HW Week 11

Md Ariful Haque Miah, Ayoola Ayodegi

11/13/2022

Problem 6.12 (a) Estimate the factor effects

```
A <- c(rep(-1,4),rep(1,4))
B <- c(rep(-1,8),rep(1,8))
obs <- c(14.037,16.165,13.972,13.907,13.880,13.860,14.032,13.914,14.821,14.757,14.843,14.878,14.888,14.9
A <- as.factor(A)
B <- as.factor(B)
dat <- data.frame(A,B,obs)
dat
```

```
##     A  B    obs
## 1  -1 -1 14.037
## 2  -1 -1 16.165
## 3  -1 -1 13.972
## 4  -1 -1 13.907
## 5   1 -1 13.880
## 6   1 -1 13.860
## 7   1 -1 14.032
## 8   1 -1 13.914
## 9  -1  1 14.821
## 10 -1  1 14.757
## 11 -1  1 14.843
## 12 -1  1 14.878
## 13  1  1 14.888
## 14  1  1 14.921
## 15  1  1 14.415
## 16  1  1 14.932
```

Finding Corner Points:

```
one <- sum(dat$obs[1:4])
one
```

```
## [1] 58.081
```

```
a <- sum(dat$obs[5:8])
a
```

```
## [1] 55.686
```

```
b <- sum(dat$obs[9:12])
b
```

```
## [1] 59.299
```

```
ab <- sum(dat$obs[13:16])
ab
```

```
## [1] 59.156
```

```r
n <- c(4)
fact_A <- 2*(a+ab-b-one)/(4*n)
fact_A
```

```
## [1] -0.31725
```

```r
fact_B <- 2*(b+ab-a-one)/(4*n)
fact_B
```

```
## [1] 0.586
```

```r
fact_AB <- 2*(ab+one-a-b)/(4*n)
fact_AB
```

```
## [1] 0.2815
```

Therefore, The factor Effect A = -0.31725, B = 0.586, Interaction effect AB = 0.2815

(b) Analysis of variance

```r
A <- c(rep(-1,4),rep(1,4))
B <- c(rep(-1,8),rep(1,8))
obs <- c(14.037,16.165,13.972,13.907,13.880,13.860,14.032,13.914,14.821,14.757,14.843,14.878,14.888,14.9
A <- as.factor(A)
B <- as.factor(B)
dat <- data.frame(A,B,obs)
dat
```

```
##     A  B    obs
## 1  -1 -1 14.037
## 2  -1 -1 16.165
## 3  -1 -1 13.972
## 4  -1 -1 13.907
## 5   1 -1 13.880
## 6   1 -1 13.860
## 7   1 -1 14.032
## 8   1 -1 13.914
## 9  -1  1 14.821
## 10 -1  1 14.757
## 11 -1  1 14.843
## 12 -1  1 14.878
## 13  1  1 14.888
## 14  1  1 14.921
## 15  1  1 14.415
## 16  1  1 14.932
```

```r
model <- aov(obs~A*B,data=dat)
summary(model)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)  
## A            1  0.403  0.4026   1.262 0.2833  
## B            1  1.374  1.3736   4.305 0.0602 .
## A:B          1  0.317  0.3170   0.994 0.3386  
## Residuals   12  3.828  0.3190                 
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p values of the main effect A and the interaction effect (A:B) is greater than $\alpha = 0.05$ level of significance. Hence the main effect A and the interaction effect (A:B) are not significant as we fail to reject H_0. On the other hand p value of the main effect B is less than $\alpha = 0.1$ level of significance. Hence the main effect B is significant as we reject H_0.

(c) Regression Equation:

```
A <- c(rep(-1,4),rep(1,4))
B <- c(rep(-1,8),rep(1,8))
obs <- c(14.037,16.165,13.972,13.907,13.880,13.860,14.032,13.914,14.821,14.757,14.843,14.878,14.888,14.
A <- as.factor(A)
B <- as.factor(B)
dat <- data.frame(A,B,obs)
dat
```

```
##     A  B    obs
## 1  -1 -1 14.037
## 2  -1 -1 16.165
## 3  -1 -1 13.972
## 4  -1 -1 13.907
## 5   1 -1 13.880
## 6   1 -1 13.860
## 7   1 -1 14.032
## 8   1 -1 13.914
## 9  -1  1 14.821
## 10 -1  1 14.757
## 11 -1  1 14.843
## 12 -1  1 14.878
## 13  1  1 14.888
## 14  1  1 14.921
## 15  1  1 14.415
## 16  1  1 14.932
```

```
model <- lm(obs~A+B+A*B,data=dat)
summary(model)
```

```
## 
## Call:
## lm(formula = obs ~ A + B + A * B, data = dat)
## 
## Residuals:
##      Min       1Q   Median       3Q      Max 
## -0.61325 -0.14431 -0.00563  0.10188  1.64475 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)    
## (Intercept)  14.5203     0.2824  51.414 1.93e-15 ***
## A1           -0.5988     0.3994  -1.499    0.160    
## B1            0.3045     0.3994   0.762    0.461    
## A1:B1         0.5630     0.5648   0.997    0.339    
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 0.5648 on 12 degrees of freedom
## Multiple R-squared:  0.3535, Adjusted R-squared:  0.1918 
## F-statistic: 2.187 on 3 and 12 DF,  p-value: 0.1425
```

y = $\beta_0 + \beta_2 * x_2 + \epsilon$ Hence, y = $14.5203 + 0.3045 * x_2 + \epsilon$

where β_0 = the intercept = the grand mean of all 16 observations and the regression coefficient β_2 is one-half the corresponding factor effect B estimate.