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Fund of Algorithms
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Sudoku Solver

Introduction

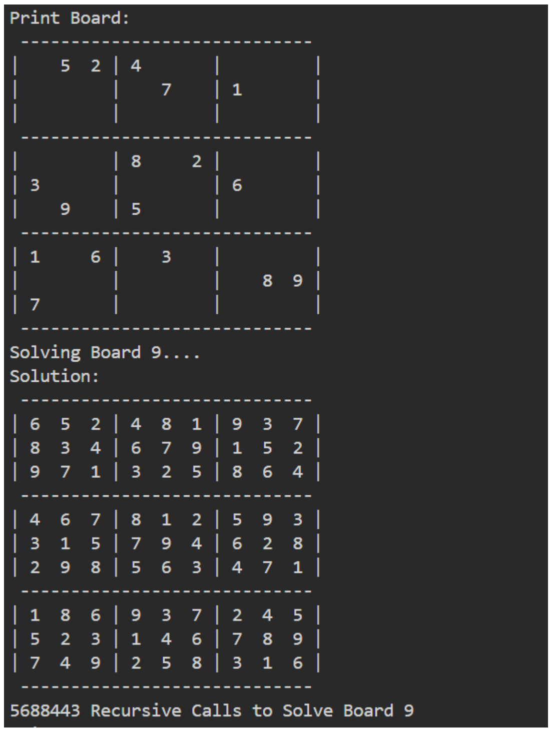
Sudoku puzzles rely on principles of logic and constraint satisfaction. Each digit within the 9x9 grid must adhere to strict rules: appearing only once within each row, column, and 3x3 square. This report details a program developed to solve Sudoku puzzles, leveraging algorithms that implement these logical rules.

Method

I implemented both the conflict list and the improved conflict list method to solve the board. Both methods use the concept of backtracking and recursion to iterate through all the possible input for the given board. The conflict list method stores a conflict list for each cell in on the board and updates them according to adding new entries and removing entries. However, this approach becomes costly when we want to backtrack and remove entries since we can't just naively turn all the conflict back to false for the entries on the same row, column, and box. This approach took a very long time for my computer to run so I implemented the improved conflict list method. Instead of storing a conflict list for each cell, I stored a conflict list for each row, column, and boxes. This way for both adding and subtracting elements the system only takes O(1) time, greatly improving the efficiency. The backtracking recursive function first checks if the board is solved or not. If not, the function finds the last empty cell (left to right, top to bottom) in the board and loops through all number possibilities and checks if it is conflicting with others. If a value is valid, then we set the cell to that number and recursively call the function itself to go down that branch. If the function found no valid solution, the function returns "false" and backtrack to the last time it reaches "true".

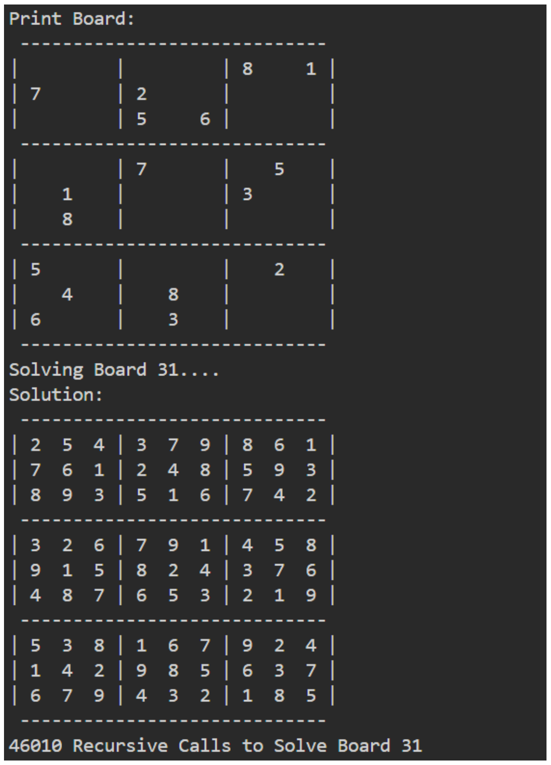
Result

Solution for Board 9:



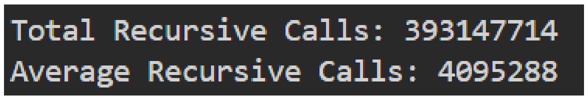
```
Print Board:
 -----------------------------
|    5  2 | 4       |         |
|         |    7    | 1       |
|         |         |         |
 -----------------------------
|         | 8     2 |         |
| 3       |         | 6       |
|    9    | 5       |         |
 -----------------------------
| 1     6 |    3    |         |
|         |         |    8  9 |
| 7       |         |         |
 -----------------------------
Solving Board 9....
Solution:
 -----------------------------
| 6  5  2 | 4  8  1 | 9  3  7 |
| 8  3  4 | 6  7  9 | 1  5  2 |
| 9  7  1 | 3  2  5 | 8  6  4 |
 -----------------------------
| 4  6  7 | 8  1  2 | 5  9  3 |
| 3  1  5 | 7  9  4 | 6  2  8 |
| 2  9  8 | 5  6  3 | 4  7  1 |
 -----------------------------
| 1  8  6 | 9  3  7 | 2  4  5 |
| 5  2  3 | 1  4  6 | 7  8  9 |
| 7  4  9 | 2  5  8 | 3  1  6 |
 -----------------------------
5688443 Recursive Calls to Solve Board 9
```

Solution for Board 31:



```
Print Board:
 ------------------------------
|         |         | 8     1 |
| 7       | 2       |         |
|         | 5     6 |         |
 ------------------------------
|         | 7       |    5    |
|    1    |         | 3       |
|    8    |         |         |
 ------------------------------
| 5       |         |    2    |
|    4    |    8    |         |
| 6       |    3    |         |
 ------------------------------
Solving Board 31....
Solution:
 ------------------------------
| 2  5  4 | 3  7  9 | 8  6  1 |
| 7  6  1 | 2  4  8 | 5  9  3 |
| 8  9  3 | 5  1  6 | 7  4  2 |
 ------------------------------
| 3  2  6 | 7  9  1 | 4  5  8 |
| 9  1  5 | 8  2  4 | 3  7  6 |
| 4  8  7 | 6  5  3 | 2  1  9 |
 ------------------------------
| 5  3  8 | 1  6  7 | 9  2  4 |
| 1  4  2 | 9  8  5 | 6  3  7 |
| 6  7  9 | 4  3  2 | 1  8  5 |
 ------------------------------
46010 Recursive Calls to Solve Board 31
```

Final Recursive Call Counts:



```
Total Recursive Calls: 393147714
Average Recursive Calls: 4095288
```

Usage

Please Check Readme file.

Acknowledge

I want to thank Prof. Su for teaching me recursion and backtracking techniques. Thank my TAs for supporting me through this class and spending countless hours grading our quizzes and answering our questions.