SIRA way of doing it!

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

Many tricks are available to solve a sudoku logically. But to solve most of the medium and high level sudokus, knowledge of only a few of them is enough.

Always remember that level of a sudoku depends heavily on the nature of clues given rather than the number of clues. The adjoining sudoku is a 4 star level puzzle with 26 clues. Let's have a look on most common tricks using this as an example.

STEP 1: Find the 'Loner'

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

"When you have eliminated the impossible whatever remains, however improbable, is the truth", said Sherlock Holmes. This is the principle by which we put the 3 in the top row. 1, 2 and 7 are eliminated by the clues in the row; 4, 5, 6 and 9 by those in the column, and 8 by the cell. This leaves the truth. One doesn't see it as very improbable; but one must give the master some poetic license. This rule may or may not be useful to begin things off, but it is indispensible in the end game (especially when it is coupled with the hidden loner rule of Step 8).

STEP 2: Basic 'Slice and Dice'

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

Let's see how to place a 4 in the bottom right cell. The horizontal lines show that it must go right into the bottom-most row, because the other two rows already have a 4 in them. These are the slices. Now one of the three squares in the bottom row of the cell already has a clue in it. The other square is eliminated by dicing. The vertical line shows that the middle column is ruled out, because it already contains a 4 in another cell. So we have finished the second move in a fiendish puzzle and found out what slicing and dicing is.

STEP 3: Applied 'Slice and Dice'

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

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

We can place two more 4s, shown in bold in the picture on the left. This requires slice and dice exactly as before. Another example: we can place a 1 by slice and dice as shown in the picture on the right.

STEP 4: Simple "hidden pairs"

7	**8**		1		**3**			2
	1				6		8	**4**
	3		8			1		9
4		7			9	23	1	
	9	3				5	4	
	6	**1**	4			9	23	
3		8			4			
	4		3					
1					5	**4**		3

"If two squares in a group contain an identical pair of candidates and no other squares in that group contain those two candidates, then other candidates in those two squares can be excluded safely." In the example on the left, a 2 and a 3 cannot appear in the last column. So, in the middle rightmost cell these two numbers can only appear in the two positions where they are "pencilled in" in small font. Since these two numbers have to be in these two squares, no other numbers can appear there.

STEP 5: "Locked candidates"

"Sometimes a candidate within a cell is restricted to one row or column. Since one of these squares must contain that specific candidate, the candidate can safely be excluded from the remaining squares in that row or column outside of the cell." Since the hidden pair 2 and 3 prevent anything else from apearing in the first two columns of the middle rightmost cell, an 8 can only appear in the last column. Now we apply the locked candidates rule.

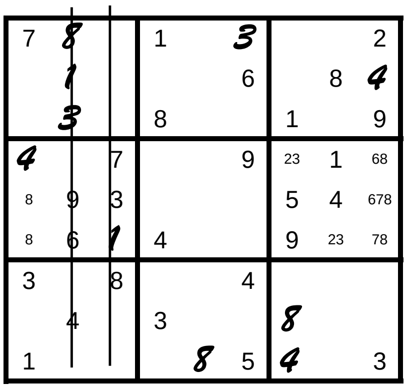
7	**8**		1		**3**			2
	1				6		8	**4**
	3		8			1		9
4		7			9	23	1	68
	9	3				5	4	678
	6	**1**	4			9	23	78
3		8			4			
	4		3					
1					5	**4**		3

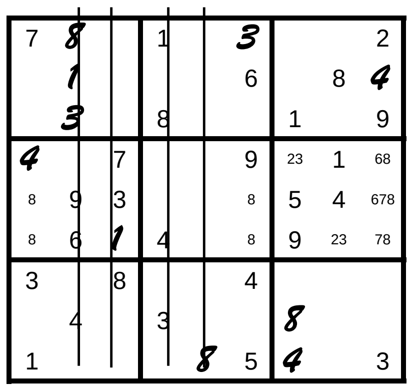
7	**8**		1		**3**			2
	1				6		8	**4**
	3		8			1		9
4		7			9	23	1	68
	9	3				5	4	678
	6	**1**	4			9	23	78
3		8			4			
	4		3			**8**		
1					5	**4**		3

We want to place an 8 in the bottom right cell. The last column can be sliced out by the locked candidate rule. Other slicing and dicing is normal, leading to the placement of the 8 as shown.

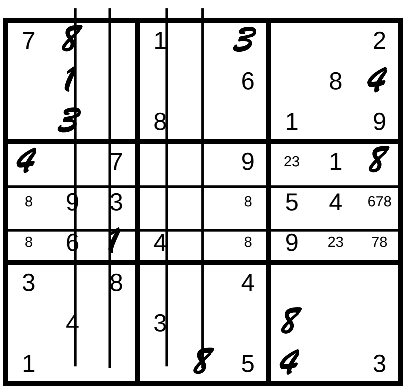
Step 6: Bootstrap by extending the logic of "locked candidates"

To get to the first step of the bootstrap from the last picture shown above, we need to slice and dice to place an 8 in the center bottom cell. You must be an expert at this method by now to get it how it is placed.

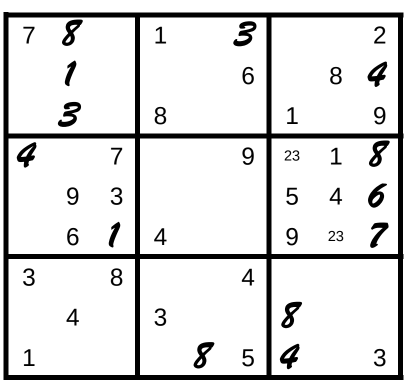




The first element of the bootstrap is to place 8s in the middle row of cells. The picture on the left shows where the 8s must be placed in the middle left cell. The picture on the right shows the placement in the central cell.



Next we extend the logic of the locked candidates. The 5th and 6th rows must each have an 8: one of them has it in the middle left cell, and the other in the central cell. Therefore the 8 in the middle right cell cannot be in either of these rows. From what we knew before, the 8 must be in the top right corner square of the cell, as shown in the picture on the left. This is almost magical. Putting together imprecise information in three different cells, we have reached precise information in one of the cells.



And now the final step of the bootstrap is shown in the picture on the left. The placement of the 8 dictates that the 6 must be just below it, and therefore the 7 in the remaining square. The diabolical magic is complete: reason enough for this to be classified as a fiendish puzzle.

Step 7: The beginning of the end

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

The worst is over. We are now truly into the end game. First complete cell C entirely by the "loner" trick: filling 6, 5, 3 and 7 in that order. Next complete the cell F. Then finish the 7th column, place the 5 in the cell D, and complete that row, in order to get the picture on the left. We are more than half done. From now on common sense prevails: fill things in one by one.

Step 8: "Hidden loner"

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

The last rule you could call the "hidden loner" rule is easily ignored. So here is the example: In the 6th row there's more than one choice in each square. However there is only one place where the 5 can go (it is excluded from the squares with X's in them). So there is a loner hidden in this row: hence the name.

We stop here, but you can go on to solve a fiendish puzzle like this by the illustrated simplest tricks exclusively.

Constraint programming

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

The minimum number of clues that should be given for a unique solution in a Su Doku is 17. Shown alongside is such a Su Doku but it requires only two tricks to solve: identifying hidden loners and simple instances of locked candidates. The key is to apply them over and over again: to each cell, row and column. The application of constraints repeatedly in order to reduce the space of possibilities is called constraint programming in computer science. "Pencilling in" all possible values allowed in a square, and then keeping the pencil marks updated is part of constraint programming.

For a free software that generates *logically solvable* sudokus and can solve *any* sudoku, just drop a mail to Amit Bhola : **amit_aromatic@yahoo.com**

This tutorial was adapted from a website dedicated to Su Doku maintained by ***Sourendu Gupta, Department of Theoretical Physics, Tata Institute of Fundamental Research.*** *http://theory.tifr.res.in/~sgupta/sudoku/algo.html*