Game Theory

Assignment 2

Magomed Magomedov

BS18-SE01

ma.magomedov@innopolis.ru

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# Introduction

Game theory is the study of mathematical models of strategic interaction among rational decision-makers [1]. It has applications in many fields, including but not limited to economics, computer science, biology, political science etc. Being pioneered by John von Neumann and Oskar Morgenstern, the theory was extensively developed starting from 1950s. During those years the main concepts were developed, such as repeated games or Nash equilibrium. [2] Nash equilibrium is of particular importance because it showed existence of consistent solution for significantly wider range of games than it was initially proved by John von Neumann. Game theory studies many different types of games, some of which are cooperative/non-cooperative, symmetric/asymmetric, zero-sum/non-zero-sum, and others. One of the most famous examples of games modelling real-human behavior is “prisoner’s dilemma”, showing how cooperation does might not emerge from rationality of the players.

# Problem definition and statement

The game being examined in this paper is being played by two players, simulating moose behavior competing for food. The game field consists of three regions A, B, C, each having increasing amount of vegetation on it, which is defined by function:

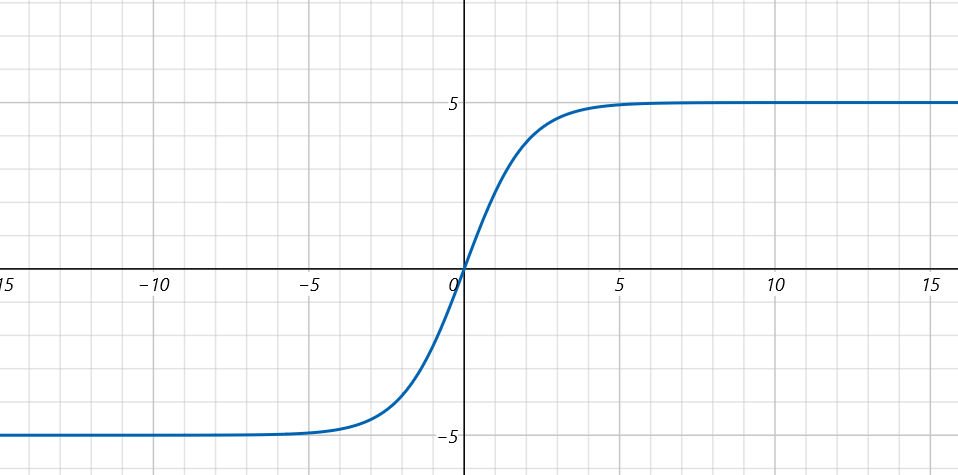
Every field starts with X=1, and increments X in every round, unless there are any players on it, in which case X is being decremented every round to the minimal value of 0.

If a player stands alone on a field, he gains score equal to . However, if multiple players move on the same field, they start to fight and none of them score anything (while still de).

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*Figure 1. Visualization of the regions’ vegetation growth function. Valid x domain is .*

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*Figure 2. Visualization of the players’ reward function. Valid x domain is x≥0.*

# Classification of the game

Examining this game from the point of view of Game theory, several characteristics can be seen. First, this is a non-cooperative game, because there are no external mechanisms for alliance enforcement. Second, it is a symmetric game, since we can change identities of the players and they payoffs would stay the same. Third, it is a non-zero-sum game, as it is possible for both players to profit simultaneously [3]. Then, it is a discrete simultaneous game due to the fact that player’s move simultaneously and one player has no prior knowledge of another player’s move. Finally, it is a 3x3 game because on every round every player has exactly 3 possible moves. Now this gives us sufficient foundation for consideration of various strategies. [4]

# Overview strategies implementation

Every strategy will be realized in the form of a Java programming language class implementing a standard Player interface. This uniform interface would allow easy testing of the agents in a tournament-like simulation (everyone against everyone). It would also help us to ensure that the competition is fair as every player would have access to the same amount of information and would be able to perform the same number of actions upon the playfield.

This interface defines 3 functions:

* void reset() – cleans up the player’s any internal state, called before every round.
* int move(int opponentLastMove, int xA, int xB, int xC) – through this function the player received information about the current settings of the playfield, and acts based on this information, returning its next move.
* String getEmail() – the code author’s identity function to be used as credentials during the tournament against other agents.

# Overview of basic player strategies

There are several simple strategies that would be useful to establish the performance baseline.

The first one we call Crazy. It simply chooses a random field every turn. Nothing sophisticated, but surprisingly it was performing very well, scoring higher than Alpha and Beta strategies.

The second strategy is Alpha. It is a simple greedy strategy, choosing a field with the highest amount of vegetation.

The third strategy is Beta. Similar to the previous one, it also utilizes greedy approach, but this time chooses a field with the second highest amount of vegetation.

# Overview of Traveller strategy

The strategy being tested again the basic strategies outlined about is a mix two behaviors, what we call “nomad” and “fighter”.

Nomad is quite straightforward. Choose any “home” cell, and jump between it and any of the 2 others cells that has some vegetation on it. If both of the other cells are suitable, the move target is chosen at random.

The “fighter” mode tries to utilize the fact that the reward function is a sigmoid, meaning that the most of its growth is centered around zero. The idea here is to allow “home” to restore its vegetation up to the point where any additional growth on the field would bring very little added value. Through experimentation the optimal value of x was determined to be equal to 5. So, two fighter players would maximize their score by choosing their different homes, then fighting for 5 rounds on the free field allowing their homes’ vegetation to reach X=5. Then they would return home, eat everything. Then they would repeat the cycle by coming to the free field to fight for the next 5 rounds.

Traveller strategy tries to combine these 2 approaches. First, it tries to determine if the opposite player is a fighter. It does so by moving into the free field (by convention it is the number 2), and stand here for 5 rounds. If during that time its home is being attacked, it means that it faces a different type of enemy, so it falls back to nomad mode. Otherwise, if it can stay on the fighting field for the 5 rounds without its home field being attacked, then come back to its home field to eat all the vegetation, while not taking any fight during that time, it concludes that the opposing player is a fighter as well, so it continues its normal cycle.

# Conclusion

Testing was conducted in the form of everyone-against-everyone tournament with participation of 2 Crazy, 4 Alpha, 4 Beta, and 3 Traveller players over 100 rounds for every game. While it is surprising that the random tactics scored the highest, Traveller outperformed both Alpha and Beta nearly by the factor of 2.

##### References

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