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CS 4300

November 13 2017

Extra Credit Lab Report

1. *Introduction*

   The path consistency algorithm performs various matrix manipulations to consider possibilities within a domain of actions. Close to Arc Consistency, Path Consistency considers pairs of variables with another third variable. Within the parameters of the constraint graph that both of the local consistency algorithms, the nodes designate cells on the board, the edges represent possible movement options that the agent can take. The Label Set is a 3x16 matrix that has 3 labels for each of the cells in the 4x4 board with each of these labels standing for Clear, Pit, and Breeze accordingly. From this algorithm comes some questions:

   Question : Does the use of path consistency improve the performance of the agent in Wumpus World?

2. *Method*

```
1  begin
2     Y^n ← R
3     repeat
4        begin
5           Y^0 ← Y^n
6              for k ← 1 until n do
7                 for i ← 1 until n do
8                    for j ← 1 until n do
9                       Y_ij^k ← Y_ij^(k-1) & Y_ik^(k-1) · Y_kk^(k-1) · Y_kj^(k-1)
10       end
11    until Y^n = Y^0;
12    Y ← Y^n
13 end
```

PC-1: the first path consistency algorithm

The algorithm for path consistency that we followed.

```
R = CS4300_Relations(D, P);
for i = 1:N+1
    Y(i).R = R;
end

Y(1).R(1,1).R = 1 - Y(1).R(1,1).R;

while ~isequal(Y(N + 1), Y(1))
    Y(1).R = Y(N+1).R;
    for k = 2:N+1
        for i = 1:N
            for j = 1:N
                Yik = Y(k-1).R(i,k - 1).R;
                Ykk = Y(k-1).R(k - 1,k - 1).R;
                Ykj = Y(k-1).R(k - 1,j).R;
                Yij = Y(k-1).R(i,j).R;
                Y(k).R(i,j).R = bitand(Yij, ((Yik * Ykk * Ykj) > 0));
            end
        end
    end

end
```

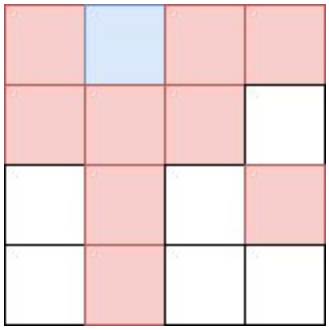
Our code based on the algorithm provided

3. *Verification*

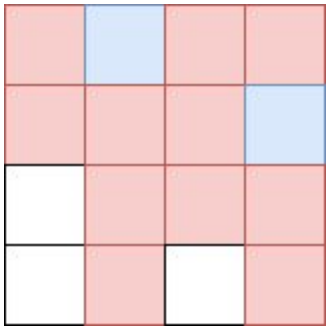
To verify our Path Consistency algorithm we used the packing queens problem on a four by four grid. Using a domain of :

D = [0,1,0,0;1,1,1,1;1,1,1,1;1,1,1,1];

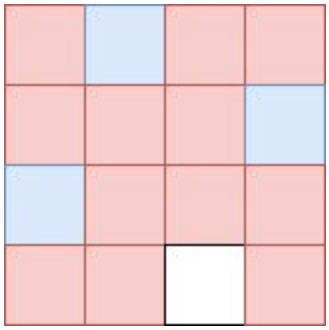
We guarantee that 1 queen must be at least on the second column of the top row. This means that no other queen can be in the 2nd column, 1 first row or on any diagonal of this space.



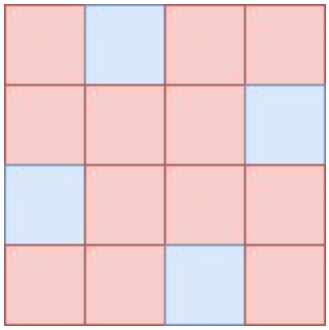
The only space in the 2nd row that could support a queen is the space on the last column.



The only space in the 3rd row that could support a queen is the space on the last column.



Finally, the only space that can support the last queen is the space on the 3rd column of the bottom row.



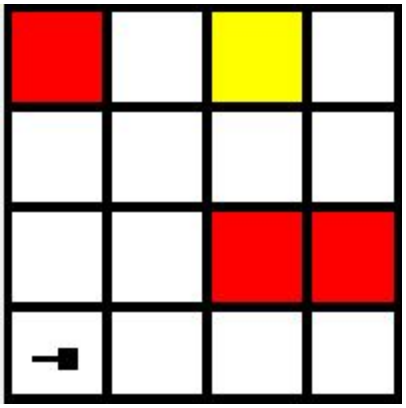
Here is a valid configuration for a 4-packing queens problem.

Here is the real result:

	1	2	3	4
1	0	1	0	0
2	0	0	0	1
3	1	0	0	0
4	0	0	1	0

4. *Data and Analysis*

Note : 500 trials for each experiment and this is the board we used



Board for data

*AC data from A2 lab report

A Arc Consistency (AC)*

Max Steps	10	20	30	50	75	100
% Alive	100	71.4	43.2	24.8	12	6.8
% Success	0	0	0	0.4	0.8	1.6
Variance % Alive	18.76	14.67	9.64	5.82	2.91	1.67
Variance	0	0	0	0.09	0.2	0.4

% Success						
95% CI % Alive	96.81 to 103.19	68.58 to 74.22	40.92 to 45.48	23.03 to 26.57	10.74 to 13.26	5.85 to 7.75
95% CI % Success	0 to 0	0 to 0	0 to 0	0.17 to 0.63	0.47 to 1.13	1.14 to 2.06

A PC Consistency (PC)*

Max Steps	10	20	30	50	75	100
% Alive	70%	48%	34%	16%	8%	0
% Success	0	0	0	0	0	0
Variance % Alive	21.43%	25.47%	22.90%	13.71	7.51	0
Variance % Success	0	0	0	0	0	0
95% CI % Alive	59.23 to 80.77	36.26 to 59.74	22.87 to 45.13	7.38 to 24.62	1.62 to 14.38	0 to 0
95% CI % Success	0 to 0	0 to 0	0 to 0	0 to 0	0 to 0	0

5. *Interpretation*

   We think there is a major problem in our code for path consistency since our agent seems to kill himself a lot and never find the gold. We did run our agent on an empty board with the gold in the top right corner and he was able to find the gold while exploring unvisited spots. We do know that our agent doesn't determine pits correctly and therefore our path consistency is broken and can't verify our question.

6. *Critique*

   The path consistency algorithm is very complex in its nature. The matrix procedures were performed in multiple nested loops making the program hard to debug within. Since the implementation in question has many issues attached to it (related to the PC agent), it is unreliable to assert a conclusion to the initial question of whether a path consistency agent performs better than an arc consistency agent. A better understanding of the path consistency algorithm would lend itself to better agent performance. A few redundancies within the algorithm could be removed and the constraint propagation policy within the algorithm has it process for much more time than what it could have done.

7. *Log:*

   Eric:

   Assignment: 9 hours

   Lab: 2 hours

   Monish:

   Assignment: 6 hours

   Lab: 2 hours