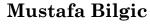
CS 583: PROBABILISTIC GRAPHICAL MODELS

TOPIC: SUMMARY





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COVERED

- Chapter 1 Introduction
- Chapter 2 Foundations
- Representation
 - Chapter 3 Bayesian network representation
 - Chapter 4 Markov network representation
 - Chapter 5 Local probabilistic models
 - Chapter 6 Template-based models
 - Chapter 7 Gaussian network models

COVERED

Inference

- Chapter 9 Variable elimination
- Chapter 10 Clique trees
- Chapter 12 Sampling
- Chapter 13 MAP inference

COVERED

- Learning
 - Chapter 16 Overview
 - Parameter estimation (Chapters 17, 19, 20)
 - Parameter estimation for Bayesian networks
 - Parameter estimation with incomplete data
 - Parameter estimation for Markov networks
 - Structure learning (Chapters 18 and 20)
 - Bayesian network structure learning
 - Markov network structure learning

OTHER NOTABLE TOPICS

- Chapter 11 Inference as optimization
- Chapter 15 Inference in temporal models
- Chapter 21 Causality
- Chapter 22 Utilities and decisions
- Chapter 24 Structured decision problems

Chapter 11 – Inference as optimization

- Approximate inference
- The underlying distribution is P
- Create a similar but "easier" distribution Q
- Answer queries using Q
- Notable approach: variational inference

CHAPTER 15 – INFERENCE IN TEMPORAL MODELS

- Temporal models are template-based models
- One approach: "unroll" the network
 - Problem: can be fairly large, infinite even
- Specific structure and queries
- For example: tracking/filtering
 - $P(X^t|o^{(1:t-1)})$ i.e, our belief about current state given everything we have observed so far
- Notable algorithm: Viterbi

Chapter 21 – Causality

- We need to distinguish between correlation and causation
 - If X and Y are correlated, it could be
 - X causes Y
 - Y causes X
 - A hidden cause Z causes both X and Y
- Useful for interventions
- Useful for interpretability
- Notable approach: do-calculus
 - Differentiate between P(Y | Z=z) versus P(Y | do(Z=z))

Chapter 22 – Utilities and Decisions

- World states have
 - Uncertainty we model this using probabilities
 - Utility how much happy/unhappy we are in each of those world states
- We need to take some actions to maximize our expected utility
- For example:
 - A two-variable world: rain/not-rain, and have-umbrella/don'thave-umbrella
 - Utility: how much happy we are in one of those four world states
 - Action: take/don't-take umbrella

Chapter 24 – Structured decision problems

- Influence diagrams Bayesian networks that represent
 - Uncertain nodes,
 - Action nodes, and
 - Utility nodes
- Inference: find the action that maximizes expected utility

WHERE DO WE GO FROM HERE?

- In addition to what we discussed, learn at least
 - Inference and learning for template-based models
 - Causality
 - Variational inference
- Read and implement papers. For example:
 - Collective classification
 - http://www.cs.iit.edu/~ml/pdfs/sen-aimag08.pdf
 - Latent Dirichlet allocation
 - http://www.jmlr.org/papers/volume3/blei03a/blei03a.pdf