Opening Book Tuning

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Abstract. In the games such as othello, chess and shogi, there are standard sequence of moves that expert players reach the conclusion that those moves are the best through their study. It is important for players to select suitable opening lines in such games. In this paper, we suggest the method that tunes opening book through self-playing games to make suitable opening book for computer game player. We apply our method to shogi opening book that is automatically made from experts' game records and confirm that opening book tuned by our method become suitable for target computer game player.

1 Introduction

In the games such as othello, chess and shogi, there are standard sequence of moves that expert players execute after reaching the conclusion that those moves are the best, through their study. In such games, most players select their moves through those sequences of moves at the opening part of the game.

There are some purposes to use opening sequence of moves. First of all, a player can play safely under opening lines because those lines are concluded as the best by expert players. The second, when the opponent player plays moves that are concluded as bad moves player can gain advantageous position if the player only knew countermeasures. The third, player can save valuable time. Players do not have to think during both of players play opening sequence of moves.

Players have to be careful in following the two things to use in opening sequence of moves effectively. The first is that players have to learn countermeasures against opponent players' mistakes. If players do not know countermeasures, they pass up the chance to gain advantageous position even if opponent player commits fatal mistake. Another one is that players have to select suitable opening lines for themselves. Expert players conclude standard sequence of moves as the best sequence because they can play well after the positions that are lead by standard sequence of moves. Therefore if players can not play well after positions lead by some opening lines, those lines are not best for them even if those lines are ideal for expert players.

In this paper, we aim to tune opening book for target program. To select suitable opening lines and to avoid unsuitable lines program tunes its opening book through self-playing game. This method does not use domain-specific knowledge. Therefore we can apply our method to any games.

In this paper, we tune opening book for our shogi program, TACOS. After tuning, we perform some experiments to confirm effectiveness of our method. We also confirm effectiveness of other tuning methods as well.

In section 2, we explain our tuning method along with other methods. In section 3, we apply our method to TACOS and confirm whether our method can tune opening book suitable for TACOS. In section 4, we give conclusion and future works.

2 Opening book tuning

If there are more than one opening sequences of moves available in a position, a player has to select one move to play. A player may evaluate moves using some factors to decide suitable opening lines. Therefore, our research question in this paper is: What factors can a player use to lead suitable opening lines?

In this section, we first explain the factors that are used in extended book of Deep Blue in 2.1. Then we suggest our method in 2.2.

2.1 Extended book of Deep Blue

Deep Blue is a computer chess playing system that defeated then-reigning World Chess Champion in 1997. According to [1], Deep Blue's opening book that was made by hand by Grandmasters had only about 4,000 positions. But in addition to the opening book, Deep Blue had another opening database that was made from 700,000 game records played by Grandmasters. Deep Blue did not use moves from that database, called extended book, as a opening standard move but used as indicators to assign bonuses during search. We can consult about what kind of moves in extended book added bonuses to decide which opening standard moves in opening book we have to select in order to lead suitable opening lines in case we make opening book from experts' game records. The following factors were used in Deep Blue.

- The number of times a move has been played.
- Relative number of times a move has been played.
- Strength of the players that play the moves.
- Recentness of the move.
- Results of the move.
- Commentary on the move.
- Game moves versus commentary moves.

We consider that some moves that are regarded as moves that leads to even or advantageous positions by many grandmaster are played many times. A position lead by those moves can make it even or advantageous for Grandmasters. Note that such position is even or advantageous for Grandmasters, not any players. If a player is strong enough to play after such positions, there is no problem. But if a player is poor at playing such positions, we think that player has to avoid leading such positions even if many Grandmasters consider that those positions have big advantages.

2.2 Tuning under self-playing game

Checking up whether a player is good at or poor at the game after each position lead by opening standard sequence of moves, we consider that we can tune opening book to lead suitable opening lines and avoid unsuitable opening lines. We suggest the tuning method that tunes opening book through self-playing games.

Then we explain our method in the following case. Each move in opening book has weight. If a position has only one opening standard move, then that move is played. If a position has more than one opening standard moves, then the move that has the biggest weight in those moves is played. First of all, weight of all moves in opening book are initialized to same value. Then self-playing game is performed from initial position. When a player is in positions included in opening book, one move is selected and played according to the rule. If a position has only one opening standard move, then that move is played. If a position has more than one move, then

the move that has the biggest value v in those moves is played. v is calculated by the following formula:

$$v = w_m + r$$

w_m is weight of opening standard move. r is random number ranges 0 to *Rand*. Self-playing game is performed till game is over. According to the result of the game, weight of opening standard moves that are played just before in self-playing game. If a opening standard move played by winner, the weight of its move is added to Δw while if a opening standard move played by loser, the weight of its move is reduced from Δw. Then perform another self-playing game and update weights reducing *Rand* and Δw till weights of moves in opening book become stable. We prepare additional option that sometimes leads out-book position intentionally when selecting opening standard move to play in self-playing game. To do this, we can check up whether target player can play strong enough in current opening line even if opponent player leads out-book position.

Using our method, opening book is tuned for target player. Target player can lead suitable position and avoid unsuitable position using tuned opening book because weight of moves that lead suitable positions become higher and weight of moves that lead unsuitable positions become lower.

3 Application to Shogi

In this section, we apply our method and other way that explained in section 2 to our shogi program TACOS and confirm if each method tunes opening book suitable for TACOS. In 3.1, we explain about opening book that is used this time. Then we tune opening book by each way in 3.2. At the end of this section, we perform self-playing experiment to confirm effectiveness of tuning.

3.1 Opening book for experiment

In this time, we use the opening book that is automatically made from experts's game records. We prepare about 29,000 game records including about 600 game records played by Habu, one of the strongest professional player, about 10,000 game records played by professional players and about 18,000 game records played in Shogi Club 24, famous Internet shogi site [2]. We use the first 45 moves of each game record as an opening standard move. We regard that expert players seldom make mistakes in early part of the game. However, as rare as they might be mistakes still do occur to players at any level. Actually, in one game record played in Shogi Club 24, first move was P-8f that is rarely played; therefore we think that black player want to play P-7f but mistake to operate. To exclude such mistake moves, we remove moves played less than 10 times in position that appears more than 100 times. Using this rule and additional rule, we make plural opening books that basically contain about 670,000 positions and 725,000 opening standard moves. Each move has weights and the move that has the biggest weight in those moves is played in each position.

3.2 Opening book tuning

In this time, we make 24 opening books. Now we explain about them.

Move information (Type-1)
We make opening book using only information of moves from experts's game records. Weight of all moves in the opening book is the same value (0). This opening book is named as Type-1.

Move and frequency information(Type-2)
We make opening book using information of moves from experts' game records and how many times those moves are played. Weights of each move in opening book are frequency of each move. This opening book is named as Type-2.

Move information of winner (Type-3)
We make opening book using only information of moves played by winner from experts's game records. We do not use moves played by loser in this opening book. If same moves are played by winner in a game record and also played by a loser in another game record, we use such moves. This opening book is named as Type-3 and has about 358,000 positions and about 385,000 standard opening moves.

Move and frequency information of winner (Type-4)
We make opening book using information of moves played by winner from experts' game records and how many times those moves are played. Weights of each move in opening book are frequency of each move played by winner. This opening book is named as Type-4 and has about 358,000 positions and about 385,000 standard opening moves.

Move, frequency and other information (Type-5a, Type-5b, Type-5c)
We make opening book using information of moves from experts' game records frequency of those moves, result of game and whether player is professional or not. We make three opening books, Type-5a, Type-5b and Type-5c.

In Type-5a, moves played by winner add 3 point and moves played by loser add 1 point to weight of opening standard moves in opening book. In Type-5b, moves played by professional player add 3 point and moves played by armature player add 1 point to weight of opening standard moves in opening book. In Type-5c, moves played by professional winner add 5 point, moves played by losing professional add 2 point, moves played by armature winner add 3 point and moves played by losing armature add 1 point to weight of opening standard moves in opening book.

Tuning through self-playing game(Type-6[1-1], Type-6[1-2], ···, Type-6[5-3])
We tune Type-1 through self-playing game and make 17 opening book. Figure 1 shows a process of these operations. The first, we tune Type-1 through 1,000 self-playing game with tuning parameter of $\Delta w = 16$ and make Type-6[1-1]. In the same way, we make Type-6[1-2] through 2,000 self-playing game, Type-6[1-3] through 3,000 self-playing game, Type-6[1-4] through 4,000 self-playing game and Type-6[1-5] through 5,000 self-playing game from Type-1. Then we tune Type-6[1-1] through 1,000 self-playing game with tuning parameter of $\Delta w = 8$ and make Type-6[2-1]. In the same way, we make other opening books such as Type-6[5-1], Type-6[5-2] and Type-6[5-3].

During self-playing game, we lead out-book position intentionally in 0.8% probability. Under this condition, about 70% games are lead to positions after 45 opening standard moves from initial position. And we use tuning parameter *Rand* as 512 for Type-6[x-1], 1024 for Type-6[x-2] and 1536 for Type-6[x-3]. We do not use some game records that become draw by repetition of moves or that become over 300 moves.

3.3 Experiment

To compare effectiveness of each tuning, we perform self-playing experiment played by TACOS with Type-1 opening book against TACOS with other opening books. In case that both of player

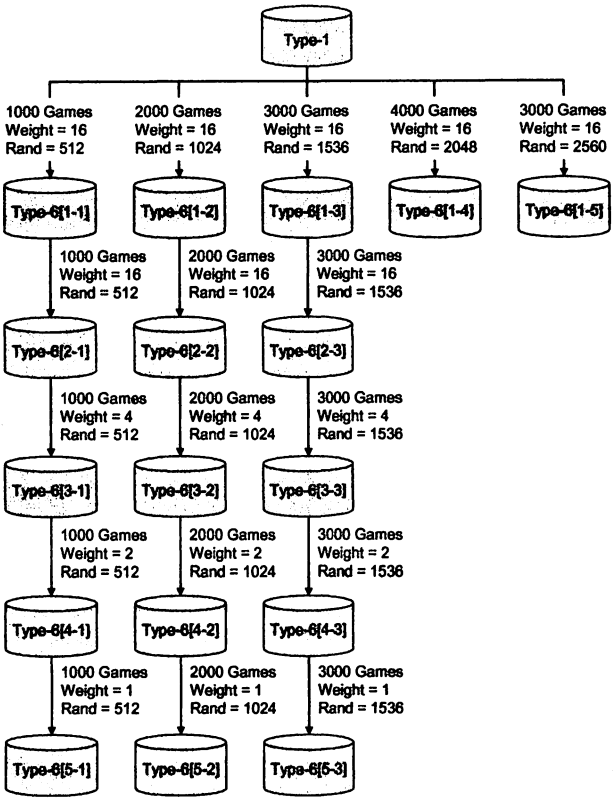

Figure 1. Process of making Type-6 opening book

use opening book, opening book always leads positions after 45 moves from initial position. But in a real game, opponent player sometimes leads out-book position; therefore, in this experiment we also leads out-book position intentionally with 0.8% probability. Each game of this self-playing experiment starts from initial position. TACOS with a opening book plays 50 games as black and 50 games as a white against TACOS with Type-1.

The result of this experiment is shown in Table 1 and Figure 3.3. We treat games that become draw by repetition of moves or that become over 300 moves as 0.5 win and 0.5 loss. The results of Type-2, Type-3, Type-4 and Type-5 show that those opening book are not suitable tuned for TACOS. This means that some opening lines are not suitable for TACOS even if those opening lines are often played by expert players. On the other hand, TACOS with kinds of Type-6 opening book win against TACOS with Type-1 opening book. This means that tuning through self-playing game we can make suitable opening book for a target program.

4 Conclusion and Future Work

In this paper, we aim to tune opening book for target program. To apply to any game, our method tunes weight of moves in opening book through self-playing game. Using this method, we tune opening book that is made from experts' game records for TACOS and using that opening book TACOS can select suitable opening lines and avoid unsuitable lines.

Table 1. Result of self-playing experiment

Type-1 - Type-2	39 - 61	Type-1 - Type-6[1-3]	43.5 - 56.5	Type-1 - Type-6[3-3]	40 - 60
Type-1 - Type-3	44 - 56	Type-1 - Type-6[1-4]	38 - 62	Type-1 - Type-6[4-1]	29.5 - 70.5
Type-1 - Type-4	50 - 50	Type-1 - Type-6[1-5]	32.5 - 67.5	Type-1 - Type-6[4-2]	37 - 63
Type-1 - Type-5a	53 - 47	Type-1 - Type-6[2-1]	49 - 51	Type-1 - Type-6[4-3]	27 - 73
Type-1 - Type-5b	46 - 54	Type-1 - Type-6[2-2]	39 - 61	Type-1 - Type-6[5-1]	37.5 - 62.5
Type-1 - Type-5c	47 - 53	Type-1 - Type-6[2-3]	39 - 61	Type-1 - Type-6[5-2]	35 - 65
Type-1 - Type-6[1-1]	43 - 57	Type-1 - Type-6[3-1]	45 - 55	Type-1 - Type-6[5-3]	38.5- 61.5
Type-1 - Type-6[1-2]	39.5 - 60.5	Type-1 - Type-6[3-2]	38.5 - 61.5		

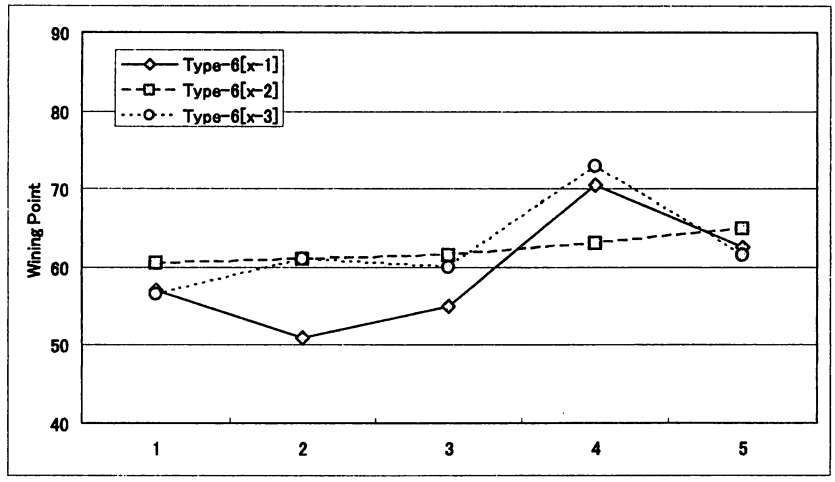

Figure 2. Result of self-playing experiment of Type-6

In this case, we tune weight of moves in opening book through self-playing games. We can easily perform many games under the condition of self-playing games, but under this condition opening book can be tuned bias. To avoid this problem, opening book has to tune through games against various opponents. That is the future work.

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