An improved opening book for computer Go

April Hersey '12, Nick Sylvester '13, Dr. Peter Drake
Department of Mathematical Sciences, Lewis & Clark College

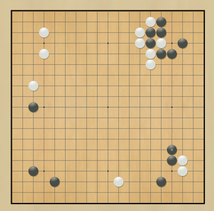
Introduction

The classical Asian game of Go is considered a grand challenge in the field of artificial intelligence [1]. Expert human players are still able to beat the best computer players with relative ease. In the beginning of a game of Go, there are too many options for a computer player to consider. Our program, Orego, handles this problem by incorporating domain-specific knowledge from human players.

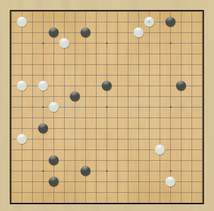
Expanding on the work of [2], we enhanced Orego's opening book to supply moves in response to a greater number of board positions. The positions added include both fuseki (full-board) and joseki (individual corner) positions.

Opening books

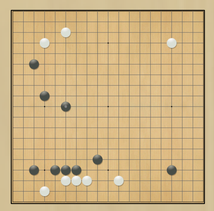
An opening book is a pre-constructed database used to find moves in response to standard openings during gameplay. Orego's gameplay bears much more resemblance to professional games when using its opening book than it does without it.



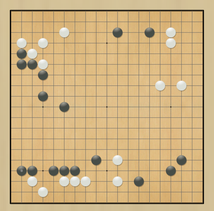
Professional game



Orego without opening book



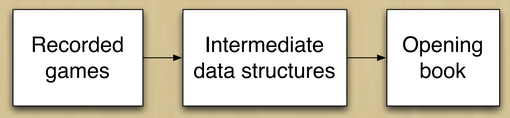
Orego with fuseki book



Orego with both books

Building the book

To create the opening book, 65,816 games from high-level players on the KGS Go Server were collected. The first 40 moves (position-response pairs) of each game were stored in a database. The most common response to each position was stored in the book. Responses were not stored for positions that did not occur many times.



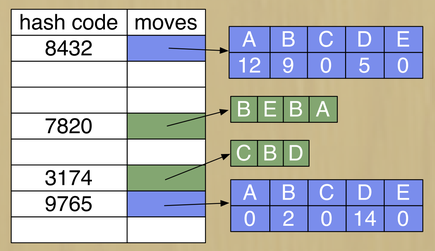
Book-building process

Not all board positions are encountered very many times. The vast majority of positions are seen only once in all of the recorded games. Of the remaining positions, most only occur a few times. To avoid wasting space, we used a three-tiered data structure to construct the opening book.

The first time a board position is encountered, it is stored in the small hash map, which associates that position with its response move (red). The next time a board position is encountered, it is stored in the big hash map. This map maintains a list of response moves to this board position (green) until a certain number of responses have been stored. At this point the list of moves is replaced with a table of move frequencies (blue).

hash code	move
8432	A
9765	D

Small hash map

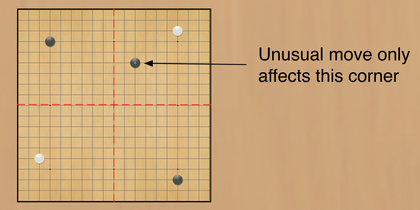


Big hash map

Benefits of the joseki book

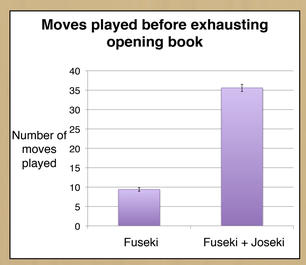
The fuseki book considers the entire board each turn to determine whether it contains a response to that position. However, the fuseki book can only respond to exact full-board positions that were encountered during the book-building process. Thus, an opponent can thwart the opening book by playing a single unusual move.

In contrast to the fuseki book, the joseki book divides the board into four quadrants in order to to examine each corner of the board independently. If an unusual move is played in one corner, the joseki book can still search for stored responses in the remaining corners. This allows Orego to progress further into the game before its opening book is exhausted.



Results

We ran Orego version 7.04 against Gnugo version 3.7.11 for 100 games using both books. We averaged the number of moves generated by the fuseki book alone and by both books combined. Orego was able to find three times as many moves using both books as it was using the fuseki book alone. The error bars in the adjacent graph represent standard error.



Conclusion

The data structures we created to build the opening book allowed us to store more moves from more games without exceeding available memory. This was essential to the improvements we made to the opening book.

Using the fuseki book combined with the joseki book allows Orego to stay in the opening book much longer than using either book alone. The ability to generate so many moves instantly is advantageous in timed games.

Acknowledgments

John S. Rogers Science Research Program
KGS Go Server
GoGui

References

1. Cai X. and Wunsch, D. 2007. "Computer go: A grand challenge to AI." *Studies in Computational Intelligence* 63, 443-465.
2. Mullins, J. and Drake, P. 2010. “Using Human Knowledge to Improve Opening Strategy in Computer Go”. In *Proceedings of the 2010 International Conference on Artificial Intelligence*, CSREA Press.

Further information

April Hersey - ahersey@lclark.edu
Nick Sylvester - nsylvester@lclark.edu
Peter Drake - drake@lclark.edu
http://legacy.lclark.edu/~drake/Orego.html