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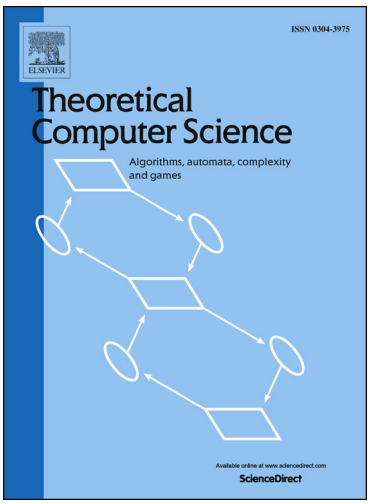

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Using Evaluation Functions in Monte-Carlo Tree Search

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Abstract

For decades the game playing algorithms of choice have been based on the mini-max algorithm and have had considerable success in many games, e.g., chess and checkers. Recently a new algorithmic paradigm called Monte-Carlo Tree Search (MCTS) has been discovered and has proven to perform well in games where mini-max has failed, most notably in the game of Go. Many view mini-max and MCTS based searches as competing and incompatible approaches. However, a hybrid technique using features of both mini-max and MCTS is possible. We call this algorithm MCTS-EPT (MCTS with early playout termination) and study it from the context of three different games: Amazons, Breakthrough, and Havannah. This paper expands and elaborates on work presented in [1] and [2].

Keywords: MCTS MCTS-EPT Breakthrough Havannah Amazons

1. Introduction

From the first days of game programming mini-max enhanced with alpha-beta pruning has been the algorithm of choice. See, for example, [3, 4]. All of this changed in 2006 when the first experiments with Monte-Carlo Tree Search (MCTS) began to appear, see [5, 6] (for a good history and survey, see [7]), and research on MCTS has exploded in the past decade.

MCTS differs from classical mini-max game tree search in two major ways. Firstly, no evaluation function is needed in MCTS. Instead, random game playouts, sometimes called simulations or rollouts, in the MCTS act as a kind of sampling of the possible outcomes from various board positions, which in turn can be used to rate (evaluate) these different positions. Random playouts are essentially random games played from a given position until the end of the game with the goal of trying to judge who has the advantage in that position. The random games are often skewed so that more reasonable moves are more likely to be made [6].

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