Bayesian analysis of longitudinal studies
Two days short course
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Wallenberg centre, STIAS
Stellenbosch University

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Longitudinal studies constitute an important class of studies in clinical research and arise when a response is repeatedly measured over time. This is in contrast to a survival study where the time to an event is recorded. In the first case the statistical analysis involves techniques for repeated measures, while in the second case one essentially uses survival analysis. In the last decade a combination of the two statistical techniques is becoming popular and involves the joint modeling of survival times and longitudinal measurements. Longitudinal data can be analyzed in the classical, frequentist framework, but the Bayesian approach offers more flexible modeling options which could be useful when the data structure is complex (multivariate outcomes, multiple levels in the data, some missing data patterns, joint modeling, etc.). We will illustrate the Bayesian approach for the analysis of such data, by means of a great variety of examples. Examples will be analysed using WinBUGS/OpenBUGS/JAGS and R-versions of them, but also other software will be used.

The course consists of 2 parts: Part I: introduction to the Bayesian approach based on the newly released book Bayesian Biostatistics of Lesaffre and Lawson and Part II: devoted to the analysis of FU studies.

Recommended reading:

Prerequisites:
The course will be oriented towards an applied audience with a good knowledge of various regression models. Some notions on classical repeated measurements analysis and classical survival analysis are helpful. The Bayesian concepts will be introduced briefly; hence a prior
course on the Bayesian approach will certainly be helpful. The concepts will be explained on real data examples for which either R, WinBUGS, etc. code will be provided together with data to try out at a later time. Knowledge of R is quite useful for the course, but no prior knowledge on WinBUGS is required for the course, although also quite useful.

**Course outline:**

1. A review of the used examples.
2. A review of classical repeated measurements analysis techniques illustrated using the SAS procedures MIXED, NLMIXED and GLIMMIX.
3. Introduction to the Bayesian concepts: Bayes’ theorem, posterior distribution, posterior predictive distribution and posterior summary measures. The choice of the prior distribution. Multivariate Bayesian inference. Sampling algorithms: basic sampling algorithms, general purpose sampling algorithms, MCMC sampling algorithms (Gibbs and Metropolis-Hastings) + convergence checks. Aspects of Bayesian software: Win/OpenBUGS, JAGS, etc.
4. An introduction to the theory of hierarchical Bayesian models together with Bayesian model selection and evaluation. Examples of Bayesian analyses of longitudinal studies: (generalized and non-linear) linear mixed models with non-standard distributions for the random parts, longitudinal models with a change point, growth curve models, multivariate mixed models, joint mixed models of several random variables, longitudinal models with smooth subject-specific evolutions, etc. In the above analyses, also the problem of missing data and dropouts will be addressed. Finally, also joint modeling of longitudinal studies with survival models to address informative missing data processes.

Practical sessions will be organized in the modules 3 and 4.

**Learning Outcomes:**
It is hoped that the course helps in analysing relatively complex longitudinal data structures.

**Instructor:**

**Emmanuel Lesaffre:**
Emmanuel Lesaffre is Professor of Biostatistics at I-Biostat, K.U.Leuven, Leuven, Belgium. His research interests include Bayesian methods, longitudinal data analysis, statistical modelling, analysis of dental data, interval censored data, misclassification issues and clinical
trials. He has written more than 350 papers in peer-reviewed statistical and medical journals. He is the founding chair of the Statistical Modelling Society, past-president of the International Society for Clinical Biostatistics and fellow of ISI and ASA. He (co-)authored five books among which the recently published Wiley book Bayesian Biostatistics (2012) together with Andrew Lawson. He has taught many statistical courses on a variety of topics in regular master programs, but also short-courses on-site both at national as well as international level. The audience consisted of medical students and researchers, engineers, mathematicians and statisticians.

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