

## Coevolution of Artificial Agents based on Genetic Algorithms and Differential Evolution in Bargaining Game

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### 1. Introduction

The theoretical model of bargaining game that Ståhl [1] and Rubinstein [2] introduced is widely used in the current bargaining game research. Many researchers in the fields of game theory, economy, psychology, and computer science have already started analyzing the underlying bargaining phenomenon which can be applied in e-commerce application [3], negotiation problem [4], dispute resolution [5], and so on.

Bargaining game analysis using metaheuristics is drawing attention in recent years. This paper investigates the interaction and co-evolutionary process among heterogeneous artificial agents in the bargaining game. In particular, the game performance with regard to payoff and deal rate through the interaction and co-evolution of agents is studied. We present 2 kinds of artificially evolving agents participating in the bargaining game: genetic algorithms [6] and differential evolution [7].

### 2. Bargaining game

The bargaining game is a division game of a fixed sum between two players within fixed stages. The sub-game perfect equilibrium of bargaining game is that the last proponent makes a proposal as the  $\epsilon$ , the lowest nonzero quantity, to the respondent always accepts the minimal proposal since any  $\epsilon$  is better than a null demand. However, experimental results of real world people are in contrast with this strategy due to the fact that the proponents tend to offer the counterpart more than the non-cooperative game theory predicts, and the respondents reject the small offers. The rejection of a low offer by the respondent can be seen as punishment. It seems discrepancy between game theory and experimental data results from the notion of fairness and the absence of common knowledge of rationality [8, 9, 10].

In this paper we proceed to study interactions of artificial agents in the heterogeneous population. We conducted experiments with genetic algorithms based agent (GA-based agent) and differential evolution based agent (DE-based agent) to play the bargaining game. Figure 1 shows the procedure of the bargaining game with two artificial agents.

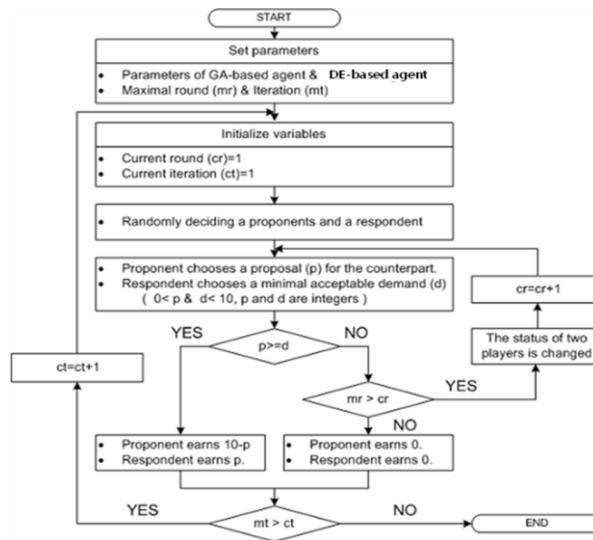


Figure 1. The procedure of the bargaining game

### 3. Experiment results

Experimental results show that the GA-based agent evolves the strategy that real world people normally use based on fairness in the bargaining game. However, the DE-based agent evolves the strategy based on the sub-game perfect equilibrium based on one of the Nash Equilibriums. As a result of coevolution between these different two strategies in the bargaining game, the two strategies earn a similar profit.

### 4. References

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