Mathematics Column (22)

Sudoku Boards

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The other day I received a parcel from Mr. Nagashige Okubo of Tokushima prefecture. He said he had developed a prototype Sudoku board, and wanted my opinion on it.

Similar to a shogi board, it was square with approximately 30-cm sides, made of cypress wood approximately 5 cm thick. It had round indentations approximately 5 mm deep and 20 mm in diameter, arranged in a 9 × 9 grid, reminding me of the griddles used to make *takoyaki* octopus balls. Included with the board were 81 disks with numbers printed on them. They were approximately 1 cm thick and a little bit smaller than the indentations on the board, making them easy to place into and withdraw from the indentations.

The numbers on these disks were printed in black on one side and red on the other. There was also a storage tray with 81 indentations for the disks, cleverly designed so that it could be placed on top of a solved problem and the entire thing flipped over to transfer the disks from playing board to storage tray.

The whole thing was quite well designed, to the point where it made me want to try my hand at a Sudoku problem. I started with one labeled "Easy" in the *New York Times* archive. I filled in the given values using black numbers, and began filling in more black numbers in 3 × 3 blocks in a way that avoided repetition within a row, column, or block.

When doing a Sudoku problem, there are cases where no correct value is evident, forcing one to apply suppositions. If there are two possible values for a given space, one can propose the validity of one using the red numbers, and continue solving in red. If doing so leads to a contradiction, the hypothesis was invalid, but this is easily fixed by removing the red numbers. You will then know that the alternative hypothesis was correct, and so can continue in black.

Using this approach allowed me to easily solve "Easy" and "Medium" problems. "Hard" problems are trickier, though—they often start with only 17 given values, and they sometimes lead to situations where three hypotheses are needed, limiting the utility of the Sudoku board.

Different people approach Sudoku problems in different ways. When solving them using paper and pencil, one must erase invalid values, making a three-way hypothesis quite challenging. Most Sudoku apps are even worse, since proposed values must be retained in memory. I had therefore given up on Sudoku problems, deciding that the hard ones were best solved using a computer.

There are various advantages to using a Sudoku board. As described above, you can use black and red numbers to distinguish between solved and hypothetical values. You can also use techniques like placing numbers upside down or at an angle, so the analog approach of wooden pieces for numbers should allow for relatively easy solutions to even three-hypothesis problems. Since there are a limited number of pieces, you can tell at a glance what numbers remain to be placed. This can be a big hint toward a solution, much like one's reserve pieces in a game of shogi.

"Sudoku" is a trademark of Nikoli Co., Ltd., but in a practical sense has fallen into common usage. It has been referred to as "Number Place" in puzzle books since 1979, but reached international fame in May 2005 when it appeared in the U.K. newspaper *The Guardian*. I was studying in England at the time, allowing me to watch its popularity develop. After returning to Japan, I summarized this in an article called "Sudoku is a hit in the U.K." in the May 2006 issue of *Mathematics Seminar*, and it was really that year in which the problem became popular throughout Japan and Asia.

Mr. Okubo says that he has built around thirty Sudoku boards, most of which he gave to friends as a present. Thinking that he should develop this as a product, I searched online and found that similar products already exist, often with square rather than round pieces. Setting aside the issue of marketability, I hope to see these in community centers and other public spaces, much as we see Go and shogi sets today.

A Sudoku board