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| Title | ボードゲームの着手評価関数の機械学習のためのパターン特徴量の選択と進化 |
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Abstract

The target of our research is the artificial intelligence of computer games. The the artificial intelligence makes computer games be more interesting. There are several areas of games that AI is contributed to, but we focus on two-player deterministic perfect-information games, because the rules of these games are simple, a lot of people know them, and these systems have been used as the simple testbed of AI research. Our goal is to make strong computer players of board games.

In general background, game tree search is frequently used for making computer game player. State evaluation functions are often necessary to evaluate a node, and action evaluation functions are also often used to enhance the search. Machine learning is quite effective to learn good evaluation functions automatically, compared to manual design, and it is already known that selection of features used for machine learning is very important for the performance.

In our specific case, we focus on the Monte Carlo Tree Search for Othello game as a game tree search, it needs a good action evaluation function using some patterns. We employ Bradley-Terry Minorization-Maximization as the learner, because it is effective in the game of Go and attracts attention. In our case, only the patterns are used as the features. But there are a lot of possible patterns, then working with pattern shapes is our motivation because we believe that there are many hidden good pattern shapes which have not been discovered.

From the reasons above, our purpose is to establish the way to obtain good pattern shapes automatically from given game records. Thus, the research questions are how to obtain better pattern shapes and how to reduce the optimization cost.

We want to optimize the pattern shapes, so two approaches are proposed to evaluate them. One is to use statistic method to measure the hopefulness of a PS before learning. Another is to use the very early result of BTMM further with less learning data. Two approaches are our contribution, and they have some reasonable results.

The game of Othello is used as an environment of experiments in this thesis, but the methods can be applied to almost all board games such as Go, Connect-6, Lines of Action, Hex, Shogi, which patterns are used. From many experiments, we have some following conclusions.

Evolution of PSs is done not by using MCTS performance but by light-BTMM for reducing cost. If MCTS performance needs 100 games to evaluate a pattern shape and each game needs 3 minutes, then we need 300 minutes to evaluate a pattern shape. Instead of using MCTS performance, if the heavy-BTMM is used, then it needs 8 minutes to evaluate a pattern shape.

However, the light-BTMM needs nearly 1 minute to evaluate a pattern shape. It is clear that using light-BTMM reduces cost significantly. MLE of the optimized patterns is improved compared to the often-used patterns by evolution. Because the MLE of the often-used patterns is -1.5 before optimization, but the MLE of the optimized patterns is -1.4 after optimization. This means that we hope the MCTS performance will be improved if the optimized patterns are applied.

The MCTS performance itself is also improved a lot. The winning ratio between two MCTS programs using the often-used patterns is 50%. But the winning ratio is increased to 70% if the MCTS using the optimized patterns, compare with the MCTS using the optimized patterns.

There are many strange patterns after evolving, this means that it is difficult for programmers to optimize pattern features by manual.

Key words: Feature selection, pattern features, action evaluation function, supervised learning, board games