

## Interdisziplinäres Qualifikationsprogramm für Nachwuchswissenschaftler/innen der Wirtschafts- und Verhaltenswissenschaftlichen Fakultät der Universität Freiburg

### Eintägiger Workshop zum Thema "Mixed Models in R – An Applied Introduction"

Dozent: Dr. Henrik Singmann, Universität Zürich

Zeit: Di 19.06.2018 10-18 Uhr (Mittagspause ca. 12-13 Uhr)

Ort: Konferenzraum, 6. OG, Institut für Psychologie

Sprache: Englisch

### Anmeldung

Zulassung: nur für Postdoktorand/innen und Doktorand/innen der WVF

Anmeldung: per E-Mail bis 10.06.2018 an [yziegler@psychologie.uni-freiburg.de](mailto:yziegler@psychologie.uni-freiburg.de)

Auswahl: erfolgt nach dem Prinzip first come, first serve

Teilnehmerzahl: 6 bis 18

### Aufbau und Inhalte des Workshops:

In order to increase statistical power and precision, many data sets in cognitive and behavioral sciences contain more than one data point from each unit of observation (e.g., participant), often across different experimental conditions. Such *repeated-measures* pose a problem to most standard statistical procedures such as ordinary least-squares regression, (between-subjects) ANOVA, or generalized linear models (e.g., logistic regression) as these procedures assume that the data points are *independent and identically distributed*. In case of repeated measures, the independence assumption is expected to be violated. For example, observations coming from the same participant are usually correlated – they are more likely to be similar to each other than two observations coming from two different participants.

The goal of this workshop is to introduce a class of statistical models that is able to account for most of the cases of non-independence that are typically encountered in cognitive

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science – *linear mixed-effects models* (Baayen, Davidson, & Bates, 2008), or mixed models for short. Mixed models are a generalization of ordinary regression that explicitly capture the dependency among data points via random-effects parameters. Compared to traditional analyses approaches that ignore these dependencies, mixed models provide more accurate (and generalizable) estimates of the effects, improved statistical power, and non-inflated Type I errors (e.g., Barr, Levy, Scheepers, & Tily, 2013).

In recent years, mixed models have become increasingly popular. One of the main reason for this is that a number of software packages have appeared that allow to estimate large classes of mixed models in a relatively convenient manner. The workshop will focus on lme4 (Bates, Mächler, Bolker, & Walker, 2015), the gold standard for estimating mixed models in R (R Core Team, 2018). In addition, it will introduce the functionality of afex (Singmann, Bolker, Westfall, & Aust, 2017), which simplifies many aspects of using lme4, such as the calculation of  $p$ -values for mixed models. afex was specifically developed with a focus on factorial designs that are common in cognitive and behavioral sciences.

Despite a number of high impact publications that introduce mixed models to a wide variety of audiences (e.g., Baayen et al., 2008; Judd, Westfall, & Kenny, 2012) the application of mixed models in practice is far from trivial. Applying mixed models requires a number of steps and decisions that are not necessarily part of the methodological arsenal of every researcher. The goal of the workshop is to change this and to introduce mixed models in such a way that they can be effectively used and the results communicated.

The workshop is split into two parts main parts and one interlude. The focus of the first part is not on mixed models, but on the basic knowledge in statistical modeling with R that necessary for competently using mixed models. The second part focuses exclusively on mixed models. It introduces the key concepts and simultaneously shows how to fit mixed models of increasing complexity. Each part will take approximately 3 hours (including breaks). The time between the two parts will be used to provide a short introduction to the tidyverse (Wickham & Grolemund, 2017), a modern set of tools for data science in R that are especially useful in this context.

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Participants of the workshop need some basic knowledge of R. For example, they should be able to read in data, select subsets of the data, and estimate a linear regression model. Participants without any R knowledge will likely not profit from the workshop. Participants also require a current version of R (currently 3.4.4: <https://cran.rstudio.com/>) and of Rstudio (<https://www.rstudio.com/products/rstudio/download/>). Note that both software needs to be downloaded and updated independently. Participants will also be required to install a number of R packages beforehand. The list will be sent out some time before the workshop to the participants.

The language of all workshop materials (i.e., slides and handout) is English. In case all participants are native German speakers, the spoken language can be German.

## References

- Baayen, H., Davidson, D. J., & Bates, D. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, 59(4), 390–412. <https://doi.org/10.1016/j.jml.2007.12.005>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, 67(1). <https://doi.org/10.18637/jss.v067.i01>
- Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, 68(3), 255–278. <https://doi.org/10.1016/j.jml.2012.11.001>
- 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(1), 54–69. <https://doi.org/10.1037/a0028347>
- Singmann, H., Bolker, B., Westfall, J., & Aust, F. (2017). afex: Analysis of Factorial Experiments. R package version 0.18-0. <http://cran.r-project.org/package=afex>
- R Core Team. (2017). R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing. <http://www.R-project.org/>
- Wickham, H., & Grolemund, G. (2017). R for Data Science: Import, Tidy, Transform, Visualize, and Model Data. Sebastopol CA: O'Reilly.

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