Planning to Guide Opening and Middle Game Play in Shogi

Reijer Grimbergen
Complex Games Lab, Electrotechnical Laboratory*

Hitoshi Matsubara
Future University-Hakodate and PRESTO†

Abstract

In shogi the use of an opening database is not as effective as for example in chess. Tests with a large opening database show that on average only move suggestions for the first nine moves can be expected. Therefore, planning the development of pieces in the opening must be guided in a different way to avoid that the program will be at a disadvantage early in the game. In this paper we propose two methods for partially matching the game position with positions in the database. The first partial matching method is *half matching*, in which only the pieces of the player to move are matched to the positions in the database. The second type of matching is *quarter matching*, where the pieces of the player to move in two 5x5 sections of the board are matched to positions in the database. We show that with these matching methods, we can extend the phase of the game in which the opening database is effective. We will also show that these partial matching methods improve the overall level of play of a shogi program. The test results also suggest that quarter matching combined with half matching is better than only using half matching.

1 Introduction

In two-player complete information games, the starting position is determined by the rules of the game. All strong game playing programs make use of this information to build an opening database from which moves can be played in the early stages of a game. This database is called an *opening book*. If the current position in the game no longer matches any of the positions in the database there are no more move suggestions: the program is *out of book*.

An opening book can have hundreds of thousands of positions, and especially in chess the use of an opening book is very important [9]. In general the opening book is implemented and updated manually, but there are also a number of programs in different games where the opening book is extended automatically by playing the program against itself and other programs. Examples are the chess programs DEEP BLUE [4], CRAFTY [5], the checkers program CHINOOK [12] and the Othello program LOGISTELLO [3].

To test how effective the use of an opening book is in shogi, we made an opening book containing more than a 1000 professional games and the opening variations given in more than 20 opening books. The complete opening book built in this way has more than 110,000 positions. This is smaller than the opening book of most strong chess programs, but much larger than most shogi programs. It is hard to build an opening book that is similar in size to the ones used in chess programs, as worldwide the number of expert shogi players is much smaller than the number of expert chess players. Therefore, in shogi the number of publicly available expert games and the number of books on opening play is much smaller than in chess.

The problem of using an opening book in shogi became clear when we tested the use of the opening book in games against strong shogi programs. We played 25 games each against four of the strongest shogi programs on the market: AI SHOGI 2000 (winner of the CSA tournament[1] in 1997), KAKINOKI SHOGI IV (winner of the Computer Shogi Grand Prix in 1999), TODAI SHOGI 2 (winner of the CSA tournament in 1998 and 2000) and KANAZAWA SHOGI 98 (winner of the CSA tournament in 1995, 1996 and 1999). In these games, we looked at the point where our program went out of book. The results of this test are given in Figure 1.

Figure 1 shows that despite the large number of positions in the opening book, the program still gets out of book rather quickly. Being out of book within five moves is no exception (32 games) and in most games (71) our program is out of book in ten moves or less. On average, the program is out of book after 8.5 moves.

It is interesting that there are important differences between the programs. Against AI SHOGI and KAKINOKI SHOGI the opening book can be used longer than against TODAI SHOGI and KANAZAWA SHOGI. AI SHOGI and KAKINOKI SHOGI seem to have a defensive playing style, while TODAI SHOGI and KANAZAWA

*Complex Games Lab, Electrotechnical Laboratory, 1-1-4 Umezono, Tsukuba-shi, Ibaraki-ken, Japan 305-8568, E-mail: grimberg@etl.go.jp.

†Future University-Hakodate and PRESTO, 116-2 Kamedanakanocho, Hakodate-shi, Hokkaido, Japan 041-8655, E-mail: matsubar@fun.ac.jp.

[1]The CSA tournament is generally considered to be the computer shogi world championship.

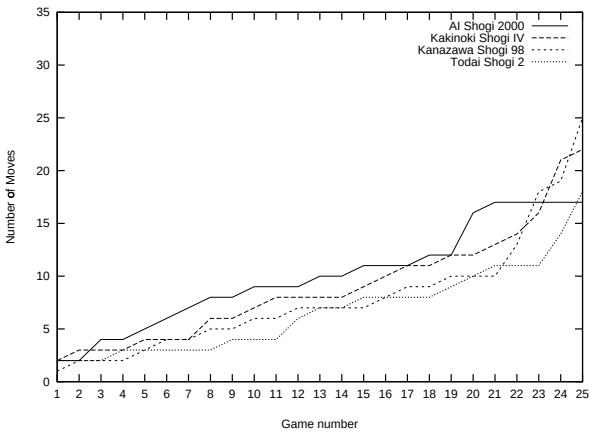

Figure 1: Full board database matches in 25 games against AI SHOGI 2000, KAKINOKI SHOGI IV, KANAZAWA SHOGI 98 and TODAI SHOGI 2.

SHOGI are very aggressive and go for an early attack that knocks our program out of the opening book very quickly. Against TODAI SHOGI our program is out of book after 6.8 moves on average, while against AI SHOGI this is after 10.4 moves on average.

To improve the opening and early middle game play, the opening book has to be used in a different way in shogi than in chess. In this paper we present a method for planning the development of pieces in the opening by extending the use of the opening book. Our method is based on the assumption that partially matching the current position with positions in the database also leads to good move suggestions.

We will explain our method in Section 2. Results of the method will be given in Section 3. In Section 4 we will compare our method with work by others. Finally, conclusions and suggestions for future work will be given in Section 5.

2 Planning by Extending the Use of the Opening Book

2.1 Partial Database Matches

Compared to chess, pieces in the opening stage of a game of shogi have more freedom. An early clash of pieces is quite rare and both sides more or less can build the position they prefer. Therefore, some way to guide the development of pieces to a strategically sound position is needed. It is hard to use search and the evaluation function for this, because opening sequences can be quite long, especially if a strong castle formation is built. During the piece development, it is often necessary that pieces are put in a bad position before they move to their ideal square later on. If the search is not deep enough, the natural development move will not be played because the position that is being aimed for is beyond the search horizon. Therefore, we need some way to plan the development of pieces in the opening and guide the search through this planning stage.

In the opening book there is a large amount of information that we would like to use even if the current position in the game is not a perfect match with the positions in the database. As said, the build-up in a shogi game is rather slow, so it can be expected that database moves will also be viable candidates even if the positions do not match exactly. Therefore, extending the use of the opening book by partially matching the current position with database positions might be a good approach.

2.2 Half Matching and Quarter Matching

The first type of matching based on opening book positions that we propose is *half matching*: if in a position in the database all of the pieces of the player to move are on the same squares as in the current position, then the move(s) suggested by the database are assumed to be good candidate moves in the current position.

The second type of matching we propose is based on the observation that in the opening the left and right side of a shogi position are often build independently. One side of the board is used for building a castle formation, while the other side of the board is used for building an attacking formation. Therefore, we propose *quarter matching* as in Figure 2.

In Figure 2 the quarter match areas for a position from black's point of view are given. The left four files and the right four files are independent, but the centre file is shared between the two areas. If the pieces of the player to move in the left (right) area of current position are on the same squares as the pieces in the left (right) area of a position in the database, then the moves played in that position might be good candidate

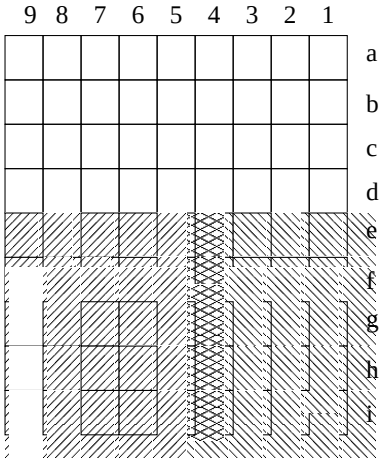

Figure 2: Quarter matches.

moves in the current position.

With quarter matching, one has to be careful with the selection of the moves, as a database match with the left area might return only moves with pieces in the right area of the board (or vice versa), or might even return moves that are not legal in the current position. Quarter matching should check this and give back only those legal moves with pieces in the area that matched the database. This also includes moves with pieces that move into the matched area or out of the matched area.

2.3 Implementation

In our implementation, the standard use of the opening book does not change. As long is there is a full match between the current position on the board and one of the positions in the database, we immediately play the book move. If there are multiple moves suggested by the database, one is selected randomly where the randomness is weighted by the frequency with which the move is stored in the database.

When there is no longer a full match between current position and database, we use both half matching and quarter matching. For half matching, only positions that have been reached by the same number of moves as the current position are matched. Quarter matching is done if the position in the database has a move number with an absolute move number difference of 10 with the current position.

After matching the current position with the database, normal search is performed. Matching with the database is an expensive operation, therefore database matching is only done at the root node of the search tree. To guide the search towards moves retrieved from database matching, the moves returned by half matching and quarter matching are given a bonus based on the frequency with which these moves have been played in the matching position:

- **Half match bonus**:
  $\max(\frac{3}{4} * PV, (\frac{1}{2} * PV + 2 * FQ))$
- **Quarter match bonus**:
  $\max(\frac{1}{4} * PV, (\frac{1}{8} * PV + FQ))$

Here PV stands for the value of a pawn and FQ is the frequency with which the move was found in the database. This bonus ensures that a database move will be given a strong positional reward, but will not be played if it leads to the loss of material.

3 Results

We have performed two tests to judge the merits of half matching and quarter matching. First, we checked how far the use of the opening book could be extended in games against strong shogi programs. Second, we performed a series of self-play experiments. We played a number of test games between identical shogi programs using no database matching, using only half matching and using both half matching and quarter matching.

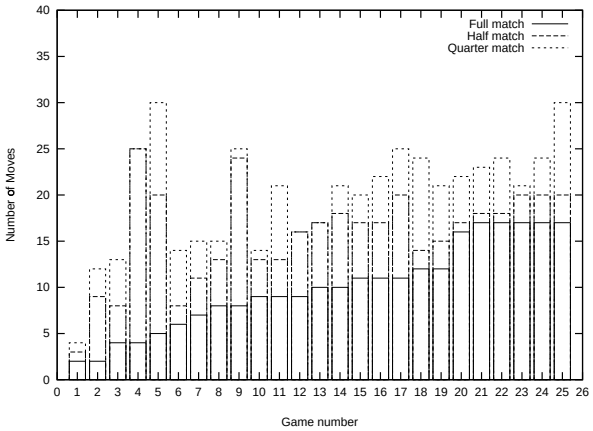

Figure 3: Full matching, half matching and quarter matching in 25 games against AI Shogi 2000.

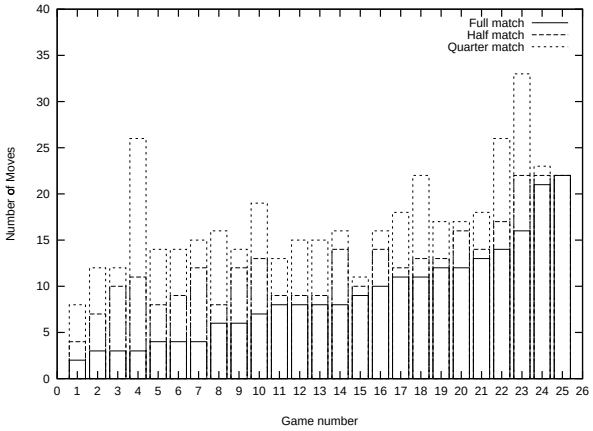

Figure 4: Full matching, half matching and quarter matching in 25 games against Kakinoki Shogi IV.

3.1 Extension Results

We matched our program 25 times against AI Shogi 2000, Kakinoki Shogi IV, Kanazawa Shogi 98 and Todai Shogi 2. This time we continued play until quarter matching did not return any move suggestions. The detailed results for all games are given in Figures 3–6.

From these figures, it can be concluded that for all games the use of half matching extends the use of the opening book. There are a number of games where the use of half matching is especially effective. For example, in game 4 against AI Shogi, half matching extends the use of the opening book from 4 to 25. In game 8 against Kanazawa Shogi half matching extends the use of the database from 5 to 23. From the figures

Opponent	Full	Half		Quarter	
	#Mv	#Mv	Played	#Mv	Played
AI Shogi 2000	10.4	15.8	76.7%	19.9	45.2%
Kakinoki Shogi IV	9.0	12.4	69.4%	17.3	47.5%
Kanazawa Shogi 98	7.6	14.6	77.1%	17.3	17.9%
Todai Shogi 2	6.8	13.2	77.0%	17.0	37.9%
Total	8.5	14.0	75.8%	17.9	39.1%

Table 1: Full matching, half matching and quarter matching and percentage of played moves for half match and quarter match move suggestions in 25 games against AI Shogi 2000, Kakinoki Shogi IV, Kanazawa Shogi 98 and Todai Shogi 2.

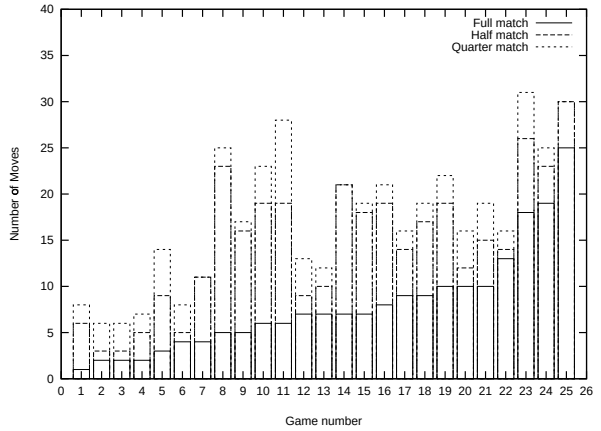

Figure 5: Full matching, half matching and quarter matching in 25 games against Kanazawa Shogi 98.

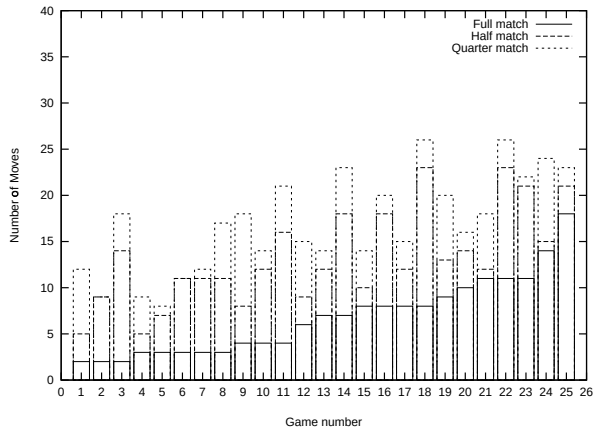

Figure 6: Full matching, half matching and quarter matching in 25 games against Todai Shogi 2.

we can also conclude that half matching is almost always useful. Only in game 25 against Kakinoki Shogi half matching did not return any moves. In this game this was not a particular problem, as already 22 moves where played by full matching.

Quarter matching returned one or more moves in 91 out of 100 test games. Sometimes quarter matching considerably extends the phase of the game where the opening book can be used. For example, in game 4 against Kakinoki Shogi there are quarter matches from move 11 to move 26.

The results of the 100 test games are summarised in Table 1. The overall results of the matching are that the use of the opening book can be extended from 8.5 moves after full matching to 14.0 moves by using half matching and 17.9 moves by using quarter matching. The results of using half matching against different programs differ considerably. Especially against Kakinoki Shogi, the average number of half matches is lower than for the other three programs. It seems that Kakinoki Shogi is programmed to start the game by quietly building its formation and then attack quickly. On the other hand, despite the early aggressiveness of Kanazawa Shogi and Todai Shogi, half matches with the database continue longer than for Kakinoki Shogi. Both programs seem to pause after the first couple of aggressive moves to build a defensive formation.

After the quarter matches, the differences between the programs have almost completely levelled off, except for AI Shogi, which seems to be the program most pre-occupied with building its own position and avoiding early tactical complications.

It is important to consider the number of times a move is picked as the best move by the program. After all, the usefulness of extended opening book matching can only be established if the moves suggested by the partial matching are actually played. The average number of times a half match move is picked is 75.8%. However, in games against Kakinoki Shogi, moves suggested by half matching were picked much less often (69.4%).

For quarter matches the number of played moves is much lower at 39.1%. However, this still means that

the program preferred a quarter match move in more than one of every three positions. It is interesting that in games against KANAZAWA SHOGI, the quarter match move is picked in only 17.9% of the positions. After the initial pause to build a defensive formation, this program continues aggressively. As a result, the quarter match move is often being replaced by a more urgent move to defend against some tactical threat.

3.2 Self Play Results

Unfortunately, our shogi program is not strong enough to compete with the four top programs in our previous test. Therefore, it will be unclear how the extended use of the opening book affects the playing strength of our program if we would match it against these strong opponents. To investigate the influence of partial database matching on playing strength, we have played a series of games between different versions of the same shogi program. One version of the shogi program is using no matching (this program is called *NM*), one program is using half matching (called *HM*) and one program is using half matching and quarter matching (called *HQM*).

The basic shogi program that we use for all three versions has the following features, which are common in most shogi programs:

- Iterative alpha-beta search.
- Principal variation search [10].
- Quiescence search [2].
- History heuristic and killer moves [11].
- Null-move pruning [1].
- Hashtables for transposition and domination [14].
- Specialised mating search [13].
- Limited plausible move generation: for pawns and major pieces non-promotion moves were deleted from the legal move candidates.

All three programs have the same evaluation function.

The set-up of the experiment is as follows. The three programs played 100 games against each other. To make sure that the games were different, all programs used full matching for the first ten moves with random move selection in case of multiple moves returned by the database. When a different position from the previous games was reached after ten moves, two games were played from this position, with each program version playing black and white once. The time limits for the games were 20 minutes per side for the whole game, time limits that are used in the CSA tournament. The self play experiments ran on a Pentium 700 MHz.

No	Version	1	2	3	P	W	L
1	HQM	x	54-46	64-36	2	118	82
2	HM	46-54	x	63-37	1	109	91
3	NM	36-64	37-63	x	0	73	127

Table 2: Results of a 100 game self play experiment between identical shogi programs using no partial matching (NM), half matching (HM) and both half matching and quarter matching (HQM).

The results of the self play experiments are given in Table 2. From the results of this small tournament it can be concluded that the program benefited significantly from using our planning method. *NM* finished last, winning only 37% of its games. It is not so clear from the results if the use of quarter matching is an improvement. Even though *HQM* beat *HM*, it was only by the small margin of 54-46. This is an indication that quarter matching is an improvement, but further testing is needed to investigate this further.

4 Related work

Our work has been inspired by that of Kotani [6]. He also recognised the problem of the limited use of an opening book in shogi. He proposed to look at only the pieces in one's own camp (first three rows of the board), thereby getting more database hits. A self-play experiment showed that a shogi program with this method of partial matching could beat an equivalent program without the partial matching in 55% of the games. Our results are better, which might be the result of using a much larger opening book. Unfortunately, Kotani does not mention the size of the opening book he used for the experiments. Another reason for the different results may be the difference in the matching method. We think that matching all pieces of the side to move gives more useful matches than matching only the pieces in the camp of the player to move, but further testing is needed to investigate this assumption.

Two other methods for extending the opening book in shogi have been proposed by Nakaie et. al. The first method [7] is a method to generate move sequences from an opening book. These move sequences are then integrated in the search. There is no partial matching in this method and the database is very small (only 800 positions in total), which makes it hard to judge the merits of the method. The second method [8] is a partial matching that is more complex, searching for patterns around the king, attack patterns and defence patterns. This method is called an opening book extension, but it is actually a general pattern matching method that can be used in all stages of the game. The size of the database used is not given, which is unfortunate as we feel that this method might be slow if a

large database needs to be searched for such complex patterns, especially if the matching is done at every node in the search tree.

5 Conclusions and Future Work

In this paper we have described a planning method for piece development in shogi. The development of pieces in the opening and middle game can be guided by extended use of the opening book. Instead of using only perfect matches of the current position with positions in the database, the database can be used for partial matches. In this paper we have described *half matching*, matching only the pieces of the side to move with the positions in the database, and *quarter matching*, matching the pieces of the side to move on the left and the right 5x5 area of the board with the positions in the database.

We have shown that half matching and quarter matching significantly extends the phase of the game in which the opening book can be used. Against four strong shogi programs the opening book use was extended from 8.5 moves on average for full matching to 14.0 moves using half matching and 17.9 moves using quarter matching. We also showed that moves suggested by half matching were considered the best move in 75.8% of the positions, while quarter match moves were considered best in 39.1% of the positions.

Self-play experiments show that the use of half matching and quarter matching improves the playing strength of a shogi program. There was also evidence that using both half matching and quarter matching is better than using only half matching, but further tests are required for a definite conclusion.

There are several other areas of further research. For example, it is possible that the bonus value for half matching and quarter matching is not optimal. Also, the matching window of ten moves for quarter matching might be too wide, slowing down the program. Finally, there are several other types of matching that can be investigated. One possibility is half matching on the left and right of the board, taking not only the pieces of the side to move into account, but also the pieces of the opponent. Another option is to match even smaller areas of the board, although given the opening characteristics of shogi we do not expect to improve upon the results given. Finally, a completely different type of matching would be to count the number of pieces that the current position has in common with positions in the database. Based on this similarity count, a bonus can be awarded to the moves suggested by the database. Implementation of these other matching methods and comparing them with the matching methods presented here remains a future work.

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