RAJALAKSHMI INSTITUTE OF TECHNOLOGY

(An Autonomous Institution, Affiliated to Anna University, Chennai)

DEPARTMENT OF CSE (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

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SEMESTER III

ARTIFICIAL INTELLIGENCE LABORATORY

MINI PROJECT REPORT

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PROJECT TITLE	**Nim Game using Python (Mini-Max Algorithm)**
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INTRODUCTION

Artificial Intelligence (AI) is a rapidly growing branch of Computer Science that focuses on creating systems capable of performing tasks that require human-like intelligence. AI-based algorithms are widely used in strategy games to demonstrate decision-making logic. This project focuses on implementing the Nim Game using the Mini-Max algorithm, which allows an AI opponent to make optimal moves based on mathematical analysis. The project demonstrates how game theory concepts can be practically implemented using Python programming.

PROBLEM STATEMENT

To develop a Python-based Nim Game that uses the Mini-Max algorithm to make intelligent decisions. The AI player should always play optimally, minimizing losses and maximizing the chances of winning against a human player.

GOAL

The goal of this project is to simulate a strategic game scenario where an AI opponent utilizes the Mini-Max algorithm for decision-making. The expected outcome is an AI that can determine the best move sequence and ensure an optimal gameplay strategy.

THEORETICAL BACKGROUND

The Mini-Max algorithm is a classical game theory algorithm used for minimizing the possible loss for a worst-case scenario. It assumes that the opponent plays optimally and recursively explores all possible moves to select the best one. The algorithm evaluates each state of the game tree and assigns a score, then selects the move with the highest guaranteed value. In the Nim Game, the algorithm uses XOR logic (Nim-sum) to determine whether a position is winning or losing.

ALGORITHM EXPLANATION WITH EXAMPLE

1. Represent the game as multiple piles containing objects.
2. At each turn, a player removes one or more objects from a single pile.
3. The player forced to take the last object loses.
4. The Mini-Max algorithm simulates each possible move recursively.
5. The AI evaluates all game states and selects the move that leads to a winning configuration (Nim-sum = 0).

IMPLEMENTATION AND CODE

The following Python code implements the Nim Game using the Mini-Max approach. The AI opponent calculates the optimal move based on Nim-sum values.

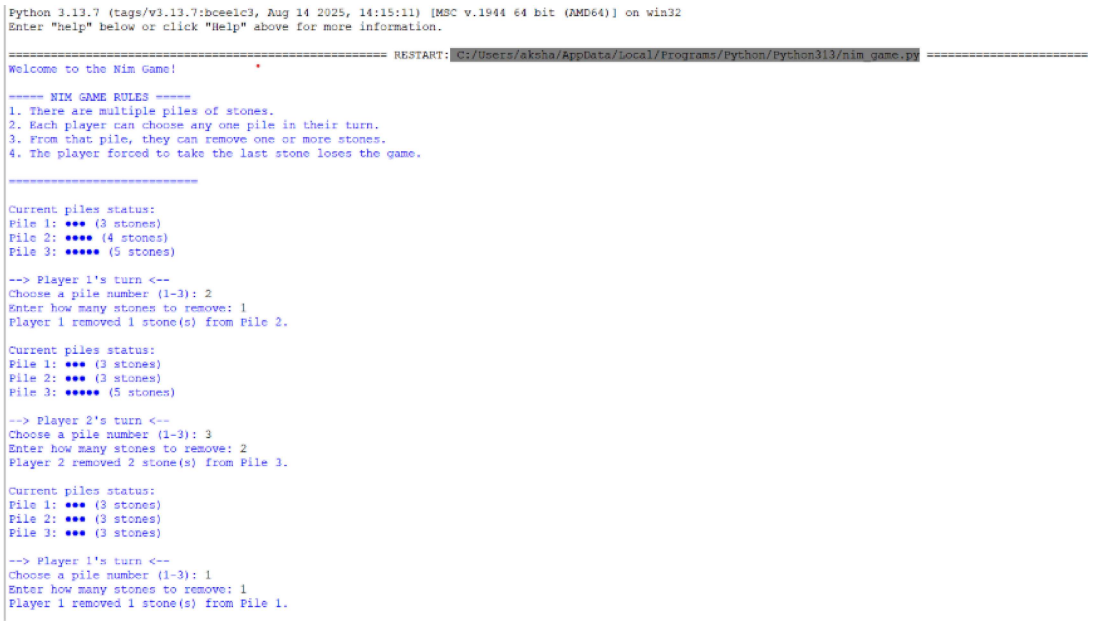
```
def nim_sum(piles):
        result = 0
        for pile in piles:
        result ^= pile
```

```
        return result

def ai_move(piles):
        for i in range(len(piles)):
        for j in range(piles[i]):
        temp = piles[i] - j - 1
        new_piles = piles[:i] + [temp] + piles[i+1:]
        if nim_sum(new_piles) == 0:
        return i, j + 1
        return 0, 1

def play_nim():
        piles = [3, 4, 5]
        player = 1
        while any(piles):
        print("Current piles:", piles)
        if player == 1:
        pile = int(input("Choose pile (1-3): ")) - 1
        remove = int(input("Remove how many: "))
        else:
        pile, remove = ai_move(piles)
        print("AI removes", remove, "from pile", pile + 1)
        if remove <= 0 or remove > piles[pile]:
        print("Invalid move! Try again.")
        continue
        piles[pile] -= remove
        if not any(piles):
        print("Player", player, "wins!")
        break
        player = 2 if player == 1 else 1

play_nim()
```

OUTPUT

The program displays the current state of piles and alternates between player and AI turns. Below is a sample interaction of the program execution:

Current piles: [3, 4, 5]
Player 1 chooses pile 3 and removes 2.
AI removes 1 from pile 1.
Current piles: [2, 4, 3]
AI wins the game.



RESULTS AND FUTURE ENHANCEMENT

This project successfully demonstrates how an AI system can make optimal decisions using the Mini-Max algorithm. The Nim Game helps visualize decision-making in zero-sum games. In the future, this can be enhanced by developing a GUI-based version, adding multiplayer options, or implementing alpha-beta pruning for improved efficiency.

REFERENCES

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