CSC 384 Test 3 on CSP

Friday, October 28, 2022

Last Name: _____

First Name: _____

Email: _____

1. Conceptual Questions (10 marks)

1.1 Let C(X, Y) be a binary constraint between two variables X and Y. Assume that **all values of X are currently arc-consistent with C(X, Y).** Which ones of the statements below are true?
Circle all the correct answers. **(3 marks)**
Hint: If you can find one counterexample, the statement is false.

a) The values of Y are arc-consistent with C(X, Y).

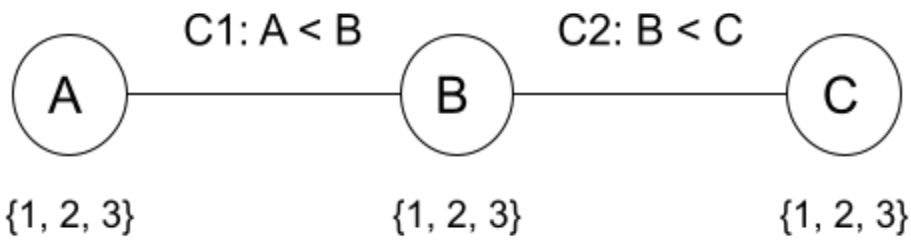
b) If we remove one value from X's domain,
the values of X will still be arc-consistent with C(X, Y).

c) If we remove one value from Y's domain,
the values of X will still be arc-consistent with C(X, Y).

1.2 The arc-consistency algorithm will result in different results for the variable domains, depending on the order in which GAC processes the arcs/constraints. Circle your answer below. **(1 mark)**

True **False**

1.3 Consider the CSP diagram below. There are three variables (A, B & C) and two constraints on these variables: C1(A, B) and C2(B, C). When looking for a solution, we will apply the **backtracking algorithm** described in class. Assume that the algorithm visits the **variables** in **alphabetical** order (i.e. A first, followed by B and then C).



(a) Suppose that the algorithm visits the values in each domain in **increasing** order (i.e. from 1 to 3). How many nodes will the algorithm visit before reaching a goal state? **(2 marks)**

_____

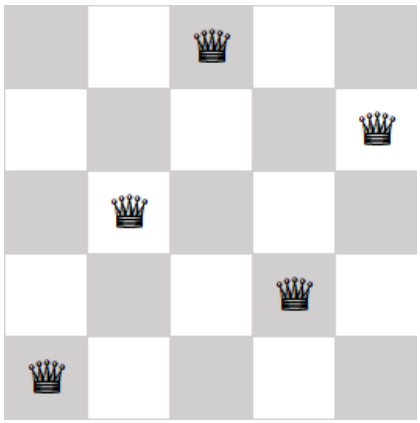
(b) Suppose that the algorithm visits the values in each domain in **decreasing** order (i.e. from 3 to 1). How many nodes will the algorithm visit before reaching a goal state? **(2 marks)**

_____

1.4 In the Sudoku diagram below, which square(s) will be selected first by the **Minimum Remaining Value heuristic**? Fill the squares with the correct value. If there are multiple correct answers, fill in all of them. **(2 marks)**

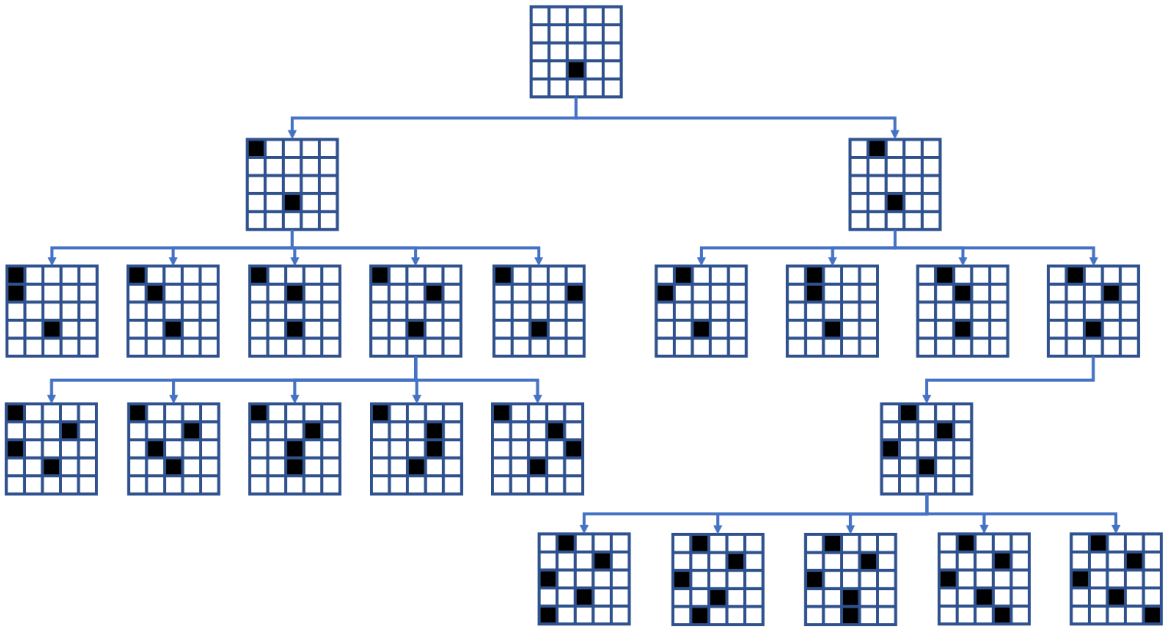
9				4		7	8	
		3	9		1			5
5		1		8		3		2
	3	5			8		6	7
2			4	7	6			3
	1		5		3	8	2	
6		4				1		8
1		7	8	5	4	2	3	
	5	8		6				9

2. Forward Checking

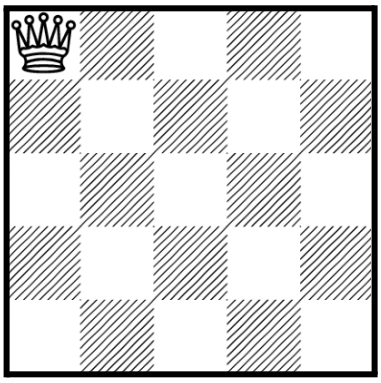


Consider the 5-Queens problem, the N-Queens problem for a 5x5 grid (see diagram on the right for an example solution).

The diagram below would be the backtracking search tree if we started by filling square (3,4). Circle all the states that are visited by the **Forward Checking** algorithm. **(8 marks)**.



3. Arc Consistency



Consider the 5-Queens problem. Recall that the rows are numbered 1 to 5 from top to bottom. Q_k refers to the queen in row k. Assume that all variables started with the domain {1,2,3,4,5}.

We placed the **first queen in the top-left corner** ($Q_1 = 1$) (see the diagram above). In the spaces below, fill in the resulting domains for Q_2, Q_3, Q_4 and Q_5 when the GAC update is complete. **(8 marks)**.

Q_2 _____ **Q_3** _____

Q_4 _____ **Q_5** _____

You can use the table on the next page to derive your answer. (We'll only look at this if the answers provided above are not correct)

Step	Q_2	Q_3	Q_4	Q_5
1				
2				
3				
4				
5				
6				

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