

Practice questions for Quiz 6

CS 228 - Winter 2009

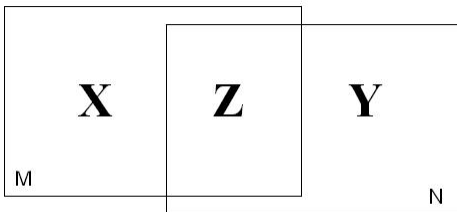
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1. DBN

Consider a fully persistent DBN over n state variables \mathbf{X} . Show that any clique tree over $\mathbf{X}^{(t)}$, $\mathbf{X}^{(t+1)}$ that we can construct for performing the belief state propagation step has induced width at least $n + 1$.

2. Parameter Estimation in Template-Based Models

Consider the following plate model:



It has two plates, $P1$ and $P2$. Let \mathcal{X} be the variables that lie only in $P1$, let \mathcal{Y} be the variables that lie only in $P2$, and let \mathcal{Z} be the variables that lie in both plates. Assume all variables are binary variables.

- Suppose you are given the plate model as above, and a data set \mathcal{D} where each training sample is a full assignment to the M variables in \mathcal{X} and N variables in \mathcal{Y} . Let $\theta_{\mathcal{X}}$ denote the parameter vector for the CPDs of \mathcal{X} , and similarly for $\theta_{\mathcal{Y}}$ and $\theta_{\mathcal{Z}}$. Thus, for example, for a variable $X_i \in \mathcal{X}$, we have a parameter $\theta_{x|\mathbf{u}}$ for each assignment x to X_i and \mathbf{u} to \mathbf{Pa}_{X_i} (note that the parents of X_i must lie in $P1$ and therefore be a subset of \mathcal{X}). Define appropriate sufficient statistics for this likelihood function, and write down the explicit form of the likelihood function in terms of the parameters and your sufficient statistics.
- Using the likelihood function you obtained, derive maximum likelihood estimates for the different parameters in $\theta_{\mathcal{X}}, \theta_{\mathcal{Y}}, \theta_{\mathcal{Z}}$.

3. MLE

Suppose we are trying to estimate θ_h , the probability that a thumbtack tossed in the air will come up heads. To gather data, we toss the thumbtack 150 times, and it comes up heads 48 times.

- Write down the likelihood function of θ_h given the data we generated.
- What is the MLE estimate for θ_h based on the data? Can you derive it from the likelihood function?

4. DBN

What are the challenges faced when attempting to perform inference in DBN's?