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The Analysis of Alpha Beta Pruning and MTD(f) Algorithm to Determine the Best Algorithm to be Implemented at Connect Four Prototype

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Abstract. Connect Four is a two-player game which the players take turns dropping discs into a grid to connect 4 of one's own discs next to each other vertically, horizontally, or diagonally. At Connect Four, Computer requires artificial intelligence (AI) in order to play properly like human. There are many AI algorithms that can be implemented to Connect Four, but the suitable algorithms are unknown. The suitable algorithm means optimal in choosing move and its execution time is not slow at search depth which is deep enough. In this research, analysis and comparison between standard alpha beta (AB) Pruning and MTD(f) will be carried out at the prototype of Connect Four in terms of optimality (win percentage) and speed (execution time and the number of leaf nodes). Experiments are carried out by running computer versus computer mode with 12 different conditions, i.e. varied search depth (5 through 10) and who moves first. The percentage achieved by MTD(f) based on experiments is win 45,83%, lose 37,5% and draw 16,67%. In the experiments with search depth 8, MTD(f) execution time is 35, 19% faster and evaluate 56,27% fewer leaf nodes than AB Pruning. The results of this research are MTD(f) is as optimal as AB Pruning at Connect Four prototype, but MTD(f) on average is faster and evaluates fewer leaf nodes than AB Pruning. The execution time of MTD(f) is not slow and much faster than AB Pruning at search depth which is deep enough.

Keywords : Board Games, Connect Four, Artificial Intelligence, Alpha Beta Pruning, MTD(*f*)

1. Introduction

Connect Four is a two-player game which the first player chooses disc colour. Players then take turns dropping coloured discs into a vertically suspended grid. The objective of Connect Four game is to connect four of one's own discs next to each other (vertically, horizontally, or diagonally)[1].

In its implementation, usually Connect Four is played by humans against other humans or computer. If against computer, an artificial intelligence (AI) is required by the computer in order to play properly like human.

There are many AI algorithms that can be implemented to board games like Connect Four, i.e. random, brute force, greedy and minimax as well as its variants such as negamax, alpha beta (AB) Pruning and negamax AB Pruning.

Research on the implementation and comparison of AI algorithms at Connect Four and other board games had been done before. Research[2] implements minimax and AB Pruning algorithm, while research [3] implements random and greedy algorithm at Connect Four. Research[4] implements