

Exercise Sheet 1

To be discussed on March 8, 2022.

In order to obtain points for the exam admission:

Please hand in your solutions to the exercises marked with a “◁” symbol until March 7, 2022, 12:00 (by email to michael.vock@stat.unibe.ch).

Exercise 1: Oats example

In Section 1.6 of Pinheiro & Bates, the `Oats` data are presented, and several models with random effects at two levels are fitted.

- (a) Try to reproduce the steps of the modeling process using the `nlme` package in R (until the top of page 50).

Notes:

- If, instead of using the `groupedData` object `Oats`, you prefer to work with an ordinary data frame (as in the examples in the lecture), you can use the following code to create it:

```
oats.df <- data.frame(Oats)
oats.df$Block <- factor(as.character(oats.df$Block))
```

- In the book, the function `update` is used to fit a new model (with some parts of the model specification changed) based on a model that has already been fitted. You can also call the `lme` function with all necessary specifications each time.
 - For the fixed-effects parameters for `Variety`, you will probably obtain estimates that are different from those in the book, since R uses a different parametrization by default.
- (b) Represent the model `fm4Oats` in the notation used in (P&B 2.2): Specify \mathbf{X}_{ij} , $\mathbf{Z}_{i,j}$, \mathbf{Z}_{ij} , Ψ_1 , and Ψ_2 . (Please try yourself first and only consult p. 61 of Pinheiro & Bates afterwards for verifying your solution. . .)
- (c) Provide an equivalent model specification with only one level of random effects. 1 ◁

Exercise 2: Machines example – covariance structures

In Examples 2.4 and 2.9 in the lecture notes, three mixed-effects models for the `Machines` data are presented.

Let \mathbf{y}_i be the vector of all productivity scores for worker i (as specified in Example 2.4).

- (a) What is the shape of the variance/covariance matrix $\text{Var}(\mathbf{y}_i)$ for the model underlying `machines.lme.1`? In particular: Which entries are equal? 1 ◁
- (b) What is the shape of $\text{Var}(\mathbf{y}_i)$ for `machines.lme.2`? 1 ◁
- (c) What is the shape of $\text{Var}(\mathbf{y}_i)$ for `machines.lme.3`? 1 ◁