Introduction to Hierarchical Bayesian Analysis for Ecological Data using WinBUGS

29 and 30th June 2014

CIRAD, Avenue Agropolis, 34398 Montpellier Cedex 5, France

Course outline

Use of Bayesian methods is becoming increasingly widespread in quantitative investigations of ecological data, particularly for scientific reporting of complex analyses involving hierarchical or multilevel data. This two-day course aims at introducing quantitative researchers to write, and infer the statistical model of their own. We will recall the principles of Bayesian modeling and inference, with emphasis on piecewise construction of hierarchical model structures and highlight by practice many of the advantages that a Bayesian approach can offer.

This course provides significant PC lab opportunities, with time for hands-on data analysis using. The course will rely on the BUGS programming language which is one of the most commonly used software for Bayesian modeling. The focus will be on writing hierarchical models with BUGS, not on the technical aspects of sampling based methods required to estimating Bayesian posterior distributions (e.g., MCMC, Gibbs).

The course will assume some elementary knowledge of probability theory (random variables, distributions) and basic familiarity with common statistical models (likelihood theory, regression model), but no previous experience of Bayesian methods nor BUGS language is required.

Course content (to be adapted in real time to the audience)

Day 1

- Bayesian methods of inference, how does it work?
  - Simulating estimates under the frequentist paradigm (Forward thinking)
  - Thinking conditionally both ways
  - Bayesian versus frequentist estimates
- Common misconceptions about a priori distributions
- Getting the posterior in practice (brief overview of MCMC sampling methods)

- Examples with implementation in BUGS
  - Capture recapture in a salad bowl
    - Make your own experiment.
    - Writing a beta binomial model under BUGS
    - Assimilating information: Do I recover the true value of the unknowns?
  - Stock-Recruitment models and other regression-like models

Day 2

- Hierarchical models to learn more from multilevel data
  - Exchangeable hierarchical models
  - Advantages of hierarchical modeling: borrowing strength and predictions
- Introducing covariates to structure the between units variability - towards "integrated models"

- Examples with implementation in BUGS
  - Capture-mark recapture model to estimate a salmon population size
  - Other examples : Hierarchical SR models for between river variability
- Writing hierarchical models under other softwares (brief tour about similarities and differences + examples of codes)
  - JAGS
  - STAN

Fees

There will be no fee and the audience will be kept limited to favor interactions. Participants shall register in advance by one of the authors and bring their own copy of our book (see www.hbm-for-ecology.org).

Participants are required to have their own laptop with the following softwares installed

- R release 3,0,2 (running under Rstudio, preferably)
- R library R2OpenBUGS
- OpenBUGS (or WinBUGS1,4 with "immortal" key)

Recommended reading

Parent, E. and Rivot, E. (2012) *Introduction to Hierarchical Bayesian Modeling for Ecological Data*. Chapman & Hall/CRC.

Kery, M. and Schaub, M.(2012) *Bayesian Population Analysis using WinBUGS/OpenBUGS: a Hierarchical Perspective*. Academic Press, Burlington, 2012.

King, R., Morgan, B.J.T., Gimenez, O. and Brooks, S.P. (2010) *Bayesian analysis for population ecology*. Chapman & Hall/CRC, London

Kery, M.(2010) *An Introduction to WinBUGS for Ecologists*. Academic Press, Elsevier Inc.

For other background materials please visit our website: www.hbm-for-ecoly.org

Teachers

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