ARISTOTLE UNIVERSITY OF THESSALONIKI

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

DEPARTMENT OF COMPUTERS & ELECTRONICS

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COURSEWORK

FOR THE COURSE

GAME THEORY

8TH SEMESTER

(5TH DELIVERABLE)

GROUP 4:

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(A) INTRODUCTION

(A.1) Description of the problem

In this coursework, we attempt to create a functional toolbox in MATLAB, capable of running simulations of the Classic Iterated Prisoner’s Dilemma (CIPD), as well as the Axelrod Tournament. This game, very simple to describe, covers a large scale of real-life situations and seems to catch the definition of conflicts of interests. Thus, a lot of different kinds of work have been done on it, involving not only mathematicians, but also social, zoological, biological as well as computer scientists. The game becomes the most used theoretical model for studying the cooperation and the evolution of cooperation in the population of agents. The game, called the Prisoner's Dilemma, could be described very simply in the following way: let us meet two artificial agents having two choices (two strategies):

(a) COOPERATE, let us write C, and say to be nice.
(b) DEFECT, let us write D, and say to be naughty.

The payoff for each player depends on the moves played by the two agents. Tab. 1 names the score of each case. The dilemma comes when exploitation of one by the other (T) is better paid than cooperation between the two (R), which itself pays more than a case where the two tried two exploit each other (P), which finally is a better choice than to be exploited (S). This can be formalized as: S < P < R < T
The dilemma stands on the fact that individual interest (Nash equilibrium) differs from collective one (Pareto issues). The one-shot game, involving rational agents and pure strategies, is solved in Game Theory by the Nash equilibrium, which is to always betray its partner: choosing the D strategy. In an iterated version players meet each other more than one time. The payoff
of an agent is then simply the sum of each of its meeting's payoff. The game is called the Classical Iterated Prisoner's Dilemma (CIPD).

(A.2) Related work

The interest in analyzing the CIPD stems mainly from the task of mathematically proving why most species in nature choose to cooperate with each other, rather than defect, something that boosts their chances of survival, as we have observed. Several papers that tackle this exact task have been published, like our referenced paperworks [2] and [3].

(B) QUICK START GUIDE

As stated in section (A), this project is a MATLAB toolbox that can simulate the Classic Iterated Prisoner's Dilemma (CIPD), as well as the Axelrod Tournament. The link to access the toolbox and the related documents, including this report is the following:

https://github.com/tmpadasn/EvolutionaryGamesToolbox

For your convenience, we have made some ready-to-run script files that you can run to reproduce the figures seen in referenced paperwork [1]. These scripts are located in the Code folder under the names FigX_TourType, where X is the number of the figure and TourType is the type of simulation being run (Fitness or Imitation).

(C) FITNESS DYNAMICS

(C.1) The process

Two kinds of experimentation are used in literature to evaluate strategies for the CIPD:

The basic one, is to make a two-by-two round robin tournament between strategies. The payoff of each one would be the total sum of each iterated game 1. A ranking could then be computed according to the score of each strategy. The higher a strategy is ranked, the better it is. As shown in previous work, [4], some cycles between strategies may be found (A better than B, which is better than C which is better than A), the order created by this method cannot be considered as total.

The second kind of experimentation is a kind of imitation of the natural selection process, and is closely related to population dynamics, but in a completely discrete context. Let us consider a population of N players, each one adopting a particular strategy. At the beginning we consider that each strategy is equally represented in the population. Then a tournament is made, and good strategies are favored, whereas bad ones are disadvantaged, by a proportional population redistribution. This redistribution process, also called a generation, is repeated until an eventual population stabilization, i.e. no changes between two generations. A good strategy is then a strategy which stays alive in the population for the longest possible time, and in the biggest possible proportion. This kind of evaluation quotes the robustness of strategies. This looks like prey-predator model, but is not. The number of species involved is not limited to two, interactions between, or into, species are much more complex, and global population is fixed. Once a population has disappeared it has no way to reappear: there is no stochastic perturbations nor
n population distribution, nor in strategies description.

Pseudocode to be added here

(C.2) Experiments

[...]

(C.3) Discussion

[...]

(D) IMMITATION DYNAMICS

(D.1) The process

[...]
Pseudocode to be added here

(D.2) Experiments

[...]

(D.3) Discussion

[...]

(E) DISCUSSION

(E.1) Comparison of Fitness Vs. Imitation Dynamics

[...]

(E.2) Imitation - Best Strategy Vs. Best Player

[...]

(E.3) Other comments

[...]

(F)

REFERENCES

[1] Mathieu, Philippe, Bruno Beaufils, and Jean-Paul Delahaye. «Studies on Dynamics in the Classical Iterated Prisoner's Dilemma with Few Strategies» - European conference on artificial evolution. Springer: Berlin Heidelberg, 1999.

[2] Axelrod, Robert, and William D. Hamilton. «The evolution of cooperation.» - Science, Vol. 211, No. 4489, pp. 1390-1396, 1981.

[3] Axelrod, Robert, and Douglas Dion. «The further evolution of cooperation.» - Science, Vol. 242, No. 4884, pp. 1385-1390, 1988.

(G) APPENDICES

(G.1) Documentation

Toolbox Functions:
[...]

(G.2) Github Repo

The link to access the toolbox and the related documents, including this report is the following:

https://github.com/tmpadasn/EvolutionaryGamesToolbox