Indefinite Sequence of Moves in Chinese Chess Endgames

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Abstract. In western chess, retrograde analysis has been successfully applied to construct 6-piece endgame databases. This classical algorithm first determines all terminal win or loss positions, i.e., those that are either checkmate or stalemate, and then propagates the values back to their predecessors until no further propagation is possible. The un-propagated positions are then declared draws.

However, in Chinese chess, there are special rules other than checkmate and stalemate to end a game. Therefore, some terminal positions cannot be determined by the typical retrograde analysis algorithm. If these special rules are ignored in the construction of the endgame databases, the resulting databases may contain incorrect information.

In this paper, we not only describe our approach in abstracting the special rules of Chinese chess and its consequent problems when retrograde analysis is applied, but also give a solution to construct complete endgame databases complying with the most important special rules.

1 Introduction

Retrograde analysis has been widely used to solve many problems. For example, it has been successfully applied to construct 6-piece endgame databases for western chess \cite{1}. This classical algorithm first determines all terminal win or loss positions, i.e., those that are either checkmate or stalemate, and then propagates the values back to their predecessors until no further propagation is possible. The un-propagated positions are then declared as a draw.

In both western chess and Chinese chess, checkmate and stalemate are the two principal rules to end a game. They are also the foundations for propagation when retrograde analysis is applied. In western chess, if a game continues with a repeated series of moves it ends in a draw. On the contrary, in Chinese chess, such a game may result in a win/loss/draw depending on the characteristics of

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the indefinite move patterns involved. The rules deciding the game outcome in such cases are called *special rules* throughout this paper\textsuperscript{1}.

The most influential special rule is *checking indefinitely*. If only one player checks his opponent continuously\textsuperscript{2}, he loses the game. Therefore, the endgame databases of Chinese chess constructed by retrograde analysis may have errors if this special rule is not taken into account. Other special rules may also spoil the endgame databases in a similar way. It is known that endgames where only one side has attacking pieces are not affected by these special rules [3]. Using this fact, endgame databases with attacking pieces on one side only are constructed [3, 4]. This paper studies the problem of constructing Chinese chess endgame databases with both sides having attacking pieces. We believe this problem has not been tackled successfully before.

2 Notations and Rules of Chinese Chess

In Chinese chess, the two sides are called Red and Black. Each side has one King, two Guards, two Ministers, two Rooks, two Knights, two Cannons and five Pawns which are abbreviated as K, G, M, R, N, C and P, respectively. The pieces Rook, Knight, Cannon and Pawn are called *attacking pieces* since they can move across the river, the imaginary stream between the two central horizontal lines of the board. In contrast, Guards and Ministers are called defending pieces because they are confined in the domestic region\textsuperscript{3}. Moreover, a side is called *armless* if it has no attacking pieces. A *position* in Chinese chess is an assignment of a subset of pieces to distinct addresses on the board with a certain player to move.

3 Special Rules in Chinese Chess

Retrograde analysis algorithms are widely used to construct the databases of finite, two-player, zero-sum and perfect information games [5]. In the endgame databases of western chess, terminal positions are either checkmate or stalemate positions. Furthermore, all unresolved positions at the end of the retrograde analysis can be safely declared as a draw (includes e.g. draws by 3-fold-repetition). In Chinese chess, on the other hand, repetitions may result in either a loss or a draw because of special rules. Resulting endgame databases using classical retrograde analysis may have errors if these special rules are neglected.

\textsuperscript{1} The detailed special rules of Chinese chess are very complicated. Some minor rules differ in the Asian, Chinese, and Taiwanese versions, and might be revised as time goes on. Our discussions in this paper are all based on the rule book [2].

\textsuperscript{2} In real games, each indefinite checking pattern is determined by the appearance of the same position for three times in a series of moves in which one side checks his opponent all the time.

\textsuperscript{3} The information of Chinese chess such as notations and rules in English can be found in FAQ of the Internet news group rec.games.chinese-chess, which is available at http://www.chessvariants.com/chinfaq.html. More detailed rules can be found at http://txa.ipoline.com/.