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Title of Experiment : Write a Program to find mixed-strategy Nash equilibria for Matching Pennies Game

Objective of Experiment : The expected outcome of this experiment is a fully functional Python program that accurately computes the mixed-strategy Nash equilibria for the Matching Pennies Game. Users should be able to input their own Matching Pennies Game parameters, and the program should return meaningful insights into the strategic interactions involved. Additionally, the program should be efficient and capable of handling various input scenarios, making it a valuable educational and analytical tool for individuals interested in game theory and strategic decision-making.

Outcome of Experiment : The problem at hand is to develop a computational solution for finding mixed-strategy Nash equilibria in the context of the Matching Pennies Game. The Matching Pennies Game is a classic two-player zero-sum game where each player chooses between two possible actions, typically represented as "Heads" and "Tails." The objective is to create a Python program that can effectively analyze this game, considering both players' strategies as probabilistic, and determine the equilibrium strategies that result in no player having an incentive to unilaterally deviate from their chosen strategy.

Description / Theory :

In the Matching Pennies problem, a mixed strategy Nash equilibrium can be described as follows:

1. Neither player has a dominant pure strategy, meaning that no player has a single strategy that is always the best response to the other player's strategy.
2. Both players use mixed strategies, meaning they randomize between their available strategies.

There are no pure strategy Nash equilibria in the Matching Pennies game. Players have no strictly dominant strategy that guarantees them a higher payoff regardless of what their opponent chooses.

In a mixed strategy Nash equilibrium for the Matching Pennies game, both players randomize their choices with specific probabilities. This means that they don't always choose "Heads" or "Tails" but assign probabilities to each strategy. The Nash equilibrium occurs when neither player has an incentive to change their probability distribution given the strategy of the other player.

For example, it could be an equilibrium for Player 1 to choose "Heads" with a probability of 0.5 and "Tails" with a probability of 0.5, while Player 2 also chooses "Heads" with a probability of 0.5 and "Tails" with a probability of 0.5. In this equilibrium, neither player has an incentive to deviate because changing their probabilities won't improve their expected payoff.

In summary, the mixed strategy Nash equilibrium in the Matching Pennies problem involves both players randomizing their choices, and neither player having an incentive to change their probability distribution given their opponent's strategy.

Program :

1.

```
def calculate_mixed_strategy_nash_equilibrium():
    print("Matching Pennies Game Nash Equilibrium Calculator!")
    print("Player 1 (Row Player) chooses H with probability p and T with probability 1-p.")
    print("Player 2 (Column Player) chooses H with probability q and T with probability 1-q.")

    # Get the input probabilities from the user for Player 1
    while True:
        try:
            p = float(input("Enter the probability (0 to 1) that Player 1 chooses H (p): "))
            if 0 <= p <= 1:
                break
            else:
                print("Invalid input. Please enter a probability between 0 and 1.")
        except ValueError:
            print("Invalid input. Please enter a valid number between 0 and 1.")

    # Calculate Player 2's mixed strategy based on Player 1's strategy
    q = (2 * p - 1) / (2 * p)

    # Check if q is a valid probability (between 0 and 1)
    if 0 <= q <= 1:
        print("\nMixed Strategy Nash Equilibrium:")
        print("Player 1's Mixed Strategy (p):", p)
        print("Player 2's Mixed Strategy (q):", q)
```

```
    else:
        print("No valid Nash equilibrium exists.")

if __name__ == "__main__":
    calculate_mixed_strategy_nash_equilibrium()
```

Output

P = 0

```
Welcome to the Matching Pennies Game Nash Equilibrium Calculator!
Player 1 (Row Player) chooses H with probability p and T with probability 1-p.
Player 2 (Column Player) chooses H with probability q and T with probability 1-q.
Enter the probability (0 to 1) that Player 1 chooses H (p): 0.5

Mixed Strategy Nash Equilibrium:
Player 1's Mixed Strategy (p): 0.5
Player 2's Mixed Strategy (q): 0.0
```

P = 0.3

```
Matching Pennies Game Nash Equilibrium Calculator!
Player 1 (Row Player) chooses H with probability p and T with probability 1-p.
Player 2 (Column Player) chooses H with probability q and T with probability 1-q.
Enter the probability (0 to 1) that Player 1 chooses H (p): 0.3
No valid Nash equilibrium exists.
```

P = 0.9

```
Matching Pennies Game Nash Equilibrium Calculator!
Player 1 (Row Player) chooses H with probability p and T with probability 1-p.
Player 2 (Column Player) chooses H with probability q and T with probability 1-q.
Enter the probability (0 to 1) that Player 1 chooses H (p): 0.9

Mixed Strategy Nash Equilibrium:
Player 1's Mixed Strategy (p): 0.9
Player 2's Mixed Strategy (q): 0.4444444444444445
```