Statistisk Dataanalyse 2023

Instruktør: Vivek Misra

Exercise Class NR9

Solutions to the Tasks

Task 1 - Description

1. The director of a university department wishes to see whether there is a difference in the knowledge of students of a course, depending on the teaching method used (1 or 2), and professor that teaches the course (A or B). Four students from each professor and teaching method are randomly selected and they are asked to attend to a single exam. Is there a significant effect of the professor and the teaching method on the student´s results? Which professor and/or method provided the best results?

	Professor A	Professor B
Method 1	20, 25, 22, 29	30, 32, 35, 29
Method 2	15, 18, 22, 21	21, 27, 18, 15

Task 1 - Solution

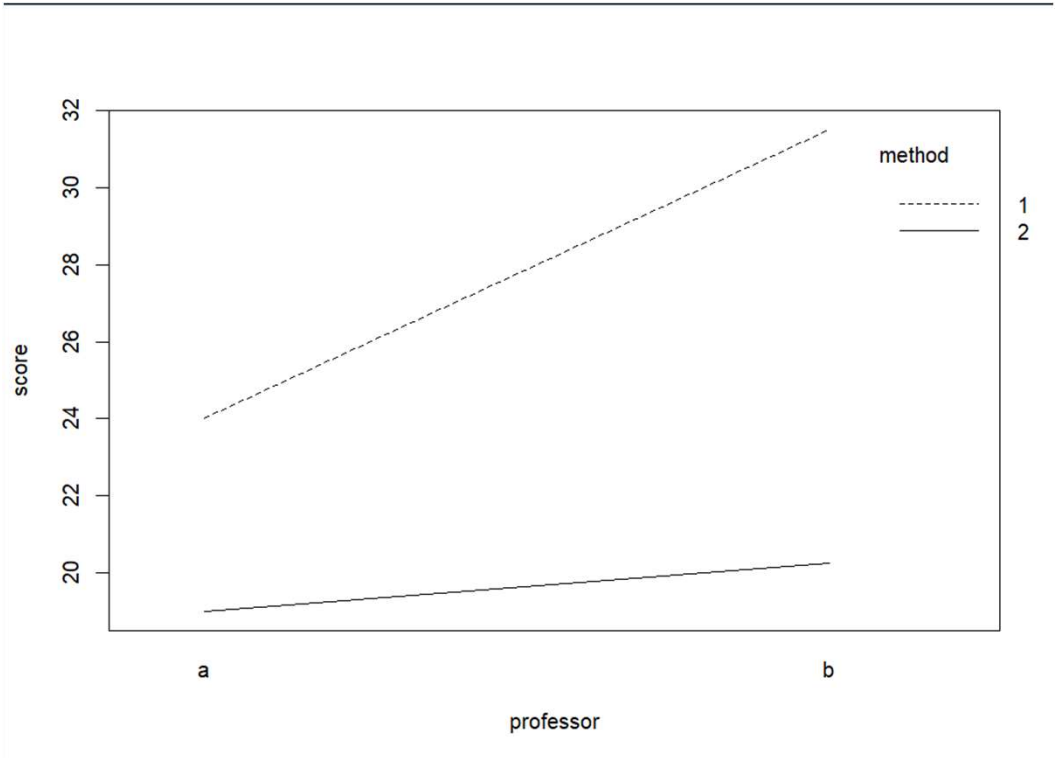
- To solve the task, we will write the following code:

```
university <-
data.frame(method=c("1","1","1","1","1","1","1","1","2","2","2","2","2","2","2","2"),professor=c("a","a","a","a"
,"b","b","b","b","a","a","a","a","b","b","b","b"),score=c(20,25,22,29,30,32,35,29,15,18,22,21,21,27,18,15))

university$method <- as.factor(university$method)

university$professor <- as.factor(university$professor)

two_way_anova_university <- aov(score~method+professor+method+professor,data=university)

summary(two_way_anova_university)

interaction.plot(university$professor,university$method,university$score,xlab="professor",ylab="score",trace.lab
el="method")
```

Task 1 - Solution

- We will get the following graph:

```
> university <- data.frame(method=c("1","1","1","1","1","1","1","1","1","2","2","2","2","2","2","2","2","2"),professor=c
("a","a","a","a","b","b","b","b","a","a","a","a","b","b","b","b"),score=c(20,25,22,29,30,32,35,29,15,18,22,21,21,27,18,15))
> university$method <- as.factor(university$method)
> university$professor <- as.factor(university$professor)
> two_way_anova_university <- aov(score~method+professor+method+professor,data=university)
> summary(two_way_anova_university)
            Df Sum Sq Mean Sq
method       1 264.06  264.06
professor    1  76.56   76.56
Residuals   13 214.81   16.52
            F value  Pr(>F)
method       15.981 0.00152 **
professor     4.633 0.05072 .
Residuals
---
Signif. codes:
  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’
  0.05 ‘.’ 0.1 ‘ ’ 1
> interaction.plot(university$professor,university$method,university$score,xlab="professor",ylab="score",trace.label="method")
```



Task 2 - Description

2. A gardening company is testing new ways to improve plant growth. Plants are randomly selected and exposed to a combination of two factors, a "Light" in two different strengths and a plant food supplement with two different mineral supplements. After a number of weeks, the plants are measured for growth and the results (in cm) are the following. Which combination of light and supplement provides the best results?

	Supp. 1	Supp. 2
Light 1	26.7 25.2	28.6 29.3
Light 2	32.3 32.8	26.1 24.2

Task 2 - Solution

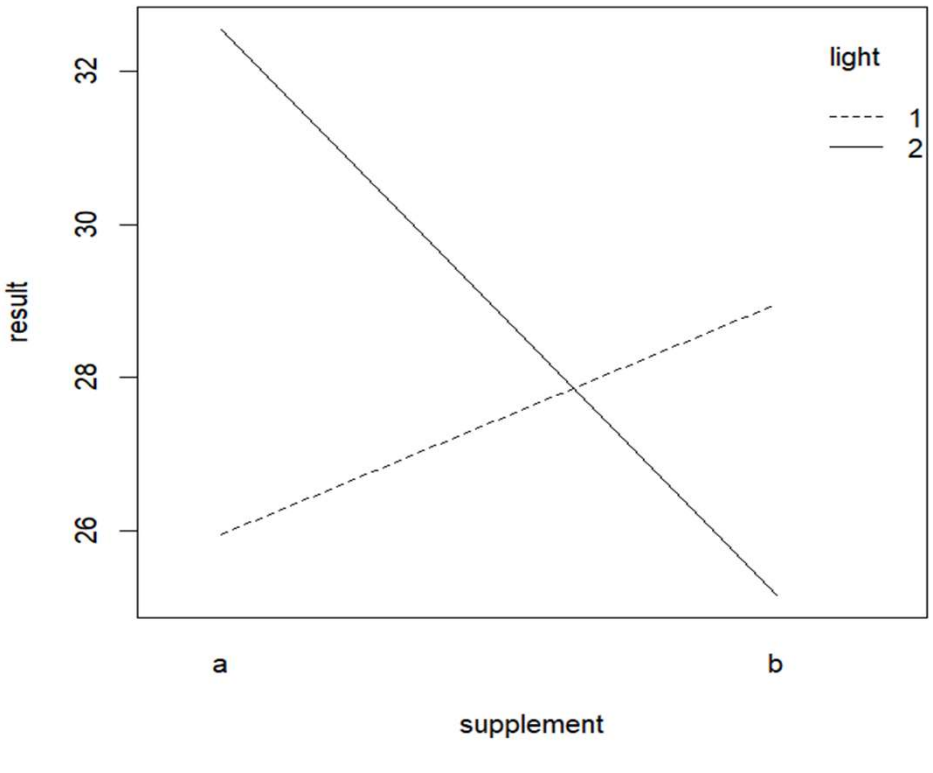
- We need to write the following code:

```
garden <-
data.frame(light=c("1","1","1","1","2","2","2","2"),supplement=c("a","a","b
","b","a","a","b","b"),result=c(26.7,25.2,28.6,29.3,32.3,32.8,26.1,24.2))

garden$light <- as.factor(garden$light)

garden$supplement <- as.factor(garden$supplement)

two_way_anova_garden <-
aov(result~light~supplement+light+supplement,data=garden)

summary(two_way_anova_garden)

interaction.plot(garden$supplement,garden$light,garden$result,xlab="supplem
ent",ylab="result",trace.label="light")
```

Task 2 - Solution

- We will get the following graph:

```
> garden <- data.frame(light=c("1","1","1","1","2","2","2","2"),supplement=c
("a","a","b","b","a","a","b","b"),result=c(26.7,25.2,28.6,29.3,32.3,32.8,26.1,24.2))
> garden$light <- as.factor(garden$light)
> garden$supplement <- as.factor(garden$supplement)
> two_way_anova_garden <- aov(result~light~supplement+light+supplement,data=garden)
Error in model.frame.default(formula = result ~ light ~ supplement + light +  :
  object is not a matrix
> summary(two_way_anova_garden)
Error in summary(two_way_anova_garden) :
  object 'two_way_anova_garden' not found
> interaction.plot(garden$supplement,garden$light,garden$result,xlab="supplement",ylab
="result",trace.label="light")
```



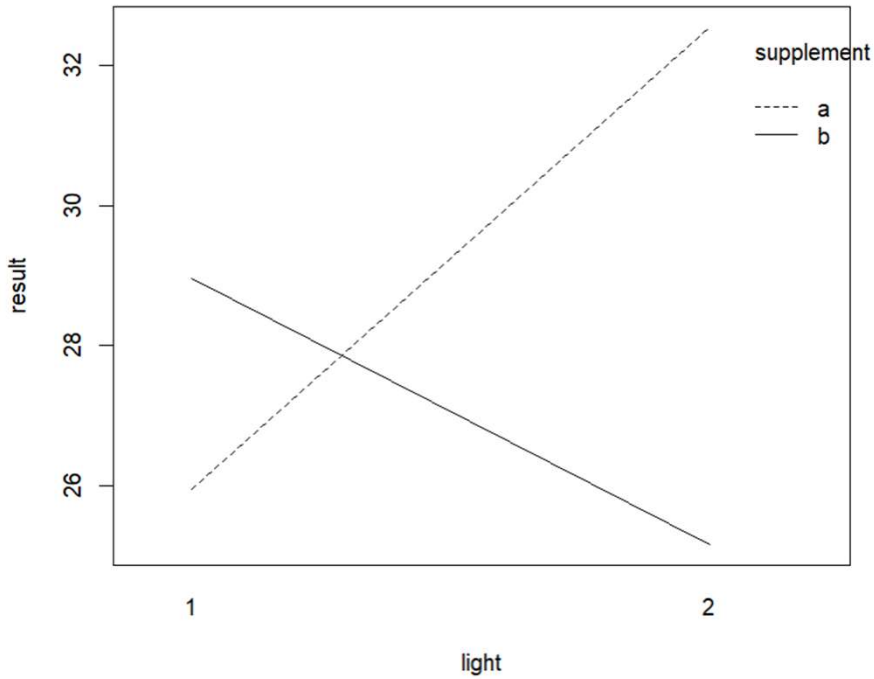
- The graph looks a bit weird…?
  - We will correct it on the next page.

Task 2 - Solution

- We will write the following code to instruct a better interactions plot.

```
interaction.plot(garden$light,garden$supplement,garden$result,xlab="light",ylab="result",trace.label="supplement")
```

- The following plot is contructed to the right:



Task 3 - Description

3. Two types of paint (A and B), were tested to see how many months they lasted before it began to peel. They were tested in two climatic conditions to study the effects of climate on the paint. Each group contained five test panels. At $\alpha=0.01$, analyze the data shown. Which paint lasts longer and in which climate?

	Climate 1	Climate 2
Paint A	60, 53, 58, 62, 57	58, 66, 68, 76, 80
Paint B	36, 41, 54, 65, 53	58, 63, 79, 55, 66

Task 3 - Solution

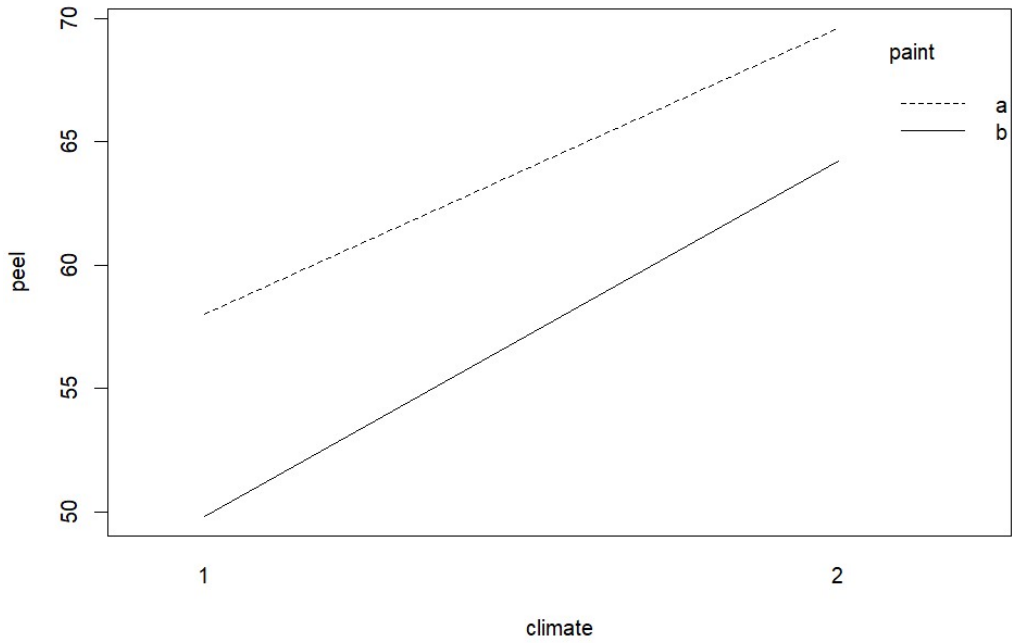
- We need to write the following code:

```
design <-
data.frame(paint=c("a","a","a","a","a","a","a","a","a","a","b","b","b","b",
"b","b","b","b","b","b","b"),climate=c("1","1","1","1","1","2","2","2","2","2",
"1","1","1","1","1","2","2","2","2","2"),peel=c(60,53,58,62,57,58,66,68,76,
80,36,41,54,65,53,58,63,79,55,66))

design$paint <- as.factor(design$paint)

design$climate <- as.factor(design$climate)

two_way_anova_design <- aov(peel~paint+climate+paint*climate,data=design)

 summary(two_way_anova_design)


interaction.plot(design$climate,design$paint,design$peel,xlab="climate",yla
b = "peel", trace.label="paint")
```

Task 2 - Solution

- We will get the following graph:

```
> design <- data.frame(paint=c("a","a","a","a","a","a","a","a","a","a","a","b","b","b","b","b","b","b","b","b","b","b"),climate=c
("1","1","1","1","1","2","2","2","2","2","1","1","1","1","1","2","2","2","2","2"),peel=c(60,53,58,62,57,58,66,68,76,80,36,41,54,65,53,58,63,79,55,66))
> design$paint <- as.factor(design$paint)
> design$climate <- as.factor(design$climate)
> two_way_anova_design <- aov(peel~paint+climate+paint*climate,data=design)
> summary(two_way_anova_design)
             Df Sum Sq
paint         1  231.2
climate       1  845.0
paint:climate 1    9.8
Residuals    16 1218.8
             Mean Sq F value
paint          231.2   3.035
climate        845.0  11.093
paint:climate    9.8   0.129
Residuals       76.2
             Pr(>F)
paint        0.10067
climate      0.00424 **
paint:climate 0.72452
Residuals
---
Signif. codes:
  0 ‘***’ 0.001 ‘**’ 0.01
  ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> interaction.plot(design$climate,design$paint,design$peel,xlab="climate",ylab = "peel", trace.label="paint")
```



Tak for i dag!

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