Introduction

Monte Carlo Tree Search (MCTS) is a method for making optimal decisions in artificial intelligence (AI) problems, typically move planning in combinatorial games. It combines the generality of random simulation with the precision of tree search. It can theoretically be applied to any domain that can be described in terms of state, action pairs and simulation used to forecast outcomes such as decision support, control, delayed reward problems or complex optimization.

The motivation behind this work is caused by the emerging GPU-based systems and their high computational potential combined with relatively low power usage compared to CPUs. As a problem to be solved we chose to develop an AI GPU-based agent in the game of Reversi (Othello) which provides a sufficiently complex problem for tree searching with non-uniform structure and an average branching factor of over 8.

We present an efficient parallel GPU MCTS implementation based on the introduced ‘block-parallelism’ scheme which combines GPU SIMD thread groups and performs independent searches without any need of intra-GPU or inter-GPU communication. The obtained results show that using my GPU MCTS implementation on the TSUBAME 2.0 system one GPU can be compared to 100-200 CPU threads depending on factors such as the search time and other MCTS parameters in terms of obtained results. We propose and analyze simultaneous CPU/GPU execution which improves the overall result.

Problem statement

Parallel tree search is one of the basic problems in computer science. It is used to solve many kinds of problems. Effective parallelization is hard, especially for more than hundreds of threads. SIMD hardware (i.e. GPU) is fast, but hard to utilize. How to utilize GPUs/CUDA?

Results and findings

• More trees = higher score
• More simulations = higher score
• More trees = fewer simulations
• Block size needs to be adjusted
• 1 GPU ~ 64-128 CPUs (AI power)

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