

# Probability Theory and Bayesian Networks

Programme course

6 credits

Sannolikhetsteori och bayesianska nätverk

TAMS22

Valid from: 2017 Spring semester

**Determined by**

Board of Studies for Computer Science  
and Media Technology

**Date determined**

2017-01-25

## Main field of study

Mathematics, Applied Mathematics

## Course level

Second cycle

## Advancement level

A1X

## Course offered for

- Computer Science and Engineering, M Sc in Engineering
- Information Technology, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Mathematics, Master's programme
- Computer Science, Master's programme

## Entry requirements

Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites

A first course in probability theory, a first course in statistics.

## Intended learning outcomes

The course gives an introduction to the analysis of causal networks. It discusses graphical modelling and algorithms for updating the probability distributions. The student should expect to acquire some basic knowledge of the theory and engineering applications of Bayesian networks. By the end of the course, the student will have:

- encountered the Bayesian paradigm.
- seen the definition of a Bayesian Network.
- seen some applications of Bayesian networks in engineering.
- understood various graphical representations of conditional independence and how to use them for efficient updating.
- learned how to construct a junction tree and how to pass messages along a junction tree to update the probability distribution over the network.
- have encountered Pearl's intervention calculus.

## Course content

- Uncertainty and the Bayesian Paradigm, Jeffrey's and Pearl's update methods, multinomial sampling and the Dirichlet distribution.
- Conditional independence and d-separation, Bayesian Networks.
- Hard, soft and virtual evidence, Bayesian sufficient statistics, Markov chain Monte Carlo methods
- Decomposable graphs, junction trees, Markov equivalence, the essential graph and chain graphs.
- Learning the conditional probability potentials.
- Learning the graph structure.
- Parameters and sensitivity; measuring distances between probability distributions.
- Graphical models and exponential families; conditional Gaussian distributions.
- Causality and Pearl's intervention calculus.
- The junction tree and message passing algorithms for probability updating.
- Factor graphs and the sum product algorithm.

## Teaching and working methods

Lectures and tutorials. Computer assignments as home exercises.

## Examination

TEN1	Written Examination	5 credits	U, 3, 4, 5
LAB1	Compulsory Assignment	1 credits	U, 3, 4, 5

## Grades

Alternative-grade scale, LiU, U, 3, 4, 5

## Department

Matematiska institutionen

## Director of Studies or equivalent

Ingegerd Skoglund

## Examiner

Torkel Erhardsson

## Course website and other links

<http://www.mai.liu.se/~jonob/kurser/TAMS22/>

## Education components

Preliminary scheduled hours: 48 h

Recommended self-study hours: 112 h

## Course literature

Timo Koski & John Noble: Bayesian Networks: An Introduction, Wiley (krävs).

## Common rules

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at [http://stydokument.liu.se/Regelsamling/Innehall/Utbildning\\_pa\\_grund-\\_och\\_avancerad\\_niva](http://stydokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).