

Rina Dechter, Spring-2018
Assigned: May 2nd
Due: May 16

COMPSCI 276: Reasoning with Graphical Models, Problem Set 3

Questions 2-3 are based on chapters 5-6 from the constraint book. The rest of the questions are based on chapters 6-7 from Dechter1 (See updated chapter6).

1. (Extra credit, 5 pts.) Read chapters 6-7 in the Dechter1 and provide comments and provide comments on clarity and typos.
2. (20 pts. question 4 chapter 5) Consider the crossword puzzle formulated using the dual-graph representation (i.e., a variable correspond to a word). Using the ordering $x_1, x_2, x_5, x_6, x_4, x_3$ show a trace, (and data structure) whose length is limited by a 1 page description, for each of the algorithm.

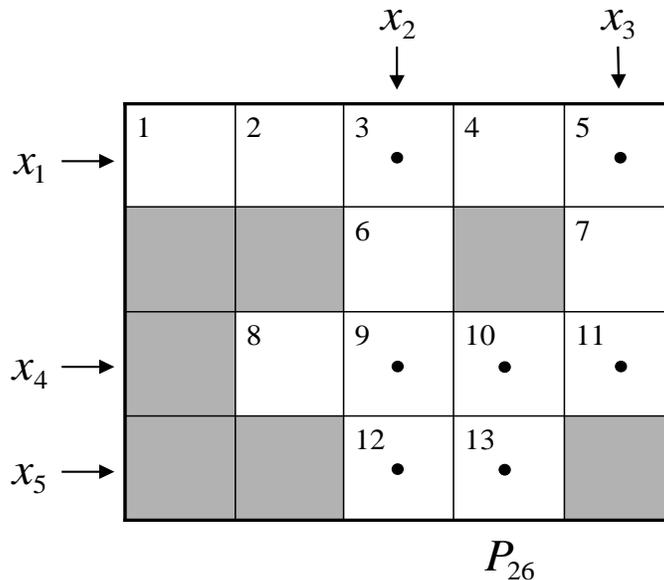


Figure 1: A crossword puzzle

- (a) Naive backtracking
- (b) Forward-checking
3. (30 pts. question 7, chapter 5) Apply the following algorithms to the 6-queens problem. Show the search space and data structures generated for finding all solutions (no more than one page per algorithm).
 - (a) Backtracking

- (b) Dynamic variable ordering by Forward checking, DVFC.
 - (c) Arc-consistency look-ahead.
4. (35 pts.) This question investigates the AND/OR search space of the network

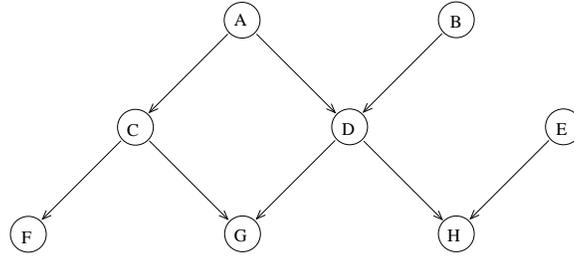


Figure 2: A directed graph

assuming each variable has 2 values in its domain. The CPTs are

a	$p(a)$	b	$p(b)$	e	$p(e)$	y	x	$p(x y)$	z	y	x	$p(x y, z)$
0	0.3	0	0.6	0	0.7	0	0	0.10	0	0	0	0.25
1	0.7	1	0.4	1	0.3	0	1	0.90	0	0	1	0.75
						1	0	0.30	0	1	0	0.60
						1	1	0.70	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

The CPTs for G , H and D are identical to the 3-dimensional CPT and the CPTs for C and F are identical to the 2-dimensional CPT.

- (a) (5) Find and present a pseudo tree of this network whose depth is minimal (do the best you can). Call this tree T_1 .
 - (b) (10) Generate an AND/OR search tree driven by T_1 assuming each variable has at most two values.
 - (c) (5) Annotate the arcs with the appropriate weights.
 - (d) (10) What would be the computational cost of computing the probability of evidence $G = 0$ and $H = 1$ in such a network if you use depth-first search over the AND/OR search tree? Demonstrate the computation (compute the value of each node).
5. (30 pts.) Consider the same graphical model in Figure 2.
- (a) (5) Can the AND/OR search tree be reduced to a smaller AND/OR search graph? If so, demonstrate.
 - (b) (5) Provide the OR-based context for every variable in your pseudo-tree.

- (c) (5) Identify all the variables that correspond to dead caches and those that are not.
 - (d) (5) Compare the time and space complexity of solving this problem by search with context-based caching vs. bucket-elimination.
 - (e) (10) Assume that the CPT $P(x|y, z)$ is changed by making some entries deterministic, as follows: set the probability column of the first 2 lines to 1 and 0 in that order (from top to bottom). Do the same for the last 2 lines (e.g., we make $P(x = 0|y = 1, z = 1) = 0$). Show what would be the changes in the AND/OR search tree as a result.
6. (5 pts.) Prove that if there is a tree-decomposition of G having a treewidth w , then we can create a pseudo-tree whose depth h satisfies $h \leq w \cdot \log n$ when n is the number of nodes in the tree.
7. (Extra credit 10 pts.) Given a graph G and an ordering d Show that if we generate an induced-ordered graph along d and then generate a DFS spanning tree over the induced graph starting from the first variable as the root, we get a pseudo-tree.