

ICS 275B
Homework Assignment 6
Spring 2005

Instructor: Rina Dechter

Due: Wednesday, May 18th

Relevant reading: Pearl's chapter 5, Bucket-elimination paper, mini-bucket paper, AND/OR paper.

1. Question 5.1 in Pearl's book.
2. Consider the Bayes network DAG in Figure 1:

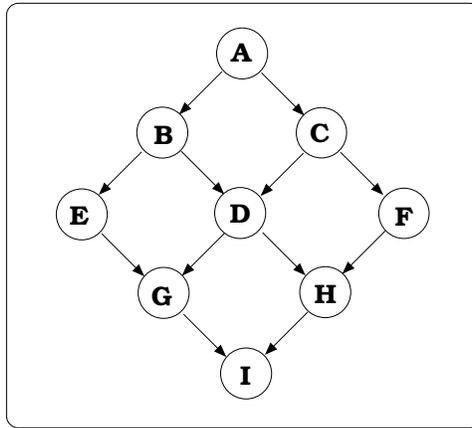


Figure 1: A Bayesian network

- (a) Discusses two exact algorithms for finding the belief of $P(A|I = 0)$. Demonstrate their performance schematically and discuss their complexity.
- (b) Assume you cannot record more than binary functions (defined on two variables), which algorithms can accommodate such restrictions? what is their time and space complexity?
- (c) Apply the approximation algorithm mbe-bel($i=3$) for the task of finding the belief in A . Trace the algorithm's performance schematically (show functions, no numbers). What is the time and space complexity of the algorithm?
- (d) Apply mbe-mpe($i=3$) to find an upper bound for the mpe of the network given $I = 0$. Trace the algorithms. Show how you construct an approximate mpe tuple.
- (e) Suppose you want to determine the belief in A using stochastic simulation (Gibbs sampling). Trace the algorithm's performance for the first 10 instantiations (less than two pages).
- (f) (extra credit) Run mini-bucket approximation, stochastic simulation, IBP or likelihood weighting to compare the approximation quality on this network. (You can use REES for MBE-bel and IBP but have to implement Gibbs sampling. This can be part of a project)

3. This question investigates the AND/OR search space of the network in Figure 2, assuming each variable has 2 values in its domain. The CPTs are given in Figure 3. The CPTs for G , H and D are identical to the 3-dimensional CPT in Figure 3 and the CPTs for H and F are identical to the two-dimensional CPT in that figure.

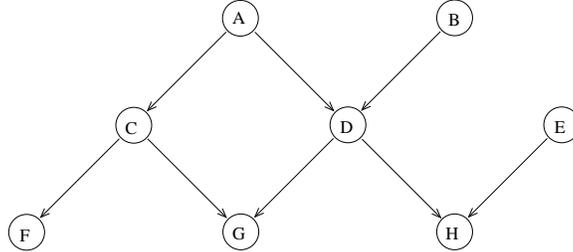


Figure 2: A directed graph

- Find and present a backbone pseudo tree of the network in Figure 2 whose depth is minimal (do the best you can). Call this tree T_1 .
- Generate an AND/OR search tree driven by T_1 assuming each variable has at most two values.
- Annotate the arcs with the corresponding labels.
- What would be the cost of computing the belief of evidence $G = 0$ and $H = 1$ in such a network if you use depth-first search over the AND/OR tree. Demonstrate the computation (compute the value of each node)
- Can the AND/OR search tree be reduced to a smaller AND/OR graph?
- Compare the time and space complexity of solving this problem by search vs bucket-elimination.

a	$p(a)$	b	$p(b)$	e	$p(e)$
0	0.3	0	0.6	0	0.7
1	0.7	1	0.4	1	0.3

y	x	$p(x y)$
0	0	0.10
0	1	0.90
1	0	0.30
1	1	0.70

z	y	x	$p(x y, z)$
0	0	0	0.25
0	0	1	0.75
0	1	0	0.60
0	1	1	0.40
1	0	0	0.10
1	0	1	0.90
1	1	0	0.20
1	1	1	0.80

Figure 3: Conditional probability tables