

CSC311 Computer Algorithms  
 Second Semester 1428/1429 AH  
 Term Project Due:  
 Instructor:

TBA  
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## Solving a Numeric Puzzle

### Introduction

Simply stated, this puzzle is composed of a grid 9 squares wide and 9 squares deep (a 9x9 matrix). The grid is also divided up by the darker lines into 9 boxes (each box is a 3x3 submatrix).

Some of the squares already have numbers in them, and others are empty. Your task is to fill in the empty squares. There is a single rule:

*Each row, column and box must end up having all the numbers from 1 to 9.*

This means that each number can appear once in every row, column and box.

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

### Solving the Puzzle

The way to solve this puzzle is to find the right squares to hold the numbers.

Pick one of the boxes; say the top-left box. It has five empty squares. All the numbers between 1 and 9 must appear in the box, so the missing numbers are: 1, 2, 5, 6 and 9. To see where the missing number 1 must go, we'll use the fact that a number can only appear once in any row, column or box. Draw lines from the row and columns that contain 1s into our box (see figure on left). This leaves just one empty square for the 1 to go into. Fix the 1 into this square.

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

4			9	5		1		
8		7		2				6
<b>1</b>		3	4			9		8
5	2				6		3	
9				7				4
	1		8		3		5	2
6		5			9	3		
2				3		4		1
		1		8	4			5

Repeat the same process for the number 2. Again this leaves just a single empty square for it. Notice that we did not draw a line from the 2 in the eighth row, cause there aren't any empty squares in that column inside the box. So for efficiency check only along rows and columns that has empty squares inside the box.

The next missing number in the top-left box is 5. Drawing lines shows there are two empty squares where the 5 could go. So we just skip 5 for the moment and try to work out the places for the other missing numbers in this box, i.e. 6 and 9. It is possible that we may randomly place 5 in one of the two empty squares and proceed. However, if things go wrong we do need to backtrack.

4		<b>2</b>	9	5		1		
8		7		2				6
<b>1</b>		3	4			9		8
5	2				6		3	
9				7				4
	1		8		3		5	2
6		5			9	3		
2				3		4		1
		1		8	4			5

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

Next we try for 6. Again we are left with two empty squares as a candidate for 6. We skip 6 and go for the next missing number, 9. Drawing lines we discover a single square where 9 must go. Now go back and try to find the proper places for 5 and 6 (see the first two figures below, respectively). The third figure (below) shows that we have solved the top-left box. Next, pick another box and similarly work it out. The unique solution is shown in the last figure.

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

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

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

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

### Project

Your task is to implement the above algorithm to solve this and any other identical puzzle. In your implementation draw the puzzle as you solve each square. Following some further detail of what I would like to have.

- You may consult books and/or the web for ideas only and it must be duly acknowledged. Contact with other fellow humans is *not* allowed. The project write-up and the coding must be your own.
- The cover sheet will have your name(s) and a sign pledge indicating that the work has been done exactly according to the said specification.

### What to Submit

- Cover sheet with your name(s) and the signed pledge.
- Write-up of the project (a brief description of your implementation, *i.e.* what kind of ADT used; cost analysis; sample runs and the conclusion).
- For sample run, execute your program on the puzzles below. Note that the first two are straightforward, while the third puzzle is a bit hard and requires some additional tricks.

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

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

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

- Floppy with the source list of the code and the executable.