The Graph-History Interaction Problem in Chinese Chess

Kuang-che Wu\textsuperscript{1,*}, Shun-Chin Hsu\textsuperscript{2}, and Tsan-sheng Hsu\textsuperscript{3,*,**}

\textsuperscript{1} Department of Computer Science and Information Engineering, National Taiwan University, Taipei, Taiwan
\texttt{kcwu@csie.org}
\textsuperscript{2} Department of Information Management, Chang Jung Christian University, Tainan, Taiwan
\texttt{schsu@mail.cju.edu.tw}
\textsuperscript{3} Institute of Information Science, Academia Sinica, Taipei, Taiwan
\texttt{tshsu@iis.sinica.edu.tw}

\textbf{Abstract.} Chinese-chess rules for cyclic moves differ from Western-chess rules in two respects. First the outcome of a cyclic game can be a win, a loss, or a draw. Second, depending on the plies made inside a loop, there are up to 16 rules a player can violate when a loop occurs. However, the same rule has to be violated three times in a row, i.e., in three consecutive loops, in order to lose a game. Therefore, a player can violate different rules in three cycles and still achieve a draw. In contrast, Western-chess rules always define a game as a draw after three consecutive loops. This paper reports on an adequate implementation of the Chinese-chess rules used to decide the outcome of a game when it falls into loops. The rules are proposed by the Asia Chinese-Chess Association.

1 Introduction

It is important that strong Chinese-chess computer programs also have a good knowledge of the game’s rules. Sometimes a player can win a game by forcing an opponent to violate the existing rules, instead of using chess tactics or strategies to capture the opponent King. However, it is not easy to apply the full set of Chinese-chess rules correctly without substantial performance degradation. There are two problems with regard to incorporating the rules into a game tree search algorithm. First, how to apply Chinese-chess rules accurately? Second, how to apply the complicated rules with a small (reasonable) performance degradation?

1.1 Chinese-Chess Rules

In addition to the basic rules of Chinese Chess, such as how to move a piece and how to capture an opponent’s piece, and the main goal of the game, there are

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\** Corresponding author.
some rules for judging games that fall into cyclic positions. Since the additional rules are hard to deal with, many players avoid playing cyclic positions. This situation also applies to computer programs. They have often implemented only a very restricted subset of the rules. Obviously, knowledge of the full set of rules is essential for players who want to play perfectly.

The rule on repetition of positions in Western Chess and Chinese Chess is completely different. After three consecutive repeated sequences of a board position have occurred in Chinese Chess, the game can end in a draw, a loss, or a win, depending on whether the participants’ moves repeatedly violate the rules in the three consecutive sequences. Many Western game researchers have discovered that cyclic positions may affect the normal search program and refer to it as a kind of graph-history interaction (GHI) problem [3]. We note that there are other kinds of GHI problems in Western Chess, for example the right of castling. The prevailing research question is: how to solve the GHI problem in cyclic games without sacrificing too much performance? [2][10][11].

In Chinese Chess, the only GHI problem is the cyclic game. Henceforth, unless otherwise stated, we refer to the GHI problem of cyclic games in Chinese Chess as the GHI problem. The problem is more difficult in Chinese Chess than in Western Chess for two reasons. The first reason is that there are complicated rules to decide the outcome of a game, which may be a win, a draw, or a loss depending on who has the advantage when the repeated pattern occurs. The intuition is that a player at a disadvantage will try to avoid losing the game by forcing an opponent to play repeated moves, so that the game results in a draw. The main strategy of such a player is to check the opponent, or threaten to capture the opponent’s King in the next move. Because the King can only move inside a 3 by 3 square in Chinese Chess, it is easy to check this. Second, strategy is to threaten to capture a major unprotected piece belonging to the opponent on the next move. For brevity of notation, when a player threatens such a move, we say the player chases the opponent’s piece. When a player threatens to capture the opponent’s King, we say the player checks the opponent.

There are many versions of Chinese-chess rules, of which the most influential ones are the one used in the Mainland China [4] and the one published by the Asia Chinese-Chess Association [8]. The China version is complicated and tries to decide who has the advantage in many possible situations, which causes a number of inconsistencies [16]. The current version, published in 1999, is expected to be revised in the near future. Although the Asia version is also very complicated, it is much simpler than the China version and is considered more stable. The Asia version, which has not been changed substantially since 1989, is more straightforward because it is easier to tell if a game is a win or a loss.

In this paper, we use the implementation of the Asia rule set as described in [9]. According to this set, when a sequence of repeated board positions occurs, two flags are output, one for each player. Each flag indicates the rule violations made by the player in every ply he made in the repeated sequence. In general, there are two levels of rule violation. The more serious level of violation is to check the opponent’s King at every ply. The other level, which contains 15 rules,