



Danish Informatics Network in  
the Agricultural Sciences

Dansk Informatiknet i  
Jordbrugsvidenskaberne

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## Monte Carlo methods for Hierarchical (Mixed) Models

### Workshop for PhD students

Koldkærgaard Landboskole, October 30-31 2003.

### Invitation

Studies within agricultural research are often characterised by an hierarchical design. Examples are studies based on measurements on plants within fields within farms, or similarly animals within herds within breeds. Hierarchical design arise both in controlled experiments and in epidemiological studies. Statistical analysis of these data are complicated because the design leads to dependency between observations. These dependencies need to be handled in the statistical model. Therefore, parameter estimation becomes very complex in most cases, and specialised numerical methods are necessary. Monte Carlo methods are becoming increasingly popular for this purpose. The workshop will present the principles behind the methods, and their application for analysing data from the hierarchical designs will be demonstrated. Typically, the models include both *fixed* effects (e.g., treatment) and *random* components that models the dependency between observations (e.g., a farm effect). Therefore, such models are often called mixed models.

The lectures and case studies will be accompanied by computer exercises where the workshop participants can get a hands on experience with the methodology.

The theoretical basis is likelihood based inference for these hierarchical or mixed models, and topics will include both traditional models and so called latent class or mixture models. Different Monte Carlo methods will be presented, e.g. importance sampling and Markov Chain Monte Carlo (MCMC). Models based on both normal (Gaussian) and other probability distributions (generalised linear mixed models) will be covered.

The workshop is aiming at

- Ph.D.-students in the agricultural and biological sciences, whose work involves data from hierarchical designs and who are interested in learning about the new possibilities for analysing these data.
- Ph.D.-students with a background in mathematics, computer science, or engineering who are interested in learning more about the applications in the biological sciences.

The DINA Research School is part of a Nordic cooperation. The workshop language will be English unless all participants have Danish as the first language.

We are looking forward to seeing you at Koldkærgård Landboskole!

Rasmus Waagepetersen  
Dina Research School  
Aalborg University

Erik Jørgensen  
Danish Institute of Agricultural Sciences  
Dina Research School

url: <http://www.dina.dk/phd/w/w12/>

# Monte Carlo methods for Hierarchical (Mixed) Models

## Preliminary Program

### Thursday, October 30

11.00 Arrival and accommodation.

12.00 Lunch

13.00 **Introduction and presentation of participants**

*Erik Jørgensen*, Dina Research School.

13.15 **Theory session I:**

*Rasmus Waagepetersen*, Aalborg University.

The concepts of hierarchical and generalized linear mixed models are discussed in relation to various datasets from the agricultural sciences. A basic problem with these models is that the likelihood function is not available in closed form. We consider various numerical techniques for calculating the likelihood function with a particular focus on Monte Carlo methods.

14.00 **Short break followed by computer exercises.**

14.45 **Discussion of exercises**

15.00 Coffee break.

15.30 **Theory session II:**

*Rasmus Waagepetersen*, Aalborg University.

We continue the discussion of Monte Carlo methods and consider importance sampling and Markov chain Monte Carlo methods for generating samples from an importance sampling distribution.

16.15 **Computer exercises.**

17.00 **Theory session III:**

*Rasmus Waagepetersen*, Aalborg University.

We discuss the Bayesian approach to inference for hierarchical models and how it can be implemented using the software BUGS.

18.00 Dinner.

19.00 **Case study I: .**

19.45 **Computer exercises (continued).**

21.45 Coffee and sandwich.

## Friday, October 31

7.30 Breakfast.

8.30 **Discussion of computer exercises.**

9.00 **Case II:**

*Ole Fredslund Christensen*, Center for Bioinformatics, Aarhus Universitet .

9.45 Coffee Break.

10.00 **Theory IV:.**

*Rasmus Waagepetersen*, Aalborg University.

The final lecture is devoted to more specialized topics in MCMC and hierarchical models with non-Gaussian random effects.

10.30 Break.

10.35 Computer exercises.

11.15 **Case III:**

11.45 **Discussion and Closing.**

*Erik Jørgensen*, Dina Research School.

12.00 Lunch and departure.

## **Practical information**

**Time** From Thursday noon, April 30, till Friday 1 pm, October 31, 2002.

**Venue** Koldkærgård Landboskole. Udkærvej 10, Skejby 8200, Århus N, Telefon 86 78 54 55, Telefax 86 78 54 70. Refer to the travel information on the web-page.

**Accommodation** Single rooms with shower and WC.

**Board** Full board starting with lunch on October 30 and ending with lunch on October 31.

**Price** The Dina Research School pays for participation including accommodation and meals. Travel costs are paid by the Department of the PhD student (except for accepted Nordic participants where NorFA covers the travel costs). Other participants pay directly to Koldkærgård (approximately 1500 DKK)

**Target group** Ph.D. students whose projects are based on a problem from the agricultural or biological sciences no matter whether the student has a background in biological or informatics science. Others may attend at their own cost.

**Conditions for participation** Active participation in discussions and exercises is expected.

**Further information** Dina Research School, Erik Jørgensen, is available for further information. Use e-mail: Erik.Jorgensen@agrsci.dk

**Registration** Send an e-mail to the research school with information about name, address and whether or not you are a PhD student.

**Deadline for registration** As soon as possible and no later than October 9, 2003.

### **Experts of the Dina Research School**

Computer Science:	Peter Sestoft, Department of Mathematics and Physics, KVL
Statistics:	Rasmus Waagepetersen Department of Mathematical Sciences, AAU
Numerical science:	Per Grove Thomsen, Informatics and Math. Modeling, DTU