Chapter 5
Assessing the Utilization of Automata in Representing Players' Behaviors in Game Theory

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ABSTRACT

Representing players' strategies in game theory has a direct impact on the players' performance. The state of art shows that automata are one of the primary techniques used for representing players' strategies and behaviors. In this paper, the author will identify different types of automata and assess their utilization in the field of game theory. Is has been found that finite automata, adaptive automata, and cellular automata are widely adopted in game theory. The utilization of finite automata is found to be limited to represent simpler players' behavior. On the other hand, adaptive automata and cellular automata are intensively applied in complex environments, where the number of interacted players is large and therefore, representing complex behaviors are needed.

1. OVER VIEW ON GAME THEORY

Game theory can be seen as a framework for building real-world social interaction models. This process of abstraction results in a formal model that typically comprises of a set of interactive individuals, i.e., players, different choices available for each individual, and a payoff function that assigns a numerical value to each individual for each possible combination of choices (Meng et al., 2015).

Generally, the game consists of the following entities:

- **Players:** Where one side of the game tries to maximize the gain (*payoff*), while the other side tries to minimize the opponent's score;
- **Environment:** This includes board position and the possible moves for the players;

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- **Successor function:** The successor function includes actions and returns a list of (move, state) pairs, where each pair indicates a legal move and the resulting state;
- **Terminal test:** The terminal test specifies when the game is over and the terminal state is reached;
- **Utility function:** The utility function is the numeric value for the terminal states.

The scientists of inter-disciplinary community believe that the time has come to extend game theory beyond the boundaries of full rationality, common-knowledge of rationality, consistently aligned beliefs, static equilibrium, and long-term convergence. These concerns have led various researchers to develop formal models of social interactions within the framework of game theory (Xu et al., 2015).

The attractive point in studying games is that models used in games are applicable to be used in real-life situations. Because of this, game theory has been broadly used in the fields of economic, biology, politics, low, and in computer sciences. Examples on the use of game theory in computer science include interface design, network routing, load sharing, and allocate resources in distributed systems and information and service transactions on the internet (Platkowski & Siwak, 2008).

In this paper, we study various types of automata and their applications in the field of game theory. Understanding the structures of these automata and their utilization in representing the players' behavior is one of the crucial factors which affect the performance of players in any given game.

The rest of the paper is organized as follows: Section 2 provides an overview of the types of automata, Section 3 discusses the applications of automata in game theory, and Section 4 offers comprehensive discussions and concluding remarks.

2. TYPES OF AUTOMATA

An automaton is a self-operating machine. The output to one automaton is a combination between the consequences of the current input and the history of the machine's previous input. An automaton is designed to automatically follow a predetermined sequence of operations or respond to encoded instructions.

There are many types of well-known automata, such as finite automata, push–down automata, and adaptive automata. Experimental simulations of automata methods, carried out by different researchers, have recommended the automaton approach in the solution of many interesting examples in parameter optimization, hypothesis testing, and in game theory (Almanasra and Rafie, 2010). Figure 1 presents a taxonomy of automata used in game theory.

Learning is strongly associated with past experiences, where these experiences are meant to permanently change the entity behavior. Learning system is characterized by its ability to improve its behavior with time in some sense tending towards an ultimate goal. Numerous approaches have been proposed for developing learning systems. One of the approaches, which gained considerable attention, is based on automata.

This approach tends to present a given problem as one of finding the optimal state among a set of possible states. This approach is referred to by learning automaton. Figure 2 illustrates the concept of automaton, where the possible states are presented by S1, S2, and S3.

Learning automaton operates in a random environment. The actions are chosen based on the inputs received from the environment to find the optimal. The learning schemes come in two structures: fixed structure and variable structure. Fixed structure schemes in stationary random environments are de-