

## **Workshop on:**

LINEAR MIXED EFFECTS MODELING FOR MULTIFACTORIAL SENSORY AND CONSUMER DATA USING THE R-PACKAGES LME4, LMERTEST AND SENSMIXED

## **Organized by:**

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## **Abstract:**

Sensory and consumer data are produced in massive numbers within as well food research and industry as within many non-food areas, e.g. high end audio and TV production industry. Mixed effects models have been used extensively for analysing both consumer and sensory data. A user-friendly open source tool, Panelcheck, for high throughput analyses of sensory quantitative descriptive analysis (QDA) is openly available ([www.panelcheck.com](http://www.panelcheck.com)) including visual tools for simple mixed models for such multi-attribute data. The scope of the mixed modelling in Panelcheck, however, is limited in several ways. In this workshop I am going to consider more complex situations such as incomplete data sets, possible carry-over, scale effects as well as more complex covariance structures within a mixed effects model framework.

I am going to introduce two newly developed R-packages ImerTest, Kuznetsova, Brockhoff & Christensen (2015) and SensMixed, Kuznetsova, Brockhoff & Christensen (2014). Both are based on the lme4 package Bates et al (2013), the well-known R-package for fitting mixed effects models. In ImerTest, among other things, automated model selection procedures are available to facilitate more easy access to proper mixed modeling for challenging structured situations, Kuznetsova et al (2015). Also recently, the so-called Mixed Assessor Model (MAM) was proposed by Brockhoff, Schlich & Skovgaard (2014) as an improved mixed model analysis of sensory data more properly taking into account the inherent effects of individual differences in perceptive scale use in such data. The MAM approach, however, was introduced in a rather restricted model setting. The combination of the MAM approach with a more general mixed modelling approach covering now most relevant sensory and consumer data situations has been implemented in SensMixed. So has also the recently suggested d-prime like visualizations of the effects in mixed model analysis of sensory and consumer data introduced in Brockhoff et al (2015). The SensMixed package runs either as a usual script-based R-package or optionally as a more user friendly Shiny GUI application.

## **Plan:**

- 1) Introduction to mixed models by the lmer package,
- 2) Background on the approaches used in ImerTest, SensMixed
- 3) Example based tutorials on using ImerTest, SensMixed
- 4) Hands-on working with examples or own data

## References

Douglas Bates, Martin Maechler, Ben Bolker and Steven Walker (2013). lme4: Linear mixed-effects models using Eigen and S4. R package version 1.0-4. <http://CRAN.R-project.org/package=lme4>

Brockhoff P. B., Amorim I., Kuznetsova A., Søren Bech, Lima R. R. (2015), D-prime interpretation of a standard linear mixed model results (*Revised version submitted to Food Quality and Preference*)

Brockhoff, P. B., Schlich, P., & Skovgaard, I. (2015). Taking individual scaling differences into account by analyzing profile data with the Mixed Assessor Model. *Food Quality and Preference*, 39, 156-166.

Kuznetsova, A., Christensen, R.H.B., Bavay, C. and Brockhoff, P.B. (2015). Automated mixed ANOVA modeling of sensory and consumer data. *Food Quality and Preference* 40, 31-38

Alexandra Kuznetsova, Per Bruun Brockhoff and Rune Haubo Bojesen Christensen (2015). lmerTest: Tests for random and fixed effects for linear mixed effect models (lmer objects of lme4 package).. R package version 2.0-29. <https://cran.r-project.org/web/packages/lmerTest/>

Alexandra Kuznetsova, Per Bruun Brockhoff and Rune Haubo Bojesen Christensen (2014). SensMixed: Mixed effects modelling for sensory and consumer data. R package version 2.0-8. <http://cran.at.r-project.org/web/packages/SensMixed/>

Panelcheck: [www.panelcheck.com](http://www.panelcheck.com)