

Rock-Paper-Scissors AI Agent

Alp Gokcek, Erdal Sidal Dogan, Mert Komurcuoglu
 {gokcekal, doganer, komurcuoglum}@mef.edu.tr
 MEF University
 December 6, 2020

I. INTRODUCTION

Rock-Paper-Scissors is a game that has been around for while and well known to almost everyone. The game is played with two players, goal is to defeat the opponent by making a choice that prevails the opponents. Rules to defeat is as follows;

- 1) Paper>Rock
- 2) Rock>Scissors
- 3) Scissors>Paper

In the beginning of the game, two players make a random choice among the Rock-Paper-Scissor triplet simultaneously. Whoever made the choice that defeats the opponents choice wins the game.

Even though it seems that the choices are random and probabilities of winning for each player is equal, scientist discover that "if a player wins for a round, they are much more likely to win to following one too". Furthermore, the choices that players make are prone to biases. [?]

II. SOLUTION DESIGN PROCESS

For this problem, our initial approach was to design a rule based system where the each case was covered with the if-else statements. Later on, we searched for another applicable method that we have covered in the lecture so far. Upon our researches, we decided to use *Discrete Markov Chains*

DMC methods suggest creating a *State Transition Matrix*. Each column of the matrix is the probability score of the upcoming move of the opponent; rows of the matrix corresponds to a previous set of plays and stochastic.

UML Diagram of the RPS_Agent class can be seen from ??.

TABLE I: Transition Matrix with initial transition values

State	R	P	S
RRR	0.333	0.333	0.333
RRP	0.333	0.333	0.333
RRS	0.333	0.333	0.333
⋮			
SSS	0.333	0.333	0.333

III. IMPLEMENTATION

The program has been implemented with *Python Language*. In order to have concise structure in the program, we defined our AI Agent as an object. This class, consist of transition

matrix and all the complementary methods such as create matrix, update matrix etc.

Most important function and variables in this class are as follows; `update_transition_matrix()`, `predict()`

A. Update Transition Matrix

The program makes probability calculations relying on last 3 moves of the opponent, hence, before this calculations game must be played at least three times. This method checks the game has played for at least 3 rounds, if not, doesn't update the matrix at all. Otherwise, it multiplies each value on the row with a predefined `decay` value in order to reduce the weight of the earlier moves and increase the effect of the last move on the probability score.

Finally, it updates the `transition_sum_matrix` where the number of occurrence for the each case is stored. As the `transition_sum_matrix` is updated, new probability scores are calculated on the `transition_matrix`

Listing 1: `update_transition_matrix()` method

```
def update_transition_matrix(self,
    opponent_move):
    global POSSIBLE_MOVES
    if len(self.moves) <= len(
        LAST_POSSIBLE_MOVES[0]):
        return None
    for i in range(len(self.
        transition_sum_matrix[self.
        last_moves])):
        self.transition_sum_matrix[self.
        last_moves][i] *= self.decay
    self.transition_sum_matrix[self.
        last_moves][POSSIBLE_MOVES.index(
        opponent_move)] += 1

    transition_matrix_row = deepcopy(self.
        .transition_sum_matrix[self.
        last_moves])

    row_sum = sum(transition_matrix_row)
    transition_matrix_row[:] = [count/
        row_sum for count in
        transition_matrix_row]
    self.transition_matrix[self.
        last_moves] =
        transition_matrix_row
```

B. Predict

Since we don't have any data to make our predictions to be based on, in the initial predictions we used the statistics that psychologists observed when conducting a research about the human behavior on Rock-Paper-Scissors.

For the later moves, we use the transition matrix as lookup table where the row corresponding the last 3 moves presents us with the probabilities of the next move. Intuitively, we choose the next state with the highest probability score. However, if one of the scores are significantly higher than the others, we assume that it will be predicted by our opponent agent and it will make their move accordingly. In order to protect ourselves from this move, we make the move with the least probability score to surprise the opponent.

Listing 2: predict () method

```
def predict(self):
    global POSSIBLE_MOVES, beats
    if len(self.predictions) == 0:
        prediction = random.choices(
            population=POSSIBLE_MOVES,
            weights=[0.45, 0.35, 0.20], k
            =1)
        return prediction[0]
    elif len(self.predictions) in range
    (1, len(LAST_POSSIBLE_MOVES[0])):
        last_prediction, last_move =
            beats[self.predictions[-1]],
            self.moves[-1]
        last_result = self.get_result(
            last_prediction, last_move)

        if last_result in [0,1]:
            prediction = beats[
                last_prediction]
        else:
            prediction = beats[last_move]
        return prediction
    else:
        row = self.transition_matrix[self
            .last_moves]
        if max(row) == min(row):
            return random.choices(
                POSSIBLE_MOVES, [0.35,
                    0.30, 0.35], k=1)[0]
        else:
            if min(row) * random.uniform
                (1.7, 3) <= max(row):
                return random.choices(
                    POSSIBLE_MOVES,
                    weights=[1-prob for
                        prob in row], k=1)[0]
            else:
                return random.choices(
                    POSSIBLE_MOVES, row, k
                    =1)[0]
```

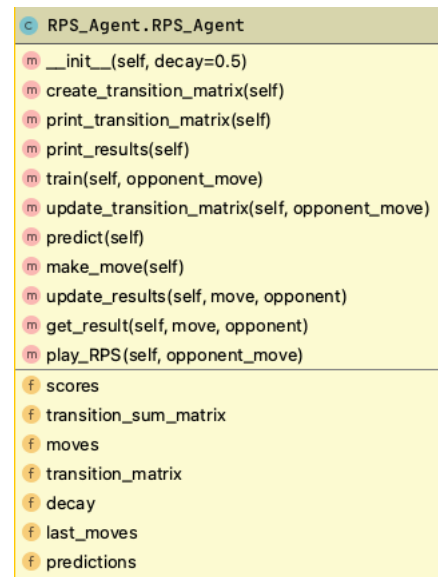


Fig. 1: "UML Diagram of the RPS Agent Class"

IV. TESTING

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Ut purus elit, vestibulum ut, placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero, nonummy eget, consectetur id, vulputate a, magna. Donec vehicula augue eu neque. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend, sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam

vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt ultrices. Lorem ipsum dolor sit amet, consectetur adipiscing elit. In hac habitasse platea dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi. Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac pulvinar elit purus eget enim. Nunc vitae tortor. Proin tempus nibh sit amet nisl. Vivamus quis tortor vitae risus porta vehicula.

Fusce mauris. Vestibulum luctus nibh at lectus. Sed bibendum, nulla a faucibus semper, leo velit ultricies tellus, ac venenatis arcu wisi vel nisl. Vestibulum diam. Aliquam pellentesque, augue quis sagittis posuere, turpis lacus congue quam, in hendrerit risus eros eget felis. Maecenas eget erat in sapien mattis porttitor. Vestibulum porttitor. Nulla facilisi. Sed a turpis eu lacus commodo facilisis. Morbi fringilla, wisi in dignissim interdum, justo lectus sagittis dui, et vehicula libero dui cursus dui. Mauris tempor ligula sed lacus. Duis cursus enim ut augue. Cras ac magna. Cras nulla. Nulla egestas. Curabitur a leo. Quisque egestas wisi eget nunc. Nam feugiat lacus vel est. Curabitur consectetur.

Suspendisse vel felis. Ut lorem lorem, interdum eu, tincidunt sit amet, laoreet vitae, arcu. Aenean faucibus pede eu ante. Praesent enim elit, rutrum at, molestie non, nonummy vel, nisl. Ut lectus eros, malesuada sit amet, fermentum eu, sodales cursus, magna. Donec eu purus. Quisque vehicula, urna sed ultricies auctor, pede lorem egestas dui, et convallis elit erat sed nulla. Donec luctus. Curabitur et nunc. Aliquam dolor odio, commodo pretium, ultricies non, pharetra in, velit. Integer arcu est, nonummy in, fermentum faucibus, egestas vel, odio.

Sed commodo posuere pede. Mauris ut est. Ut quis purus. Sed ac odio. Sed vehicula hendrerit sem. Duis non odio. Morbi ut dui. Sed accumsan risus eget odio. In hac habitasse platea dictumst. Pellentesque non elit. Fusce sed justo eu urna porta tincidunt. Mauris felis odio, sollicitudin sed, volutpat a, ornare ac, erat. Morbi quis dolor. Donec pellentesque, erat ac sagittis semper, nunc dui lobortis purus, quis congue purus metus ultricies tellus. Proin et quam. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos hymenaeos. Praesent sapien turpis, fermentum vel, eleifend faucibus, vehicula eu, lacus.

V. TEAMWORK

VI. IMPLEMENTATION

REFERENCES