Game Theory Assignment II

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***Abstract*—This document is a report for the third-year Bachelors Game Theory Course Assignment. The report describes the problem statement, different players, observations, testing, the solution and conclusion.**

***Index Terms*—Game theory, player, iterated game, moose behaviour, simulation**

I. Problem Statement

Moose are large quadrupedal herbivores which range in Northern longitudes from the Northern United States, Canada, Scandinavia, and Russia. They are territorial in nature and they are known for fighting when encountering each other. In this simulation, we will create a model of the environment in order to understand the nature of these creatures.

II. Problem Definition

A. Environment Model

The environment for Moose is three territorial regions (A, B, and C fields). Each field has various vegetation growth, which is defined in a sigmoid fashion by equation:

$$f(x) = \frac{10 * e^x}{1 + e^x} \tag{1}$$

B. Fields Behaviour

All fields start with X=1, i.e. f(1). If a Moose is not present in the square, then the X of the field is increased by 1. If one or two Moose are present in the same field, then the X of the field is decreased by 1, to a minimum of 0.

C. Moose payoffs

If there is only one Moose in the field k, then he eats the vegetation based on the amount available and gains:

$$payoff = f(X_k) - f(0) \tag{2}$$

If both of Moose are in the same field, then they will fight. Fighting is exhausting and prevents eating and damages the local area, and causes payoff equal to 0 for both of Moose.

III. Overview of payoff function

If we look closer to payoff function it seems that there is a point where function becomes a line:

If we look at approximate values of payoff function:

We see that value 6 or higher values fed in the payoff function gives the maximum payoff, so the **minimum integer value for getting maximum payoff is 6**. Thus, there is no need of fighting for the best fields after X values of fields become 6 or more. This is an interesting observation that will be used further in the description of strategies of different players.

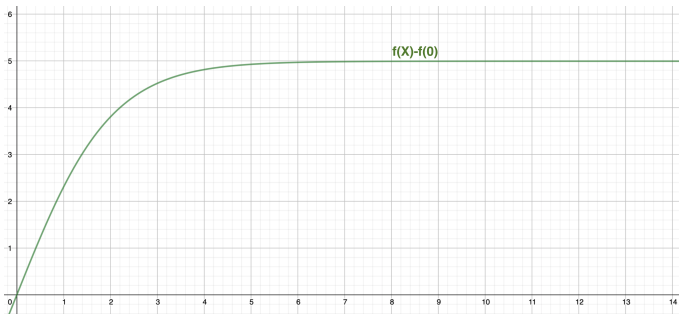

Fig. 1. Payoff function graph

payoff(1)	2.3
payoff(2)	3.8
payoff(3)	4.5
payoff(4)	4.8
payoff(5)	4.9
payoff(6)	5
...	5

IV. Description Of My Player

My friends suggested me to cooperate, and I agreed because real world also includes cooperation in order to get maximum payoff. Thus, my player firstly tries to cooperate. He/she chooses the random field until the moment when he/she and opponent chose different fields. After that moment the player remembers the field, this field will be "his/her" field (*farmingField*) where he/she will eat the grass. In addition, the player remembers the field (*restField*) where he/she will stand and wait the moment when "his/her" field will reach X value equal to 6 (III). *restField* is neither player's *farmingField* or opponent's *farmingField* and logically the same for both players. So, finally after the resolving the types of all fields, player stands on *restField* until his/her *farmingField* value reached the value of 6, and then performs the following moves:
farmingField - restField - farmingField - restField
until the end of the game by getting 5 points each 2 moves.
If the opponent went on player's *farmingField*, then player offends and plays in WiseGreedyPlayer manner, which will be described further.

V. Other Players

I have implemented seven another types of players for testing and comparing:

A. Random Player

Really simple, however not the worst player. The name is pretty self-explanatory. It always takes random field.

B. Circular Player

I implemented genetic algorithm to understand what sequence of steps is the best out of all [3]. The gene was the number of particular field, the chromosome was the sequence of genes, and fitness function was how many points this chromosome gained in the tournament. Algorithm didn't take the last move of the opponent into account. After program has finished [3], Circular chromosomes (steps on fields in circular manner, e.q. 123123... or 231231...) got the highest scores. However, this player didn't perform well against other real players.

C. Altruistic Player

Player that takes always middle field. Neither the best and the worst.

D. Greedy Player

The most intuitive and popular agent that comes to mind is Greedy. Player that always takes the field with the highest X value (best field). If there more than one best, it does random choice out of them.

E. Swapping Player

Player that swaps the Altruistic and Greedy strategies each move. Initially, he/she takes random strategy among these two and continues swapping.

F. Wise Greedy Player

Player that plays greedy until there is some field with value 6 or greater, then he randomly chooses between middle field and top field. The chance that only one field will be 6 and other values will be much less is really small. As we saw the table of payoffs III, 6 is minimal value to stop the fighting.

G. Cooperative Player

This player tries to cooperate, if opponent doesn't perform the same, player starts to play greedy. To understand whether the opponent is a friend, both of the players need to stand on the 1st field(A) 5 first moves. It is done for getting the approximate maximum payoff on other fields. After first 5 cooperative moves players perform the random move on the 2nd(B) or 3rd(C) field. If players will choose different fields, it determines the direction, where to move in the next rounds. If they chose the same field, then they return to the 1st field(A) and repeat until determination of the direction.

H. Tournament

This tournament contained 100 rounds for each game, each Player played with each another Player, amount of each type of players was 12, so, 96 players participated. To understand how well each type of player performed I took average amount of points they gained.

Player	№	Score Average
RufinaTalalaevaCode	12	20296.86
CooperativePlayer	12	19840.33
WiseGreedyPlayer	12	20270.00
GreedyPlayer	12	19403.49
AltruisticPlayer	12	4892.80
SwappingPlayer	12	15521.99
RandomPlayer	12	12078.87
CircularPlayer	12	10437.72

As we see the worst players are AltruisticPlayer, CircularPlayer, RandomPlayer and SwappingPlayer. Thus, I decided to test with 4 remaining classes.

Player	№	Score Average	№	Score Average
RufinaTalalaevaCode	20	20042.94	20	20127.99
CooperativePlayer	20	19250.28	20	18776.91
WiseGreedyPlayer	40	19552.88	30	19560.12
GreedyPlayer	20	18165.12	30	17932.18

We see that Greedy performs worse than others, so I decide to exclude it and test further. What we see:

Player	№	Score Average	№	Score Average
RufinaTalalaevaCode	20	19986.42	30	20449.80
CooperativePlayer	20	20367.85	20	20319.40
WiseGreedyPlayer	60	19528.72	50	19509.24

My agent performs worse than another CooperativePlayer in 20-20-60 distribution, thus, we decided to have more people having our strategy up to 30 and we see that in this distribution (30-20-50) our player wins.

VI. Conclusion

I have implemented 8 strategies for the Moose game, showed how I tested them and explained my choice of the agent for the competition. The process of solving the task was very interesting because there was the need to invent different players, foresee the opponents' moves and get benefits from cooperation with other students.

Acknowledgment

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References

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