



oikostat.ch



vogelwarte.ch

Course and Workshop

## Bayesian Data Analyses Using Linear Models with and Stan

7. - 10. January 2019, Sempach, Switzerland

Bayesian data analysis becomes more and more standard in the analyses of biological data. Bayesian methods are the only methods that provide exact estimates of the standard errors in non-normal, hierarchical and more complex models (see e.g. Bolker et al. 2008, TREE 24:127-135). They allow fitting models that are too complex to be fitted easily using frequentist methods, e.g. hierarchical ecological models. Furthermore, existing knowledge about a parameter can formally be used when analysing the data, and the results have a natural interpretation such as the probability of a meaningful hypothesis.

The course introduces the principles of Bayesian data analyses together with a sound training in applying linear models. Today, life scientists, especially ecologists, are expected to be familiar with **normal linear models** (LM), **linear mixed models** (LMM), **generalised linear models** (GLM), and **generalised linear mixed models** (GLMM). These four types of models form the basis for a variety of more complicated models, such as hierarchical ecological models, mark-recapture, animal movement and population models.

Participants will apply linear models using Bayesian methods with the free statistical software R ([www.r-project.org](http://www.r-project.org)) and the add-on packages *arm*, *rstanarm* and *rstan*. The course follows Gelman & Hill 2007, *Data Analysis Using Regression and Multilevel/Hierarchical Models*, Cambridge University Press, Korner-Nievergelt et al. 2015, *Bayesian Data Analysis in Ecology Using Linear Models with R, BUGS and Stan*, Elsevier, New York, and McElreath (2016) *Statistical Rethinking*, CRC Press, New York.

Worked examples will include:

- graphical data exploration (various plotting functions)
- fit of the model to data (R-Functions *lm*, *lmer*, *glm*, *glmer*, *stan\_glm*, *stan\_glmer*)
- assessment of model fit and model assumptions (diagnostic plots of residuals, predictive checking)
- model comparisons, information theory, regularizations (ridge regression)
- visualization of the results and drawing conclusions

During the last day of the course, participants analyse their own data.

Date: 7.-10. January 2019

Location: Swiss Ornithological Institute, Room Aquila, Seerose 1, CH - 6204 Sempach

Teachers: Fränzi Korner-Nievergelt, Bettina Almasi, Pius Korner-Nievergelt, Swiss Ornithological Institute ([www.vogelwarte.ch](http://www.vogelwarte.ch)) and oikostat GmbH, Ettiswil ([oikostat.ch](http://oikostat.ch))

Contents: Day 1: Short introduction to R (optional)  
Introduction to Bayesian statistics  
Overview frequentist and Bayesian statistics  
Normal linear model (LM): ANOVA, ANCOVA, regression

Day 2: Model comparison via information theory, regularization  
Linear mixed effects model (LMM)  
Generalised linear model (GLM): binomial and Poisson-model

Day 3: Posterior predictive model checking  
Generalised linear mixed model (GLMM)  
Including prior information in linear models

Day 4: Participants work on their own (or example) data and give short presentations

Course form: Lectures, exercises and work on own data  
The number of participants is limited to 20.  
Participants are expected to bring their own laptop with R installed.  
For the last day, participants should bring own data suitable for analyses using a linear model.

Course hours: 9 00 to 17 00 including two coffee breaks and a one hour lunch break.

Prerequisite: Make sure you are familiar with the following terms: mean, standard deviation, standard error, and t-test (e.g. chapter 2 in Korner-Nievergelt et al. Bayesian Data Analysis in Ecology Using Linear Models with R, BUGS and Stan).

Costs: Student price CHF. 680.-/ regular price CHF 840.-

Registration and information: Fränzi Korner-Nievergelt, [fraenzi.korner@oikostat.ch](mailto:fraenzi.korner@oikostat.ch)

**oikostat.ch**



**vogelwarte.ch**