

University of Florence, October 6-7, 2026

Short course

Mixed models

Geert Verbeke

Leuven Biostatistics Centre, KU Leuven (Belgium)

geert.verbeke@kuleuven.be

https://perswww.kuleuven.be/geert_verbeke

Outline

This course explains the use of linear, generalized linear, and non-linear mixed models to deal with correlated, clustered, or longitudinal two-level as well as multi-level data in practice. The focus lies on the modeler's perspective and on applications with emphasis on model formulation, parameter estimation, and inference, rather than on mathematical detail.

Throughout the course, all developments will be extensively motivated using real world datasets, most of which will be made available to the course participants. Those applications will also be used to illustrate special topics and frequently observed mistakes or misconceptions.

Nowadays, many commercial as well as freely available software packages are available for fitting mixed models. In order to accommodate all participants, no software implementation will be discussed. Instead, focus will be on understanding why different packages may lead to (very) different results, and on considerations which may help choosing the most appropriate software for specific data structures and research questions at hand.

Finally, there will be ample opportunity for participants to interact with the teacher and to discuss own case studies and encountered problems.

October 6

- Session 1 (9.00 – 10.30):
 - Correlated data
 - Introduction to linear mixed models
 - How do mixed models handle correlation ?
 - Mixed models for paired observations
- Session 2 (11:00 – 12:30):
 - Mixed models for longitudinal observations
 - The general linear mixed model
 - The hierarchical versus marginal model

LUNCH BREAK

- Session 3 (13:30 – 15:00):
 - Maximum likelihood versus restricted maximum likelihood
 - (RE)ML likelihood ratio tests for fixed effects
- Session 4 (15:30 – 17:00):
 - Multi-level linear mixed models
 - Empirical Bayes estimation
 - Average versus cluster-specific prediction

October 7

- Session 5 (9:00 – 10:30):
 - Shrinkage
 - Introduction to generalized linear mixed models
- Session 6 (11:00 – 12:30):
 - Logistic mixed models
 - Various approximations of the likelihood function
 - Multi-level generalized linear mixed models

LUNCH BREAK

- Session 7 (13:30 – 15:00):
 - Poisson mixed models
 - Parameter interpretation: Linear versus generalized linear mixed models
 - Marginalizing generalized linear mixed models
- Session 8 (15:30 – 17:00):
 - Non-linear mixed models
 - Tests for variance components
 - Distributional assumptions for random effects
 - Missing data issues