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ASPECTS OF OPENING PLAY

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ABSTRACT

In this paper, we study opening play in games. We show experiments using minimax and a semi-random player. In the experiment, we let each semi-random player use an opening-book, created by different player. Results show evidence for the following statements. The game length increases. Expert player against an intermediate player should not use an opening book in a tournament match. Some opening books are good for novices and some opening books are bad for novices. The game outcome will approach the outcome of the game when the opening book was created, and if a grandmaster creates the opening book then the outcome will be the same as the grandmaster's.

Keywords: Opening play, Opening book, Semi-random play, Artificial intelligence.

INTRODUCTION

An opening book is a database of opening moves used by computer programs in games (Nagashima, 2007; Donninger & Lorenz, 2006; Hyatt, 1999). These programs are significantly enhanced by an electronic version of an opening book. This eliminates the need for the program to calculate the best lines during the very early stages of the game, where the positions are extremely open-ended and thus computationally expensive to evaluate. As a result the computer uses considerably less resources and is more effective than if it calculated the moves itself.

The strong Chess program, Deep Blue (Campbell, Hoane & Hsu, 2002) guides the opening book play by propagating leaf evaluations to the root using the minimax algorithm and extending lines by expanding mini-max leaves. This algorithm avoids repeatedly losing in the same way and explores new variations. In games such as Shogi and Go, where the grandmaster (GM) is stronger than computers, an opening book is constructed by taking some opening lines played by GMs in actual games, which have led to a good outcome. Interestingly, such an opening book is also used by weaker players who cannot understand the meaning of the opening lines.

Opening books can also be observed in daily life. For example, when people start to do something new and have no idea how to do it, they may follow social or a successor's behavior. This is the same as when you use an opening book in a game. When you were born, you try to speak like your family does. When you were young, you go to the school like other children. When you start your work in a company, you enter the new recruit training. When you have a son, you also do the same thing that exists in society. Something important is gained from following these behaviors. Selecting the right opening book for a targeted learner has been shown to positively influence outcome (McKenna 2011).

It is possible that opening books might affect the length of games. The information of the game length interests researchers of the entertainment (Iida, Takeshita & Yoshimura, 2002).

In high profile games like Deep Blue (Campbell, Hoane & Hsu, 2002) or other important tournament matches, both players struggle for victory and picking strong moves that eventually lead to a win is essential.

This paper studies the questions “How does opening book affect game length?”, ”Is it wise for a stronger player to follow an opening book against a weaker one in tournament?”, ”How does an opening book affect game outcome?”. In this study we try to understand the more general influences of an opening book. We use semi-random play (Kajihara 2000) and tic-tac-toe.

THREE ASPECTS OF OPENING BOOKS

SOLVING

A solved game is where the optimum outcome for the first player (win, draw or loss) is defined. It seems likely that sophisticated games which have been competitively played for a long time when solved will turn out to be a draw (Iida 2007). There are many ways to solve games (van den Herik, Uiterwijk & van Rijswijck, 2002). A basic approach is to test all existing moves known as brute force search. Due to the large search space that adequate games usually provide, it will be impossible to search deep enough to solve. For example in GO, there are 361 empty spaces to choose in the initial position. However, with an opening book, complexity might be reduced. Games are classified as imperfect and perfect information. There are obstacles to prevent reaching solutions in both perfect information and imperfect information games. In imperfect information games, we often find difficulty or limitations in gathering information when considering the best move. Even in perfect information case, the search space is too large for a normal human to understand.

WINNING

Strong strategies require a good opening, mid game and end game. An opening book is the best way to improve the play style without effecting previous ability, since the program is constructed based on statistics. Opening phase is full of mysteries, and sometimes leads to different paths, or unseen positions, through the game. With a good understanding of the opening book, a player can lead an opponent to where he can perform better in the middle of the game.

ENTERTAINMENT

The initial position can have a large search space and a player can be confused about this phase of the game since there are too many possible moves. An opening book can reduce frustration at the beginning of the game and enhance entertainment. A player - experiences different amounts of complexity by following different opening books. We provide a discussion in detail in a later section.

OPENING PLAY IN VARIOUS GAMES

The opening book plays an important role in the opening of games such as Go, Chess, Othello and others. We consider that opening play also appears in many other well-known types of game. Using game-play as a classifier, we analyze board games, card games and video games.

BOARD GAMES

Board games are played by moving or placing pieces on a board. Usually, board games provide each player with the same resources at the beginning of the game. Since people have a full vision of the board, they are known as perfect information games. To win or lose depends on the player's choice of move. The principle line represents the optimum moves for both players. If a player plays away from the perfect opening line, they lose advantage.

CARD GAMES

Card game players try to gain maximum profit with their dealt hand. Players cannot look at the opponent's cards, so card games are known as imperfect information games. It is impossible to find the perfect opening line in this type of game. Since players need to play more than one round to decide the winner of a tournament, players can gather information by learning form their past moves, during game play or history. No perfect opening line exists but professional player can use their opening line to gather information about their opponents or hide information from opponents. They also need to make use of the information from opponents as much as possible. However, since no such "One best opening book" exists, "Strategy" is more of a focus in this field rather than "Opening Book".

VIDEO GAMES

Video games are popular today. To play, players select a character and find and reach sub goals of that character. The given character can develop powers, used to solve their problems, in some specific way. As the game progresses, players will have to choose to develop some ability or buy some equipment. If there are limited resources, decisions depend on players' preference. Players can sometimes defeat the same opponent easily with a new ability. There are player versus environment (PvE), e.g. Diablo (Blizzard Entertainment, 1996.), and player versus player (PvP), e.g. Dota (Icefrog, n.d.).

In PvE, players need to interact with non-player-characters (NPC), and compete or cooperate. This task requires players to learn their possible moves and strategies by gathering information. The player perceives that the opponent has the advantage. Players usually have various opening books to win against this environment depending on the selected character. Unlike the 2 person competitive game, PvE type of game was built to be won by the player. An opening book, usually perfect opening book in this game field, is known as a "Walkthrough". The opening book will provide an optimum move to avoid, or react to, the worst case. Therefore, the player will be more likely to win the game after following the opening book.

PvP is more interesting than PvE. A good PvP game can provide a feeling of balance to players, and the feeling of a character you built up enough to compete against others. The balanced game is where every possible move is reasonable, and can compete with other moves. However in reality, it is difficult to measure the balance in PvP games. Games always start with a unique resource or ability for each player. Each character has pros and cons that lead to specific strategies and planning. An opening book is built depending on the in characters in the arena, known as a "Matchup". Though an opening book does not increase winning probability against careful players, it gives players less to think about. This will make it easier for the player to control their character.

METHOD

We use tic-tac-toe as a testbed.

SEMI-RANDOM PLAYER

Semi-random play (Kajihara & Iida, 2000) is achieved by the following procedure. First, search by minimax to a specified depth. If there is a way to win by MAX, choose it, or else, if there is a way to win by MIN, prevent it. Otherwise, choose randomly among possible moves. Note that semi-random play does not have an evaluation score, and only relies on a result such as win, lose or draw. There is some randomness in semi-random play. Depth of search can define the strength of each player since they use the same reasoning. However, a stronger player does not have 100% win against a weaker one.

CREATING AN OPENING BOOK

”If you have won a game, try it the same way next time”. We create the opening book database using statistics. Using self-play experiment, we observe the highest wining rate for each first move. Pn means a semi-random player who searches to depth n. We perform self-play on P4 and P5. Statistics from 10,000 games are shown in table 1.

TABLE 1. Result for the first move.

	P4 vs P4 (1ply)			P5 vs P5 (1ply)		
Position	win	draw	lose	win	draw	lose
Middle	42.64	57.88	0	50.73	49.27	0
Corner	38.82	52.25	8.93	87.05	12.95	0
Edge	20.32	54.88	24.8	52.05	35.65	12.3

The experiment results show that the best initial move for P4 is the middle, as it has a 42.64% win ratio. But for P5, the best initial move is the corner, with 87.05%. The strongest opening moves are used as the initial moves of the game, and self-play statistics are gathered for the second move. The result is shown in table 2.

TABLE 2. Result for the second move.

	P4 vs P4 (2ply) Continue from Middle			P5 vs P5 (2ply) Continue from Corner		
Position	win	draw	lose	win	draw	lose
Middle	-	-	-	0	100	0
Corner	0	100	0	100	0	0
Edge	85.68	14.32	0	100	0	0

From this experiment, we observe two reasonable opening lines, P4vP4 (middle, corner) and P5vP5 (corner, middle). Both opening books give a 100% draw outcome. Self-play with P4 using P4’s opening book gives 100% draw outcome. Self-play with P5 using P5’s opening book gives 100% draw outcome.

RESULTS

We create 5 computer players, labeled P0 to P4, where for Pi, the minimax algorithm searches to depth *i* and then evaluates the board position according to the semi-random player as described above. In this way, beginner (P0; P1), intermediate (P2; P3) and expert (P4) players are defined. We perform a round-robin tournament, each Pi versus Pj, such that.

1. No opening book is used for either player.
2. P4 opening book is used for both players.
3. P5 opening book is used for both players.

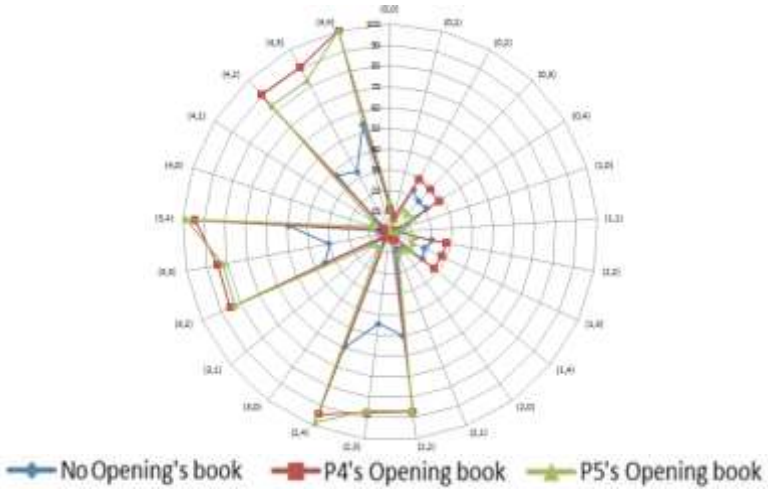
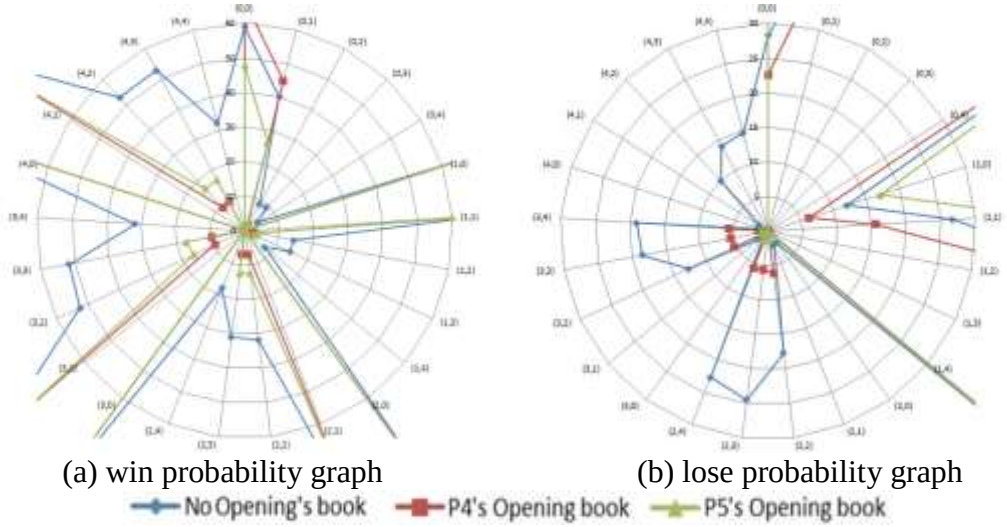


FIGURE 1. The draw percentage

10,000 games were played for each match. Figure 1 shows the percentage of draw outcome. For the 9 cases of at least intermediate players (where both players are at least P2), the percentage of draw outcome increases from approximately 40% to 90%. This shows that the outcome is more likely to be the same as the outcome of the opening book.



(a) win probability graph (b) lose probability graph

FIGURE 2. The winning and losing percentage (zoomed in version)

Figure 2 shows the winning and losing percentage for the same tournament. This result shows that in the case of at least intermediate players, not using opening book, increases the chance of winning but also increases the chance of losing. This is called “speculative play”.

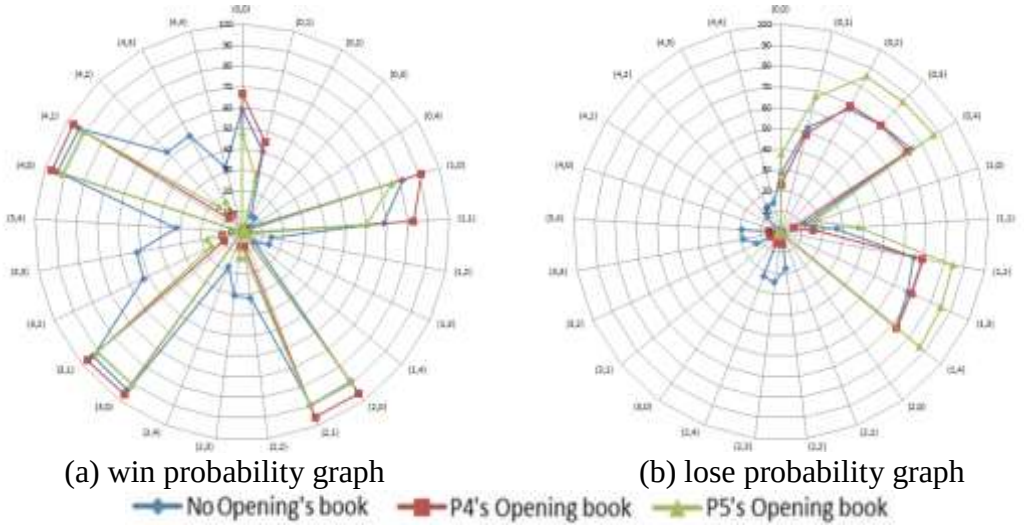


FIGURE 3. The winning and losing percentage

Figure 3 shows the winning rate and losing rate for the same tournament. The result shows that P4’s opening book increases the winning rate for the novice, but also P5’s opening book increases the losing rate and decreases the winning rate for the novice. Therefore, a novice should take care because not all opening books are beneficial to them.

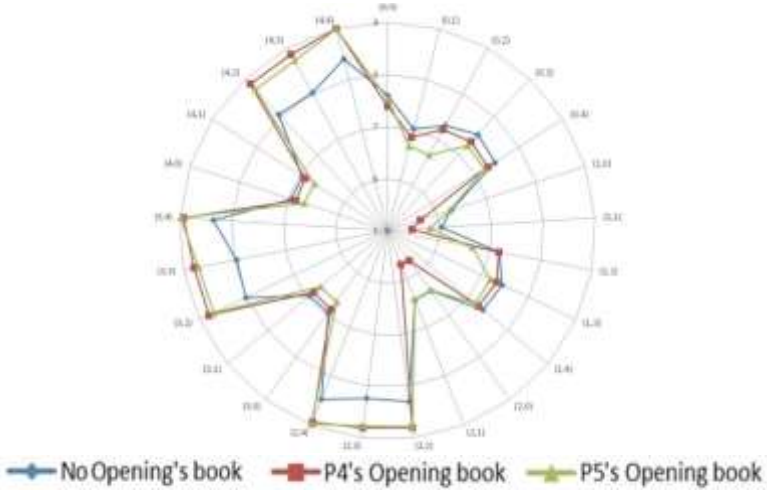


FIGURE 4. The game length

Figure 4 shows the average game length for the same round-robin tournament. The Figure shows that when both players are at least intermediate, the game length increases from approximately 8 to approximately 9. Iida et al. (2004) proposed an equation for game entertainment. Their model shows a decrease in entertainment from an increase in game length. However, opening book provides novices with guidance and therefore they will be less frustrated.

CONCLUDING REMARKS

In this paper we conclude that, if both players are at least intermediate, there are the following affects. If both player use an opening book, the game length increases. If neither player uses an opening book, the chance of winning increases and the chance of losing increases. Expert players playing against intermediate players should not use an opening book in tournament matches. Some opening books are good for novices and some opening books are bad for novices so care should be taken. If an opening book is used, the game outcome will approach the outcome of the game when the opening book was created.

"Strategy", "Walkthrough" and "Matchup" are other kinds of opening books that can be found in other types of games. They work well along the three aspects that have been described. They help average players to understand the game, show how to clear the difficult tasks in games and provide experienced players with alternative ways to enjoy a game.

In competitive games, the result of the perfect game play is likely to be a draw (Iida, 2007). In life, we compete with other people all of the time. The social system is built to make every person equal. If you are performing a good opening book in life, you will likely gain equality with other people and reduce the chance to fail. However, playing along an opening book will make you ordinary. If we talk about business, big successful business plans always offer something different compared to previous opening books. We are likely to find that a biography of a successful person will show their life to be different to normal people. However, not following an opening book tends to give you more chance to fail in life, and you can see many failed business plans.

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