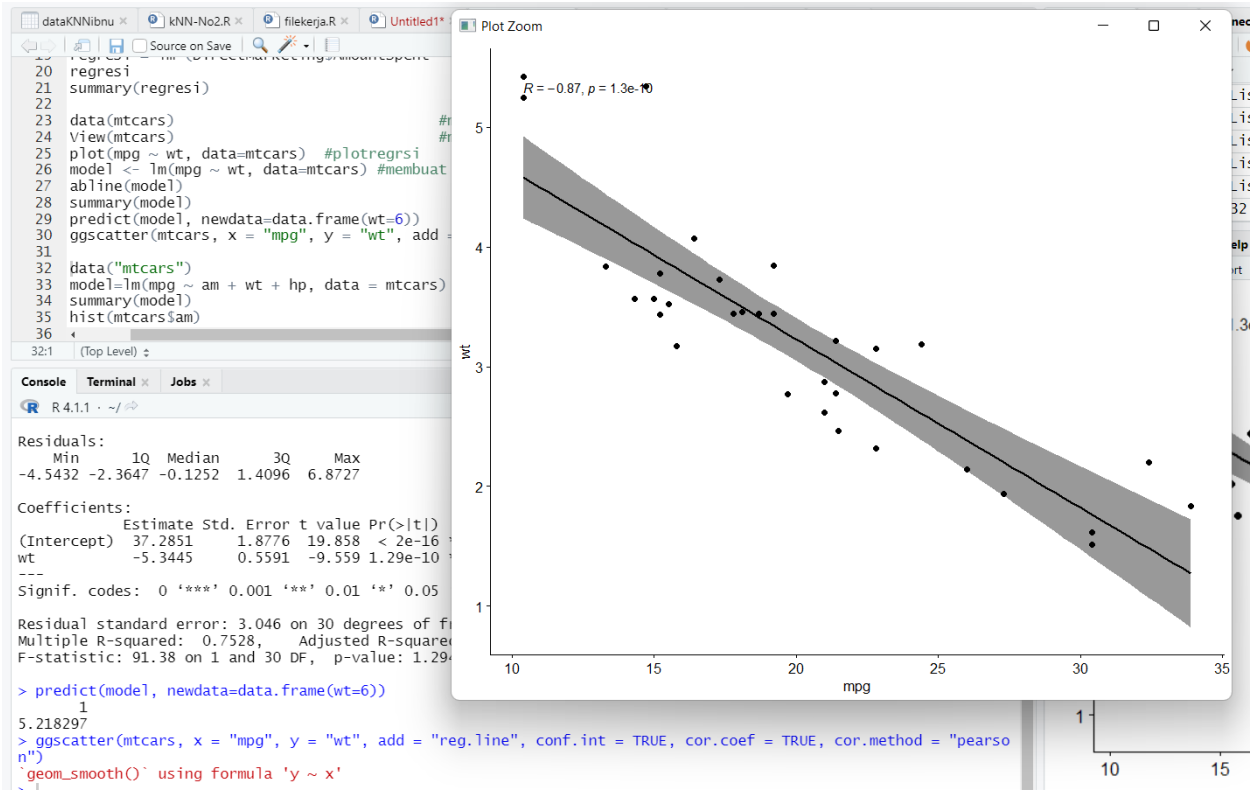
```
> predict(model, newdata=data.frame(wt=6)) #misalkan nilai wt adalah 6 maka hasil prediksinya adalah
```

OUTPUT

```
> predict(model, newdata = data.frame(wt=6))
    1
5.218297
```

```
> ggscatter(mtcars, x = "mpg", y = "wt",
        add = "reg.line", conf.int = TRUE,
        cor.coef = TRUE, cor.method = "pearson")
```

OUTPUT



Regresi Linier Berganda

Jika variabel dependen-nya dihubungkan dengan lebih dari satu variabel independen, maka persamaan yang dihasilkan adalah persamaanregresi linier berganda (*multiple linier regression*). Dalam hal ini kita membatasi pada kasus dua peubah bebas X_1 dan X_2 saja. Dengan hanya dua peubah bebas, persamaan regresi contohnya menjadi :

$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2$$

Salah satu ukuran kebaikan model adalah dengan melihat koefisien determinasi R^2 yang menyatakan proporsi keragaman variabel Y yang dapat dijelaskan oleh variabel X. Namun penggunaan yang lebih baik adalah dengan menggunakan nilai **R-Sq(adj)**, yang merupakan nilai estimasi yang tidak bias (*unbiased estimate*) dari populasi.

```
> data("mtcars")
> model=lm(mpg ~ am + wt + hp, data = mtcars)
> summary(model)
```

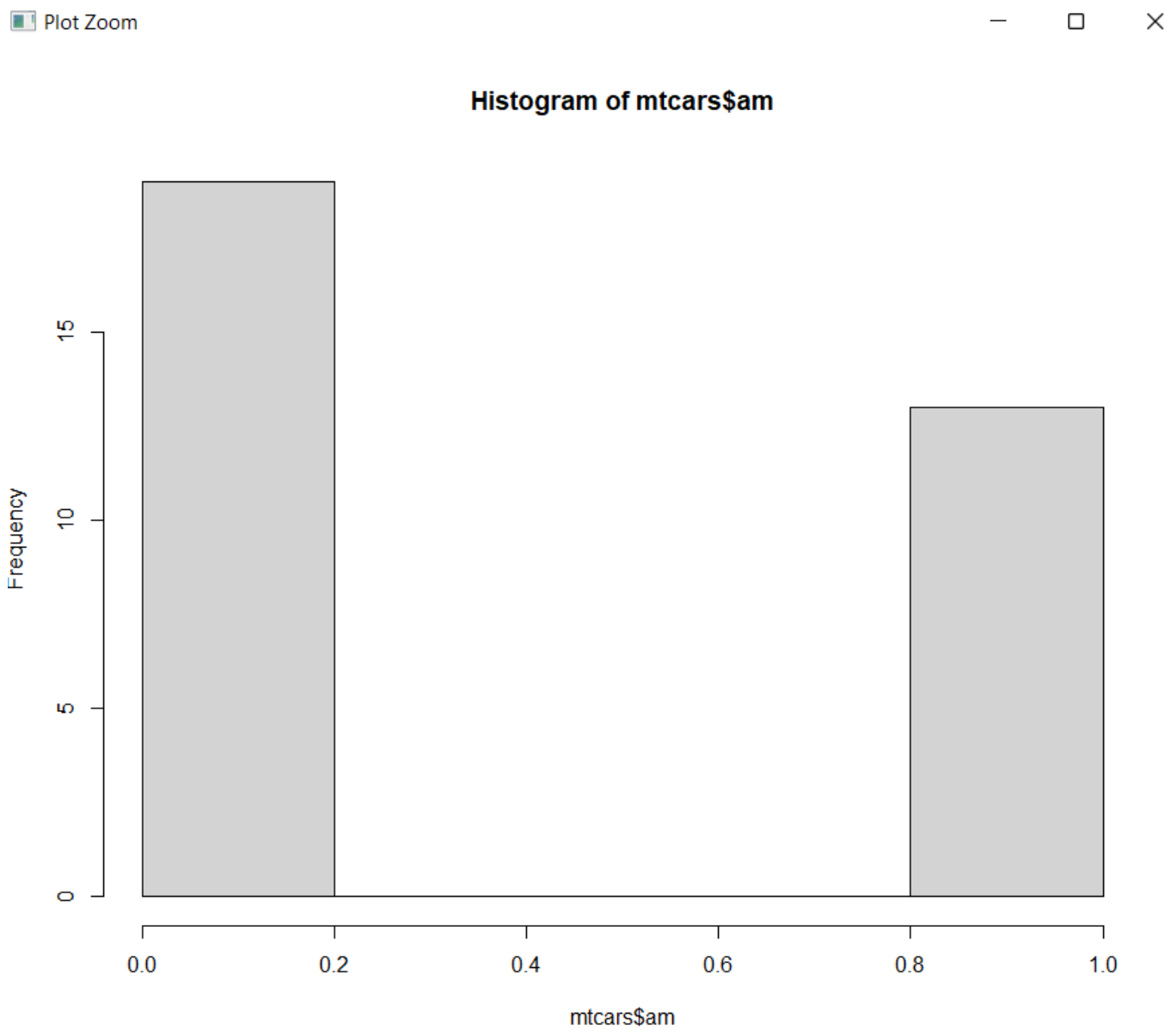
OUTPUT

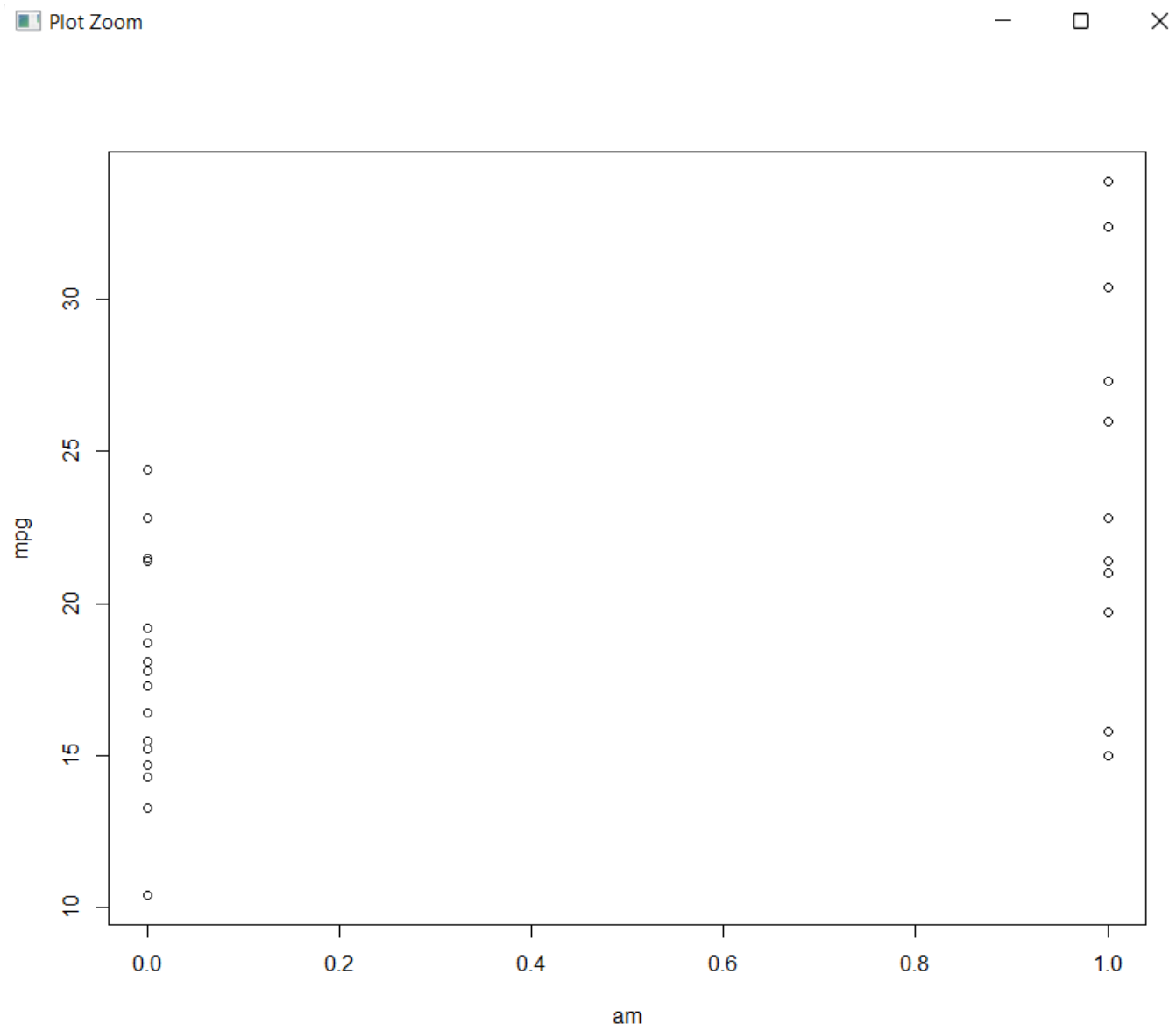
```
> data("mtcars")
> model=lm(mpg ~ am + wt + hp, data = mtcars)
> summary(model)

Call:
lm(formula = mpg ~ am + wt + hp, data = mtcars)

Residuals:
    Min      1Q  Median      3Q     Max
-3.4221 -1.7924 -0.3788  1.2249  5.5317

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 34.002875   2.642659  12.867 2.82e-13 ***
am           2.083710   1.376420   1.514 0.141268
wt          -2.878575   0.904971  -3.181 0.003574 **
hp          -0.037479   0.009605  -3.902 0.000546 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.538 on 28 degrees of freedom
Multiple R-squared:  0.8399,    Adjusted R-squared:  0.8227
F-statistic: 48.96 on 3 and 28 DF,  p-value: 2.908e-11
```

Pada output diatas tedapat variabel yang tidak signifikan…maka variabel tersebut jangan langsung dibuang. Lakukanlah explorasi data.

```
> hist(mtcars$am)
> plot(mpg~am,data=mtcars)
```

OUTPUT


Plot Zoom
Histogram of mtcars$am
Frequency
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0
mtcars$am



Melihat Korelasi Antar Variabel

```
> dataku=mtcars[,c(1,4,6,9)]
> cor(dataku,method = "pearson")
```

OUTPUT

```
> cor(dataku,method = "pearson")
           mpg         hp         wt         am
mpg  1.0000000 -0.7761684 -0.8676594  0.5998324
hp  -0.7761684  1.0000000  0.6587479 -0.2432043
wt  -0.8676594  0.6587479  1.0000000 -0.6924953
am   0.5998324 -0.2432043 -0.6924953  1.0000000
>
```

```
> ols_correlations(model)
```

OUTPUT

```
> ols_correlations(model)
               Correlations
-----------------------------------------
Variable    Zero Order    Partial     Part
-----------------------------------------
am               0.600      0.275    0.114
wt              -0.868     -0.515   -0.241
hp              -0.776     -0.593   -0.295
-----------------------------------------
> |
```

Zero Order

Pearson correlation coefficient between the dependent variable and the independent variables.

Part

Unique contribution of independent variables. How much R2R2 will decrease if that variable is removed from the model?

Partial

How much of the variance in **Y**, which is not estimated by the other independent variables in the model, is estimated by the specific variable?

ELEMEN KOMPETENSI II

Deskripsi : Dapat melakukan pemodelan linier sederhana dan berganda.

Kompetensi Dasar : Mampu melakukan pemodelan linier sederhana dan berganda.

TUGAS

Dalam praktikum ini akan dipelajari dan dipraktekkan bagaimana melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data advertising.

Data is about advertising data sales (in thousands of units) for a particular product advertising budgets (in thousands of dollars) for TV, radio, and newspaper media. On the basis of this data, suggest a marketing plan for next year that will result in high product sales using regression analysis.

https://rstudio-pubs
static.s3.amazonaws.com/249959_d71491a56f8242909331dfee0e25b813.html

LINEAR REGRESSION

```
> library(MASS)
> library(ISLR)
> library(RMySQL)
> con = dbConnect(MySQL(), user = 'root', password = '', dbname =
+                                  'Advertising', host = 'localhost')
>
> myQuery <- "select * from tabel1;"
> Advertising <- dbGetQuery(con, myQuery)
> head(Advertising)
```

OUTPUT

```
> head(Advertising)
     TV Radio Newspaper Sales
1 230.1  37.8      69.2  22.1
2  44.5  39.3      45.1  10.4
3  17.2  45.9      69.3  12.0
4 151.5  41.3      58.5  16.5
5 180.8  10.8      58.4  17.9
6   8.7  48.9      75.0   7.2
```

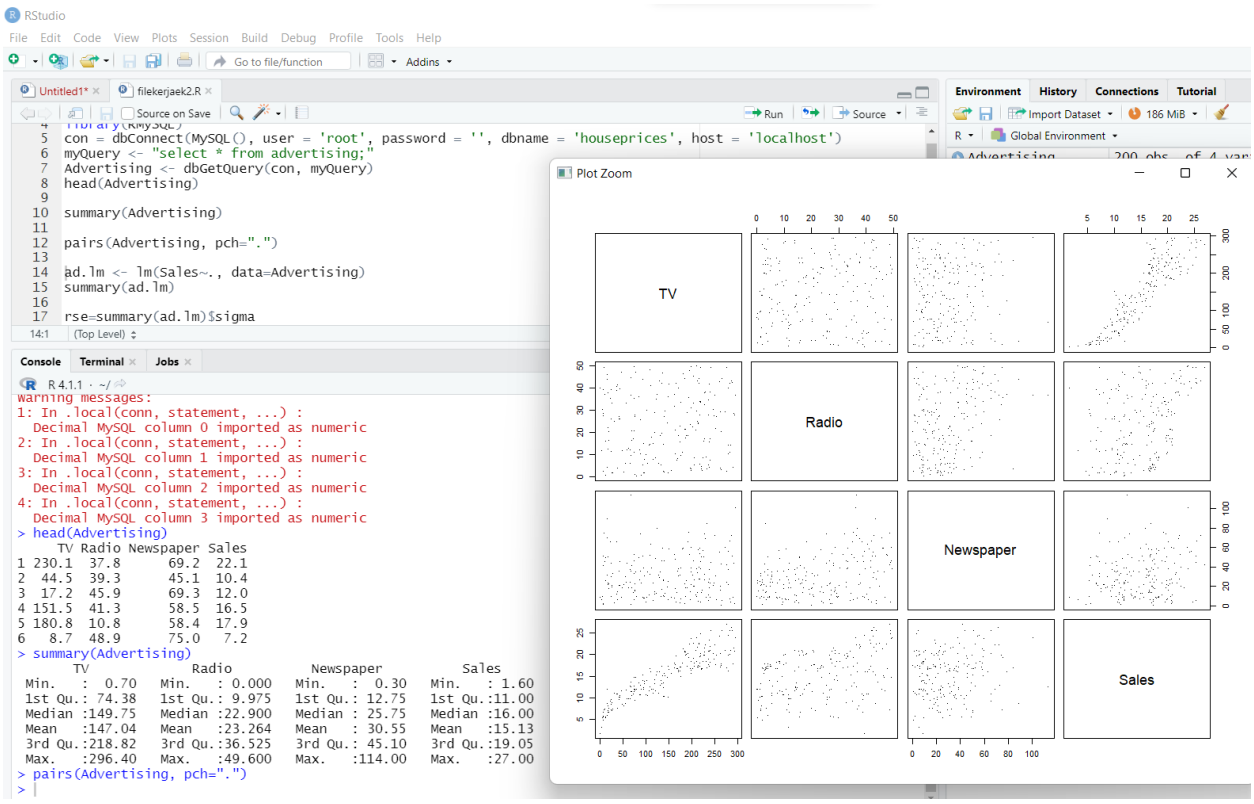
```
> summary(Advertising)
```

OUTPUT

```
> summary(Advertising)
       TV              Radio          Newspaper          Sales
 Min.   :  0.70   Min.   : 0.000   Min.   :  0.30   Min.   : 1.60
 1st Qu.: 74.38   1st Qu.: 9.975   1st Qu.: 12.75   1st Qu.:11.00
 Median :149.75   Median :22.900   Median : 25.75   Median :16.00
 Mean   :147.04   Mean   :23.264   Mean   : 30.55   Mean   :15.13
 3rd Qu.:218.82   3rd Qu.:36.525   3rd Qu.: 45.10   3rd Qu.:19.05
 Max.   :296.40   Max.   :49.600   Max.   :114.00   Max.   :27.00
>
```

```
> pairs(Advertising, pch=".")
```

OUTPUT



IS THERE A RELATIONSHIP BETWEEN ADVERTISING SALES AND BUDGET?

> ad.lm <- lm(sales~., data=Advertising)
> summary(ad.lm)

OUTPUT

```
> summary(ad.lm)

Call:
lm(formula = Sales ~ ., data = Advertising)

Residuals:
    Min      1Q  Median      3Q     Max
-7.3034 -0.8244 -0.0008  0.8976  3.7473

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 4.6251241  0.3075012  15.041   <2e-16 ***
TV          0.0544458  0.0013752  39.592   <2e-16 ***
Radio       0.1070012  0.0084896  12.604   <2e-16 ***
Newspaper   0.0003357  0.0057881   0.058    0.954
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.662 on 196 degrees of freedom
Multiple R-squared:  0.9026,    Adjusted R-squared:  0.9011
F-statistic: 605.4 on 3 and 196 DF,  p-value: < 2.2e-16
```

HOW STRONG IS THE RELATIONSHIP?

```
> rse=summary(ad.lm)$sigma
>
> #RSE= 1.686
> mean(Advertising$sales)
```

OUTPUT

```
> rse=summary(ad.lm)$sigma
> #RSE= 1.686
> mean(Advertising$Sales)
[1] 15.1305
>
```

```
> rse/mean(Advertising$sales)
```

```
> rse/mean(Advertising$Sales)
[1] 0.1098242
>
```

OUTPUT

[1] 0.1098242

```
> rsq=summary(ad.lm)$r.sq
> rsq #0.8972106
```

OUTPUT

[1] 0.9025913

```
> rsq=summary(ad.lm)$r.sq
> rsq #0.8972106
[1] 0.9025913
>
```

```
> # rsq is calculated by the following formuala
> yhat=ad.lm$fitted.values #predicted
> y=Advertising$Sales #observed
> rsq=1-sum((y-yhat)^2)/sum((y-mean(y))^2) #orginal formula
Warning message:
In mean.default(y) : argument is not numeric or logical: returning NA
>
>
> #Other way to get R2
> var(yhat)/var(y) #other formula
Error in var(y) : 'x' is NULL
> # rsq is calculated by the following formuala
> yhat=ad.lm$fitted.values #predicted
> y=Advertising$sales #observed
> rsq=1-sum((y-yhat)^2)/sum((y-mean(y))^2) #orginal formula
>
>
> #Other way to get R2
> var(yhat)/var(y) #other formula
```

OUTPUT

```
> # rsq is calculated by the following formuala
> yhat=ad.lm$fitted.values #predicted
> y=Advertising$Sales #observed
> rsq=1-sum((y-yhat)^2)/sum((y-mean(y))^2) #orginal formula
> #Other way to get R2
> var(yhat)/var(y) #other formula
[1] 0.9025913
```

```
> 1-sum((y-yhat)^2)/sum((y-mean(y))^2) #orginal formula
```

OUTPUT

...

```
> cor(yhat,y)^2 #alternate formula
```

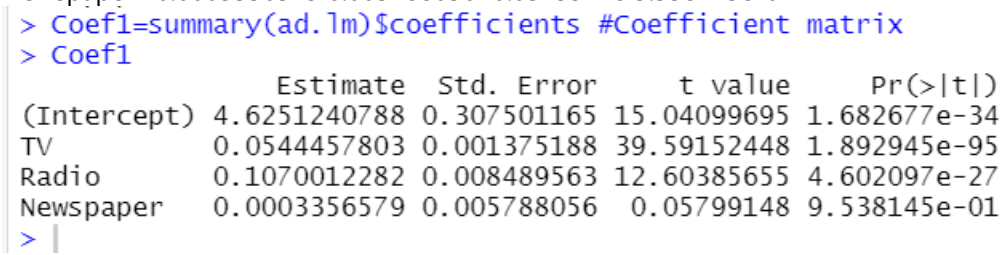
OUTPUT

…

```
> Coef1=summary(ad.lm)$coefficients #Coefficient matrix
> Coef1
```

OUTPUT

```
             Estimate  Std. Error     t value     Pr(>|t|)
(Intercept) 4.6251240788 0.307501165 15.04099695 1.682677e-34
TV          0.0544457803 0.001375188 39.59152448 1.892945e-95
Radio       0.1070012282 0.008489563 12.60385655 4.602097e-27
Newspaper   0.0003356579 0.005788056  0.05799148 9.538145e-01
```

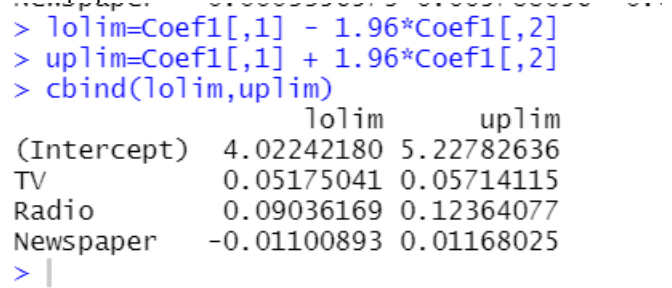


How large is the effect of each medium on sales?

```
> lolim=Coef1[,1] - 1.96*Coef1[,2]
> uplim=Coef1[,1] + 1.96*Coef1[,2]
> cbind(lolim,uplim)
```

OUTPUT

```
               lolim      uplim
(Intercept)  4.02242180 5.22782636
TV           0.05175041 0.05714115
Radio        0.09036169 0.12364077
Newspaper   -0.01100893 0.01168025
```




```
> confint(ad.lm)
```

OUTPUT

```
                2.5 %     97.5 %
```

(Intercept) 4.01868836 5.23155980
TV 0.05173372 0.05715784
Radio 0.09025861 0.12374384
Newspaper -0.01107921 0.01175052

```
> confint(ad.lm)
                  2.5 %     97.5 %
(Intercept)  4.01868836 5.23155980
TV           0.05173372 0.05715784
Radio        0.09025861 0.12374384
Newspaper   -0.01107921 0.01175052
> 
```

```
> require(car)
Loading required package: car
Loading required package: carData

Attaching package: 'car'

The following object is masked from 'package:arules':

    recode

Warning messages:
1: package 'car' was built under R version 3.4.4
2: package 'carData' was built under R version 3.4.4
> vif(ad.lm)
```

output

```
      TV    Radio Newspaper
1.004611 1.144952  1.145187
```

HOW ACCURATELY CAN WE PREDICT FUTURE SALES?

```
> #for the  average  response f(X)
> predict(ad.lm, newdata=data.frame(TV=149,radio=22,newspaper=25),
+         interval="confidence")
```

OUTPUT

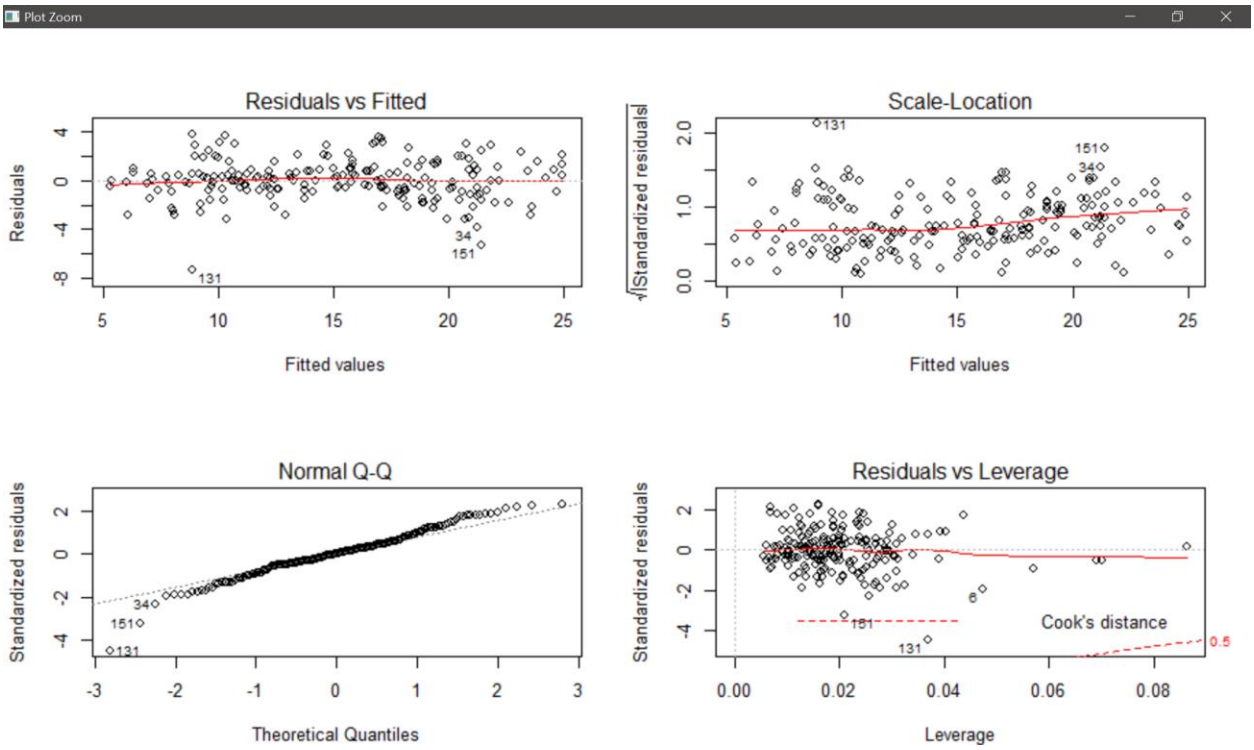
```
      fit     lwr     upr
1 15.09996 14.86063 15.3393
```

```
> predict(ad.lm, newdata=data.frame(TV=149,Radio=22,Newspaper=25),interval="confidence")
       fit      lwr      upr
1 15.09996 14.86063 15.3393
> 
```

Is the relationship linear?

> plot(ad.lm) #diagnostic plot

OUTPUT



Is there synergy among the advertising media?

> ad.lm2 <- lm(sales~.^2, data=Advertising)
> summary(ad.lm2)

```
> ad.lm2 <- lm(Sales~.^2, data=Advertising)
> summary(ad.lm2)

Call:
lm(formula = Sales ~ .^2, data = Advertising)

Residuals:
    Min      1Q  Median      3Q     Max
-5.9705 -0.8885 -0.0305  1.0222  3.6491

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      6.265e+00  5.307e-01  11.805  < 2e-16 ***
TV               4.438e-02  2.689e-03  16.506  < 2e-16 ***
Radio            2.953e-02  1.908e-02   1.548    0.123
Newspaper       -5.919e-04  1.683e-02  -0.035    0.972
TV:Radio         4.658e-04  9.553e-05   4.876 2.26e-06 ***
TV:Newspaper    -4.112e-05  5.981e-05  -0.688    0.493
Radio:Newspaper  2.832e-04  3.949e-04   0.717    0.474
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.568 on 193 degrees of freedom
Multiple R-squared:  0.9146,    Adjusted R-squared:  0.9119
F-statistic: 344.4 on 6 and 193 DF,  p-value: < 2.2e-16
```

OUTPUT


```
> ad.lm2 <- lm(Sales~.^2, data=Advertising)
> summary(ad.lm2)

Call:
lm(formula = Sales ~ .^2, data = Advertising)

Residuals:
    Min      1Q  Median      3Q     Max
-5.9705 -0.8885 -0.0305  1.0222  3.6491

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      6.265e+00  5.307e-01  11.805  < 2e-16 ***
TV               4.438e-02  2.689e-03  16.506  < 2e-16 ***
Radio            2.953e-02  1.908e-02   1.548    0.123
Newspaper       -5.919e-04  1.683e-02  -0.035    0.972
TV:Radio         4.658e-04  9.553e-05   4.876 2.26e-06 ***
TV:Newspaper    -4.112e-05  5.981e-05  -0.688    0.493
Radio:Newspaper  2.832e-04  3.949e-04   0.717    0.474
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.568 on 193 degrees of freedom
Multiple R-squared:  0.9146,    Adjusted R-squared:  0.9119
F-statistic: 344.4 on 6 and 193 DF,  p-value: < 2.2e-16
```


the Advertising data may not be additive.

> summary(ad.lm2)$r.sq;summary(ad.lm)$r.sq

OUTPUT

[1] 0.914582
[1] 0.9025913

```
> summary(ad.lm2)$r.sq;summary(ad.lm)$r.sq
[1] 0.914582
[1] 0.9025913
>
```

NON-LINEAR TRANSFORMATIONS OF THE PREDICTORS

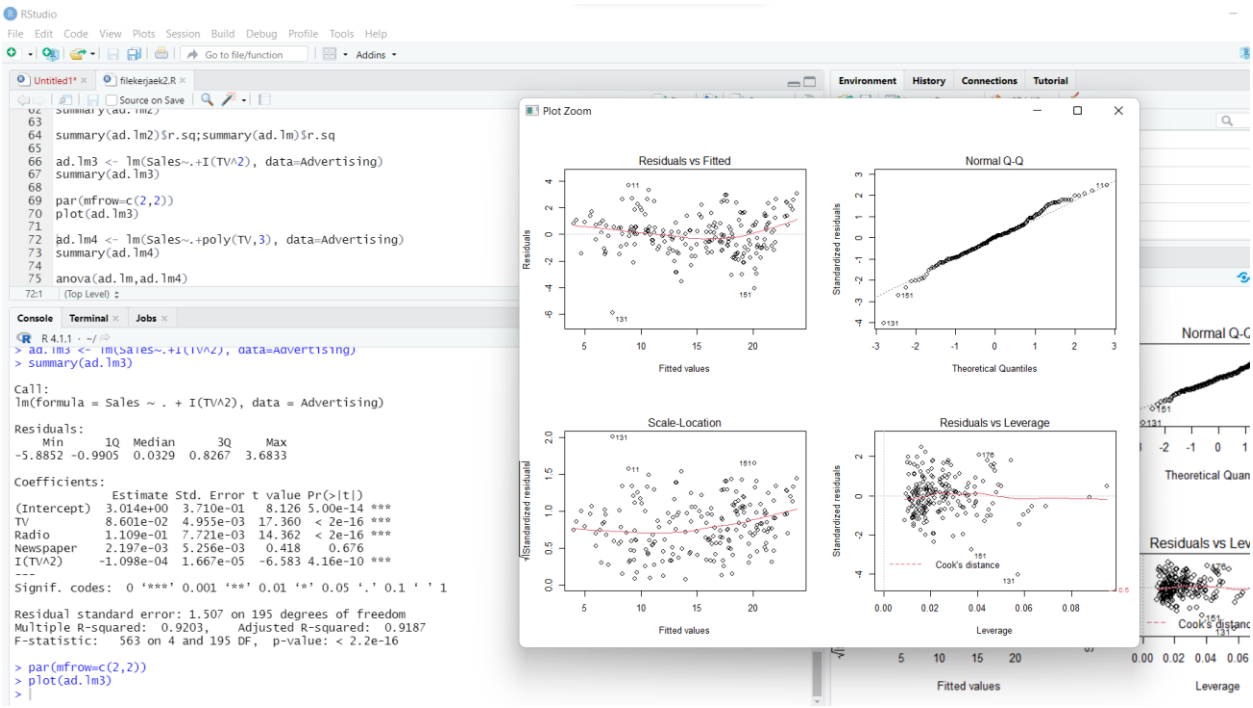
> ad.lm3 <- lm(sales~.+I(TV^2), data=Advertising)
> summary(ad.lm3)

OUTPUT

```
> ad.lm3 <- lm(Sales~.+I(TV^2), data=Advertising)
> summary(ad.lm3)

Call:
lm(formula = Sales ~ . + I(TV^2), data = Advertising)

Residuals:
    Min      1Q  Median      3Q     Max
-5.8852 -0.9905  0.0329  0.8267  3.6833

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.014e+00  3.710e-01   8.126 5.00e-14 ***
TV           8.601e-02  4.955e-03  17.360  < 2e-16 ***
Radio        1.109e-01  7.721e-03  14.362  < 2e-16 ***
Newspaper    2.197e-03  5.256e-03   0.418    0.676
I(TV^2)     -1.098e-04  1.667e-05  -6.583 4.16e-10 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.507 on 195 degrees of freedom
Multiple R-squared:  0.9203,    Adjusted R-squared:  0.9187
F-statistic:   563 on 4 and 195 DF,  p-value: < 2.2e-16
```

> par(mfrow=c(2,2))
> plot(ad.lm3)

OUTPUT




```
> ad.lm4 <- lm(sales~.+poly(TV,3), data=Advertising)
> summary(ad.lm4)
```

OUTPUT

```
> ad.lm4 <- lm(Sales~.+poly(TV,3), data=Advertising)
> summary(ad.lm4)

Call:
lm(formula = Sales ~ . + poly(TV, 3), data = Advertising)

Residuals:
     Min       1Q   Median       3Q      Max
-5.5485 -0.9573 -0.0582  0.9481  3.5291

Coefficients: (1 not defined because of singularities)
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   4.474604   0.279054  16.035  < 2e-16 ***
TV            0.054377   0.001244  43.716  < 2e-16 ***
Radio         0.111927   0.007736  14.469  < 2e-16 ***
Newspaper     0.001840   0.005249   0.351    0.726
poly(TV, 3)1        NA         NA      NA       NA
poly(TV, 3)2 -9.999065   1.513028  -6.609 3.65e-10 ***
poly(TV, 3)3  2.142519   1.509865   1.419    0.157
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.503 on 194 degrees of freedom
Multiple R-squared:  0.9211,    Adjusted R-squared:  0.9191
F-statistic: 453.1 on 5 and 194 DF,  p-value: < 2.2e-16
```

> anova(ad.lm,ad.lm4)

OUTPUT

Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
  Res.Df   RSS Df Sum of Sq   F   Pr(>F)
1   196 541.20
2   194 438.24 2   102.96 22.79 1.289e-09 ***

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

```
> anova(ad.lm,ad.lm4)
Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
  Res.Df    RSS Df Sum of Sq     F    Pr(>F)
1    196 541.20
2    194 438.24  2    102.96 22.79 1.289e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

> anova(ad.lm3,ad.lm4)

OUTPUT

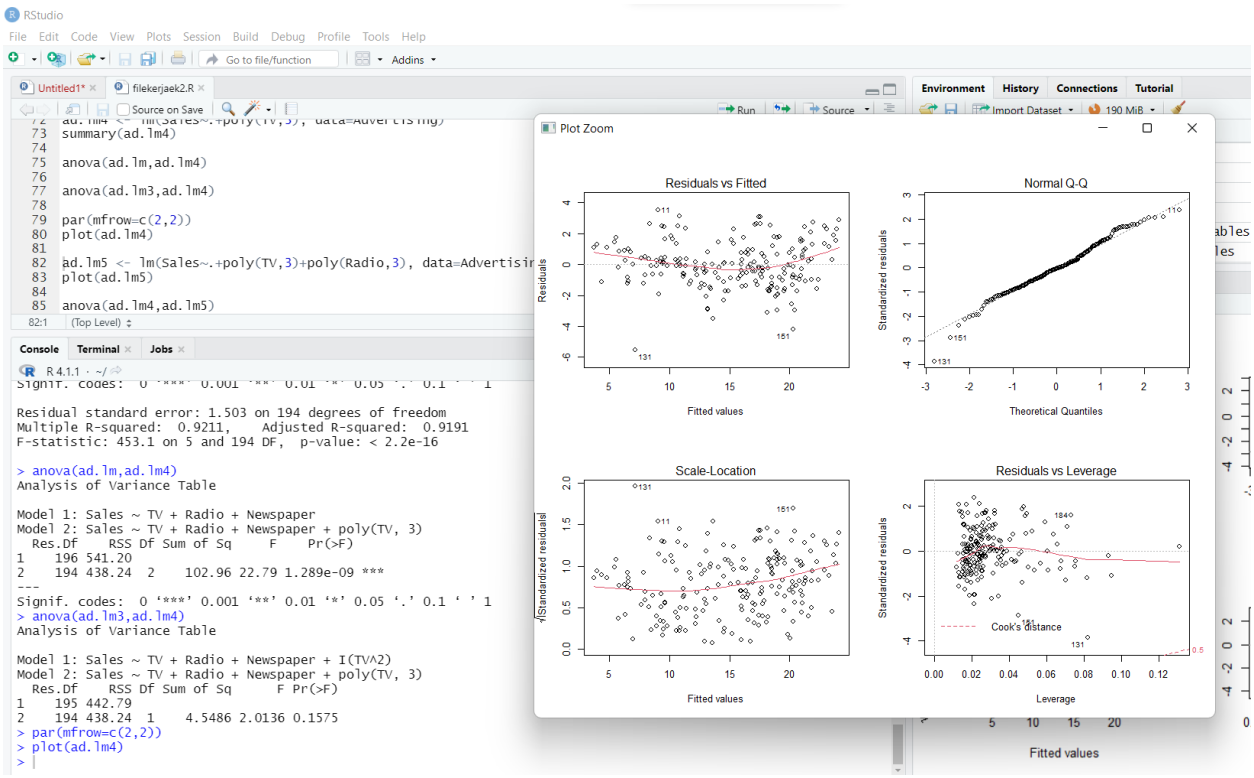
Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper + I(TV^2)
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
  Res.Df   RSS Df Sum of Sq   F Pr(>F)
1   195 442.79
2   194 438.24 1   4.5486 2.0136 0.1575

```
> anova(ad.lm3,ad.lm4)
Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper + I(TV^2)
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
  Res.Df    RSS Df Sum of Sq      F Pr(>F)
1    195 442.79
2    194 438.24  1    4.5486 2.0136 0.1575
>
```

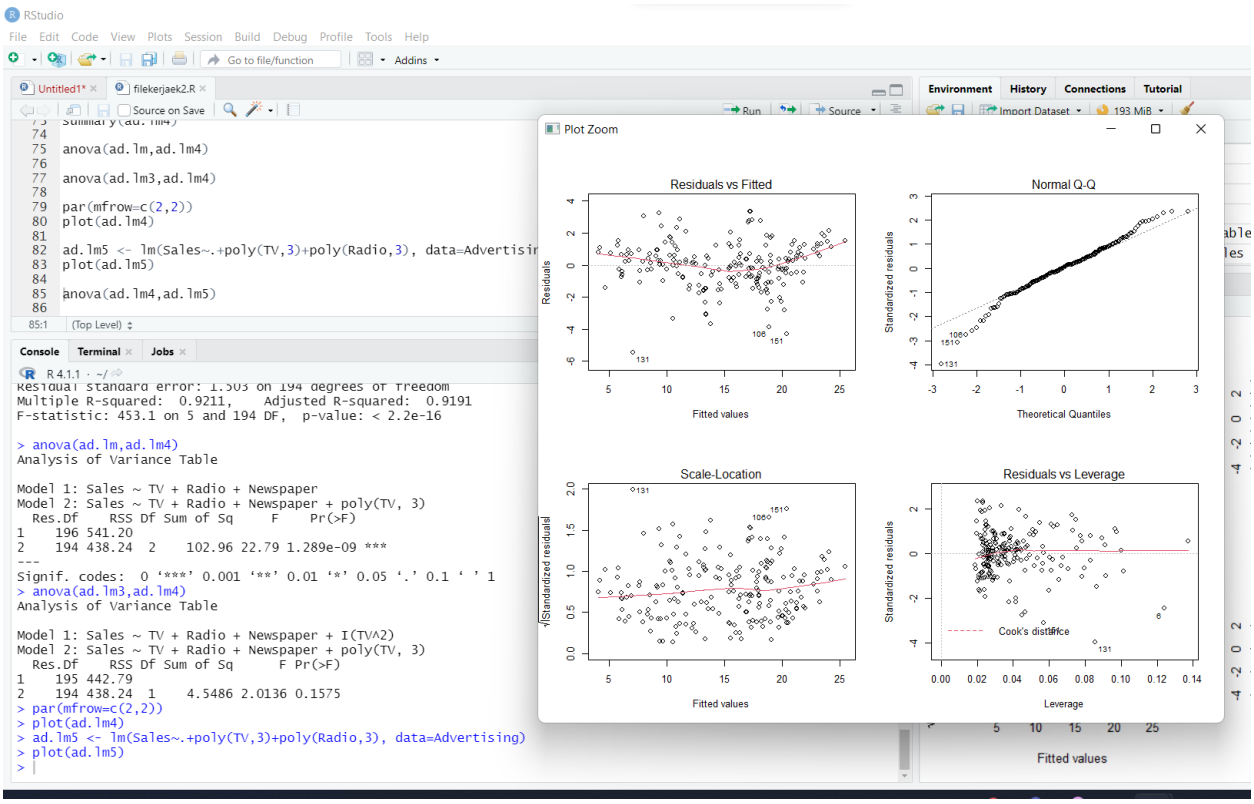
> par(mfrow=c(2,2))
> plot(ad.lm4)

OUTPUT




```
> ad.lm5 <- lm(sales~.+poly(TV,3)+poly(radio,3), data=Advertising)
> plot(ad.lm5)
```

OUTPUT



> anova(ad.lm4,ad.lm5)

OUTPUT

Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3) + poly(Radio, 3)
Res.Df RSS Df Sum of Sq F Pr(>F)
1 194 438.24
2 192 398.33 2 39.91 9.6185 0.0001045 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> anova(ad.lm4,ad.lm5)
Analysis of Variance Table

Model 1: Sales ~ TV + Radio + Newspaper + poly(TV, 3)
Model 2: Sales ~ TV + Radio + Newspaper + poly(TV, 3) + poly(Radio, 3)
  Res.Df    RSS Df Sum of Sq      F    Pr(>F)
1    194 438.24
2    192 398.33  2     39.91 9.6185 0.0001045 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
```

Output:

1. **Cek List**

No	Elemen Kompetensi	Penyelesaian	
		Selesai	**Tidak**
1	**Elemen Kompetensi I** Dapat melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data houseprices, directmarketing, dan mtcars.	✓	
2	**Elemen Kompetensi II** Dapat melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data advertising.	✓	

2. **Form Umpan Balik**

Elemen Kompetensi	Waktu Pengerjaan	Kriteria
Elemen Kompetensi I Dapat melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data houseprices, directmarketing, dan mtcars.	30	1
Elemen Kompetensi II Dapat melakukan pemodelan linier sederhana dan berganda menggunakan beberapa library dengan menggunakan data advertising.	30	1

Kriteria

1.Sangat Menarik

2.Cukup Menarik

3.Kurang Menarik

4.Sangat Kurang Menarik