

Probabilistic Graphical Models

Problem Set 13/14

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Problem 1: Reading Summary

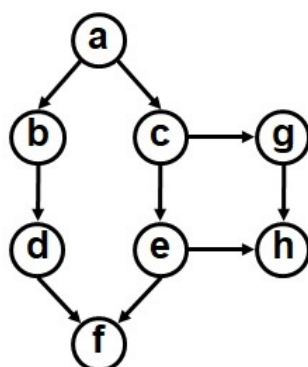
Write a summary of the previous lecture. Accompany your report by an audio file (max: 10 minutes) in which you explain in your words important topics of the lecture, particularly:

- Cluster tree definition; running intersection property; clique tree
- Clique-tree message passing; clique tree calibration; sum-product belief propagation
- Two approaches for constructing a clique tree
- MAP inference; max-product variable elimination; max-marginalization
- Max-product variable elimination; finding the most probable assignment
- Temporal models; trajectory; Markov assumption; stationary Markovian system
- Dynamic Bayesian networks; state-observation model; linear dynamical systems
- Evaluation, decoding, and learning in HMMs (sketch the derivation of the formulas)
- Profile HMMs for sequence alignment

* Write down all formulas in your written summary and explain in detail each step of the derivation. In your audio file, only mention the main points of the derivations.

Problem 2: Clique tree construction

Consider the following Bayesian network.



- (a) build a clique tree for the above network using the variable elimination algorithm with ordering b, f, d, a, c, h, e, g.
- (b) Repeat the previous part using chordal graphs.
- (c) Compute $P(e)$ using the obtained clique tree in part a. Write down all the steps.

Problem 3: Profile HMMs for classifying α -chain and β -chain of MHC II molecules

In this exercise, your task is to use *aphid* package in R to learn profile HMMs for two sets of multiple alignments for α -chain and β -chain of MHC II molecules, alignments available in files 'MHC_II_Alpha.txt' and 'MHC_II_Beta.txt', respectively. Then you need to use the learned models to classify some test input sequences in 'unclassified.txt' file. The first 25 sequences of the test file belong to the α -chain and remaining sequences are from the MHC II β -chain family.

Submit your solutions to naser.elmi@ut.ac.ir and fahimehpalizban@ut.ac.ir by Khordad 18, 1398.