

Graphical Models: syllabus

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Here is the list of topics covered in the Graphical Models course which you might find helpful while preparing for the exam.

1. Basic probability and graph theory notions
 - Basic rules of probability
 - Independence
 - Basic Graph definitions
2. Belief networks
 - Definitions
 - Independence in belief networks
 - d-connection and d-separation
 - Graphical vs. distributional independence
 - Markov equivalence
3. Markov Networks and Factor Graphs
 - Definitions
 - Examples: Boltzmann machine, Ising model
 - Independence in Markov networks
 - Markov equivalence
 - Expressiveness of Belief networks, Markov networks and Factor Graphs
4. Markov chains and Hidden Markov Models
5. Inference in Trees
 - Sum-product and Max-product algorithms. Message passing.
 - Examples: Inference in HMMs (forward and backward messages)
6. Junction Tree algorithm
7. Decision Making
 - Decision Trees, Influence diagrams

- Bandits: UCB1 algorithm, applications to Game planning (intuitions)
 - Markov Decision Processes
8. Learning in Belief Networks
- Maximum Likelihood as counting. Relation to KL-divergence minimization
 - Coin bias example. ML vs Bayesian approach
 - Naive Bayes classifier.
9. Learning with hidden variables
- Why hidden variables complicate learning.
 - EM algorithm. Free energy.
 - Examples: EM for Mixture of Bernoullis, EM for HMMs (a.k.a. Baum-Welch).
10. Variational Inference
- Problem setting. KL-divergence. Which one to use.
 - Mean-field approximation.
 - Coordinate ascent
11. Sampling
- Problem setting
 - Importance sampling.
 - Rejection sampling. Acceptance rate.
 - MCMC methods. Detailed balance.
 - Examples: Gibbs Sampling and Metropolis-Hastings algorithm, the algorithms and why they satisfy detailed balance conditions.