CS 540: Introduction to Artificial Intelligence
Solutions for Homework Assignment # 4

Problem 1. Neural Networks [15]

(a) (i) Let $g(a) = \frac{1}{1+e^{-a}}$
Output of node h_1 is $g(1 \times 1.5 + 0 \times 2.5 + 1 \times 1) = g(2.5) = 0.9241$
Output of node h_2 is $g(1 \times 2 + 0 \times (-1.5) + 1 \times (-3)) = g(-1) = 0.2689$
Output of node $\hat{y}$ is $g(1 \times (-1) + 0.9241 \times 1 + 0.2689 \times 0.5) = g(0.05855) = 0.5146$

- 5 pts if all three answers are correct (within roundoff error).
- 4 pts if only two answers are correct (within roundoff error).
- 3 pts if only one answer is correct (within roundoff error).
- 0 pt if none of the answers is correct.

(ii) $\frac{\partial E}{\partial z_{\hat{y}}} = (g(z_{\hat{y}}) - y)g(z_{\hat{y}})(1 - g(z_{\hat{y}})) = (0.5146 - 1) \times 0.5146 \times (1 - 0.5146) = -0.1212$
$w_{\hat{y}h_1} = 1 - (0.1)(-0.1212)(0.9241) = 1.0112$
$w_{\hat{y}h_2} = 0.5 - (0.1)(-0.1212)(0.2689) = 0.5033$
$w_{\hat{y}b} = -1 - (0.1)(-0.1212)(1) = -0.9879$
$w_{h_1x_1} = 2.5 - (0.1)(-0.1212)(1)(0.9241)(1 - 0.9241)(0) = 2.5$
$w_{h_1x_2} = 1 - (0.1)(-0.1212)(1)(0.9241)(1 - 0.9241)(1) = 1.0009$
$w_{h_1b} = 1.5 - (0.1)(-0.1212)(1)(0.9241)(1 - 0.9241)(1) = 1.5009$
$w_{h_2x_1} = -1.5 - (0.1)(-0.1212)(0.5)(0.2689)(1 - 0.2689)(0) = -1.5$
$w_{h_2x_2} = -3 - (0.1)(-0.1212)(0.5)(0.2689)(1 - 0.2689)(1) = -2.9988$
$w_{h_2b} = 2 - (0.1)(-0.1212)(0.5)(0.2689)(1 - 0.2689)(1) = 2.0012$

- 10 pts if all nine answers are correct (within roundoff error).
- 9 pts if eight answers are correct (within roundoff error).

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- 2 pts if only one answer is correct (within roundoff error).
- 0 pt if none of the answers is correct.

Problem 2. Constraint Satisfaction Problem [20]

(a) A={1}, B={1,2,3}, C={3}, D={1,2,3}, E={2}, F={1,3}, G={1,3}
Deduct one point each incorrect domain.

- 5 pts if all seven variables' domains (domains of A to G) are correct.
- 4 pts if six variables' domains are correct.

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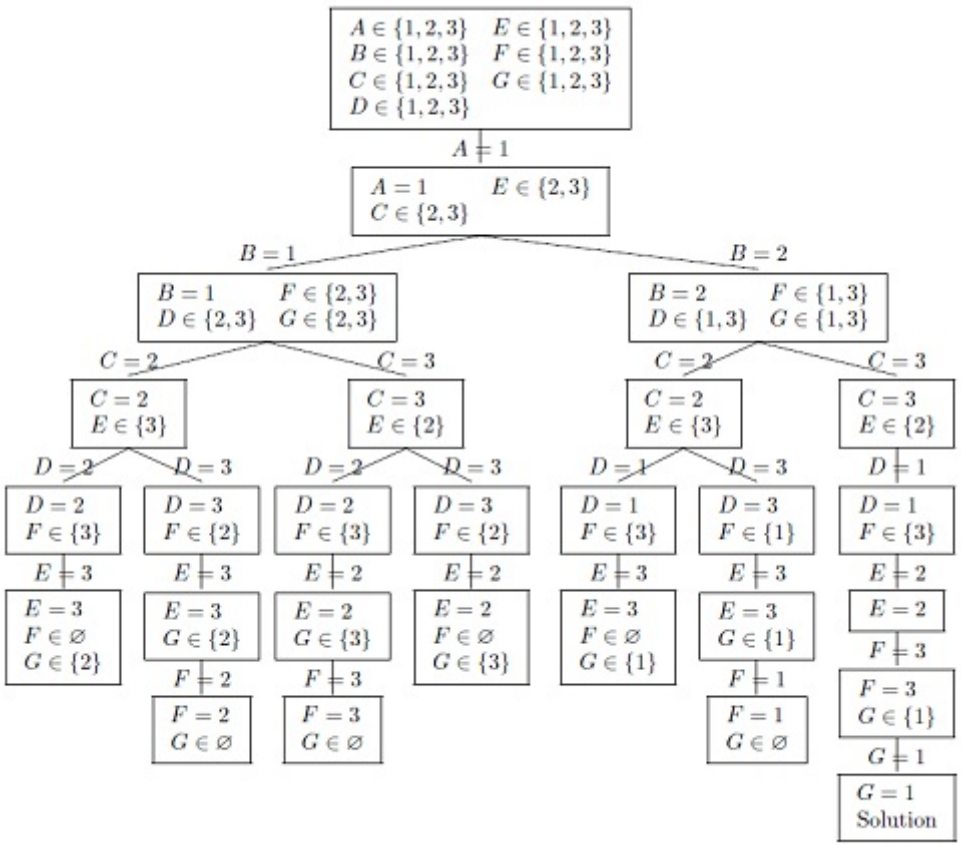
- 1 pts if three variables' domains is correct.
- 0 pt if two or less variables' domains are correct.

(b) The following search tree shows the search until a solution is found. Nodes show only variables whose domains changed with respect to its parent's domain.



Only need to look at the resulting solution. Deduct one point each incorrect assignment of the resulting solution. Deduct 5 pts up front if there is no search tree and only resulting solution is provided.

- 10 pts if all seven assignments (A to G) are correct.
- 9 pts if six assignments are correct.

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- 4 pts if one assignments is correct.
- 0 pt if none of the assignments correct.
- 0 pt if the answer is "no solution".

(c)

A	B	C	D	E	F	G
1	1	2	3	3	2	∅
1	1	2	3	3	∅	2
1	1	2	2,3	3	2	∅
1	1	2	2,3	3	∅	2
1	1	2	1,2,3	3	2	∅
1	1	2	1,2,3	3	∅	2
1	1	2	2	3	∅	2
1	1	2	2	∅	3	2
1	1	2	2,3	3	∅	2
1	1	2	2,3	∅	3	2
1	1	2	1,2,3	3	∅	2
1	1	2	1,2,3	∅	3	2
1	1	2	3	3	2	∅
1	1	2	3	∅	2	3
1	1	2	2,3	3	2	∅
1	1	2	2,3	∅	2	3
1	1	2	1,2,3	3	2	∅
1	1	2	1,2,3	∅	2	3

Students only need to provide up to 5 outcomes. If the students submit more than 5 answers, only consider the first 5.

- 5 pts if at least one of the first 5 outcomes is correct (according to the table above.)
- 0 pt if none of the first 5 outcomes is correct.