# FSF3963 Probabilistic Graphical Models in Multivariate Statistical Inference 7.5 credits

## Probabilistiska grafiska modeller inom multivariat statistisk inferens

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

## Establishment

Course syllabus for FSF3963 valid from Spring 2019

## Grading scale

P, F

## Education cycle

Third cycle

## Specific prerequisites

A minimal requirement is a basic course in mathematical statistics such as SF1901 and an advanced level course in probability (SF2940).
Undergraduate and graduate courses in multivariate statistical inference are recommended.

## Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

## Intended learning outcomes

After having passed the course the student is supposed to be able to:

- State the Hammersley-Clifford theorem for undirected graphs and explain its connection to the factorization of the underlying probability distribution;
- State the graphoid axioms and relate them to the dependence structure induced by graph separation and conditional independence in a multivariate probability distribution;
- Derive the fundamentals of the Gaussian graphical models and log-linear modes for contingency tables;
- Derive the concept of decomposability of a graph and explain its role for both graph structure learning and parametric inference;
- Explain the role of hyper-Wishart and the hyper-inverse Wishart distributions for the Bayesian inference within the context of Gaussian graphical models;
- Explain the role of hyper-Dirichlet distribution for Bayesian inference within the context of the log-linear modes for contingency tables;
- Judge whether probabilistic graphical modelling can be regarded as a promising inferential strategy for a given real-world problem;
- Design, apply and validate a graph structure learning algorithms along with the corresponding parametric inference strategy, suitable for a specific real-world consideration.
- Place the probabilistic graphical modelling into a general perspective of multivariate statistical inference.
- Review the modern literature on a selected topic of the probabilistic graphical modelling and write a technical report presenting graph-theoretic concepts and algorithms.

## Course contents

Conditional independence, Markov properties and graphoid axioms. Hammersley-Clifford theorem, exponential family and canonical parameters, decomposable graphical models and criteria of decomposability.

Gaussian graphical models (GGM), covariance and concentrations graph models, Bayesian parametric inference on GGMs, a family of hyper- Wishart distributions on decomposable GGMs, model determination in GGMs. Discrete hierarchical log-linear models, Bayesian analysis on graphs for contingency tables, a family of hyper-Dirichlet distributions. Sampling algorithms for both graph and parametric posterior inference.

Project work comprises graph modelling and analysis where theoretical knowledge acquiring during the course will be applied within a chosen area of interests.

## Disposition

Lectures and seminars. Students presentation of some book chapters and research papers. Project work during the course with the presentation at the end.

## Course literature

Lauritzen, Steffen. Graphical models.  Oxford Science publications, 2004.   Studeny Milan, Probabilistic conditional independence structures,  Springer, 2005.

Selected journal papers.

## Examination

- PRO1 - Project work, 7.5 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

An oral exam and a project report supervised by and submitted to the examiner.

## Other requirements for final grade

Approved result of the oral examination and accepted project report.

## Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.