Applications of Artificial Intelligence and Machine Learning in Othello TJHSST Computer Systems Lab 2009-2010

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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.

Keywords: Artificial Intelligence, Machine Learning, Othello

1 Introduction and Background

1.1 Search Algorithms

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.

1.2 Board Evaluation Functions

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.

1.3 Machine Learning

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.

2 Procedure and Methodology

The first part of this project is the implementation of an Othello referee program to run the game. It will keep track of the board state and allow two players, AI or human, to play a game against each other. The referee will be implemented in Python.

I will also implement a graphical user interface for the game. This may be implemented in C++, Python, or Ruby. It may use the Qt or Tk graphics toolkits.

The primary focus of the project is to write Othello AI players. I will investigate several AI techniques, implement them, and compare various players to test their effectiveness. I will implement AI players in C++.

3 Expected Results

An Othello AI player would be evaluated by playing games against another player. Overall, the success of a player would be judged based on the number of games won and the score differences in the games. I will implement multiple players using different algorithms and techniques. I will then compare their success to evaluate the effectiveness of these algorithms. Players using machine learning would be expected to improve as they play more games. I expect the project to result in a fairly strong Othello AI player.

I have chosen to work with AI game-playing because games like Othello are highly constrained while sufficiently difficult to allow significant exploration of AI techniques. Although the AI player implemented in this project will be designed for Othello, many of the AI approaches are game-independent, and could even be applied to similar problems other than games.

References

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