

Course 1	Bayesian networks
Program	<p>1. Basics of Bayesian networks</p> <p>1.1. Reasoning with uncertainty</p> <p>1.2 Probabilistic conditional independence</p> <p>1.3 Correspondence between graph and model: D-separation</p> <p>1.4 Bayesian networks: properties</p> <p>1.5 Building Bayesian networks</p> <p>2. Inference in Bayesian networks.</p> <p>2.1 Different queries: deductive, diagnostic and intercausal reasoning, abduction</p> <p>2.2 Exact inference:</p> <ul style="list-style-type: none"> - Brute force approach - Variable elimination - Message-passing <p>2.3 Approximate inference</p> <p>3 Learning Bayesian networks from data</p> <p>3.1 Introduction</p> <p>3.2 Factorization of the joint probability distribution</p> <ul style="list-style-type: none"> - Methods based on testing conditional independence - Methods based on score + search - Hybrid methods - Applications <p>3.3 Bayesian classifiers</p> <ul style="list-style-type: none"> - Naive Bayes - Seminaive Bayes - Tree augmented network - K- dependence network - Markov Blanket - Bayesian multinets <p>4 Real applications</p> <p>Practical demonstration: GeNIe, Weka, Bayesia and R (packages bnlearn and gRain)</p>
Bibliography	<ul style="list-style-type: none"> • Neapolitan, R.E. (2004) <i>Learning Bayesian Networks</i>. Prentice Hall. • Castillo, E., Gutiérrez, J.M., Hadi, A.S. (1997) <i>Expert Systems and Probabilistic Network Models</i>. Springer. • Koller, D., Friedman, N. (2009) <i>Probabilistic Graphical Models. Principles and Techniques</i>. MIT Press. • F. Jensen, T. Nielsen (2007) <i>Bayesian Networks and Decision Graphs</i>. Springer.
Prerequisites	<p>The student is supposed to be familiar with basic notions of probability and graphs.</p> <p>Also, the students who feel comfortable with R can follow the practical demonstration in R by running the code themselves. In this case, they should have R and the required packages (we will provide instructions in due time) installed before the course starts, so no lecture time is spent on this. Should the student have any trouble installing the software, she may contact the course professors for assistance.</p>

Readings before coming

The student will benefit more from the course if she reads before coming:

- Chapters 1 and 2 of Kjærulff, U. B. and Madsen, A. L. (2005), [Probabilistic Networks - An Introduction to Bayesian Networks and Influence Diagrams](#).
- Video lecture on 'Learning Bayesian networks' by Richard E. Neapolitan: http://videlectures.net/kdd07_neapolitan_lbn/
- Video lecture on "Introduction to Graphical Models" by Z. Ghahramani: http://videlectures.net/mlss07_ghahramani_grafm/
- Video lecture on general Bayesian networks by P. Dasgupta: <http://www.youtube.com/watch?v=rFQsbArQE6Y>
- Video lecture on "Reasoning with Bayes networks" by P. Dasgupta http://www.youtube.com/watch?v=cMN6ykIYF_U