Exam Stat 210 Sep5, 2011

Rough translation by TE Aug 19, 2012

Data

The problems are based on the simulated data of Appendix 1. There are 24 observations and the variables are as follows.

- **For** Three types of feed 'For1', 'For2' og 'For3'.
- **Frittgående** The variable is 'Ja' for freely moving chickens and otherwise 'No'.
- **Besetning** Lifestock. The variable indicates which of 6 lifestock (or farms for that matter) the chicken comes from.
- **Vekt** Weight in gram (g).

Exercise 1.

Only variables **Besetning** and **Vekt** are used in this exercise. Consider

$$y_{ij} = \mu + a_i + e_{ij} \text{ where}$$
$$i = 1, 2, \cdots, 6 \text{ correspond to 'Bes1', 'Bes2' ..., 'Bes6',}$$
$$j = 1, 2, \ldots, 4 \text{ correspond to the four observations of each Besetning,}$$
$$y_{ij} = \text{'Vekt'}, \; a_i \sim N(0, \sigma_A^2) \text{ and } e_{ij} \sim N(0, \sigma_e^2).$$

The random variables on the right hand side of the modell equation are assumed independent.

a) Use the output in Appendix 2 to test at 5% significance level the null hypothesis

$$H_0 : \sigma_A^2 = 0.$$

Formulate a conclusion.

b) Use the output in Appendix 2 to estimate σ_e^2. Construct a 95% confidence interval for σ_e^2. What is the 95% confidence interval for the standard deviation. σ_e ? Interpret the confidence interval for σ_e .

c) The correlation coefficient for observations from the same **Besetning** is

$$\rho = \frac{\sigma_A^2}{\sigma_A^2 + \sigma_e^2}.$$

Use the output in Appendix 2 to estimate ρ. Comment.

d) Mean **Vekt** is 925.6. Use this and the output of Appendix 2 to estimate μ an to calculate a 95% confidence interval for μ.

Exercise 2.

We now use the variables **For, Frittgående** og **Vekt** and consider the model

$$y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{ijk} \text{ where}$$
$$i = 1,2,3 \text{ correspond to 'For1','For2' og 'For3',}$$
$$j = 1,2 \text{ correspond to 'Ja' or 'Nei',}$$
$$k = 1,2,\ldots,4 \text{ correspond to replications,}$$
$$y_{ijk} = \text{'Vekt' and } e_{ijk} \sim N(0,\sigma_e^2),$$
$$\sum_{i=1}^{3}\alpha_i = 0 \quad \sum_{j=1}^{2}\beta_j = 0 \quad \sum_{i=1}^{3}(\alpha\beta)_{ij} = 0 \; \sum_{j=1}^{2}(\alpha\beta)_{ij} = 0 \; .$$

We assume e_{ijk} to be independent.

a) Use the output in Appendix 3 to determine if there is an interaction between **For** and **Frittgående** by stating a null hypothesis and formulating a conclusion. Use 5% significance level. Use the output in Appendix 3 to determine if there is a main effect of the variable by stating a null hypothesis and formulating a conclusion. Use 5% significance level.

b) For the remaining part we use the model

$$y_{ij} = \mu + \alpha_i + e_{ij} \text{ where}$$
$$i = 1,2,3 \text{ correspond 'For1','For2' og 'For3',}$$
$$j = 1,2...,8, \text{ correspond to the eight observations for each For,}$$
$$y_{ij} = \text{'Vekt' and } e_{ij} \sim N(0,\sigma_e^2),$$
$$\sum_{i=1}^{3}\alpha_i = 0.$$

We assume e_{ij} to be independent.

Use the output in Appendix 4 to show that there are significant differences between **For** at 5% significance level. Between which types of **For** are there differences? Use Tukey's test and the output of Appendix 4 for your answer.

c) Use the output in Appendix 4 to estimate μ, α_1, α_2 og α_3.

d) *Skip this one 2012:* Vi ønsker å sammenligne fortype 'For1' mot gjennomsnittet av 'For2' og 'For3'. Formuler en passende kontrast og beregn et 95% confidence interval for denne. Kommenter resultatet.

e) Calculated predicted **Vekt** for a chicken fed on 'For1'.
   Also calculate the residual for the first observation of Appendix 1.

f) Describe the assumptions assumptions for the modell in b) above. Would you say that the assumptions are met? Your answer is supposed to be be brief and you can use the figures of Appendix 5.

Appendix 1.

	For	Frittgående	Besetning	Vekt
1	For1	Ja	Bes1	910
2	For1	Ja	Bes1	938
3	For1	Ja	Bes2	933
4	For1	Ja	Bes2	915
5	For1	Nei	Bes1	963
6	For1	Nei	Bes1	935
7	For1	Nei	Bes2	969
8	For1	Nei	Bes2	991
9	For2	Ja	Bes3	908
10	For2	Ja	Bes3	911
11	For2	Ja	Bes4	935
12	For2	Ja	Bes4	919
13	For2	Nei	Bes3	939
14	For2	Nei	Bes3	906
15	For2	Nei	Bes4	948
16	For2	Nei	Bes4	898
17	For3	Ja	Bes5	925
18	For3	Ja	Bes5	905
19	For3	Ja	Bes6	919
20	For3	Ja	Bes6	919
21	For3	Nei	Bes5	920
22	For3	Nei	Bes5	880
23	For3	Nei	Bes6	878
24	For3	Nei	Bes6	950

Appendix 2

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Analysis of variance (unrestricted model)
Response: Vekt
            Sum Sq Df Mean Sq F value Pr(>F)
Besetning  5274.83  5 1054.97    1.74 0.1761
Residuals 10903.00 18  605.72       -      -

            Err.term(s) Err.df VC(SS)
1 Besetning         (2)     18    112
2 Residuals           -      -    606
(VC = variance component)
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Appendix 3

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Response: Vekt
                Sum Sq Df F value  Pr(>F)
For             4470.3  2  4.9146 0.01981 *
Frittgående      816.7  1  1.7956 0.19691
For:Frittgående 2704.3  2  2.9731 0.07662 .
Residuals       8186.5 18
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```

Appendix 4

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Analysis of Variance Table
          Df  Sum Sq Mean Sq F value  Pr(>F)
For        2  4470.3  2235.2  4.0093 0.03351 *
Residuals 21 11707.5   557.5
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  925.583      4.820 192.043   <2e-16 ***
For1          18.667      6.816   2.739   0.0123 *
For2          -5.083      6.816  -0.746   0.4641
---
  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov.default(formula = LinearModel.19)

$For
             diff       lwr       upr     p adj
For2-For1 -23.75 -53.50714  6.007144 0.1340322
For3-For1 -32.25 -62.00714 -2.492856 0.0321413
For3-For2  -8.50 -38.25714 21.257144 0.7545317
```

Appendix 5