

CS598 Project Proposal: Parallel Sudoku Solver

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Sudoku puzzles consists of partially filled matrix $N \times N$. The algorithm needs to fill the blank positions with values 1 through N such that no number is repeated on each of the N rows, N columns or the squares of $\sqrt{N} \times \sqrt{N}$ cells that split the original matrix. The goal will be to solve the grid in the least possible time using the parallelization model provided by Charm++.

Sudoku is an NP-complete problem. The solution space rapidly explodes as we move to higher grid dimensions. For example, it has been proven that the total number of valid Sudoku grids, for $N = 9$, is 6,670,903,752,021,072,936,960 or approximately 6.671×10^{21} . This precludes using brute force techniques. We would investigate heuristics based on the "logical" properties of Sudoku to reduce the search space and optimize the running time of the algorithm. Sudoku solutions are achieved incrementally by solving instances of smaller problems. Updates to one part of the grid may significantly impact other parts which leads to a high degree of communication between objects handling the grid. Load imbalance is inherent in the problem since some parts of the grid may be easier to proceed with than other. We plan to leverage the Charm++ model to tackle these challenges. In later stages of the project, we may include the use of the Charm checkpointing support for a part of the algorithm which guesstimates certain numbers, and backtracks if a dead end is found.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 3 | | | 7 | | | | |
| 6 | | | 1 | 9 | 5 | | | |
| | 9 | 8 | | | | | 6 | |
| 8 | | | | 6 | | | | 3 |
| 4 | | | 8 | | 3 | | | 1 |
| 7 | | | | 2 | | | | 6 |
| | 6 | | | | | 2 | 8 | |
| | | | 4 | 1 | 9 | | | 5 |
| | | | | 8 | | | 7 | 9 |

Figure 1: Sudoku Grid

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