PROBLEM 2 :

Prey and Predator model using Bayesian Network
PART 1

Part-1: Deterministic Algorithm
[**Please use Jupyter notebook or Google colab to run ipython notebook]**

Output Format:-

First board is the starting position of the game (assuming all start at different positions). **'1' and '2' represent cavemen 1 and 2's position respectively. '3' represents the position of the sheep.**

The second board is the last configuration of the board at the end of game (if sheep caught or 100th iteration)

[Note: At the end of the game, it is possible that cavemen and sheep occupied the same position, in that case, at the output, you may not see cavemen or sheep position differently, but game is ending as sheep got caught at the same location of cavemen.]

Game #1 starting board
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 1, 0]
[3, 0, 0, 0, 0, 0, 0, 0]
[0, 2, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]

Solved, Cavemen 1 caught the sheep
Final board at the end of game 1:
[0, 0, 0, 0, 0, 0, 3, 0]
[0, 0, 0, 0, 0, 0, 1, 0]
[0, 2, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]

NOTE:
Board coordinates indexing and output format: (x_cordinate,y_cordinate)
(0, 0) (0, 1) (0, 2) (0, 3) (0, 4) (0, 5) (0, 6) (0, 7)
(1, 0) (1, 1) (1, 2) (1, 3) (1, 4) (1, 5) (1, 6) (1, 7)
(2, 0) (2, 1) (2, 2) (2, 3) (2, 4) (2, 5) (2, 6) (2, 7)
(3, 0) (3, 1) (3, 2) (3, 3) (3, 4) (3, 5) (3, 6) (3, 7)
(4, 0) (4, 1) (4, 2) (4, 3) (4, 4) (4, 5) (4, 6) (4, 7)
(5, 0) (5, 1) (5, 2) (5, 3) (5, 4) (5, 5) (5, 6) (5, 7)
(6, 0) (6, 1) (6, 2) (6, 3) (6, 4) (6, 5) (6, 6) (6, 7)
(7, 0) (7, 1) (7, 2) (7, 3) (7, 4) (7, 5) (7, 6) (7, 7)

Game #2 starting board
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 2, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 1, 0]
[0, 0, 3, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]

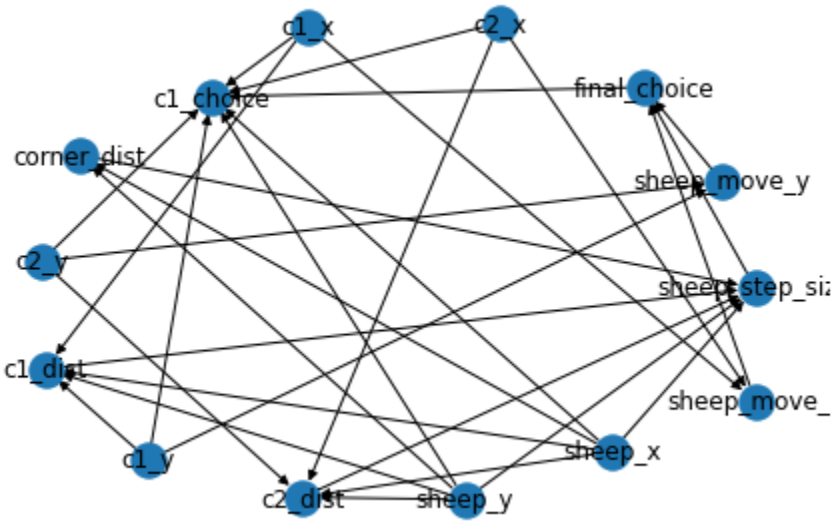
Solved, Cavemen 1 caught the sheep
Final board at the end of game 2:
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 2, 1, 0]
[0, 0, 0, 0, 0, 0, 3, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0, 0, 0]

In both the above random 2 cases, I got cavemen 1 caught the sheep.

PART 2
Prey and Predator model using Bayesian Network

Note: Please use Google Colab or Jupyter Notebook for running the python notebook

Library Used: `pgmpy for bayesian network`



Formed bayesian network. C1,c2 are cavemen.

Note:- Was only able to run for the 1,000 iteration for the size of 6X6 grid due resource limitation and also running time limit on Google colab. Thus, the results are not optimal.

```
Game #1 starting board
[0, 0, 0, 2, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 1, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 3]
[0, 0, 0, 0, 0, 0]

Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
498.11it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.13it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
493.83it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 57.95it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
456.52it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.33it/s]
```

```
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
457.10it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 64.93it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
384.04it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 54.42it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
571.17it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 34.87it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
522.39it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.59it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
486.09it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 59.87it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
467.14it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.96it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
472.66it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 55.32it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
486.68it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.16it/s]

Solved, Cavemen  2  caught the sheep
Final board at the end of game 1:
[0, 1, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 2, 0]
[0, 0, 0, 0, 3, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
----------------------------------------
Game #2 starting board
[0, 0, 0, 0, 0, 0]
[1, 0, 0, 0, 0, 0]
[0, 0, 0, 2, 0, 0]
[0, 0, 0, 0, 0, 3]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]

Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
497.54it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.07it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
504.84it/s]
```

```
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.77it/s]

Solved, Cavemen  2  caught the sheep
Final board at the end of game 2:
[1, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 2, 0]
[0, 0, 0, 0, 3, 0]
[0, 0, 0, 0, 0, 0]
----------------------------------------
Game #3 starting board
[0, 3, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 1, 2, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]

Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
554.74it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 54.58it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
480.04it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 58.93it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
574.80it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.01it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
579.98it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 32.63it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
473.78it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 59.42it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
497.79it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 58.76it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
467.15it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.16it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
543.84it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.63it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
546.18it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.74it/s]
```

```
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
460.75it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.45it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
498.40it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 53.01it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
491.42it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 57.93it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
551.13it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.45it/s]

Solved, Cavemen  2  caught the sheep
Final board at the end of game 3:
[0, 0, 0, 1, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 3, 0, 0, 0, 0]
[0, 2, 0, 0, 0, 0]
----------------------------------------
Game #4 starting board
[2, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 1]
[3, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]

Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
452.04it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 54.72it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
481.82it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 59.72it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
488.12it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 56.77it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
466.50it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 52.84it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
564.04it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 62.54it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
494.60it/s]
```

```
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.22it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
445.80it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 54.92it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
507.76it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 58.32it/s]

Solved, Cavemen  2  caught the sheep
Final board at the end of game 4:
[0, 0, 0, 0, 0, 1]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 3, 0, 0, 0]
[0, 0, 2, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
----------------------------------------
Game #5 starting board
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 0, 3, 0]
[0, 2, 0, 0, 0, 0]
[0, 0, 0, 0, 0, 0]
[0, 0, 0, 1, 0, 0]

Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
483.79it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.28it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
637.92it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.97it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
547.17it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 63.49it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
580.53it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.87it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
500.04it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 62.77it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
482.27it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 64.21it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
499.69it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 61.20it/s]
```

```
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
490.41it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 59.70it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
470.70it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 60.39it/s]
Finding Elimination Order: : 100%|██████████| 5/5 [00:00<00:00,
486.26it/s]
Eliminating: sheep_move_x: 100%|██████████| 5/5 [00:00<00:00, 64.61it/s]
```

On running the program, pgmpy was taking so much time. Please ignore the above finding elimination or logs. Due to continuously running timeouts, I am able to add results for 4 games.