

A brief encounter with **Sudoku**

You either do it every day, or you're wondering what all the fuss is about. If you happen to be one of the minuscule minority that has not heard of a Sudoku, here's the lowdown from **Gautam Appa, Kai Helge Becker** and **Katerina Papadaki** of LSE's Operational Research Department.

A Sudoku is a number puzzle spreading round the world faster than a virus. You are given a 9x9 square – nine rows and nine columns – forming 81 cells. The square is further divided up into nine smaller 3x3 squares that we shall call bricks. Some of the 81 cells are filled with numbers from 1 to 9. Your job is to fill all the empty squares in such a way that each row, each column and each brick ends up with all nine numbers – see the Sudoku puzzle at the end of this article.

Where was it invented? Well, history is never straightforward. In alphabetical order, Germany, Japan, New Zealand, UK and the US can lay a claim. The first completed 9x9 Sudoku grid appeared in a 1956 German language article by Behrens, not as a solution to a number puzzle but as a 'gerechte' (meaning fair) experimental design for analysing the effectiveness of crop treatments in areas of good and poor fertility.

What we know as a Sudoku was set by an American architect, Howard Garns, and started appearing from 1979 in the American magazine *Dell Pencil Puzzles and Word Games* under the title 'Number Place'. Then in 1984 they appeared in the Japanese firm Nikoli's magazine under the name of 'suji wa dokushin ni kagiru' meaning single (as in unmarried) numbers. Afterwards, Nikoli patented it in the shortened name – Sudoku, so that later Japanese imitators called it by other names. So, what the rest of the world calls Sudoku is known to many in Japan by its English name – 'Number Place'. When judge Wayne Gould, a

New Zealander working in Hong Kong for the British authority, discovered Sudoku he wrote a computer programme to set the puzzle and showed it to *The Times* in London, which published the first one in November 2004. This started the fad in the UK that has spread more widely round the world than cricket.

How long can this craze last? After all, how many different 9x9 Sudoku squares can there be? Like the 3x3 game of noughts and crosses, can't we work out all possible puzzles and worry about something else? Well, not easily. Using an esoteric branch of mathematics

called Group Theory people have worked out that there are about 7×10^{21} (7 followed by 21 zeros) of them. Mind you, that does not stop repetitions. For any one Sudoku, there are about a billion lookalikes obtained, for example, by rotating the square or swapping numbers. In fact deciding whether two Sudoku puzzles are essentially the same is a much more difficult problem to solve than solving either Sudoku.

How do you solve them efficiently? Logic helps. Try the exercise below and test your skills. Check on the LSE Alumni Relations website for the answer at www.lse.ac.uk/alumni ■

Try this

Can you find a way to prove that $X = 1$ in this Sudoku without entering any other missing numbers? Working only with where in each brick (3x3 grids indicated by bold lines) number 1 can possibly go, you should be able to deduce that the number in Row 7 and Col 9 which is labelled X equals 1. The process requires considering every single brick and yet it is not possible to fill any other cell with a 1.

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

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