

# Probabilistic Modelling and Reasoning

School of Informatics, University of Edinburgh

Instructor: Prof Chris Williams

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**Assessment** By formal examination (70%) and two assignments (15% each).

**Online material** is available through the course web page at <http://www.inf.ed.ac.uk/teaching/courses/pmr>.

## Resources

The course textbook is “Pattern Recognition and Machine Learning” by Christopher M. Bishop, Springer (2006).

Additional useful texts for some of the material are: “Information Theory, Inference and Learning Algorithms” by D. J. C. MacKay (Cambridge University Press, 2003), and “Artificial Intelligence: A Modern Approach” by S. Russell and P. Norvig (Prentice Hall, second edition 2002).

## Syllabus

- Introduction
- Probability
  - random variables, joint, conditional probability
- Discrete belief networks
- Inference in discrete belief networks: the Junction Tree Algorithm
- Continuous distributions, graphical Gaussian models
- Learning
  - Maximum Likelihood parameter estimation
  - Bayesian methods for parameter estimation
- Decision theory
- Hidden variable models
  - mixture models and the EM algorithm
  - factor analysis
  - ICA, non-linear factor analysis
- Dynamic hidden variable models

- Hidden Markov models
  - Kalman filters (and extensions)
- Bayesian Learning of Belief Networks
  - Model comparison
- Information theory
  - entropy, mutual information
  - source coding, Kullback-Leibler divergence
- Undirected graphical models
  - Markov Random Fields
  - Boltzmann machines