Parallel Minesweeper Solver

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1 Introduction

Minesweeper is a classic interactive puzzle game that aims to recover all positions of mines without detonating any of them, using clues that tell how many mines are adjacent to a discovered cell. Solving a consistent board has been prove to be co-NP-Complete. [1] Due to the interactive nature of this game, there is a significant portion of a solving process that is going to be sequential, but the hard part of deciding which cells are safe at each step can be sped up using parallel back-tracking. As size of the board grows larger and by deducting multiple safe cells given each board state, the proportion of sequential computations should decrease, giving parallel solver a higher speedup.

2 Related Work

There are many existing algorithms for solving a minesweeper, almost all revolve around the "border" cells that are adjacent to at least one discovered cell. Using the given information, we could usually deduce a subset in the "border" cells that are safe to click on. This deduction process could be done through backtracking – by enumerating which configurations of the "border" cells are possible – which is the intended algorithm for this project. [2] There are also heuristic algorithms based on this to improve performances. [3] Another algorithm generates matrix equation given the board state and solving it yields locations with/without a mine. [4]

There are also a few other implementations of the minesweeper game for reference. [5]

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[1] Scott, A., Stege, U. & van Rooij, I. Minesweeper May Not Be NP-Complete but Is Hard Nonetheless. Math Intelligencer 33, 5–17 (2011). https://doi.org/10.1007/s00283-011-9256-x

[2] https://github.com/ljishen/Minesweeper

[3] https://luckytoilet.wordpress.com/2012/12/23/2125/

[4] https://quantum-p.livejournal.com/19616.html

[5] https://www.cs.kent.ac.uk/people/staff/sjt/craft2e/Games/