Chapter 19
A Decision Making Method Based on Society of Mind Theory in Multi-Player Imperfect Information Games

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ABSTRACT

The authors are concerned with a card game called Daihinmin (Extreme Needy), which is a multi-player imperfect information game. Using Marvin Minsky's "Society of Mind" theory, they attempt to model the workings of the minds of game players. The UEC Computer Daihinmin Competitions (UECda) have been held at the University of Electro-Communications since 2006, to bring together competitive client programs that correspond to players of Daihinmin, and contest their strengths. In this paper, the authors extract the behavior of client programs from actual competition records of the computer Daihinmin, and propose a method of building a system that determines the parameters of Daihinmin agencies by machine learning.

1. INTRODUCTION

Games are used in artificial intelligence research as test environments for formulating internal models of the human mind. This is because the activities for problem solving of human in the real world can be considered as the activities of players in a gaming environment.

Marvin Minsky proposed a number of theories as an approach to the problem of how the human mind works in his book "The Society of Mind" (Minsky, 1988). He defined processing units called "agents" that execute small, mindless processes, and put forward the hypothesis that a mind can be created by complex interactions between agencies which are groups of these agents.

In situations where the human mind resolves problems in the real world, such as in politics, economics, or society, it is impossible to obtain perfect information about the surrounding conditions, and the actions of an unspecified number of other people will affect the results of the actions of each person. It is therefore expected that it will be possible to analyze the human decision making process by using Minsky's "Society of Mind" theory to model the workings of the minds of players in a multi-player imperfect information game. Grimbergen presented some ideas about how to implement Minsky's "Society of Mind" theory in game-playing domain, especially board games (Grimbergen, 2007).

We are concerned with a card game called Daihinmin (Extreme Needy), which is a multi-player imperfect information game. The UEC Computer Daihinmin Competitions (UECda) have been held at the University of Electro-Communications since 2006, to bring together competitive programs that correspond to players of Daihinmin, and contest their strengths (UECda-2015 Project Team, 2015). These competitions have spurred on the implementation of various different client programs, as well as research (Fujimura, 2013; Yoshiwara et al., 2012; Ito et al., 2013; Okubo et al., 2015; Tajima & Tagashira, 2015).

In this paper, we regard the Daihinmin agencies as neural networks such as deep learning machines (Asoh, 2013). We extract the behavior of client programs from actual competition records of the computer Daihinmin, and propose a method of building a system that determines the parameters of Daihinmin agencies by machine learning.

2. DAIHINMIN

Daihinmin (Extreme Needy) is a card game which originated in Japan and which is also called Daifugo (Grand Millionaire). Daihinmin uses a pack of 53 cards, 13 cards per suit plus one Joker, and is normally played by 2 to 5 players. At the start of a round of the game, the same amount of cards is dealt to each of the players. The players take it in turn to play a card or cards from their hands, and the person who plays all his cards quickest wins, but the round continues until all the players' titles are determined.

Each time a round ends, the players are given the titles of "Daifugo (the grand millionaire)", "Fugo (the millionaire)", "Heimin (the commoner)", "Hinmin (the needy)", and "Daihinmin (the extreme needy)" (when five people are playing), in the order in which they finished that round. Immediately after the initial deal of the next round, cards are exchanged as follows:

1. The daihinmin hands over the two strongest cards in his hand to the daifugo who returns any two worthless cards to the daihinmin; and
2. The hinmin hands over the strongest card in his hand to the fugo who returns any one worthless card to the hinmin.

After the exchange of cards, the round of the game repeats as described above.

In Daihinmin, card strengths are determined by their face values, usually in the sequence: 2, A, K, Q, J, .., 5, 4, 3. The Joker is used as a wild card that can replace any other card, and is the strongest card when played alone, with some exceptions.

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