**🎯 Assignment: Understanding the Tic-Tac-Toe Problem in AI**

**🧠 What is the Tic-Tac-Toe Problem?**

Tic-Tac-Toe is a simple two-player game played on a 3x3 grid. Players take turns placing their symbol (usually **X** and **O**) in empty squares. The first player to get **three of their symbols in a row** — horizontally, vertically, or diagonally — wins. If all 9 squares are filled without any player winning, the game is a **draw**.

In Artificial Intelligence, **Tic-Tac-Toe** is often used to teach:

* Game playing agents
* Search trees
* Minimax algorithm
* Utility-based decision making

**🧩 Components of a Tic-Tac-Toe Search Problem**

* **Initial State**: Empty 3x3 board.
* **Actions**: Place X or O in any empty cell.
* **Goal Test**: Check if the player has won (3 in a row) or if the board is full (draw).
* **Path Cost**: Usually not considered here, but each move could be counted as one step.
* **Type**: Goal-based problem, deterministic, fully observable.

**📘 Tasks**

**Task 1: Representing the Game**

**1.Draw an initial empty 3x3 board?**

**2.List all possible first moves for Player X?**

**3.How many possible unique board states are there after the first move?**

**# 3.How many possible unique board states are there after the first move?**

**Ans:-**

4.  #1. Draw an initial empty 3x3 board.

5.  board = ["-", "-", "-",

6.           "-", "-", "-",

7.           "-", "-", "-"]

9.  #2. List all possible first moves for Player X.

10. possible\_moves\_for\_X = [

11. """

12. X, -, -,

13. -, -, -,

14. -, -, -

15. """,

16. """

17. -, X, -,

18. -, -, -,

19. -, -, -

20. """,

21. """

22. -, -, X,

23. -, -, -,

24. -, -, -

25. """,

26. """

27. -, -, -,

28. X, -, -,

29. -, -, -

30. """,

31. """

32. -, -, -,

33. -, X, -,

34. -, -, -

35. """,

36. """

37. -, --, -,

38. -, -, X,

39. -, -, -

40. """,

41. """

42. -, , -,

43. -, -, -,

44. X, -, -

45. """,

46. """

47. -, -, -,

48. -, -, -,

49. -, X, -

50. """,

51. """

52. -, , -,

53. -, -, -,

54. -, -, X

55. """

56. ]

57.

58. #3. How many possible unique board states are there after the first move?

59. After Player X makes the first move, one cell will have an X and the remaining 8 cells will be empty.

60. Since there are 9 empty positions initially, and placing X in any one of them creates a unique state:

61.  There are 9 possible unique board states after the first move.

**Task 2: Game Tree Exploration**

1. **Create a small search tree of Tic-Tac-Toe up to depth 2:**
   * **Root node: initial board**
   * **Depth 1: All possible moves by X**
   * **Depth 2: All possible responses by O**

**2.Label each node with the board state?**

**Ans:-**Game Tree (Depth 0 to 2)

Root (Depth 0)

- - -

- - -

- - -

Depth 1 (X moves)

X1:

X - -

- - -

- - -

X2:

- X -

- - -

- - -

X3:

- - X

- - -

- - -

... up to X9

Depth 2 (O moves — sample for first few)

From X1:

X1-O2

X O -

- - -

- - -

X1-O3

X - O

- - -

- - -

X1-O4

X - -

O - -

- - -

... up to X1-O9

From X2:

X2-O1

O X -

- - -

- - -

X2-O3

- X O

- - -

- - -

... up to X2-O9

From X3:

X3-O1

O - X

- - -

- - -

X3-O2

- O X

- - -

- - -

... up to X3-O9

✅ Full Tree:

* 9 Depth 1 nodes (X moves)
* 72 Depth 2 nodes (O moves — 8 per X move)

**Task 3: Classifying the Problem**

Answer the following questions:

1. **Is this a goal-based agent problem?**

**Ans:-** Yes, Tic Tac Toe is a goal-based agent problem. The goal for each player (X and O) is to:

- Win the game by getting three of their marks in a row (horizontally, vertically, or diagonally)

- Block the opponent from winning

The agents (players) make decisions based on their goal to win or block the opponent, making it a goal-based problem.

1. **Is Tic-Tac-Toe a deterministic game? Why?**

**Ans:-** Yes, Tic Tac Toe is a deterministic game.

Why?

1. Perfect Information: Both players have complete knowledge of the game state (the board) at all times.

2.No Randomness: The outcome of a move is entirely determined by the current state of the board and the move itself. There are no random elements or chance events.

3. Predictable Outcomes: Given the current state of the board and a specific move, the next state of the board is entirely predictable.

These characteristics make Tic Tac Toe a deterministic game, where the outcome of a game is determined solely by the players' moves and not by chance or randomness

1. **Is it a fully observable environment?**

**Ans:-** Yes, Tic Tac Toe is a fully observable environment.

Why?

- Both players have complete knowledge of the game state (the board) at all times.

- Players can see all the moves made by their opponent and themselves.

- There is no hidden information or uncertainty about the state of the game.

This complete visibility of the game state makes Tic Tac Toe a fully observable environment.

1. **Is it a single-agent or multi-agent problem?**

**Ans:-** Multi-agent

Tic Tac Toe is a multi-agent problem because:

- There are two players (X and O) interacting with each other.

- Each player makes decisions based on the actions of the other player.

- The outcome of the game depends on the interactions and decisions made by both players.

This interaction between multiple agents (players) makes Tic Tac Toe a multi-agent problem.

**Task 4: Python Mini-Project**

Implement a simple **Tic-Tac-Toe game** in Python:

* Two-player mode (X and O input manually)
* Show the board after every move
* Detect win or draw conditions

(*Optional*: Use a 2D list and functions like check\_win(board))

**✅ Submission Guidelines**

* Submit your answers to conceptual questions as a Word doc.
* Python code (if attempted) with the Word doc must be pushed to your github repositories.