A Self-Play Experiment in Computer Othello

Hayato Kita[1)] and Hiroyuki Iida[1,2)]

[1]Department of Computer Science, Shizuoka University
[2]Information and Systems, PRESTO, Japan Science and Technology Agency

Abstract. This paper presents a self-play experiment in the domain of computer Othello. It explores the relation between playing strength and other factors, including the length of games, the difference of discs at the end of a game, winning rate and draw rate. The self-play experiment has been performed using one of the strongest Othello programs, Wzebra. The experimental results show some deep insight into the game properties of Othello. We expect that statistics obtained by such a self-play experiment would be an indicator to predict the game-theoretic value of complex games like chess and shogi.

1. Introduction

This paper presents a self-play experiment in the domain of computer Othello. It explores the relation between playing strength and other factors, including the length of games, the difference of discs at the end of a game, winning rate and draw rate. The self-play experiment has been performed using one of the strongest Othello programs, Wzebra. The experimental results show some deep insight into the game properties of Othello. As a result of self-play in computer Othello, the clear difference was seen with the search ply in white and black winning rates, the difference of the number of discs, and its variation.

2. Experiment method

We played nine matches at fixed iteration depths ranging from 9-17 plies with 300-400 games per match. The self-play experiment has been performed using one of the strongest Othello programs, Wzebra[4]. We used a 2.4GHZ Pentium4 computer running Windows XP. We removed same records, and 200 games were extracted at random. We investigated winning rates and draw rate, the difference of number of discs and its variance.

3. Experimental results

The following results were obtained after experimenting using the above-mentioned experiment setting.

ply	Black win	White win	Draw
9	61	125	14
10	98	80	22
11	87	91	22
12	86	98	16
13	72	107	21
14	85	93	22
15	73	102	25
16	77	104	19
17	61	108	31

Table 1. Search ply and number of winning

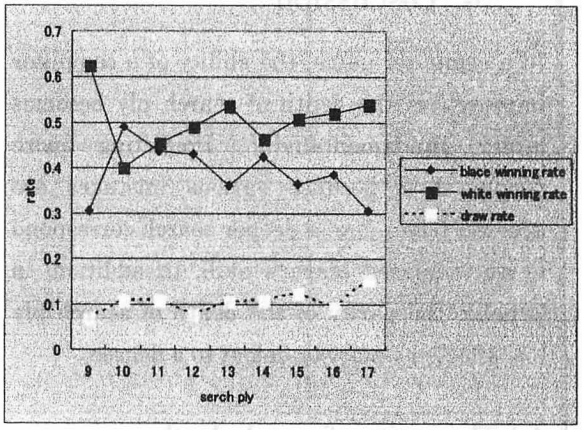

Figure 1. Search ply and winning rate

ply	Black win	White win	Draw
9	0.305	0.625	0.070
10	0.490	0.400	0.110
11	0.435	0.455	0.110
12	0.430	0.490	0.080
13	0.360	0.535	0.105
14	0.425	0.465	0.110
15	0.365	0.510	0.125
16	0.385	0.520	0.095
17	0.305	0.540	0.155

Table 2. Search ply and winning rate

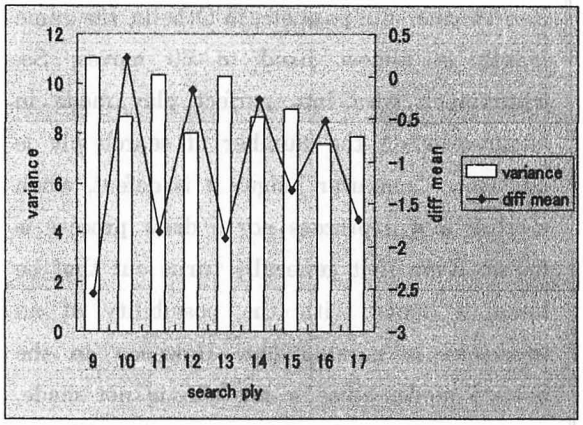

Figure 2. Search ply and difference of discs and its variance

ply	*diff	variance
9	-2.550	11.05
10	0.215	8.637
11	-1.825	10.32
12	-0.160	7.983
13	-1.910	10.26
14	-0.275	8.608
15	-1.335	8.973
16	-0.525	7.561
17	-1.690	7.841

Table 3. Search ply and difference of discs and its variance(diff: What subtracted the number of white stones from the number of black stones)

A big difference is seen by whether the search ply of any result is odd, or the number is even. Moreover, the deeper the depth of search ply, the smaller the gap between the odd and even search becomes.

4. Discussion

In a computer game, the ability of a computer improves as the depth of search ply becomes larger fundamentally[3]. Predicting more deeply, it is because various mistakes are avoided. Therefore, a deeper search correspond to an increased player's skill. In addition, in Othello, the parity of the depth of search ply has affected victory or defeat to a degree.

4.1 The parity of search depth

Although some exceptions exists by intervention of a pass etc. in Othello, the game length is almost fixed to 60 moves. So, white/black goes into perfect play mode in advance when the number of search ply is odd/even. Computer judges it is defeat, when neither a win process nor a draw process is found. Even if it generally turns out that he loses, a move with the possibility of an inversion is pointed out. However, in the perfect mode, since a mistake is not made, remaining game after it is meaningless. That is to say that, the game ends as it sees the player who goes into the perfect mode first.

4.2Peculiar character of Othello

Fig.1 and Fig.2 show that a result is sharply changed with the search ply. The degree of Othello from which the situation of a board changes by a move is larger than other games. The average number of legal move is about ten. Fully, it confuses a player who deals with it. So, it will be easy to produce the inversion of the situation if it happens before reaching the perfect mode. If it says in another viewpoint, it can be said that there is the possibility of an improvement about the state of affairs evaluation of the opening part and the middle stage. In shogi or Go, there is no program which can be fought fifty-fifty with man's top player, but in Othello, the computer is overwhelmingly stronger than man[Reference]. Although the search space of Othello is much smaller than shogi and Go, and it has influenced that it applies a burden greatly to man's memory capability that the rate of change of a state of affairs is large.

4.3 The difference of the winning rate of and number of the discs

The tendency to converge the winning rate and a disc difference on a certain value is seen as the search depth becomes large. Simultaneously, a tendency for the variation in data to become small is clear. From Fig. 1, it is seen that there is a tendency to converge the winning rate of black is almost 50% and the winning rate of white is almost 40%. From Fig. 2, it is predicted that what will be converged on white wins with 1 disc difference.

Following are the two pieces of information acquired from above. The 1st is that the program used for the experiment has appropriate state of affairs evaluation. Fig. 1 shows that there is a big difference in the winning rate of black and white at the time of the depth 9 of search ply. However, the winning rate of black and white is reversed at the time of the depth 10 of search ply. This is coming from the predominance which can go into the perfect mode first, as already stated.

The advantage from which prediction goes into the perfect mode previously in a shallow stage is very large. Then, how is the size of the advantage in case of deep prediction? The

winning rate in case the search ply is 16, and the winning rate at the time of being 17 have a small difference compared with the time of 9 and 10 which are the shallow stages of prediction. This shows that the state of affairs evaluation is stabilized and a program becomes strong, if prediction becomes deep. When considering a player who is close to a random player, it is clear to become advantageous if it can go into perfect mode first. As prediction becomes deep, the advantage which goes into the perfect mode previously becomes smaller. This shows that the computer is carrying out suitable state of affairs evaluation.

The 2nd things is, in Othello, white is fundamentally advantageous. Except for the time of the search ply being 10, the white winning rate has exceeded the black winning rate in all cases. Since the search ply is still shallow when the search ply is 10, a play which is close to a random player is carried out. Therefore, the advantage which goes into the perfect mode first is large. Consequently, it is thought that was the reason the winning rate was reversed. However, in all other cases white has exceeded black in its winning percentage. If the search ply is made deep, the performance of the state of affairs evaluation will improve and a decisive mistake will not be made. That can be read also in change of variation. Variation is smaller as the search ply becomes deep. When prediction is deep, the mistake of a program decreases and it chooses the move considered to be right. The difference of the winning rate of white and black is decisive in such a state. From this, if it plays directly, Othello will be considered to be a game which is more advantageous to white.

5. Summary

As a result of self-play in computer Othello, the clear difference was seen with the search ply in white and black winning rates, the difference of the number of discs, and its variation. It was possible to express the correctness of the evaluation function of a program, and the special characteristics of Othello. In the future we would like to predict what kind of results it would yield when the game of Othello is solved by using the data acquired from this study with 6 x 6 Othello. We will also try to determine where the game's equilibrium lies by focusing on the changes in evaluation values and analyzing how it compares to games with long history of refinement in term of excitement.

References

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