Probabilistic Graphical Models

Problem Set 2

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Problem 1: Reading Summary

Write a half-page summary of lecture 2 (max: 1 page). Accompany your report by an audio file (max: 10 minutes) in which you explain in your words important topics of the lecture, particularly:

- For the BN $I \to S \leftarrow D$, explain how you parameterize $P(I)$, $P(D)$ and $P(S|I, D)$.

- The naive Bayes model

- Factorization and local independencies

- By an example of a simple BN, explain how local independencies results in the BN factorization.

- I-Map, I-Map to factorization, factorization to I-Map

- Reasoning patterns: causal reasoning, evidential reasoning, intercausal reasoning

- Did you learn anything new about representation, inference, learning?

Problem 2: Genetic inheritance

Consider the genetic inheritance Bayesian network G illustrated in the below figure. For simplicity, assume only alleles A and B are possible (hence only genotypes AA, AB, and BB and blood types A, AB, and B are possible). Additionally, assume genotypes AA, AB, and BB are equally probable for G_{Homer} and G_{Marge}.
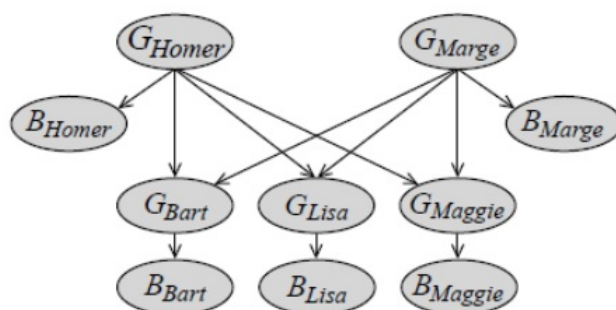
Factorization:

(a) Write down the joint distribution of the network G in a factorized way.

(b) Let G_p and B_p represent person p's genotype and blood type, respectively. Write down conditional probability table for $P(B_p|G_p)$.

(c) Let m and f be parents of person p. Write down conditional probability table for $P(G_p|G_m, G_f)$.

Independencies:

(d) Compute local independencies of $B_{Bart}, G_{Lisa}, G_{Marge}$, and B_{Homer}.

Inference:

(e) Compute the following probability queries by hand.

    (i) $Pr(B_{Bart} = A)$

    (ii) $Pr(G_{Bart} = AA \mid G_{Homer} = AB)$

    (iii) $Pr(G_{Bart} = AA \mid G_{Homer} = AB, G_{Lisa} = AB)$

    (iv) $Pr(G_{Homer} = AB \mid G_{Marge} = AB)$

    (v) $Pr(G_{Homer} = AB \mid G_{Marge} = AB, G_{Bart} = BB)$

(f) Use the *bnlearn* package to compute the above probabilities.

Submit your solutions to naser.elmi@ut.ac.ir by Esfand 5, 1397.