HW#6 Solution (week7 HW)

10/17/2019

HW 20.2 Coin-operated terminals.

```
# HW 19.10
HW20  <- read.table(
   url("https://raw.githubusercontent.com/npmldabook/Stat3119/master/Week7/CH20PR02.txt"))
# rename the variables
names(HW20)<- c("response", "location", "week")

HW20$location <- as.factor(HW20$location)
HW20$week <- as.factor(HW20$week)


str(HW20)
```

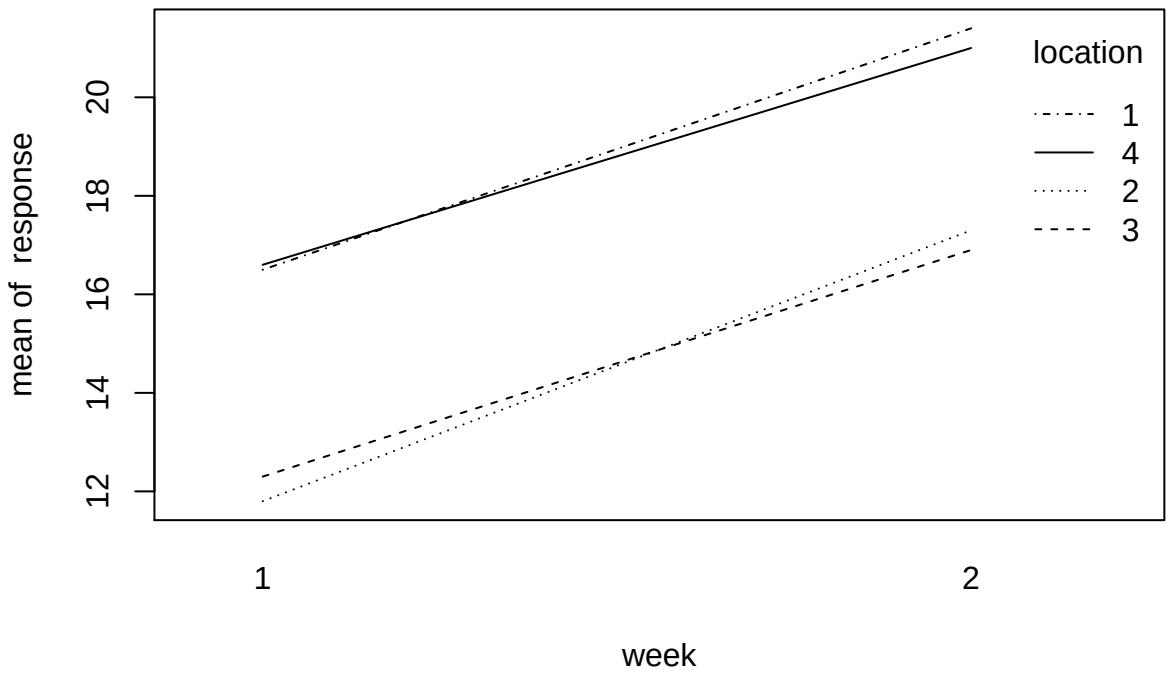
```
## 'data.frame':    8 obs. of  3 variables:
##  $ response: num  16.5 21.4 11.8 17.3 12.3 16.9 16.6 21
##  $ location: Factor w/ 4 levels "1","2","3","4": 1 1 2 2 3 3 4 4
##  $ week    : Factor w/ 2 levels "1","2": 1 2 1 2 1 2 1 2
```

```
HW20
```

```
##   response location week
## 1     16.5        1    1
## 2     21.4        1    2
## 3     11.8        2    1
## 4     17.3        2    2
## 5     12.3        3    1
## 6     16.9        3    2
## 7     16.6        4    1
## 8     21.0        4    2
```

a. plot observation

```
with(HW20, interaction.plot(x.factor = week, trace.factor = location, response = response))
```



Results: It appears that interaction effects are not present, but both main effects of factors A and B are present.

b.ANOVA test

```
fit = aov(response~ location+ week  , data= HW20 )
summary(fit)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## location     3  37.00   12.33   107.3 0.001503 **
## week         1  47.04   47.04   409.1 0.000264 ***
## Residuals    3   0.35    0.12
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Kimball inequality
1- .95*.95
```

```
## [1] 0.0975
```

H_0: all α_i equal zero $(i = 1, ..., 4)$, H_a: not all α_i equal zero.
$F^* = 12.3350/.1150 = 107.26$, $F(.95; 3, 3) = 9.28$. If $F^* \leq 9.28$ conclude H_0, otherwise H_a. Conclude H_a. P-value $= .0015$
H_0: $\beta_1 = \beta_2 = 0$, H_a: not both β_1 and β_2 equal zero.
$F^* = 47.0450/.1150 = 409.09$, $F(.95; 1, 3) = 10.1$. If $F^* \leq 10.1$ conclude H_0, otherwise H_a. Conclude H_a. P-value $= .0003$. $\alpha \leq .0975$

C. pairwise comparison with Bonferroni procedure with a 90 percent family confidence coefficient

```
library(emmeans)
EstA.mean = emmeans(fit, ~ location)
pairs.A<- confint(pairs(EstA.mean))

EstB.mean = emmeans(fit, ~ week)
pairs.B<- confint(pairs(EstB.mean))
```

Calculate the Bonferroni multiple

```
g=7 #
df =3 #(a-1)(b-1)
alpha=0.1
(B=qt(1- alpha/(2*g), df))
```

```
## [1] 5.137655
```

Calculate the CI

```
(paired.mean=  c(pairs.A$estimate, pairs.B$estimate))
```

```
## [1]  4.40  4.35  0.15 -0.05 -4.25 -4.20 -4.85
```

```
(sd.paired.mean=  c(pairs.A$SE, pairs.B$SE))
```

```
## [1] 0.3391165 0.3391165 0.3391165 0.3391165 0.3391165 0.3391165 0.2397916
```

```
data.frame( paired.mean= paired.mean,
             LCI= paired.mean-B*sd.paired.mean ,
            UCI=paired.mean+B*sd.paired.mean)
```

```
##   paired.mean       LCI       UCI
## 1        4.40  2.657737  6.142263
## 2        4.35  2.607737  6.092263
## 3        0.15 -1.592263  1.892263
## 4       -0.05 -1.792263  1.692263
## 5       -4.25 -5.992263 -2.507737
## 6       -4.20 -5.942263 -2.457737
## 7       -4.85 -6.081966 -3.618034
```

HW 20.3 Coin-operated terminals.

- use regression approach

```
Factor1<- (HW20$location==1)*1  + (HW20$location==4)*(-1)
Factor2<- (HW20$location==2)*1 + (HW20$location==4)*(-1)
Factor3<- (HW20$location==3)*1 + (HW20$location==4)*(-1)
Factor4<- (HW20$week==1)*1 + (HW20$week==2)*(-1)

LMfit<-lm( response~ Factor1+Factor2+ Factor3+Factor4, data=HW20 )

new <- data.frame(Factor1, Factor2, Factor3,Factor4)
pred.CI <- predict(LMfit, new, interval="confidence", level = 0.95, se.fit=T)
data.frame(HW20[,2:3], pred.CI )
```

```
##   location week fit.fit fit.lwr fit.upr    se.fit df residual.scale
## 1        1    1  16.525 15.6718 17.3782 0.2680951  3      0.3391165
## 2        1    2  21.375 20.5218 22.2282 0.2680951  3      0.3391165
## 3        2    1  12.125 11.2718 12.9782 0.2680951  3      0.3391165
## 4        2    2  16.975 16.1218 17.8282 0.2680951  3      0.3391165
## 5        3    1  12.175 11.3218 13.0282 0.2680951  3      0.3391165
## 6        3    2  17.025 16.1718 17.8782 0.2680951  3      0.3391165
## 7        4    1  16.375 15.5218 17.2282 0.2680951  3      0.3391165
## 8        4    2  21.225 20.3718 22.0782 0.2680951  3      0.3391165
```

Results: When location =3 , week=2, the mean estimate=17.025, variance = (0.26809)^2 =0.0719, the 95% CI is (16.1718, 17.8782)

HW 20.4 Coin-operated terminals.

```
## make the data into matrix A*B Form (dim a * b)
library(additivityTests)
(HW20m =  matrix( HW20$response, nrow=4, ncol=2, byrow=T ))
```

```
##      [,1] [,2]
## [1,] 16.5 21.4
## [2,] 11.8 17.3
## [3,] 12.3 16.9
## [4,] 16.6 21.0
```

```
##
tukey.test( HW20m, alpha = 0.025)
```

```
##
## Tukey test on 2.5% alpha-level:
##
## Test statistic: 0.5897
## Critival value: 38.51
## The additivity hypothesis cannot be rejected.
```

Results:The additivity hypothesis cannot be rejected. It suggest that interaction effects are not present.