COMPSCI 276
Homework Assignment 4
Spring 2017

Instructor: Rina Dechter Due:Wednesday, May 3rd

Relevant reading: Dechter chapter 4 and 3.4 and Darwiche chapter 6

1. (Extra credit, 5 pts). Read Dechter chapter 4 and provide comments on clarity and typos.

2. Consider the Bayesian network in Figure 1.

   (a) Apply BE-bel to obtain the:

   i. marginal probability of variable F.

   ii. marginal probability of variable G

   iii. joint marginal probability of variables F and G.

   For each part show the schematic computation over buckets (you can take advantage of shared computation). The computation itself can be done manually or using any software tool of your choice.

   (b) Suppose now that the evidence $\{D = 0, C = 1\}$ has been observed. Apply BE-bel to obtain the probability of evidence. You can do calculation by hand or use any software tool to solve the computational parts of this question.

   (c) Explain how BE-mpe can find the most probable explanation (mpe) given the evidence F=0. Demonstrate your computation. Again, you can do calculation by hand or use any software tool to solve the computational parts of this question.

3. (Question 6.5 in Darwiche): Consider a network N that has a single root X and n leaves $Y_1, ..., Y_n$ where N contains edges $X \rightarrow Y_i$, for all i from 1 to n.

   (a) What is the width of the order $Y_1, ..., Y_n, X$ with respect to N?

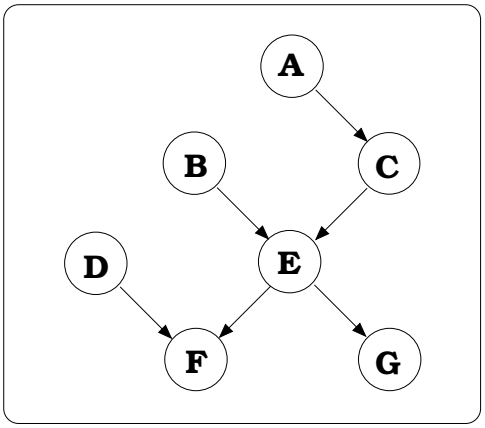
   (b) What is the width of the order $X, Y_1, ..., Y_n$ with respect to N?

4. (Question 6.8 in Darwiche) What is the width of order A, B, C, D, E, F, G, H with respect to the network in Figure 2?

5. Given the directed graph G in Figure 3,

   (a) Compute the induced-graph along ordering: $d_1 = F, C, A, G, D, H, E, B$ and the induced-width for each variable. What is G's induced-width along d_1?

   (b) Use min-induced width (MIW) to compute an ordering, called d_2. Show its ordered graph. Compute the induced-width along d_2.



a	$p(a)$
0	0.3
1	0.7

b	$p(b)$
0	0.6
1	0.4

d	$p(d)$
0	0.7
1	0.3

a	c	$p(c\|a)$
0	0	0.15
0	1	0.85
1	0	0.25
1	1	0.75

e	g	$p(g\|e)$
0	0	0.10
0	1	0.90
1	0	0.30
1	1	0.70

b	c	e	$p(e\|b,c)$
0	0	0	0.40
0	0	1	0.60
0	1	0	0.45
0	1	1	0.55
1	0	0	0.60
1	0	1	0.40
1	1	0	0.30
1	1	1	0.70

d	e	f	$p(f\|d,e)$
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 1:

(c) What is the induced width of the graph G? Explain your answer.

(d) Apply BE-bel along the ordering d_1 and show the λ functions created, their placement and the expressions for deriving the functions. (optional: do the same for ordering d_2)

6. (Question 5.1 in Pearl's book.) The questions relate to the information in question 3 in Homework 3. (You can run BE manually, or write code for it (matlab) and show the output of the code. Make sure to explain everything you do).

   (a) Find the most likely seven-symbol string in L that starts and ends with ϵ.

   (b) Find the message most likely to have been transmitted given the string $\epsilon, \epsilon, A, C, A, \epsilon, \epsilon$ is received.

7. (Darwiche 7.1) Answer the following queries with respect to the Bayesian network in Figure (figure 7.18, below):

   (a) $P(B, C)$

   (b) $P(C, D = true)$.

   (c) $P(A|D = true, E = true)$.

   You can prune the network before attempting each computation, and use any inference method you find most appropriate. (same as above: You can run BE manually, or write code for it (matlab) and show the output of the code. Make sure to explain everything you do).

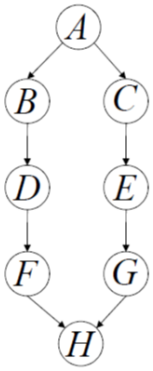


Figure 6.11: A Bayesian network structure.

Figure 2: A Bayesian network

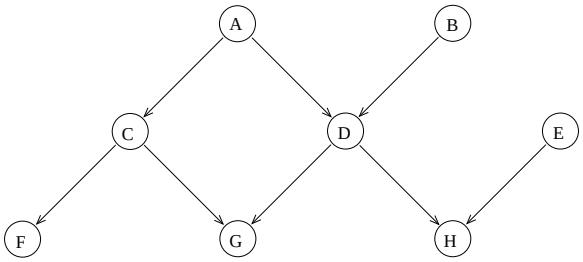
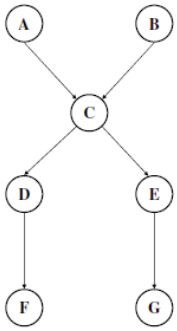


Figure 3: A directed graph



A	f_A
true	.6
false	.4

B	f_B
true	.5
false	.5

A	B	C	f_C
true	true	true	.9
true	true	false	.1
true	false	true	.1
true	false	false	.9
false	true	true	.5
false	true	false	.5
false	false	true	.3
false	false	false	.7

C	D	f_D
true	true	.2
true	false	.8
false	true	.7
false	false	.3

C	E	f_E
true	true	.1
true	false	.9
false	true	.2
false	false	.8

D	F	f_F
true	true	.7
true	false	.3
false	true	.6
false	false	.4

E	G	f_G
true	true	.2
true	false	.8
false	true	.8
false	false	.2

Figure 7.18: A Bayesian network.