

Teachers

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- Professor **Serafin Moral**, Department of Computer Science, University of Granada, Granada, Spain.
- Professor **Linda C. van der Gaag**, Institute of Information and Computing Sciences, Uthrech University, Utrecht, The Netherlands.
- Senior Scientist, **Erik Jørgensen**, *Dina Research School* and Danish Institute of Agricultural Sciences, Denmark.

Language and credits

The language of the course will be English. The number of credits is 6 ECTS.

National contact persons

Denmark: Anders Ringgaard Kristensen, *Dina Research School* (see address below).

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Financial support

The course in general is financed by NOVA and NorFA. Thus travel costs and course fee as well as accommodation and meals for Ph.D. students are covered by this general grant.

Further information and registration at URL:

<http://www.dina.dk/phd/s/s6/>

Tune Landboskole

Tune Landboskole is situated in a rural environment approximately 30 km from the centre of Copenhagen. The oldest buildings are from 1857, but the course centre has concurrently been extended and modernized in order to remain appealing and pleasant.

Teaching Facilities



Tune Landboskole has 4 major lecture rooms and a number of smaller rooms intended for group sessions and meetings.

The lecture rooms are equipped with AV-facilities, and the course centre has modern computer facilities for teaching.

Staying at Tune Landboskole

In the leisure time, guests may use the library or they may relax in the evening in a pleasant environment in the "cowshed". The course centre also has a minor swimming pool and a sauna as well as various equipments for physical exercise.



The Food

Daily meals are served by the kitchen with emphasis on wholesome and home-made food.

180303

Reasoning under Uncertainty in Agriculture:

Bayesian Networks and Graphical Models

Tune Landboskole, Denmark
August 10-21, 2003



Nordic PhD course

Financed by NOVA & NorFA

Organized by the **Dina** Research School

on behalf of
Nordic Informatics Network
in the Agricultural Sciences

Summer School, August 10-21 2003

Reasoning under Uncertainty in Agriculture:

Bayesian Networks and Graphical Models

Background

Within agricultural and other kinds of biological research many problems involving the need for reasoning without perfect knowledge are studied. Examples are numerous and includes for instance:

- The diagnostic problem in veterinary medicine: Based on more or less specific symptoms, the veterinarian must establish a diagnosis in terms of a specific diseases that the animal suffers from. If the symptoms are too vague, the veterinarian may take supplementary observations as for example laboratory analyses that may increase his belief in a specific disease. In many cases, however, certainty is never obtained.
- The diagnostic problem in plant protection: In case of plant diseases, the decision maker faces an analogous problem of identifying a plant disease based on on or more symptoms. In this case, however, the uncertainty about the weather conditions during the next days will increase the uncertainty concerning the need for treatment.
- The pregnancy test problem: If an animal is mated there is a certain probability that it is pregnant. If furthermore it does not show heat in the next cycle, our belief in pregnancy will increase, and later a positive pregnancy test will increase it further, but until the offspring is actually born there will be a slight uncertainty concerning the true state of the animal.
- The trouble shooting problem in agricultural engineering: If some kind of technical equipment (e.g. a feeding machine or a tractor) fails, a number of tests are used in order to identify the cause. A well-structured test/repair sequence is needed in order to fix problem with a high degree of certainty at a low cost.

A common trait of the examples mentioned is that we try to identify the true state of some system. The problem is, however, that this state is not directly observable. Instead we observe some other variables which in some sense are correlated to the true state. Based on those indirect observations we try to make a conclusion concerning the true state.

Bayesian networks (or more generally, graphical models) provide an excellent framework for handling this kind of problems in a consistent way. During the recent years, several agricultural applications relying on this technique have been developed, and also from a theoretical point of view, the research area of graphical modeling is currently experiencing a burst. It is now one of the main areas of research in artificial intelligence.

Aim of the course

The first objective of the course is to give the participants an overview of the basic principles for reasoning in graphical models. During the course, the principles will be emphasized through illustrative examples from agriculture and other biological sciences.

An other objective is to introduce the participants to model building in practice through exercises and a minor project using a computer tool for graphical models. Therefore methods for estimation of the probability distributions used in such models are introduced.

After the course, the PhD students will be able to build graphical models of a biological or technical domain originating from their main project. They are familiar with the basic principles for reasoning including observation and entering of evidence, propagation and conclusion.

Topics and Key Words

The summer school will focus on the following main topics:

- graphical modeling of biological systems by use of Bayesian networks and related techniques,
- estimation of probability distributions,
- decision graphs
- implementation of the models on a computer,
- use of the resulting system for reasoning under uncertainty,
- learning from data (data mining)
- evaluation of the computed results

The material will be illustrated with various examples from agriculture and biology, and supplemented with guest lectures on related issues.

Throughout the course, the theory will be supplemented with exercises and computer assignments. At the end of the course, the students will work on a two-day project that involves both

modeling and computing aspects.

The following key words describe the technical contents of the course:

- Causal networks.
- Probability calculus.
- Bayesian networks.
- Conditional independence, d-separation.
- Modeling with graphical networks: Methods, examples, tricks.
- Compilation: Triangulation, moralization, junction trees.
- Software for graphical models.
- Techniques for estimation of conditional probability distributions.
- Sensitivity analyses.

Required knowledge

Familiarity with computers at user level, and with basic probability calculus and related concepts.

Preliminary Programme

Monday 11: Introduction, aims of the course, Baye's Theorem, basic probability calculus, graphical models, introductory examples

Tuesday 12: Causal relations, conditional distributions, Bayesian networks, examples from agriculture and biology

Wednesday 13: Conditional independence, d-separation, Markov property

Thursday 14: Model building with Bayesian networks, methods, examples and tricks, evidence and propagation, dynamic models

Friday 15: Estimation of conditional distributions, learning from data I

Sunday 17: Learning from data II, trouble shooting, triangulation, moralization, junction trees, propagation methods

Monday 18: Decisions and utilities: Decision graphs, current trends in graphical modeling

Tuesday 19 - Thursday 21: Project work, presentation, evaluation

Further information and registration at URL:

<http://www.dina.dk/phd/s/s6/>

The website is updated as information becomes available.