Problem Set 3 Exercise #29: Mini Sudoku [Challenge]

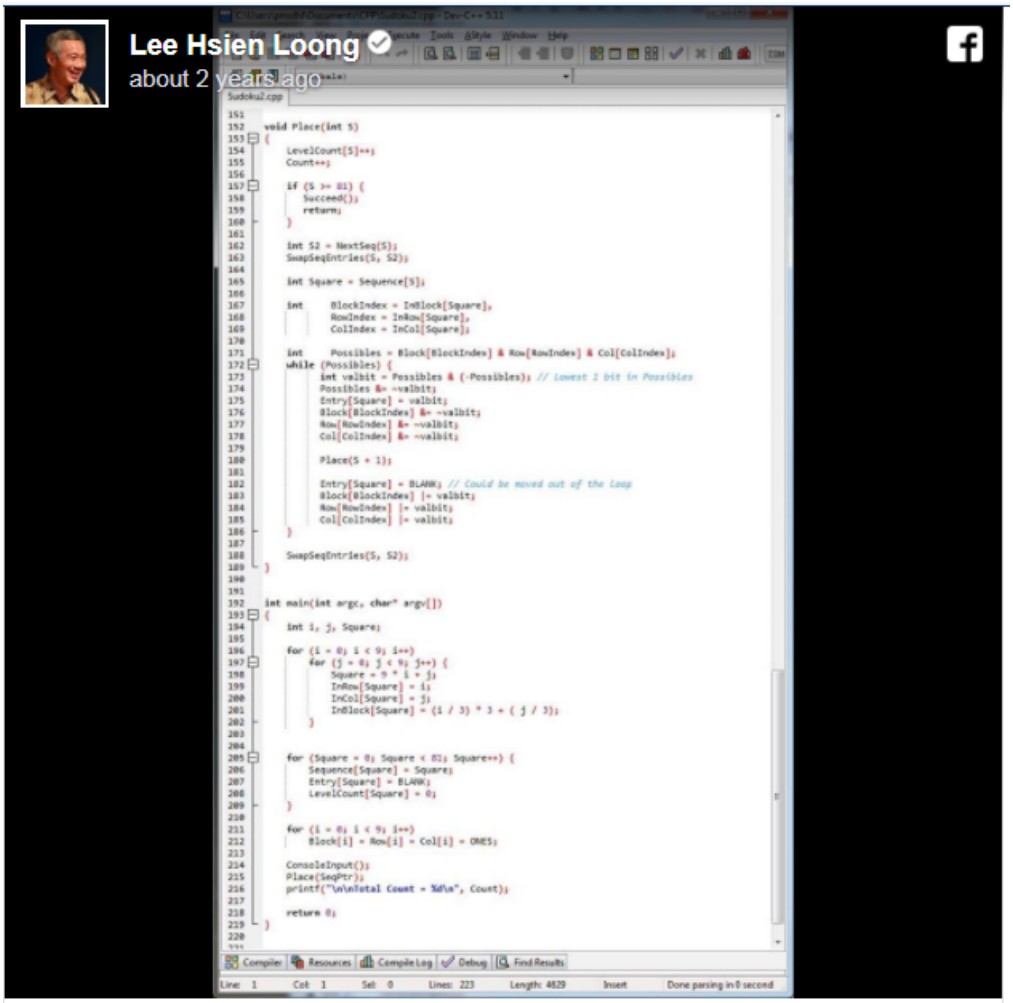
Reference: Lecture 8 notes

Learning objectives: Two-dimensional array; Algorithm design; Writing long programs

Estimated completion time: 180 minutes

Problem statement:

In Prime Minister's Founders Forum Smart Nation speech on April 20, 2015, Prime Minister Lee Hsien Loong revealed his secret love for coding. The last computer programme he wrote was a Sudoku solver, written in C++ several years ago:



Sudoku is a popular logic-based number placement puzzle. The 9×9 board has 9 rows, 9 columns and 9 sections of 3×3 cells. The objective is to fill the board so that each row, each column and each section contains the digits from 1 to 9. There is only one unique solution. **Figure 1** below, taken from Wikipedia: Sudoku, shows a Sudoku puzzle and its solution.

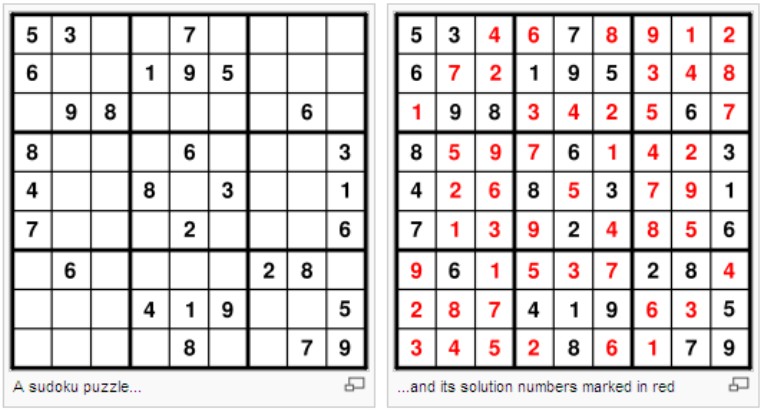


Figure 1. A Sudoku puzzle and its solution

In this exercise, we shall solve mini-Sudoku puzzles on a **4×4 board** (easier than what PM has solved). The board consists of digits from 0 to 4 where 0 represents a blank cell. The solver needs to replace all the 0s with the correct values (1 - 4).

We will only give you the simplest Sudoku puzzles to solve: these puzzles are such that at any time, there is at most one blank cell (0) in a certain row, a column, or a 2×2 section. Hence, you are able to fill in the blank cells progressively until the whole board is filled.

A very simple algorithm to solve mini-Sudoku is described below.

Repeat the following until no more blank cells can be filled:

- **For each row, check whether there is a single 0. If so, replace that 0 with the obvious value.**
- **For each column, check whether there is a single 0. If so, replace that 0 with the obvious value.**
- **For each 2×2 section, check whether there is a single 0. If so, replace that 0 with the obvious value.**

We will use an example to illustrate the above algorithm. **Figure 2a** below shows a puzzle with seven blank cells, labelled from ***A*** to ***G*** for easy reference.

1	***A***	3	***B***
3	***C***	***D***	2
4	3	2	1
E	***F***	***G***	3

Figure 2a. Sample image

1	***A***	3	4
3	***C***	***D***	2
4	3	2	1
2	***F***	***G***	3

Figure 2b.

1	***A***	3	4
3	***C***	1	2
4	3	2	1
2	1	4	3

Figure 2c.

1	2	3	4
3	4	1	2
4	3	2	1
2	1	4	3

Figure 2d. The solution

After examining each row, we cannot fill in any blank cell as none of the rows has a single blank cell.

We proceed to examine every column. In the first column, we find that we can fill ***E*** with 2, and in the fourth column, ***B*** with 4, as shown in **Figure 2b**.

We proceed to examine every 2×2 section. We find that we can fill ***D*** with 1, ***F*** with 1, and ***G*** with 4. See **Figure 2c**.

The puzzle is still not solved, so we repeat the process. As we examine the rows this time, we find that we are able to fill ***A*** with 2, and ***C*** with 4. This gives the solution as shown in **Figure 2d**.

An almost empty skeleton program **PS3_Ex29_MiniSudoku.java** is given to you. Feel free to edit it. You would probably want to write a modular program as the code is complex and modular design helps in plan and debugging.

Sample run #1:

```
Enter board (0 for blank cell):
1 0 3 0
3 0 0 2
4 3 2 1
0 0 0 3
The Sudoku puzzle solved:
1 2 3 4
3 4 1 2
4 3 2 1
2 1 4 3
```

Sample run #2:

```
Enter board (0 for blank cell):
0 1 3 2
2 0 1 0
1 0 0 3
3 4 2 1
The Sudoku puzzle solved:
4 1 3 2
2 3 1 4
1 2 4 3
3 4 2 1
```