Chap10

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```
library(xtable)
library(gmodels)
```

First, set working directory. 'data' is a table with two columns and same number of rows, and should be numeric. Columns have headers indicating the names of the variables. **User will also input desired variable names in double quotes**

```
data <- read.csv("chap10.csv", header = FALSE, skip = 1)
colnames(data) <- c("free_recall", "cued_recall")
```

We now combine the observations into one long column (score)

```
colnames(data) <- c("V1", "V2")
score=c(data$V1,data$V2)
```

We now prepare the labels for the 3 x 2 x 10 scores according to the factor levels: Factor A — 12 words 24 words 48 words, 12 words 24 words 48 words, . . . etc.

```
list_length=gl(3,1,3*2*10, labels=c("12 Words","24 Words","48 Words"))
```

Factor B — Free Recall Free Recall , Cued Recall Cued Recall etc.

```
recall_type=gl(2,3*10,3*2*10, labels=c("Free Recall","Cued Recall"))
```

We generate a second column (group), that identifies the group for each score.

```
group=gl(2*3,10,3*2*10, labels=c("a1b1", "a2b1", "a3b1", "a1b2","a2b2", "a3b2"))
```

We now form a data frame with the dependent variable and the factors. Then we print the data.

```
data=data.frame(score = score, Factor_A = factor(list_length),
                Factor_B = factor(recall_type), Group = group)
knitr::kable(xtable(data))
```

score	Factor_A	Factor_B	Group
11	12 Words	Free Recall	a1b1
13	24 Words	Free Recall	a1b1
17	48 Words	Free Recall	a1b1
9	12 Words	Free Recall	a1b1
18	24 Words	Free Recall	a1b1
20	48 Words	Free Recall	a1b1
13	12 Words	Free Recall	a1b1
19	24 Words	Free Recall	a1b1
22	48 Words	Free Recall	a1b1
9	12 Words	Free Recall	a1b1
13	24 Words	Free Recall	a2b1
13	48 Words	Free Recall	a2b1
8	12 Words	Free Recall	a2b1

score	Factor_A	Factor_B	Group
8	24 Words	Free Recall	a2b1
21	48 Words	Free Recall	a2b1
7	12 Words	Free Recall	a2b1
15	24 Words	Free Recall	a2b1
16	48 Words	Free Recall	a2b1
12	12 Words	Free Recall	a2b1
13	24 Words	Free Recall	a2b1
23	48 Words	Free Recall	a3b1
11	12 Words	Free Recall	a3b1
9	24 Words	Free Recall	a3b1
19	48 Words	Free Recall	a3b1
10	12 Words	Free Recall	a3b1
8	24 Words	Free Recall	a3b1
20	48 Words	Free Recall	a3b1
10	12 Words	Free Recall	a3b1
14	24 Words	Free Recall	a3b1
19	48 Words	Free Recall	a3b1
12	12 Words	Cued Recall	a1b2
13	24 Words	Cued Recall	a1b2
32	48 Words	Cued Recall	a1b2
12	12 Words	Cued Recall	a1b2
21	24 Words	Cued Recall	a1b2
31	48 Words	Cued Recall	a1b2
7	12 Words	Cued Recall	a1b2
20	24 Words	Cued Recall	a1b2
27	48 Words	Cued Recall	a1b2
9	12 Words	Cued Recall	a1b2
15	24 Words	Cued Recall	a2b2
30	48 Words	Cued Recall	a2b2
9	12 Words	Cued Recall	a2b2
17	24 Words	Cued Recall	a2b2
29	48 Words	Cued Recall	a2b2
10	12 Words	Cued Recall	a2b2
14	24 Words	Cued Recall	a2b2
30	48 Words	Cued Recall	a2b2
12	12 Words	Cued Recall	a2b2
13	24 Words	Cued Recall	a2b2
33	48 Words	Cued Recall	a3b2
10	12 Words	Cued Recall	a3b2
14	24 Words	Cued Recall	a3b2
25	48 Words	Cued Recall	a3b2
7	12 Words	Cued Recall	a3b2
16	24 Words	Cued Recall	a3b2
25	48 Words	Cued Recall	a3b2
12	12 Words	Cued Recall	a3b2
7	24 Words	Cued Recall	a3b2
28	48 Words	Cued Recall	a3b2

We now define the contrasts

```
Linear=c(-1,0,1)
Quadratic=c(1,-2,1)
```

```
a1_vs_a2_a3=c(-2,1,1)
a2_vs_a3=c(0,1,-1)
AB_contrast=c(-2,2,1,-1,1,-1)
```

We now perform the ANOVA on the data, then print the results

```
aov1=aov(score~list_length*recall_type, data=data)
summary(aov1)
```

```
##                          Df Sum Sq Mean Sq F value   Pr(>F)
## list_length               2   2080    1040  115.56  < 2e-16 ***
## recall_type               1    240     240   26.67 3.58e-06 ***
## list_length:recall_type   2    280     140   15.56 4.62e-06 ***
## Residuals                54    486       9
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
print(model.tables(aov1,"means"),digits=3)
```

```
## Tables of means
## Grand mean
##
## 16
##
##  list_length
## list_length
## 12 Words 24 Words 48 Words
##       10       14       24
##
##  recall_type
## recall_type
## Free Recall Cued Recall
##          14          18
##
##  list_length:recall_type
##            recall_type
## list_length Free Recall Cued Recall
##    12 Words 10          10
##    24 Words 13          15
##    48 Words 19          29
```

```
interaction=list_length:recall_type
```

We now organize the results

```
Df_Linear=summary(aov(score~list_length+recall_type+interaction,
                      contrasts=list(list_length=make.contrasts(Linear))),split =
                    list(list_length = list("Linear" = 1)))[[1]]$Df
Df_Quadratic=summary(aov(score~list_length+recall_type+
                           interaction,contrasts= list(list_length= make.contrasts(
                             Quadratic))), split = list(list_length = list("Quadratic" =
                                                                             1)))[[1]]$Df
Df_a1_vs_a2_a3=summary(aov(score~list_length+recall_type+
                             interaction, contrasts=list(list_length = make.contrasts(
                               a1_vs_a2_a3))),split = list(list_length = list("a1_vs_a2_a3" =
                                                                                1)))[[1]]$Df
```

```
Df_a2_vs_a3=summary(aov(score~list_length+recall_type+
                          interaction,contrasts = list(list_length = make.contrasts(
                            a2_vs_a3))), split = list(list_length = list("a2_vs_a3" =
                                                                           1)))[[1]]$Df
Df_AB_contrast=summary(aov(score~list_length+recall_type+
                             interaction,contrasts = list(interaction = make.contrasts(
                               AB_contrast))),split = list(interaction = list("AB_contrast" =
                                                                                1)))[[1]]$Df
Df_Cont = data.frame(rbind(Df_Linear, Df_Quadratic,
                           Df_a1_vs_a2_a3, Df_a2_vs_a3, Df_AB_contrast))
SS_Linear=summary(aov(score~list_length+recall_type+interaction,
                      contrasts=list(list_length=make.contrasts(Linear))),split =
                    list(list_length = list("Linear" = 1)))[[1]]$Sum
SS_Quadratic=summary(aov(score~list_length+recall_type+
                           interaction, contrasts=list(list_length =
                                                         make.contrasts(Quadratic))), split = list(list_
                                                                                                   lis

SS_a1_vs_a2_a3=summary(aov(score~list_length+recall_type+
                             interaction,contrasts = list(list_length =
                                                            make.contrasts(a1_vs_a2_a3))), split = list

SS_a2_vs_a3 = summary(aov(score~list_length + recall_type +
                            interaction,contrasts = list(list_length =
                                                           make.contrasts(a2_vs_a3))), split = list(lis
                                                                                                    l

SS_AB_contrast = summary(aov(score~list_length + recall_type +
                               interaction, contrasts = list(interaction =
                                                               make.contrasts(AB_contrast))), split = li

SS_Cont = data.frame(rbind(SS_Linear, SS_Quadratic,
                           SS_a1_vs_a2_a3, SS_a2_vs_a3, SS_AB_contrast))
MS_Linear = summary(aov(score~list_length + recall_type +
                          interaction, contrasts = list(list_length =
                                                          make.contrasts(Linear))), split = list(list_l
                                                                                                 list

MS_Quadratic = summary(aov(score~list_length + recall_type +
                             interaction, contrasts = list(list_length =
                                                             make.contrasts(Quadratic))), split = list(

MS_a1_vs_a2_a3 = summary(aov(score~list_length + recall_type +
                               interaction, contrasts = list(list_length =
                                                               make.contrasts(a1_vs_a2_a3))), split = li

MS_a2_vs_a3 = summary(aov(score~list_length + recall_type +
                            interaction, contrasts = list(list_length =
                                                            make.contrasts(a2_vs_a3))), split = list(lis

MS_AB_contrast = summary(aov(score~list_length + recall_type +
                               interaction, contrasts = list(interaction =
                                                               make.contrasts(AB_contrast))),split = lis

MS_Cont=data.frame(rbind(MS_Linear, MS_Quadratic, MS_a1_vs_a2_a3,
                         MS_a2_vs_a3, MS_AB_contrast))
```

```
F_Linear = summary(aov(score~list_length + recall_type +
                         interaction, contrasts = list(list_length =
                                                         make.contrasts(Linear))), split = list(list_le
                                                                                                list(
F_Quadratic = summary(aov(score~list_length + recall_type +
                            interaction, contrasts = list(list_length =
                                                            make.contrasts(Quadratic))), split = list(li

F_a1_vs_a2_a3 = summary(aov(score~list_length + recall_type +
                              interaction, contrasts = list(list_length =
                                                              make.contrasts(a1_vs_a2_a3))), split = lis

F_a2_vs_a3 = summary(aov(score~list_length+recall_type +
                           interaction,contrasts = list(list_length =
                                                          make.contrasts(a2_vs_a3))), split = list(list_
                                                                                                   lis
F_AB_contrast = summary(aov(score~list_length + recall_type +
                              interaction, contrasts = list(interaction =
                                                              make.contrasts(AB_contrast))), split = lis

F_Cont = data.frame(rbind(F_Linear, F_Quadratic, F_a1_vs_a2_a3,
                          F_a2_vs_a3, F_AB_contrast))
Pr_Linear = summary(aov(score~list_length + recall_type +
                          interaction, contrasts = list(list_length =
                                                          make.contrasts(Linear))), split = list(list_le
                                                                                                 list
Pr_Quadratic = summary(aov(score~list_length + recall_type +
                             interaction, contrasts = list(list_length =
                                                             make.contrasts(Quadratic))), split = list(

Pr_a1_vs_a2_a3 = summary(aov(score~list_length + recall_type +
                               interaction, contrasts = list(list_length =
                                                               make.contrasts(a1_vs_a2_a3))), split = li

Pr_a2_vs_a3 = summary(aov(score~list_length + recall_type +
                            interaction, contrasts = list(list_length =
                                                            make.contrasts(a2_vs_a3))), split = list(lis

Pr_AB_contrast = summary(aov(score~list_length + recall_type +
                               interaction, contrasts = list(interaction =
                                                               make.contrasts(AB_contrast))),split = lis
```

We organize the results on new tables, then print the tables

```
Pr_Cont = data.frame(rbind(Pr_Linear, Pr_Quadratic,
                           Pr_a1_vs_a2_a3, Pr_a2_vs_a3, Pr_AB_contrast))
Contrast_names=c("Linear", "Quadratic", "a1 vs a2 &a3", "a2 vs a3","AB")
Cont_mat=rbind("Linear"=Linear,"Quadratic"=Quadratic,"a1 vs a2&a3"=a1_vs_a2_a3,"a2 vs a3"=a2_vs_a3,"AB"=
Contrasts=data.frame(G1=Cont_mat[,1], G2 = Cont_mat[,2], G3 =
                       Cont_mat[,3], G4 = Cont_mat[,4], G5 = Cont_mat[,5], G6 =
                       Cont_mat[,6])
Contrast_Summary=data.frame(Contrast = Contrast_names, DF = c(Df_Cont[1:4,2], Df_Cont[5,4]),
                            Contrast_SS = c(SS_Cont[1:4,2], SS_Cont[5,4]),
```

```
                            Mean_Square = c(MS_Cont[1:4,2], MS_Cont[5,4]),
                            F_Value = c(F_Cont[1:4,2], F_Cont[5,4]),
                            Pr=c(Pr_Cont[1:4,2], Pr_Cont[5,4]))

knitr::kable(xtable(Contrasts))
```

	G1	G2	G3	G4	G5	G6
Linear	-1	0	1	-1	0	1
Quadratic	1	-2	1	1	-2	1
a1 vs a2&a3	-2	1	1	-2	1	1
a2 vs a3	0	1	-1	0	1	-1
AB	-2	2	1	-1	1	-1

```
print(Contrast_Summary)
```

```
##       Contrast DF Contrast_SS Mean_Square   F_Value           Pr
## 1       Linear  1        1960        1960 217.77778 1.351403e-20
## 2    Quadratic  1         120         120  13.33333 5.896216e-04
## 3 a1 vs a2 &a3  1        1080        1080 120.00000 2.459198e-15
## 4     a2 vs a3  1        1000        1000 111.11111 1.024991e-14
## 5           AB  1         120         120  13.33333 5.896216e-04
```