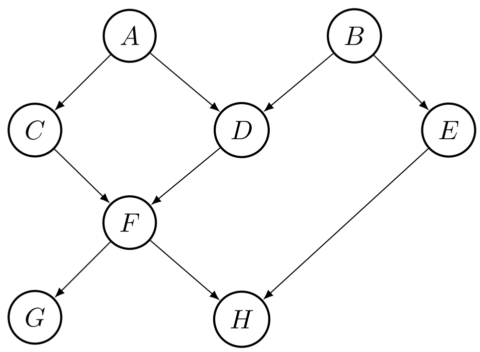
CS 161: Fundamentals of Artificial Intelligence

Winter 2021– Assignment 6

Questions



A	$\Pr(A)$
1	.2
0	.8

B	$\Pr(B)$
1	.7
0	.3

B	E	$\Pr(E\|B)$
1	1	.1
1	0	.9
0	1	.9
0	0	.1

A	B	D	$\Pr(D\|AB)$
1	1	1	.5
1	1	0	.5
1	0	1	.6
1	0	0	.4
0	1	1	.1
0	1	0	.9
0	0	1	.8
0	0	0	.2

Figure 1: A Bayesian network with some of its Conditional Probability Table(CPT)s.

1. Consider the Bayesian network in Figure 1:

(a) List the Markovian assumptions (also known as topological semantics) encoded in the Bayesian network structure.

(b) Provide the Markov blanket for variable D.

(c) Express $\mathsf{Pr}(A, B, C, D, E, F, G, H)$ as a multiplication of conditional and marginal probabilities, using the chain rule for Bayesian networks.

(d) Derive $\mathsf{Pr}(E, F, G, H)$ from the result of $\mathsf{Pr}(A, B, C, D, E, F, G, H)$ computed above. Express it using factors.

(e) Multiply the factors (tables) of $\Pr(D|AB)$ and $\Pr(E|B)$. Show the new factor.

(f) Sum out D from the factor computed above. Show the new factor.

(g) Express $\mathsf{Pr}(a, \neg b, c, d, \neg e, f, \neg g, h)$ in terms of the parameters in the Conditional Probability Table(CPT)s in Figure 1 (here a denotes $A = 1$ and $\neg a$ denotes $A = 0$). Use placeholder symbols for the parameters that are not shown in the CPTs.

(h) Compute $\mathsf{Pr}(\neg a, b)$.

(i) Compute $\mathsf{Pr}(\neg e \mid a)$.

2. Consider the following sentences:

i. John likes all kinds of food.
ii. Apples are food.
iii. Chicken is food.
iv. Anything anyone eats and isn't made sick by is food.
v. If you are made sick by something, you are not well.
vi. Bill eats peanuts and is well.
vii. Sue eats everything Bill eats.

Translate the above sentences(i to vii) into formulas in first-order logic [use different variables each time when quantifying].

For first-order syntax, feel free to use the following text file notation: `|` (for disjunction), `&` (for conjunction), `-` (for negation), `=>` (for implication), `<=>` (for equivalence), `E` (for existential quantification, e.g., `E x, y, Loves(x, y)`), and `A` (for universal quantification, e.g., `A x, y, Loves(x, y)`).