Linear Mixed-Effects Models

(aka Statistics III)

Bernd Figner
b.figner@psych.ru.nl

Week 8: March 31, 2014

1

Today: The End...

- Some brief reminders
- Project presentations 2
  - Sandra
  - Jannie & Koen
- What have we learned; what couldn't be covered?
  - Further reading and other recommendations
- **Feedback and Questions**

2

Reminders

- Deadline for take-home: tonight midnight!
- In-class multiple choice exam: April 7
- Online evaluation form: available shortly after April 7

→ Pretty please: Fill it out! Important for us to get feeback

3

Project Presentations

- Sandra: Soccer
- Jannie and Koen: Cognitive Bias Modification Training

4

What have we learned?

What haven't we learned?

5

Planned Topics

- What are linear mixed-effects models and when are they useful?
- Pros and cons of mixed-effects models
- Many names for the same/similar models
- "Clustered errors," slopes and intercepts
- Fixed and random effects
- Gaussian and generalized (binary, Poisson) linear mixed-effects models

6

- One, two, three, and more levels
- **How to analyze different types of data sets**
  - repeated-measures data
  - longitudinal data
  - nested/hierarchical data
  - questionnaire data; ...

→ Your Data!

- Centering: grand-mean; participant-wise; group-wise
- Crossed/orthogonal random effects
- Within-level and cross-level interactions
- Contrast coding

7

- Significance testing of "coefficients" and "effects"
  - Many ways to get *p* values
- How to build my model: theory-driven and data-driven approaches
- Non-convergence: what now?
- Speeding up computations: using multiple cores
- Report models and their results in text and figure

8

- **The multilevel perspective:** ICCs, model-building, reporting, etc
- Indicators of goodness-of-fit: approaches to compute R^2 and other indicators
- Advanced R programming techniques

Time permitting

- Mediation in a mixed-effects framework
- Mixed-effects models with other packages (e.g., nlme, afex, MCMCglmm, etc)
- Mixed-effects models in SPSS
- Power analysis

9

Some additional pointers/reading/tips

(0) lme4-related functions

- `confint(mymodel)` → CIs → `?confint.merMod()`
- `qqmath(ranef(mymodel))` → plot of random effects
- package `influence.ME` → influence statistics for lme4 models (Cook's distance, dfbeta, ...)

10

(1) Generalized models: Jaeger web page

- http://hlplab.wordpress.com/
- http://wiki.bcs.rochester.edu/HlpLab/LSA2013Regression

And, as always: http://glmm.wikidot.com/faq

(2) Questionnaires→ Rasch model in lme4

Doran, H., Bates, D., Bliese, P., & Dowling, M. (2007). Estimating the Multilevel Rasch Model: With the lme4 Package, *Journal of Statistical Software, 20,* 1-18.

11

(3) Figures for mixed-effects models

- **package** `effects` → `plot(allEffects(mymodel))`
  http://www.jstatsoft.org/v08/i15/paper
- **package** `arm` → `binnedplot(mymodel)`
  diagnostic plots for logistic models
- **packages** `languageR`; `LMERConvenienceFunctions`
  → `LMERplot.fnc()` and `LMERplot3d.fnc()`
  → NOT for most recent lme4
  → http://www.sfs.uni-tuebingen.de/~hbaayen/software.html

12

(4) (Pseudo)R^2 for mixed-effects models

No universal agreement!

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models, *Methods in Ecology and Evolution, 4,* 133–142

→ **for lmer and glmer models**

see also finished code/functions:

- https://jonlefcheck.net/2013/03/13/r2-for-linear-mixed-effects-models/
- https://github.com/jslefche/rsquared.glmer
- http://mbjoseph.github.io/blog/2013/08/22/r2/

13

(5) lme4 on several cores?

Recently: Interesting question on R-sig-mixed list

→ **More than 1 core (or GPU) when running an lme4 model?**
→ **Nope**

BUT: If you have to run several models, you can run them simultaneously, saving a lot of time!

Mac/Linux

- several instances of R simultaneously (from shell/terminal)
- step-by-step how-to: https://files.nyu.edu/mg152/public/

14

(6) Other possibly useful packages

Proceed with caution...

- package `afex` command `mixed()` → fits model, plus all simplifications, and compares them via LRTs
- package `lmerTest` (automated step-wise model selection; p values; and other functions)
- similar: package `LMERConvenienceFunctions`
- package `phia` ("Post-Hoc Interaction Analysis")
- package `multilevel` specifically for multilevel models, ICC, etc (a bit outdated)

15

(7) Mixed-Models in non-R?

Judd C. M., Westfall, J., & Kenny, D. A. (2012). Treating stimuli as a random factor in social psychology: a new and comprehensive solution to a pervasive but largely ignored problem. *Journal of Personality and Social Psychology, 103,* 54-69.

Contains code for R, SPSS, and SAS

16

(8) Mediation and Power Analysis

Mediation

Complicated

- http://statistics.ats.ucla.edu/stat/r/faq/ml_mediation2.htm
- Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15,* 209-233.

Easy

- "joint significance" http://journal.sjdm.org/stat.htm
- http://www.quantpsy.org/medmc/medmc111.htm

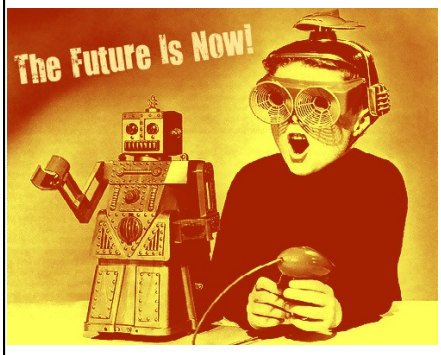
Power Analysis

Complicated: http://rpubs.com/bbolker/11703

Easy: –

17

(9) The future is now?



After educational science, linguistics, and social psychology, now also in the neurosciences

Aarts, E., Verhage, M., Veenvliet, J. V., Dolan, C. V., & van der Sluis, S. Nature Neuroscience (April 2014)

A solution to dependency: using multilevel analysis to accommodate nested data

http://www.nature.com/neuro/journal/v17/n4/pdf/nn.3648.pdf

18

Questions?

Feedback

What was bad, good, ...
How could things be improved?

- Content
- Form: Lectures, Exercises, Homework
- Reading materials
- BlackBoard
  - „Discussion“ board
  - Scripts, materials, slides, ...
- ...

20

Good Luck with the exams!!!