

TAMS38

Computer exercises 4

Preparation: Read about multi-factor designs, block and Latin square design.

Bring collection of formulas and tables, and calculators to the computer exercise class.

1 – Analysis using the Latin Square

An experimental is planned according to Latin square for comparing five methods (A_1, \dots, A_5) to secure the wires in a semiconductor cable. Five different technicians (M_1, \dots, M_5) conducted mountings and five different plastic materials (P_1, \dots, P_5) used to encapsulate the devices. The force required to break the attachment was determined. Results:

Plastic materials	Technicians									
	M_1	M_2	M_3	M_4	M_5	M_1	M_2	M_3	M_4	M_5
P_1	A_1	3.0	A_2	2.4	A_3	1.9	A_4	2.2	A_5	1.7
P_2	A_2	2.1	A_3	2.7	A_4	2.3	A_5	2.5	A_1	3.1
P_3	A_3	2.1	A_4	2.6	A_5	2.5	A_1	2.9	A_2	2.1
P_4	A_4	2.0	A_5	2.5	A_1	3.2	A_2	2.5	A_3	2.2
P_5	A_5	2.1	A_1	3.6	A_2	2.4	A_3	2.4	A_4	2.1

You should now analyze the data according to an additive three factor model.

a) Give the model. ($y_{ijk} = \dots$)

Put y -values (take them by rows) in column C1. Define the A-levels in column C2, and the plastic levels in C3

```
SET C3
(1,2,3,4,5)5
end
```

and the technicians levels in C4

```
SET C4
5(1,2,3,4,5)
end
```

Check that data fits the levels in the columns C2, C3 and C4. Name columns by A, P and M, respectively.

A non-complete model has been analyzed using ANCOVA and its commands. Unfortunately ANCOVA is not any more in the menu of Minitab. One can use **Stat/ANOVA/General Linear Model...** (see below) or write as follows

```
ANCOVA Y=A P M;
FITS C6;
RESIDUALS C5;
MEANS A P M.
```

that gives analyze of variance table (but not only). Do some plots for residuals for example using

```
PLOT C5*C6
PLOT C5*C2
PLOT C5*C3
PLOT C5*C4
NSCORES C5 C7
PLOT C7*C5
```

Alt. Go to **Stat/ANOVA/General Linear Model...** and choose

Response: Y
Model: A P M

Under **Graphs** choose Normal plot, Residuals versus fits, Residuals versus A P M

Under **Results** choose Analysis of variance table and Display least squares means... A P M

Look at each of plots and note conclusions.

- b) Are all mounting methods equally good? Perform an appropriate test on level 0.05.
- c) Are all plastic materials equally good? Perform an appropriate test on level 0.05.
- d) How to estimate standard deviation? Degrees of freedom?

e) Do pairwise comparisons for mounting methods using the confidence intervals and Tukeys method with simultaneous confidence level 0.95. Can we recommend any of those methods?

f) Can we recommend any of the plastic materials? Compare e).

g) Study residual plots!

h) Is there any disadvantage of this study plan and analyzing method?

2 – Analysis of three factorial design with three block

A supermarket wants to compare how sales of a particular canned product depends of the shelf position (A-factor), the price tag paint (B-factor) and size of the package (C factor). Amounts of sold products were recorded on Tuesday, on Wednesday and on Thursday of each level combination. Level combinations within block "weekday" were taken in random order. Since the sales level can be assumed to vary between days of the week, days of the week (D-factor) we should be taken into account in the analysis.

Upload file uppg4.MPJ from the course webpage.

Open new project. Go to **File/Other Files/Import Special Text....** In **Store Data in columns** write c1-c5. Choice file kons.dat.

In C1 we have A-levels

A1: low position on shelf A2: intermediate position A3: high position

In C2 we have B-levels

B1: red price tag B2. green price tag

In C3 C-levels

C1: 284g C2: 340g C3: 454g C4: 680g

In C4 levels for blocking factor

D1:Tuesday D2: Wednesday D3: Thursday.

and in C5 we have the sales Y. Name columns A, B, C, D and Y.

Let block factor D be additive and do the analysis using **Stat/ANOVA/Balanced**

ANOVA... with

Response: Y

Model: $A/B/C D$

Results: Display means $A/B/C D$

Graphs: Alla residualplottar (Four in one samt mot $A B C D$)

Storage: Fits; Residuals.

a) According to which model was the data analyzed?

b) Was it justified to take into account the differences between weekdays? (do the appropriate test on level 0.05.)

c) Which of the interaction effect is significant on the level 0.05?

d) To study interaction between two factors one can use **Stat/ANOVA/Interactions Plot...** It gives interactions plots for $A*B$, $A*C$, $B*C$. Fill in, **Response:** Y ; **Factors:** $A B C$; and click on Full interaction plot matrix.

Try to make a practical interpretation: What color should the labels be for the different shelf levels? Which shelf is best for the different can sizes?

For interaction between B and C we do not find such clear pattern.

e) When several two-factor interactions are significant, it may be difficult to draw reliable conclusions from the plots In d) and from the corresponding parameter estimates. One can write models as

$$Y_{ijkl} = \mu_{ijk} + \delta_l + \varepsilon_{ijkl}$$

To study μ_{ijk} and to illustrate what happens for the different can sizes when changing shelf level and color of the price tag, we create a new column in which each combination of A and B levels have a unique value. Write in the session window `Let c8=10*c1+c2`

Call the column AB . Go to **Stat/ANOVA/Interactions Plot...** and put **Response:** Y , **Factors:** $C AB$ (in this order). Do not click on Display full interactions plot.

What looks to be the best for all can sizes? Try if you have time to make a recommendation for placement of the cans in such a way that all shelves are used.

f) Look at the estimates \bar{y}_{ijk} . av μ_{ijk} . Do pairwise comparisons μ_{ijk} for each can size k . How many intervals will we have for each size of can? Together? Let simultaneous confidence level be at least 70%. Do you find any significant differences?