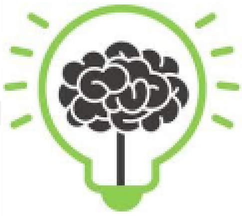
SUDOKU

INTRODUCTION

Sudoku is a puzzle in which players insert the numbers one to nine into a grid consisting of nine squares subdivided into a further nine smaller squares in such a way that every number appears once in each horizontal line, vertical line, and square.

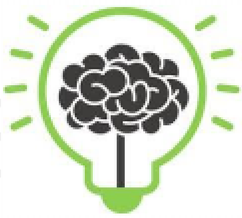
In simple words Sudoku is a logic-based, combinatorial number-placement puzzle. The objective is to fill a 9×9 grid with digits so that each column, each row, and each of the nine 3×3 sub grids that compose the grid contain all of the digits from 1 to 9.

ADVANTAGES OF SUDOKU



Sudoku is a brain game which can help delay dementia and Alzheimer's disease, and protect the brain from decline. It offers a good exercise and stimulation for the brain and can actually be very relaxing.

BENEFITS OF PLAYING SUDOKU



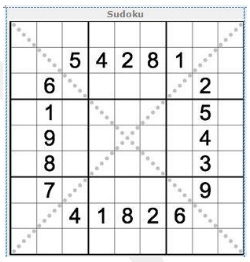
- **Improves your memory**. Memory and logic work side-by-side when you are playing Sudoku. We use our memory to memorize the numbers, when we use our logic to figure out the next blank.
- **Stimulates your mind.** It keeps you practicing your logical thinking process when you are solving a puzzle, and eventually improve your number skills.
- **Reduces the chances of developing Alzheimer's** by keeping your brain active.
- **Learns to do things quickly.** Not only playing Sudoku is interesting but it helps to increase your sense of time. You will learn how to make a decision and take an action with less hesitation.
- **Increases your concentration power**. Sudoku requires players to think strategically and solve problems creatively. Once you stop playing in the middle of the game, you have to

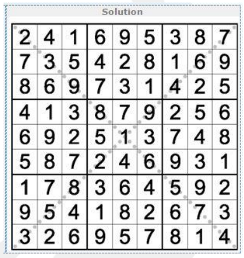
start the whole thinking process, which helps you to develop your concentration power and re-focus skills.

- **Feel Happy.** Sudoku gives you a sense of accomplishment when you can solve a puzzle; especially the puzzle is a difficult one.

TYPES OF SUDOKU

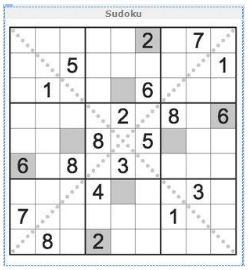
Diagonal

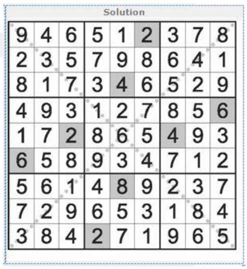




Place a digit from 1 to 9 into each of the empty squares so that each digit appears exactly once in each of the rows, columns and the nine outlined 3x3 regions. Additionally, each digit appears exactly once in each of the two main diagonals.

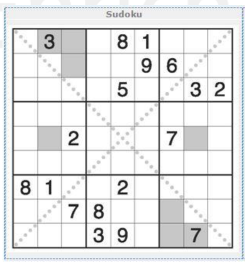
Diagonal Even





Place a digit from 1 to 9 into each of the empty squares so that each digit appears exactly once in each of the rows, columns and the nine outlined 3x3 regions. Additionally, each digit appears exactly once in each of the two main diagonals and the grey squares in the grid must contain even digits.

Diagonal Odd



Place a digit from 1 to 9 into each of the empty squares so that each digit appears exactly once in each of the rows, columns and the nine outlined 3x3 regions. Additionally, each digit appears exactly once in each of the two main diagonals and the grey squares in the grid must contain odd digits.

Solution

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

Even

Place a digit from 1 to 9 into each of the empty squares so that each digit appears exactly once in each of the rows, columns and the nine outlined 3x3 regions. The grey squares must contain even digits.

Sudoku

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

Solution

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

HOW TO SOLVE SUDOKU

Traditional rules for solving Sudoku:

1. Each row, column, and nonet can contain each number (typically 1 to 9) exactly once.
2. The sum of all numbers in any nonet, row, or column must match the small number printed in its corner. For traditional Sudoku puzzles featuring the numbers 1 to 9, this sum is equal to 45.

TECHNIQUES TO SOLVE SUDOKU

✓ The Rules

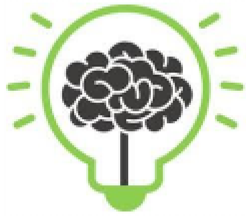
Here's a 'classical' Sudoku puzzle. It's a grid 9 squares wide and 9 squares deep. The lines of squares running horizontally are called rows, and the lines running vertically are called columns. The grid is further divided by the darker lines into nine 3 X 3

Square 'boxes.

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

Some of the squares already have numbers in them. Your task is to fill in the blank squares. There's only one rule:

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



This rule has an important side-effect, which is the basis of all solving techniques:

Each number can only appear once in a row, column or box.

✓ Getting started

Solving Sudoku is all about eliminating the impossible. It's also about looking at the same thing in different ways.

- The crosshatching and slicing/dicing techniques shown in the first part of this page are enough, on their own, to solve most easy puzzles. If you're new to Sudoku, it's worth generating some easy puzzles and practising these techniques.

To solve more difficult puzzles you need to use crosshatching in combination with other techniques.

Crosshatching - finding squares for numbers

The obvious way to solve a Sudoku puzzle is to find the right numbers to go in the squares. However the best way to start is the other way round - finding the right squares to hold the numbers.

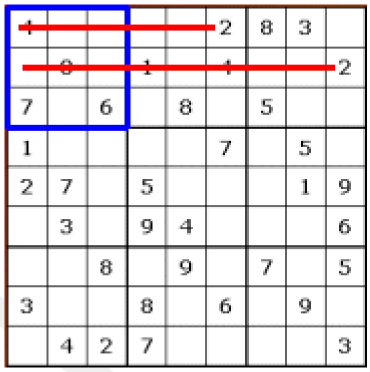
This uses a technique called 'crosshatching', which only takes a couple of minutes to learn. It can solve many 'easy' rated puzzles on its own.

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

Crosshatching works in boxes (the 3 X 3 square subdivisions of the grid). Look at the top-left box of our sample puzzle (outlined in blue). It has five empty squares. All the numbers from 1 to 9 must appear in the box, so the missing numbers are 1,2,3,5 and 9.

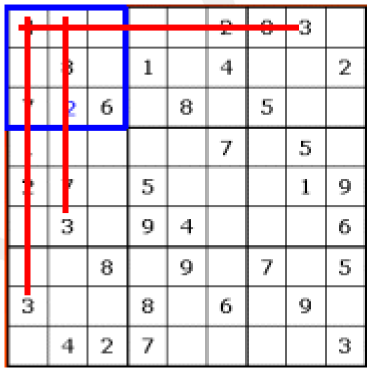
We'll ignore 1 for a moment (because it doesn't provided a good example!), and see if we can work out which square the missing 2 will go into.

To do this, we'll use the fact that a number can only appear once in any row or column. We start by looking across the rows that run through this box, to see if any of them already contain a 2. Here's the result:



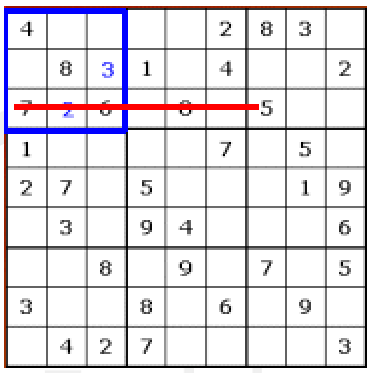
Bingo! The first two rows already contain 2s, which means that squares in those rows can't possibly contain the 2 for this box. That's all we need to know, because the third row only has one empty square, so that must be the home for the 2.

Now let's see if we can place the 3 for this box. This time we end up checking the columns that run down through the box, as well as the rows that run across it:



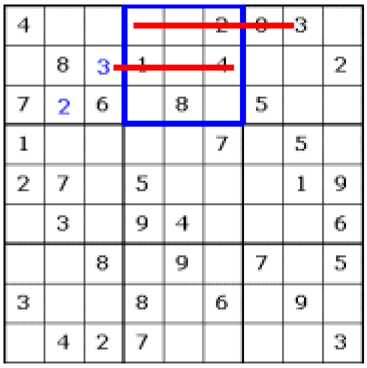
Again, we get a result first time - there's only one empty square that the 3 can possibly go into. You can see from this example why it's called 'crosshatching' - the lines from rows and columns outside the square criss-cross each other.

Of course you don't always get a result first time. Here's what happens when we try to place the 5:



There's only one 5 already in the rows and columns that run through this box. That leaves three empty squares as possible homes for the 5. For the time being, this box's 5 (and its 1 and 9) have to remain unsolved.

Now we move on to the next box:



Here we're crosshatching for 3, the first missing number in this box. Note how we treat the 3 we placed in the first box as if it had been pre-printed on the puzzle. We still can't place this box's 3 though, so we'll move on to the next missing number (5), and so on.

• In Sudoku, accuracy is essential. If the 3 in the first box is wrong, we'll be starting a chain of errors that may prove impossible to unravel. Only place a number when you can prove, logically, that it belongs there. Never guess, and never follow hunches!

An important factor in crosshatching (and Sudoku in general) is that the more numbers you place, the more likely you are to place others - including ones you couldn't place earlier.

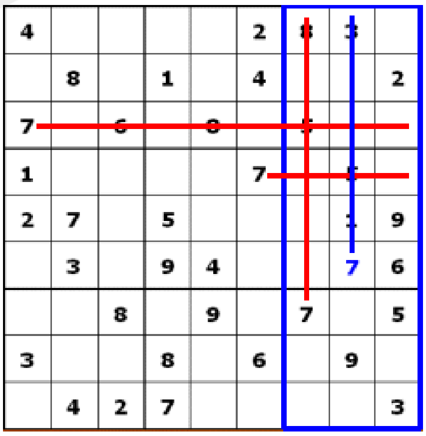
Placing numbers in the second box may well make it possible to go back and place missing numbers in the first. It's good to get into the habit of looking backwards as well as forwards, re-checking whether the numbers you've just placed have made numbers placeable elsewhere in the puzzle.

Slicing and dicing

In Sudoku it pays to look at the same thing in different ways. By using crosshatching slightly differently, you can often get quicker results.

Instead of looking at a single box and its missing numbers, you can look at a group of three boxes running across or down the puzzle, trying to place each number from 1 to 9 in as many of the boxes as you can.

In this example we're trying to place 7s in the three right-hand boxes:



The stack of boxes starts out with just one 7 in place (bottom box). This solves the middle box's 7 (entered in blue), and entering that immediately solves the top box's 7 as well.

This 'chain reaction' of solving wouldn't occur in single-box crosshatching. It happens here because we're focussing on a single number across multiple boxes - looking at things differently.

Crosshatching and slicing/dicing are basically the same thing, but slicing/dicing can be more efficient, and often feels less laborious than doggedly working through the empty squares in a single box (although that's what you will have to do in order to solve tough puzzles, so be prepared!).

The right start...

It's a good idea to start any puzzle by slicing and dicing, perhaps switching to single-box crosshatching if you get stuck.

Most easy (and many moderate) puzzles can be solved that way - just make a first 'pass' through the whole puzzle placing all the numbers you can, then go back and start again, seeing if any more numbers can now be placed. Keep doing that, and eventually you'll fill the whole puzzle.

In practice you'll soon find that you stop working in passes through the whole puzzle, and begin darting to whichever area looks most likely to have solvable squares.

If you get stuck (i.e. you can't place any more numbers), then it's worth making another methodical pass through the whole puzzle. This will often reveal a solvable square you've missed.

... But when the going gets tough...

On tough puzzles crosshatching and slicing/dicing will eventually run out of steam - you'll make a pass through the whole puzzle without being able to place any more numbers.

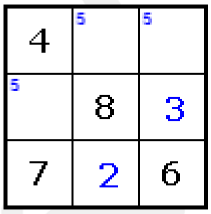
When this happens it's time to switch to a different approach, using the solving techniques described in the second part of this page.

The first step, however, is more crosshatching. This time you need to go through the entire puzzle, box by box, crosshatching each box for all its missing numbers. As you do that, you make a note of which squares each missing number can possibly go into. This is called 'pencilling in'.

✓ Pencilling in

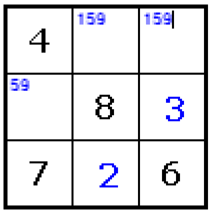
The solving techniques needed for more difficult puzzles all depend on having an accurate list of the possible numbers (called 'candidates') for each empty square. You can build this list by pencilling the candidates in as you make a complete crosshatching pass through the puzzle.

Looking at the top-left box of our original puzzle, crosshatching produced three possible squares where the missing 5 could go. Here's the box, with 5 'pencilled-in' to the corners of its three possible squares:



✓ (It's called 'pencilling-in' because on a printed puzzle many people use a pencil, so that they can rub numbers out later (an essential part of the solving process). On my Sudoku page, you click in the top-left corner of the square, then type and delete numbers like a normal text box)

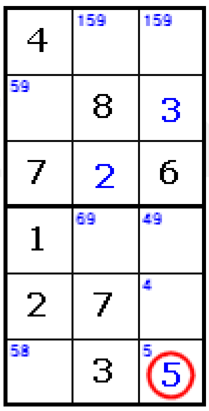
1 and 9 were also unsolved for this box. Here's the box with all its missing numbers pencilled into their possible squares:



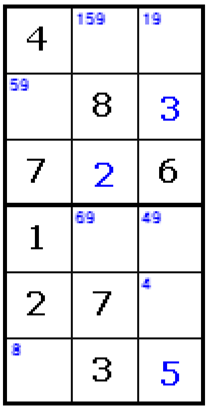
This list must be complete and accurate, otherwise you risk creating another chain of errors. That's why it's essential to crosshatch every missing number for every box before starting the next stage of solving.

Candidate lists must also be kept up to date (the reasons for this will become obvious later!). Here's what it means:

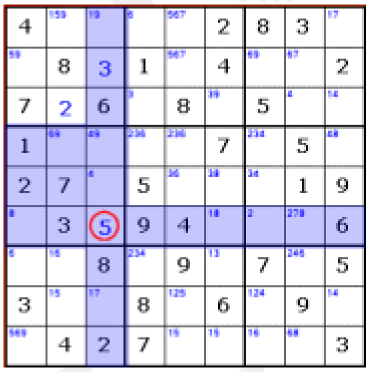
First is the top-left box, and the one below it. We've just entered a 5 in the bottom-right square of the lower box.



Now we remove that square's candidate list. We also remove 5 from the candidate list at the top of the same column, and the left of the same row. Here's how the boxes look afterwards:



Whenever you fill in a square, remove the number you've used from all candidate lists in the same row, column and box. Here are the areas we needed to check for candidate 5s after filling in this square:



Don't worry if that looks complex - in practice it's quick and easy to scan through the same row, column and box as the square you've just filled.

When you're crosshatching the puzzle, remember to update any candidate lists that are affected by numbers you place.

SUMMARY

- ✓ **WHAT IS SUDOKU?**
- ✓ **BENEFITS OF SOLVING SUDOKU.**
- ✓ **TYPES OF SUDOKU**
- ✓ **HOW TO SOLVE SUDOKU**
- ✓ **TECHNIQUES TO SOLVE SUDOKU**
- ✓ **ADVANTAGES OF SUDOKU**