

C19 : Unsupervised Machine Learning

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- Supervised machine learning
 - = regression/classification = conditional density/distrib. estimation
 - Requires training pairs; input/output
 - Sometimes “easier”
 - Lower dimensional parameter space (needn't model inputs)
- Unsupervised Machine Learning
 - = dimensionality reduction = joint density estimation
 - Requires data + model
 - Often harder
 - Must model inputs
 - Richer models
 - Many supervised models arrive from conditioning unsupervised models on observed data
 - Conditioning on observed data = fixing values of some variables in joint
 - Inference techniques for unsupervised models automatically work for supervised models

- Understand connection between graphical models and joint distributions (Bishop, Ch. 8; Murphy Ch. 10, 19)
- Be able to “invent” graphical models for problems of interest
- Understand sampling techniques (Bishop, Ch. 11; Murphy Ch. 24)
 - Basic sampling techniques
 - Markov chain Monte Carlo (MCMC)
 - Metropolis Hasting (MH)
 - Gibbs
- Understand conjugacy and how to exploit it for analytic marginalization (Bishop pg. 117; Murphy pg. 74)
- Understand how to derive and implement MCMC samplers for arbitrary graphical models
- Understand Monte Carlo integration
- Understand how to formulate inference questions in terms of integrals

- Lecture Notes and Problem Sheet :

http://www.robots.ox.ac.uk/~fwood/teaching/C19_hilary_2013_2014/

- Books :

- Pattern Recognition and Machine Learning [Bishop, 2007]
- Bayesian data analysis [Gelman et al., 1995]
- Machine Learning : a probabilistic perspective [Murphy, 2012]
- Sequence Monte Carlo Methods in Practice [Doucet et al., 2001]
- (free online) Information Theory, Inference, and Learning Algorithms [MacKay, 2003]

- Tutorials :

- Probabilistic Inference using MCMC methods [Neal, 1993]
- A Tutorial on particle Filters for Online Nonlinear/Non-Gaussian Bayesian Tracking [Arulampalam et al., 2002]

- M Sanjeev Arulampalam, Simon Maskell, Neil Gordon, and Tim Clapp. A Tutorial on Particle Filters for Online Nonlinear / Non-Gaussian Bayesian Tracking. *IEEE Transactions on Signal Processing*, 50(2): 174–188, 2002. ISSN 1053587X. doi: 10.1109/78.978374. URL <http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=978374>.
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