Applications of Artificial Intelligence and Machine Learning in Othello

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Abstract

The purpose of this project is to explore Artificial Intelligence techniques in the board game Othello. I will investigate several improvements to minimax game-tree search algorithms and explore higher-quality evaluation functions. I will also apply various machine learning methods to enable an AI player to improve the quality and speed of play based on experience.

Background and Introduction

The primary aspect of most AI players is the search algorithm, which is used to evaluate a board state based on a prediction of future moves from that state. The standard basic game-tree search algorithm is minimax with alpha-beta pruning. I plan to implement several more advanced improvements on minimax search. One enhanced minimax search algorithm is MTD(f), which uses zero-window alpha-beta searches to search more efficiently. Another important way to improve search speed is to cache information about board states that have already been evaluated in a transposition table, which allows the player to avoid repeated searches. Selective search algorithms can further enhance game-tree search by pruning parts of the game tree that probably will not affect the overall minimax value. This allows the player to search much deeper in the relevant parts of the game tree. I will also investigate other search techniques, such as quiescence search and negascout.

The board evaluation function is another important aspect of AI players. Traditionally, the evaluation function is based on human knowledge about the game. In Othello, evaluation functions are often based on several “complex” features, such as mobility and stability. However, using a collection of “simple” features, which evaluate patterns in a small number of disks, can improve board evaluation. I will investigate various board evaluation methods such as these.

The relative weights of board evaluation features are traditionally hand-tuned. I will explore the use of machine learning to train an evaluation function by automatically optimizing the relative feature weights. There are several machine learning techniques that can be applied to this problem. I will also explore other ways to enable an AI player to improve the quality and speed of play based on experience.

Discussion

Results and Conclusions