A Decision Tree Analysis of a Multi-Player Card Game With Imperfect Information

Masato Konishi, The University of Electro-Communications, Chofu, Tokyo, Japan
Seiya Okubo, University of Shizuoka, Shizuoka, Shizuoka, Japan
Tetsuro Nishino, The University of Electro-Communications, Chofu, Tokyo, Japan
Mitsuo Wakatsuki, The University of Electro-Communications, Chofu, Tokyo, Japan

ABSTRACT

This article describes how computer Daihinmin involves playing Daihinmin, a popular card game in Japan, by using a player program. Because strong player programs of Computer Daihinmin use machine-learning techniques, such as the Monte Carlo method, predicting the program’s behavior is difficult. In this article, the authors extract the features of the player program through decision tree analysis. The features of programs are extracted by generating decision trees based on three types of viewpoints. To show the validity of their method, computer experiments were conducted. The authors applied their method to three programs with relatively obvious behaviors, and they confirmed that the extracted features were correct by observing real behaviors of the programs.

KEYWORDS

Daihinmin, Decision Tree, Game Informatics, Multiplayer Imperfect Information Game, Player Program

1. INTRODUCTION

Because results of game informatics research are expected to be applied to fields such as economics and psychology, many games have been studied. Among others, Daihinmin, a popular card game in Japan, is known as a multiplayer imperfect information game. Computer Daihinmin involves playing Daihinmin by using a player program. As a competition for Daihinmin computer programs, UEC Computer Daihinmin Competition (UECda) (http://uecda.nishino-lab.jp) is annually held since 2006 at The University of Electro-Communications (UEC), and every year, the champion program is getting increasingly stronger (Wakatsuki, Fujimura & Nishino, 2015). Strong player programs that participated in UECda use machine learning techniques such as the Monte Carlo method. However, predicting the behavior of a program using machine learning is generally known to be difficult (Ayabe, Okubo & Nishino, 2016). Hence, studies on the classification of player programs using cluster analysis have been conducted. However, the extraction of the features determining the behavior of each player program is difficult.

This study is intended at extracting features that determine the behavior of various programs used for playing Daihinmin. For this, we propose a method for extracting the features of player programs by collecting the log of the game and performing data mining using decision tree analysis on the log. In our method, a decision tree is generated focusing on three types of variables, the processing

DOI: 10.4018/IJSI.2018070101

Copyright © 2018, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.
time of a turn, situation of specific cards, and type of submission on the empty field. Then, to verify whether the method accurately extracts the features of the program, we analyzed a representative player program (Default, Nakanaka, Snowl) whose behavior is difficult to predict. Results showed that the extracted features can approximately predict the actual behavior.

In addition, we analyzed player programs whose behavior is difficult to predict.

2. RULE OF COMPUTER DAIHINMIN

In this study, we adopt the rules used for UECda-2015. The rules are almost the same as those in UECda-2007, and their details are as follows.

2.1. Basic Rule

For Daihinmin, the game is played by five players. Daihinmin uses 53 cards, which consist of 13 (A-K) Hearts, Clubs, Spades, and Diamonds, as well as a Joker. When beginning a round of the game, each player is dealt 10 or 11 cards. The card strength order is 2, A, K, Q, J, 10, 9, 8, 7, 6, 5, 4, 3. The cards that a player has in the hand are called his “hand”, and the player submits cards from his hand during his turn. A round of the game ends when four players win; that is, they eliminate all of their cards (this is called “Agari”), and the titles are provided in the order of the winning players against the loser. The highest title is Daifugo (the grand millionaire), followed by Fugo (the millionaire), Heimin (the commoner), Hinmin (the needy), and Daihinmin (the extremely needy), in that order. After all the players’ titles are determined, the cards are exchanged at the beginning of the next round in the following manner. Two cards are exchanged between the Daihinmin and Daifugo, and one card is exchanged between the Hinmin and Fugo. At this time, the Daihinmin and Hinmin must hand over their strongest cards in the hand.

2.2. Submission of Cards

There are three types in which the players can submit their cards: single, group, sequence. Single implies submitting only one card. Group implies submitting multiple cards of the same number simultaneously. Sequence implies submitting three or more cards of the same mark that are consecutive numbers. In addition, a player can pass, which means not submitting cards at his turn.

The submitted cards remain in the field until “Nagare”, which means clearing the cards from the field. The main conditions of “Nagare” include the case of “8-ender” and that when all players “pass” in the game. If there are no cards in the field (this situation is called a “lead”), the next player can submit any card. If there are some cards in the field (this situation is called a “follow”), the next player can submit only the cards that are of the same type and are stronger than the cards remaining in the field.

There are special situations of the field such as “lock” and “revolution”, wherein “lock” happens when cards with the same mark as the last submitted cards are submitted, and only the cards with the same mark can be submitted until “Nagare”, and “revolution” happens when a player submits a group of four or more cards, or a sequence with five or more cards; the strengths of all cards are reversed until the end of the round or until another revolution occurs.

There are some special cards in Daihinmin. Main special cards are Joker and the cards with the number 8.

If submitted cards contain an 8-card, the “8-ender” occurs, which forces “Nagare” to occur. Joker can be used as the strongest card when using with “single” and can be substituted as any number card when using with a group or sequence.

3. DECISION TREE

A decision tree is a data mining technique that generates a conceptual representation of a tree structure in which each internal node represents an explanation for classification and each leaf represents a
Concepts and Strategies for Quality of Modeling
www.igi-global.com/chapter/concepts-strategies-quality-modeling/23789?camid=4v1a

Combinatorial Testing
www.igi-global.com/chapter/combinatorial-testing/37033?camid=4v1a