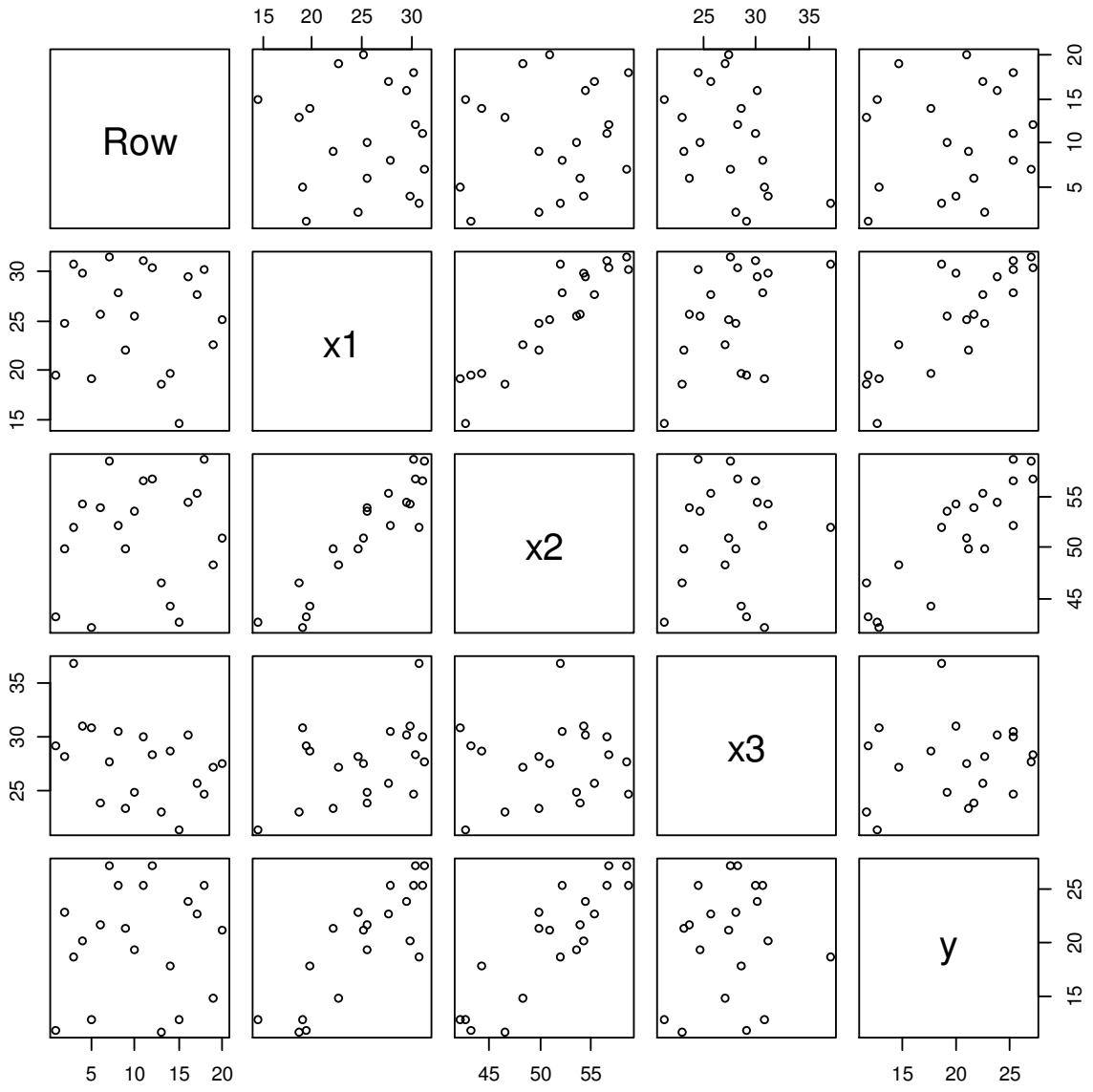
```
# R code for Body fat example p256
fat=read.table("C:/Users/Mihinda/Desktop/bodyfat.txt", header=1)
#the data file
fat
plot(fat)
fit <- lm(y ~ x1 + x2 + x3, data=fat)
summary(fit) # show results
anova(fit)
fit1 <- lm(y ~ x1, data=fat)
anova(fit1)
fit2 <- lm(y ~ x2, data=fat)
anova(fit2)

library(car)

#Partial F tests
anova(fit, fit1)
anova(fit, fit2)
anova(fit2, fit) # which model is 1st doesn't matter

# Type II and Type III SS in R
Anova(lm(y ~ x1 + x2 + x3, data=fat), type="II")
Anova(lm(y ~ x1 + x2 + x3, data=fat), type="III")

#Calculating Type I, Type II and Type III SS
fit1 <- lm(y ~ x1, data=fat)
anova(fit1)

fit12 <- lm(y ~ x1 + x2, data=fat)
anova(fit12)

fit13 <- lm(y ~ x1 + x3, data=fat)
anova(fit13)

fit23 <- lm(y ~ x2 + x3, data=fat)
anova(fit23)

fit123 <- lm(y ~ x1 + x2 + x3, data=fat)
anova(fit)

# Type III SS for intercept
fit0 <- lm(y ~ 0+ x1 + x2 + x3, data=fat) #No intercept model
fit11 <- lm(y ~ 1+ x1 + x2 + x3, data=fat)
anova(fit0)
anova(fit)
anova(fit11)
```

R Output

```
> # R code for Body fat example p256
> fat=read.table("C:/Users/Mihinda/Desktop/bodyfat.txt",
header=1) #the data file
> fat
   Row   x1   x2   x3    y
1    1 19.5 43.1 29.1 11.9
2    2 24.7 49.8 28.2 22.8
3    3 30.7 51.9 37.0 18.7
4    4 29.8 54.3 31.1 20.1
5    5 19.1 42.2 30.9 12.9
6    6 25.6 53.9 23.7 21.7
7    7 31.4 58.5 27.6 27.1
8    8 27.9 52.1 30.6 25.4
9    9 22.1 49.9 23.2 21.3
10  10 25.5 53.5 24.8 19.3
11  11 31.1 56.6 30.0 25.4
12  12 30.4 56.7 28.3 27.2
13  13 18.7 46.5 23.0 11.7
14  14 19.7 44.2 28.6 17.8
15  15 14.6 42.7 21.3 12.8
16  16 29.5 54.4 30.1 23.9
17  17 27.7 55.3 25.7 22.6
18  18 30.2 58.6 24.6 25.4
19  19 22.7 48.2 27.1 14.8
20  20 25.2 51.0 27.5 21.1
> plot(fat)
```




```
> fit <- lm(y ~ x1 + x2 + x3, data=fat)
> summary(fit) # show results

Call:
lm(formula = y ~ x1 + x2 + x3, data = fat)

Residuals:
    Min      1Q  Median      3Q     Max
-3.7263 -1.6111  0.3923  1.4656  4.1277
```

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  117.085     99.782   1.173    0.258
x1             4.334      3.016   1.437    0.170
x2            -2.857      2.582  -1.106    0.285
x3            -2.186      1.595  -1.370    0.190

Residual standard error: 2.48 on 16 degrees of freedom
Multiple R-squared: 0.8014,     Adjusted R-squared:
0.7641
F-statistic: 21.52 on 3 and 16 DF,  p-value: 7.343e-06

> anova(fit)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 57.2768 1.131e-06 ***
x2         1  33.17   33.17  5.3931   0.03373 *
x3         1  11.55   11.55  1.8773   0.18956
Residuals 16  98.40    6.15
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> fit1 <- lm(y ~ x1, data=fat)
> anova(fit1)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27  44.305 3.024e-06 ***
Residuals 18 143.12    7.95
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
> fit2 <- lm(y ~ x2, data=fat)
> anova(fit2)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value  Pr(>F)
x2         1 381.97  381.97  60.617 3.6e-07 ***
Residuals 18 113.42    6.30
```

```
> library(car)
Loading required package: MASS
Loading required package: nnet

> #Partial F tests in R
> anova(fit, fit1)
Analysis of Variance Table

Model 1: y ~ x1 + x2 + x3
Model 2: y ~ x1
  Res.Df     RSS Df Sum of Sq      F  Pr(>F)
1     16  98.405
2     18 143.120 -2   -44.715 3.6352 0.04995 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
> anova(fit, fit2)
Analysis of Variance Table

Model 1: y ~ x1 + x2 + x3
Model 2: y ~ x2
  Res.Df     RSS Df Sum of Sq     F Pr(>F)
1     16  98.405
2     18 113.424 -2   -15.019 1.221  0.321
> anova(fit2, fit) # which model is 1st doesn't matter
Analysis of Variance Table

Model 1: y ~ x2
Model 2: y ~ x1 + x2 + x3
  Res.Df     RSS Df Sum of Sq     F Pr(>F)
1     18 113.424
2     16  98.405  2    15.019 1.221  0.321
>
```

```
# Type II and Type III SS in R
> Anova(lm(y ~ x1 + x2 + x3, data=fat), type="II")
Anova Table (Type II tests)

Response: y
          Sum Sq Df F value Pr(>F)
x1        12.705  1  2.0657 0.1699
x2         7.529  1  1.2242 0.2849
x3        11.546  1  1.8773 0.1896
Residuals 98.405 16


> Anova(lm(y ~ x1 + x2 + x3, data=fat), type="III")
Anova Table (Type III tests)

Response: y
             Sum Sq Df F value Pr(>F)
(Intercept)   8.468  1  1.3769 0.2578
x1           12.705  1  2.0657 0.1699
x2            7.529  1  1.2242 0.2849
x3           11.546  1  1.8773 0.1896
Residuals    98.405 16
>
> fit1 <- lm(y ~ x1, data=fat)
> anova(fit1)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27  44.305 3.024e-06 ***
Residuals 18 143.12    7.95
---
```

```
> fit12 <- lm(y ~ x1 + x2, data=fat)
> anova(fit12)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 54.4661 1.075e-06 ***
x2         1  33.17   33.17  5.1284    0.0369 *
Residuals 17 109.95    6.47
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
>
> fit13 <- lm(y ~ x1 + x3, data=fat)
> anova(fit13)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 56.5312 8.406e-07 ***
x3         1  37.19   37.19  5.9674   0.02579 *
Residuals 17 105.93    6.23
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
>
> fit23 <- lm(y ~ x2 + x3, data=fat)
> anova(fit23)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x2         1 381.97  381.97  58.441 6.737e-07 ***
x3         1   2.31    2.31   0.354    0.5597
Residuals 17 111.11    6.54
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
>
```

```
> fit123 <- lm(y ~ x1 + x2 + x3, data=fat)
> anova(fit)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 57.2768 1.131e-06 ***
x2         1  33.17   33.17  5.3931   0.03373 *
x3         1  11.55   11.55  1.8773   0.18956
Residuals 16  98.40    6.15
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
>
```

```
> # Type III SS for intercept
> fit0 <- lm(y ~ 0+ x1 + x2 + x3, data=fat) #No
intercept model
> fit11 <- lm(y ~ 1+ x1 + x2 + x3, data=fat)
> anova(fit0)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq   F value  Pr(>F)
x1         1 8507.4  8507.4 1353.2510 < 2e-16 ***
x2         1    0.8     0.8    0.1219 0.73125
x3         1   37.1    37.1    5.9007 0.02651 *
Residuals 17  106.9     6.3
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
> anova(fit)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 57.2768 1.131e-06 ***
x2         1  33.17   33.17  5.3931   0.03373 *
x3         1  11.55   11.55  1.8773   0.18956
Residuals 16  98.40    6.15
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
> anova(fit11)
Analysis of Variance Table

Response: y
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 352.27  352.27 57.2768 1.131e-06 ***
x2         1  33.17   33.17  5.3931   0.03373 *
x3         1  11.55   11.55  1.8773   0.18956
Residuals 16  98.40    6.15
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’
0.1 ‘ ’ 1
```

>