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Standard 5 Section 'B' Roll No. 092

Subject Artificial Intelligence Lab.

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03.	15-Oct 2024	A* search for 8-puzzle with Misplaced Tiles & Manhatten Distance	13 - 16	S. Pradhan 14/10/24 (10/10)

Lab - 1

1.) Vaccum Cleaner Algorithm :

1. Initialize goal state :
   - Set goal_state = {'A': '0'; 'B': '0'}
     (0 = clean, 1 = dirty)
   - Initialize cost = 0.

2. Input the vaccum location :
   - Get vaccum's location :
     location_input = 'A' or 'B'.
   - Get status of the current room :
     status_input = '0' or '1'.
   - Get status of the other room :
     status_input_complement = '0' or '1'.

3. Vaccum in Room A :
   - If location_input == 'A':
     - If status_input == '1' (A is dirty):
       - Clean A, set goal_state ['A'] = '0',
         increment cost.
     - If status_input_complement == '1'
       (B is dirty):
       - Move to B, clean it.
       - update goal_state ['B'] = '0'
       - increment cost.

4. Vaccum in Room B :
   - If location_input == 'B':
     - If status_input == '1' (B is dirty):

- Clean B, set goal_state ['B'] = '0',
- increment cost.

- If status_input_complement == '1' (A is dirty):
  - Move to A, clean it
  - update goal_state ['A'] = '0'
  - increment cost.

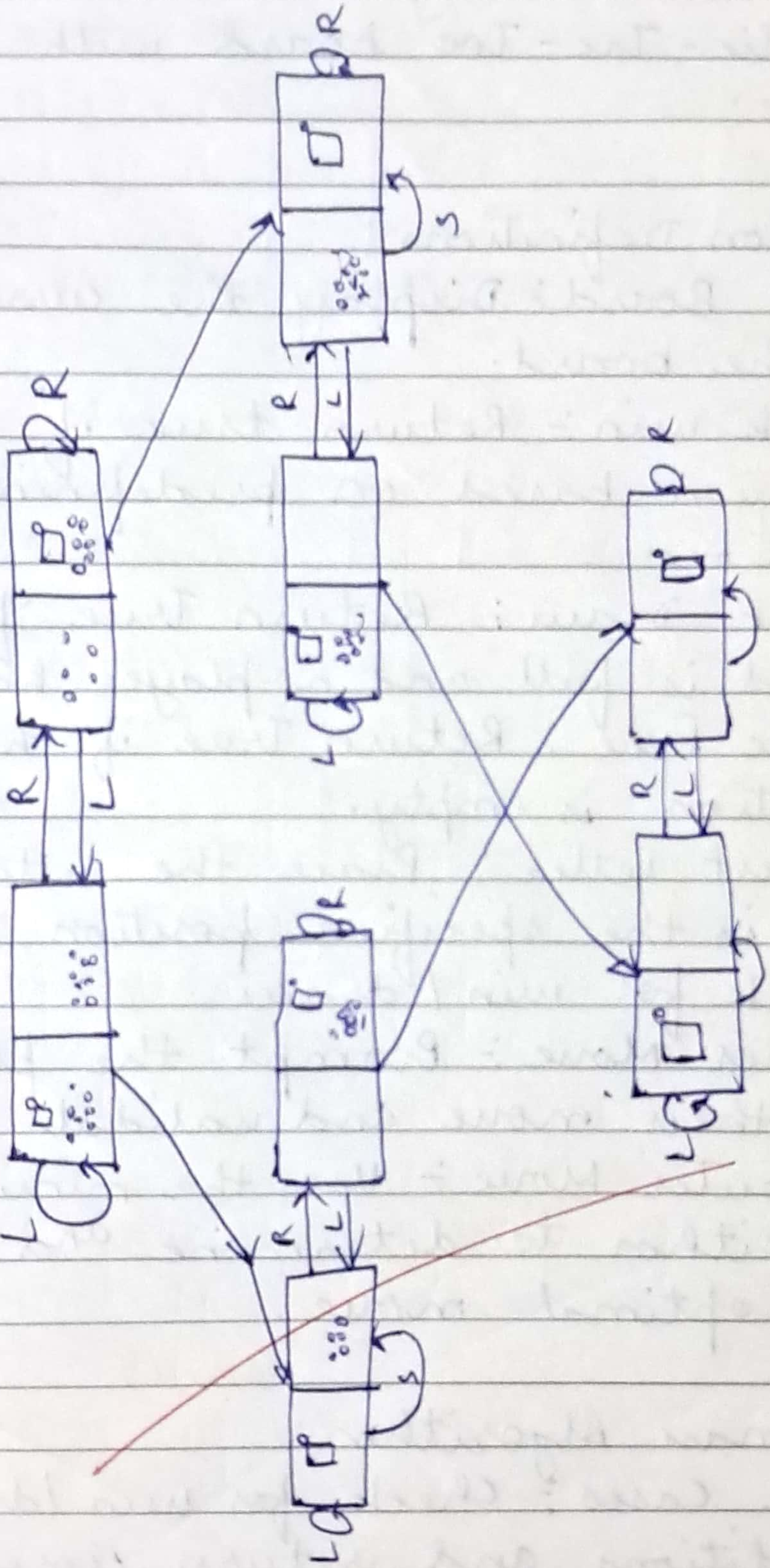
5. Output:
   - print goal_state and cost as the performance measure.

Output:- Initial condition : {'A' : '1', 'B' : '1'}
Vaccum is placed in location A.
Location A is dirty.
Cost for Cleaning A : 1
Location A has been cleaned.

Location B is Dirty.
Moving right to location B.
Cost for moving Right : 2
Cost for Cleaning : 3
Location B has been cleaned.

GOAL State :
{'A' : '0', 'B' : '0'}
Performance Measurement : 3

State space Tree



2) Tic - Tac - Toe.

Algorithm :

1. Initialize the board.
Create a dictionary (or list) to represent the Tic - Tac - Toe board with empty spaces.

2. Function Definitions :
- Print Board :- Display the current state of the board.
- Check win :- Return true if any player has won based on predefining wining conditions.
- Check Draw : Return True if the board is full and no player has won.
- Space Free : Return True if the selected position is empty.
- Insert letter : Place the letter ('X' or 'O') in the specified position and check for win / draw.
- Player Move :- Prompt the player for their move and validate input.
- Computer Move :- Use the minimax algorithm to determine and make the optimal move.

3. Minimax Algorithm :
- Base Cases : Check for win / draw conditions and return scores based on the outcome.
- Recursion : For maximizing (computer) and minimizing (player), evaluate

possible moves and return the best score.

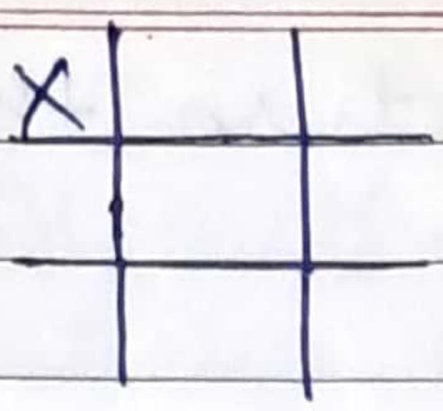
4. Main Game Loop.
- While the game is ongoing:
  - If no win/draw, call computer Move.
  - Check for win/draw conditions.
  - If no win/draw, call Player move.
  - Check for win/draw conditions.

5. End Game:
- Display the final board and announce the result (win/draw).

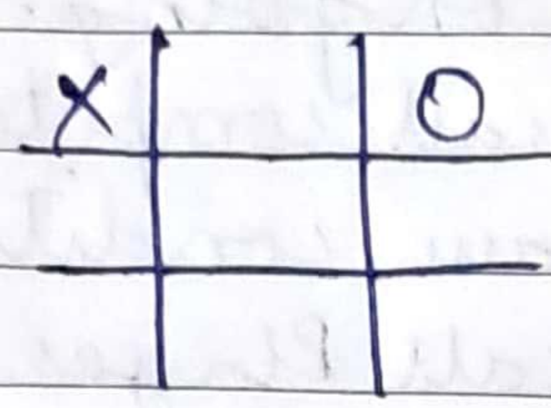
Pseudocode :-

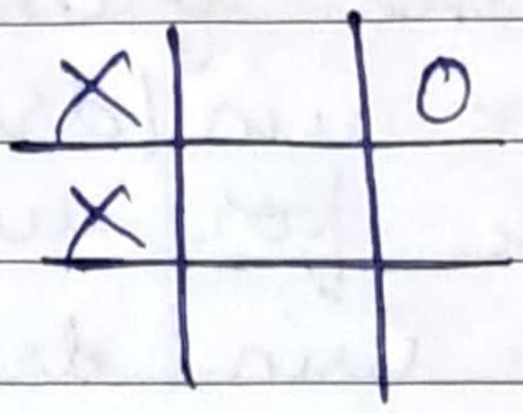
```
Initialize board
While true:
    If not checkWin() && not checkDraw();
        compMove()
    If checkWin() or checkDraw();
        break;
    If not checkWin() && not checkDraw();
        playerMove()
    If checkWin() or checkDraw():
        break
Display final board.
Announce result.
```

Output:-

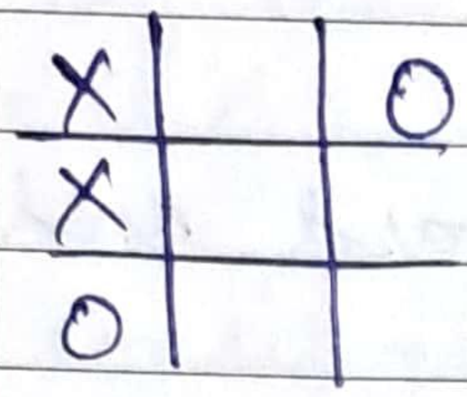


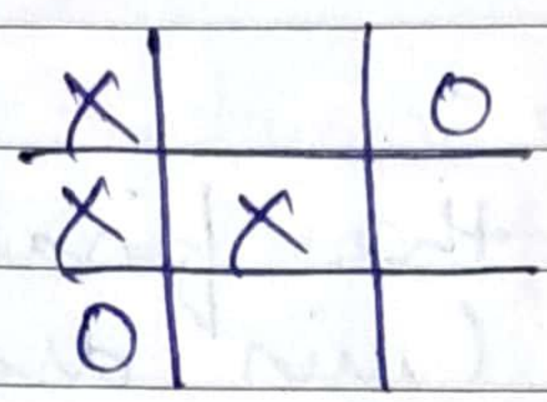
Enter position for O (1-9) : 3



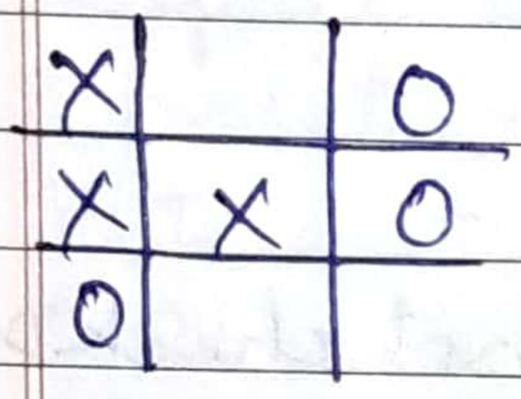


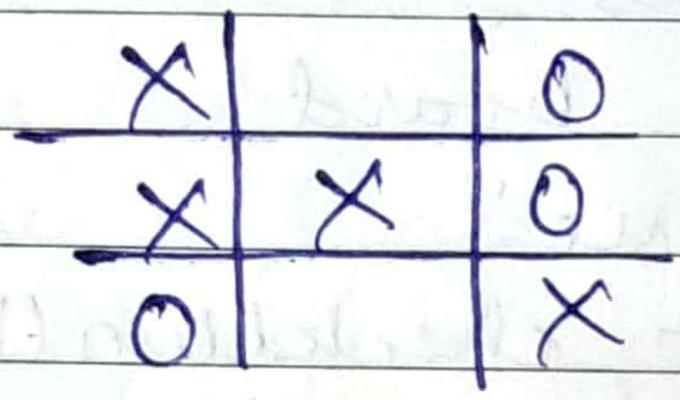
Enter position for O (1-9) : 7.



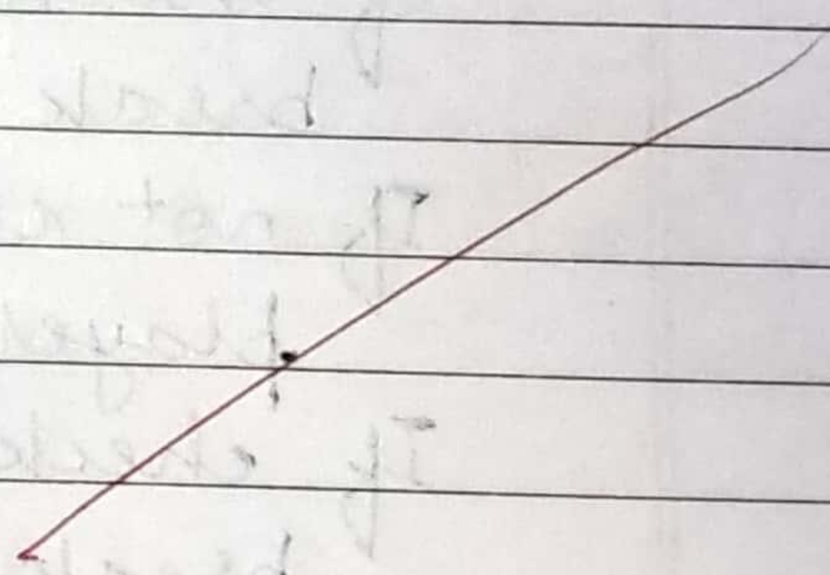


Enter position for O (1-9) : 6

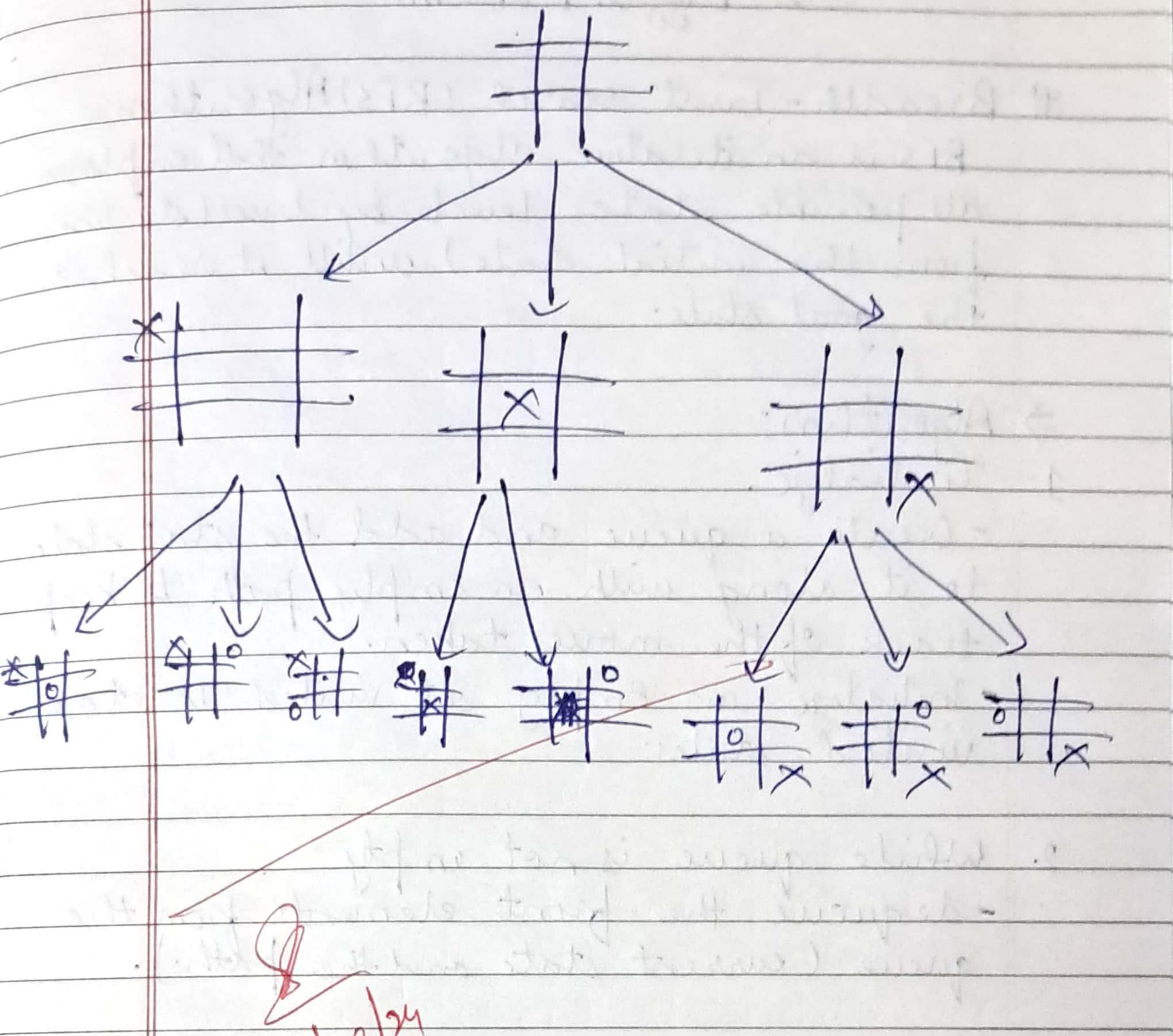




Bot wins !



- State Space Tree :



1/10/24

Lab - 2

8 - Puzzle Problem.

Breadth - First Search (BFS) Algorithm.

BFS is an iterative algorithm that explores all possible states level by level (starting from the initial state) until it reaches the goal state.

⇒ Algorithm :-

1. Initialize.
   - Create a queue and add the start state to it, along with an empty path to keep track of the moves taken.
   - Initialize an empty set 'visited' to store visited states.

2. While queue is not empty:
   - dequeue the front element from the queue (current state and the path).

3. Check goal.
   - If the current state is the goal state, return the path (solution).

4. Mark current State as visited.
   - add the current state to 'visited set'.

5. Generate successors:
   - For each valid move from the current state:
     - apply the move to get a new state.
     - If the new state has not been visited:

- add the new state and the updated path to the queue.

6. Return Failure.:
- If the queue is empty and no solution has been found, return failure (no solution).

⇒ Output :-

Initial state :-

1	2	3
4	0	6
7	5	8

Solving using BFS:

Exploring state in BFS:

[1, 2, 3]
[4, 0, 6]
[7, 5, 8],

Exploring state in BFS:

[1, 0, 3]
[4, 2, 6]
[7, 5, 8]

- BFS solution: ['down', 'right']

Exploring state in DFS:

[1, 2, 3]
[4, 5, 6]
[7, 8, 0]

8-puzzle problem using Depth-First Search Algorithm

DFS explores a branch as far as possible before backtracking when it reaches a dead end (or goal).

⇒ Algorithm:

1- Initialize:
- Create a stack and add the start state to it, along with an empty path to keep track of the moves taken.
- Initialize an empty set 'visited' to store visited states.

2- While stack is not empty:
- pop the top element from the stack (the current state and the path).

3. Check goal:
- If the current state is the goal, return the path (solution).

4. Mark current state as visited:
- add the current state to the 'visited set'.

5. Generate successors:
- For each valid move from the current state:
  - apply the move to get a new state.
  - If the new state has not been visited:
    - push the new state and the updated path to the stack.

6. Return Failure :-
- If the stack is empty and no solution has been found, return failure (no solution exists).

⇒ Output :
Solving using DFS:
Exploring state in DFS:
[1, 0, 3]
[4, 2, 6]
[7, 5, 8]
Exploring state in DFS:
[2, 3, 6]
[8, 0, 5]
[4, 1, 7]
Exploring state in DFS:
[1, 2, 3]
[4, 8, 6]
[7, 0, 5]

DFS solution: ['right', 'down', 'left', 'up', 'right', ... , 'right']

Tree for 8-puzzle problem.

State Space Tree

Start
8 puzzle

Lab-3

Algorithm 1: A* search for 8-puzzle with Misplaced Tiles Heuristic.

1. Initialize
   Open list ← {start node}
   Closed list ← ∅
   g(start) ← 0
   h(start) ← number of misplaced tiles.
   f(start) ← g(start) + h(start)

2. Loop untill Open list is empty
   - Select the node n from the Open list with the lowest f(h).
   - Remove n from the Open list and add it to the Closed list.

3. For each neighbour of node n.
   - If the neighbour is in the closed list, skip it.
   - Calculate g(neighbour) ← g(n) + 1 (Depth of node)
   - Calculate h(neighbour) ← number of misplaced tiles
   - Calculate f(neighbour) ← g(neighbour) + h(neighbour)
   - If the neighbour is not in the Open list, add it.
   - If the neighbour is not in the Open list, and this path is better (lower f(n)), update the path.

4. Repeat steps 2-3 untill the goal is reached or the Open list is empty.

State Space Tree.

5	4	
6	1	8
7	3	2

Initial

	1	2
3	4	5
6	7	8

Goal state.

g = 1
h1 = 8
f = 9

5		4
6	1	8
7	3	2

g = 1
h1 = 8
f = 9

5	4	8
6	1	
7	3	2

g = 2, h1 = 7
f = 9

5	1	4
6		8
7	3	2

g = 2, h1 =

5	4	
6	1	8
7	3	2

g = 2, h1 = 8
f = 10

	5	4
6	1	8
7	3	2

g = 2, h1 = 8
f = 10

5	4	8
6		1
7	3	2

g = 2, h1 = 8
f = 10

5	4	8
6	1	
7	3	2

g = 3
h1 = 7
f = 10

5	1	4
	6	8
7	3	2

g = 3
h1 = 7
f = 10

5	1	4
6	8	
7	3	2

5	1	4
6	3	8
7		2

g = 3
h1 = 7
f = 10

g = 4
h1 = 6
f = 10

5	1	4
6	3	8
	7	2

g = 4
h1 = 7
f = 11

5	1	4
6	3	8
7	2	

g = 5
h1 = 5
f = 10

5	1	4
	3	8
6	7	2

Algorithm 2: A* Search for 8-puzzle with Manhattan Distance Heuristic.

1. Initialize
   open list ← {start node}
   closed list ← ϕ
   g(start) ← 0
   h(start) ← Manhattan distance
   f(start) ← g(start) + h(start)

2. Loop until open list is empty.
   - Select the node n from the open list with the lowest f(n)
   - If n is the goal state/node, terminate and return the path.
   - Remove n from the open list and add it to the closed list.

3. For each neighbour of node n,
   - If the neighbour is in the closed list, skip it.
   - Calculate g(neighbour) ← g(n) + 1 (Depth of node)
   - Calculate h(neighbour) ← Manhattan Distance.
   - Calculate f(neighbour) ← g(neighbour) + h(neighbour)

   - If the neighbour is not in the open list, add it.
   - If the neighbour is in the open list and this path is better (lower f(n)), update the path.

4. Repeat steps 2-3 until the goal is reached or the open list is empty.

State Space Tree

Initial

2	8	3	
1		4	
7	6	5	

$g=0$

$h_2=4$

$f=4+0=4$

1	2	3	
8		4	
7	6	5	

2	8	3	
	1	4	
7	6	5	

$g=1$

$h(n)=1+1+2+1=5$

$f=6$

2		3	
1	8	4	
7	6	5	

$g=1$

$h(n)=3$

$f(n)=4$

2	8	3	
1	4		
7	6	5	

$g(n)=1$

$h(n)=5$

$f(n)=6$

	2	3	
1	8	4	
7	6	5	

$g(n)=2$

$h(n)=1+1=2$

$f(n)=4$

2	3		
1	8	4	
7	6	5	

$g(n)=2$

$h(n)=1+1+1+1$

$f(n)=2+4=6$

1	2	3	
	8	4	
7	6	5	

$g(n)=3$

$h(n)=1$

$f(n)=3+1=4$

1	2	3	
8		4	
7	6	5	

1	2	3	
7	8	4	
	6	5	

5. Pradip
15/10/2024

Final state
goal reached.