

The Design of the Algorithm of Creating Sudoku Puzzle

Jixian Meng and Xinzhong Lu*

College of Mathematics, Physics and Information Engineering of Zhejiang Normal University,
Zhejiang, Jinhua, P.R. China, 321004
luxinzhong@zjnu.cn

Abstract. Sudoku puzzle is a well-known and logical-based game. To generate some puzzles of varying difficulty with “unique solution” is not so easy. We make a standard of difficulty based on the player’s position, that is, difficulty of solving methods. Then we develop an algorithm to generate puzzles satisfied the requirement. For the complexity of our algorithm, we divide it into two parts. One is the complexity of the algorithm to generate the complete grid. We discover the randomness of generating complete grid increases when the complexity increases, that is, the randomness higher and the complexity greater. We have developed an algorithm which guarantees the most important premise “unique solution” and ensures the complexity is low enough.

Keywords: Sudoku puzzles, complexity, algorithm.

1 Introduction

Sudoku is a well-known and time-honored game. Original Sudoku puzzle enjoys a tight relationship with Latin Square. It firstly appeared as a logic-based placement puzzle in “Dell Pencil Puzzles and Word Games” in 1979. In 1984 Nobuhiko Kanamoto introduced it to Japan. The modern Sudoku was invented in Indianapolis in 1979 by Howard Garns. He picked up a Japanese Sudoku magazine and became so enamored of the puzzle that he spent six years writing a program named “Pappocom” which could automatically generate the puzzles of varying number of difficulty levels.

The aim of the Sudoku puzzle is to put in a numerical digit from 1 through 9 in each cell of a 9×9 grid made up of 3×3 sub-grids (called “block”), starting with various digits given in some cells (the “givens”) with the others empty; each row, column, and block must contain only one instance of each numeral. Now a large number of mathematicians and computer engineers are researching the Sudoku puzzles problem [1-5]. In this paper, we consider the Sudoku puzzles as the classical Sudoku with 9×9 cells.

As we know, developing an algorithm to generate Sudoku puzzle is harder than to solve Sudoku. The difficult and key aspects are how to make the standard of difficulty level and how to guarantee a unique solution of the Sudoku puzzle generated by our algorithm.

* Corresponding author.

3.2.2.4 Generate Puzzles of Level 4 and 5

The processes to generate puzzles of Level 4 and 5 are extremely similar to 3.2.2.3.

3.2.3 Complexity of Our Algorithm

In order to generate some puzzles of varying difficulty, we use different methods to dig holes. Each digging a hole is corresponding to a different solving method, and then we define the digging strategies as the inverse processes of solving methods. At the same time, we guarantee the two inverse processes are one-to-one mapping.

For the complexity of our algorithm, we divide it into two parts. One is the complexity of the algorithm to generate the complete grid. We discover the randomness of generating complete grid increases when the complexity increases, that is, the randomness higher and the complexity greater. In order to ensure certain randomness, we don't intend to reduce the present complexity. Therefore we find the algorithm to generate a random complete grid is logical and feasible. For different digging algorithms, we have made our greatest efforts to minimize their complexity. We have developed an algorithm which guarantees the most important premise "unique solution" and ensures the complexity is low enough.

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