Seminar in Statistics: Mixed-effects Models

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1 Linear Mixed-Effects Models

1. **Motivation and Introduction (Jürg)**
   Introducing mixed-effects models by examples. Pinheiro und Bates (2000) ch. 1, Bates (2010) ch. 1-4, Bates (2009) ch. 1-3,5.

2. **The Linear Mixed-Effects Probability Model (Manuel)**
   Formulation of the model and estimation for known θ. Bates (2010) 1.4.1, 5.1 - 5.4, (maybe) 5.6: Definitions, the conditional distribution, integrating $h(u)$ in the linear mixed model, determining the PLS solutions, (maybe) the fill reducing permutation, (maybe) step by step evaluation of the profiled deviance, determining r_θ^2 and $\hat{\beta}_\theta$.

3. **Optimization Algorithms (Jürg)**
   Present the three general types of algorithm: EM, Newton-Raphson, Fisher-Scoring. Demidenko (2004) ch. 2.1, 2.2, 2.5, 2.8-2.15, 13.3 and Pinheiro und Bates (2000) chapter 2.2.8.

4. **Hypothesis Tests, Confidence Intervals (Manuel)**
   Bates (2010) 1.5, 1.6: Assessing the variability of parameter estimates, Assessing the Random Effects. (See Demidenko (2004) 3.4 and 3.5 for additional information.) Discuss some examples of Bates (2010) ch. 2 and 3. Give contrast to the methods used in other software packages (B.T. West (2007) 2.6, 3.11.6, 3.11.10: approximate F distribution, degrees of freedom)

5. **LMMs in Practice (Jürg)**
   Present the complete analysis of several data examples. Pinheiro und Bates (2000) ch. 3-5, Bates (2010) ch. 1-4, B.T. West (2007) ch. 1-7.

6. **Prediction of New Observations (Manuel)**
   Prediction of new observations in contrast to prediction of random effects. Principles of prediction: Welham u. a. (2004). (Further Resources: Vidoni (2006) and Jiang (2007).)

2 Nonlinear Mixed-Effects Models

7. **Overview and Motivation: Introduction to NLS Models (Jürg)**
   Ruckstuhl (2006), Bates und Watts (1988) ch. 2

8. **Theory: NLMMs (Jürg)**
   Pinheiro und Bates (2000) ch. 7, maybe Bates (2010)

9. **Fitting Nonlinear Mixed-Effects Models (Jürg)**
   Pinheiro und Bates (2000) ch. 6 and 8, maybe Bates (2010)

3 Generalized Mixed-Effects Models

10. **Overview and Motivation: Introduction to GLM Models (Manuel)**
    Stahel (2009) ch 13, Collett (2002) ch 3

11. **Theory: GLMMs (Manuel)**
    Bates (2010) 5.7, Collett (2002) ch 8, Demidenko (2004) ch 7.

12. **GLMMs in Practice (Manuel)**
    Present the complete analysis of one or more examples. Bates (2010) and Collett (2002).

Remark:
In order to run the R-code in Bates (2010), you require the packages `lme4a` and `Matrix`, loaded by

```
install.packages("lme4a", repos="http://R-Forge.R-project.org")
install.packages("Matrix", repos="http://R-Forge.R-project.org")
```

References

[Bates 2009] Bates, D.: *Linear mixed model implementation in lme4*. URL `http://stat.ethz.ch/CRAN/web/packages/lme4/vignettes/Implementation.pdf`, 2009. – vignettes of lme4

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[Bates und Watts 1988] Bates, Douglas M. ; Watts, Donald G.: *Nonlinear regression analysis and its applications*. New York : Wiley, 1988 (Wiley Series in Probability and Mathematical Statistics)

[B.T. West 2007] B.T. West, A.T. G.: *Linear Mixed Models - A Practical Guide Using Statistical Software*. Chapman & Hall/CRC, 2007

[Collett 2002] Collett, D.: *Modelling binary data*. CRC Pr I Llc, 2002

[Demidenko 2004] Demidenko, E.: *Mixed Models, Theory and Applications*. Wiley, 2004

[Jiang 2007] Jiang, J.: *Linear and generalized linear mixed models and their applications*. Springer Verlag, 2007

[Pinheiro und Bates 2000] Pinheiro, José C. ; Bates, Douglas M.: *Mixed-Effects Models in S and S-Plus*. Springer, 2000 (Statistics and Computing)

[Ruckstuhl 2006] Ruckstuhl, A.: *Einführung in die nichtlineare Regression*. 2006. – Lecture Notes

[Stahel 2009] Stahel, W.: *Verallgemeinerte lineare Regression*. 2009

[Vidoni 2006] Vidoni, P.: Response prediction in mixed effects models. In: *Journal of Statistical Planning and Inference* 136 (2006), Nr. 11, S. 3948–3966

[Welham u. a. 2004] Welham, S. ; Cullis, B. ; Gogel, B. ; Gilmour, A. ; Thompson, R.: Prediction in linear mixed models. In: *Australian & New Zealand Journal of Statistics* 46 (2004), Nr. 3, S. 325–347