# Exercise section 18

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## Answer

ابتدا داده ها را وارد نرم‌افزار می‌کنیم:

At the first we want to input our data to R:

```
s<-factor(rep(1:4 ,each = 15))
v<-factor(rep(c(1:3) ,4 ,each = 5))
y1<-
c(59.3,60.3,60.9,60.6,60.4,59.3,59.4,60.0,58.9,59.5,59.4,60.2,60.7,60.5,60.1,

63.7,64.1,63.4,63.2,63.2,60.6,61.0,60.7,60.6,60.3,63.8,63.2,63.3,63.2,63.1,

68.1,68.0,68.5,68.6,68.6,64.0,63.4,63.5,63.4,63.5,68.0,68.7,68.7,68.4,68.6,

69.8,69.5,69.5,69.9,70.3,66.6,66.5,67.1,65.8,65.6,70.1,72.3,69.7,69.9,69.8)
y2<-
c(4.5,4.5,5.3,5.8,6.0,6.7,4.8,5.1,5.8,4.8,5.1,5.3,6.4,7.1,7.8,5.4,5.4,5.4,5.3
,

5.0,6.8,6.5,6.8,7.1,6.0,5.7,6.1,6.0,5.9,5.4,3.4,2.9,3.3,3.1,3.3,3.6,3.9,3.7,

3.7,4.1,3.7,3.5,3.8,3.5,3.4,1.4,1.3,1.3,1.3,1.1,1.8,1.7,1.7,1.8,1.9,1.7,0.7,
      1.5,1.3,1.4)
y3<-
c(38.4,38.6,37.2,38.1,38.8,37.9,36.6,38.7,37.5,37.0,38.7,37,37.4,37,36.9,39.5
,

39.2,39.0,39,39,38.1,38.6,38.8,38.6,38.5,40.5,40.2,40,40,39.7,42.2,42.4,41.5,

41.9,42.1,10.9,41.4,41.6,41.4,41.1,42.3,41.6,40.7,42.0,41.4,48.4,47.8,46.9,
      47.5,47.1,45.7,46.8,46.3,46.3,46.1,48.1,47.8,46.7,47.1,46.7)
y4<-
c(295,302,318,345,325,275,290,295,296,330,299,315,304,302,308,271,284,281,291
,

270,248,264,257,260,261,282,284,291,299,295,280,284,286,284,268,233,248,244,

266,244,293,284,277,299,285,265,247,231,268,247,205,239,230,235,220,253,249,
      226,248,236)
```

حال با همه داده ها را بصورت یک فهرست نمایش می‌دهیم:

Now we make a data frame to see our data:

```
Data<-data.frame(s,v,y1,y2,y3,y4)
head(Data)

##   s v   y1  y2   y3  y4
## 1 1 1 59.3 4.5 38.4 295
## 2 1 1 60.3 4.5 38.6 302
## 3 1 1 60.9 5.3 37.2 318
## 4 1 1 60.6 5.8 38.1 345
## 5 1 1 60.4 6.0 38.8 325
## 6 1 2 59.3 6.7 37.9 275

tail(Data)

##    s v   y1  y2   y3  y4
## 55 4 2 65.6 1.9 46.1 220
## 56 4 3 70.1 1.7 48.1 253
## 57 4 3 72.3 0.7 47.8 249
## 58 4 3 69.7 1.5 46.7 226
## 59 4 3 69.9 1.3 47.1 248
## 60 4 3 69.8 1.4 46.7 236
```

حال مدل خود را با فرضیات زیر تشکیل می‌دهیم ، در اینجا ما 3 تا فرضیه را بصورت همزمان آزمون میکنیم:

No we make our model with this hypothesis,we have 3 hypothesis here:

$$\begin{cases} H0: V_1 = V_2 = V_3 = 0 \\ H1: at\ least\ one\ of\ them\ diffrent \end{cases}$$

$$\begin{cases} H0: S_1 = S_2 = S_3 = S_4 = 0 \\ H1: at\ least\ one\ of\ them\ diffrent \end{cases}$$

$$\begin{cases} H0: V_1S_1 = V_2S_1 = V_3S_1 = V_1S_2 = V_2S_2 = V_3S_2 = V_1S_3 = V_2S_3 = V_3S_3 = V_1S_4 = V_2S_4 = V_3S_4 = 0 \\ H1: at\ least\ one\ of\ them\ diffrent \end{cases}$$

```
response<-cbind(y1,y2,y3,y4)
result0<-manova(response~s*v)
summary(result0 , test = "Wilks")

##           Df    Wilks approx F num Df den Df    Pr(>F)
## s          3 0.001952   95.196     12 119.35 < 2.2e-16 ***
## v          2 0.065642   32.660      8  90.00 < 2.2e-16 ***
## s:v        6 0.161611    4.523     24 158.20 2.999e-09 ***
## Residuals 48
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

According to the p-values<alpha=0.05, we can say that all of our treatments and s , v are signifact with our response and all of the first hypothesis reject.

باتوجه به مقادیر p-مقدار داریم که همه آنها از آلفا که همان 0.05 هست کمترند ولذا تمامی فرض‌های 0 ما یعنی برابری ها نیز رد می‌شود.