Monte-Carlo Techniques: Applications to the Game of the Amazons

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Abstract

We propose in this dissertation our study of so-called Monte-Carlo techniques applied to the game of the Amazons. Unlike traditional game-programming methods using static evaluation functions combined to tree-search techniques relying on the min-max principle, Monte-Carlo techniques are based on a completely different paradigm. Monte-Carlo based programs typically play in any given situation the move leading to the best average result. This method leads to programs usually displaying higher strategical abilities than traditional programs, although often at the expense of tactical sense. For this reason, Monte-Carlo methods have been applied with great success to create strong Go programs, a game requiring a good strategical ability.

The game of the Amazons is a two-player deterministic board-game with perfect informations usually put into the category of territory games like the game of Go. Unlike it however, the game of the Amazons uses sliding pieces like the game of Chess or Shogi, making it an intermediate between these two families of games. In this dissertation, we study the adaptation of Monte-Carlo techniques to create a strong Amazons program. We show that the basic Monte-Carlo paradigm used in most programs cannot be used efficiently as-is, and propose to modify it using an evaluation function. We also show how various techniques originally used both for traditional programs and for Monte-Carlo programs can - and have to - be adapted to create a Monte-Carlo Amazons program.

We also give the results of our work applied to more specific parts of the game: opening game and endgame. Concerning the latter, we show that the strong strategical sense of Monte-Carlo gives it an edge to play well combinations of subgames - a problem usually solved using combinatorial game theory - and that even if its tactical sense is weaker - leading to slightly less good performances than traditional techniques for the task of playing well single subgames. Finally, on the topic of opening game, we show how it is possible to use Monte-Carlo techniques to automatically create opening-books for the game of the Amazons, considering in this case these techniques as Machine-Learning techniques.

Key Words: **Monte-Carlo, Tree-Search, N-armed bandit problem, UCT, exploration-exploitation, Amazons, endgame, combinatorial game theory, opening-book**