AI PROJECT REPORT 1
Sudoku Solver using Artificial Intelligence

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1 Introduction

In the realm of problems or puzzles, Sudoku remains one of the most famous and intriguing challenges requiring logic, deduction, pattern recognition, and many more. A standard Sudoku, which is 9x9, can still be quite challenging to even seasoned puzzle enthusiasts. However, imagine a Sudoku puzzle scaled to any size of $n^2 \times n^2$. This can be quite challenging, maybe even time-consuming and irritating, which is where Artificial Intelligence comes in to solve the Sudoku puzzles efficiently and in a short amount of time.

2 Understanding the Problem

Lets take a standard 9x9 (n = 3) puzzle to understand more about the problem statement. Sudoku puzzles consisting of a 9x9 grid, subdivided into nine 3x3 subgrids. The objective is to fill each cell with a number from 1 to 9, ensuring that each row, column, and subgrid contains each digit exactly once. This rule can be extended to any Sudoku puzzle of size $n^2 \times n^2$. While the rules are straightforward, the challenge lies in the puzzle's initial configuration and the subsequent logical deductions required to reach a unique solution. The complexity of Sudoku puzzles varies widely, ranging from simple grids that can be solved with basic techniques to fiendish puzzles that demand advanced strategies and intricate reasoning. Consequently, manual solving often becomes a time-consuming and mentally taxing endeavour, particularly for puzzles at the higher end of the difficulty spectrum.

2.1 Sudoku Puzzle Example

Before attempting to solve a Sudoku puzzle, it's essential to identify the possible values that can be placed in each empty cell based on the puzzle's constraints. Let's consider an example cell within the Sudoku grid.

- According to the subgrid rule, possible values are narrowed down to: 1, 2, 5, 6, 7, 8.

- Next, we examine the column to eliminate further possibilities, resulting in: 1, 2, 7, 8.

- Finally, considering the row, we conclude that the possible values for this cell are: 1, 2, 8.

- Now we repeat this for each and every blank space and fill it following the above rules.
  NOTE We must also understand that sometimes we have to erase the already chosen value to another value depending on the contstraints hence we use AI to do backtracking algorithms to solve the SUDOKU.

This process of narrowing down possible values based on row, column, and subgrid constraints is fundamental to solving Sudoku puzzles be it a Human Solver or AI Solver. Figure 1 illustrates a typical Sudoku puzzle grid with cells containing various possible values.
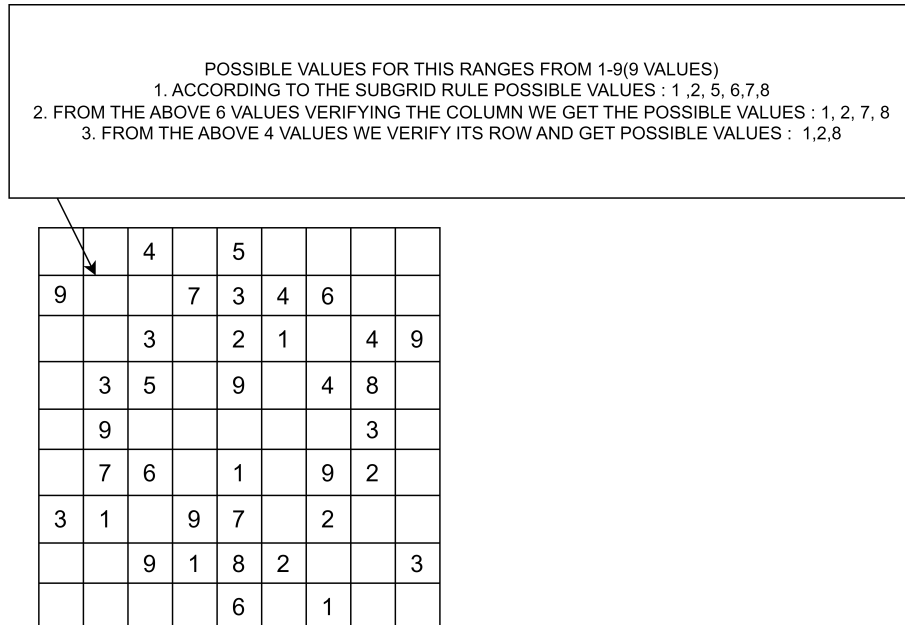
POSSIBLE VALUES FOR THIS RANGES FROM 1-9(9 VALUES)
1. ACCORDING TO THE SUBGRID RULE POSSIBLE VALUES : 1 ,2, 5, 6,7,8
2. FROM THE ABOVE 6 VALUES VERIFYING THE COLUMN WE GET THE POSSIBLE VALUES : 1, 2, 7, 8
3. FROM THE ABOVE 4 VALUES WE VERIFY ITS ROW AND GET POSSIBLE VALUES : 1,2,8

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

Figure 1: Example of a Sudoku Puzzle

3 The Benefit of AI in Sudoku Solving

AI offers powerful solutions to simplify the problem-solving process by using tracking algorithms such as the A* graph algorithm, deep first branch bounding (DFBB), and α-β pruning technology to explore the state puzzle state space and determine the best solution. We can develop skills to use the best image to intelligently traverse the status of the assembly and analyze the structure, process gradually and create solutions to save time. Here's how you can solve Sudoku puzzles:

1. **Efficiency**: Smart people can solve complex puzzles quickly and deliver solutions in a fraction of the time it would take them to solve them on their own.

2. **Accuracy**: Artificial intelligence algorithms provide accurate solutions, eliminate human error and provide reliable results.

3. **Accessibility**: AI solves puzzles and provides help and guidance tailored to each user's needs.

4. **Educational Value**: By observing AI-generated strategies and solutions, users can enhance their problem-solving skills, gaining insights into the logical principles of the problem.

5. **Innovation**: AI-driven approaches continue to push the boundaries of Sudoku solving, introducing novel techniques and optimizations that enrich the solving experience.

4 Conclusion

In summary, artificial intelligence is a powerful ally in solving Sudoku puzzles by providing the perfect combination of computational power, pattern recognition and problem-solving capacity. Using the power of intelligent algorithms, we can overcome Sudoku challenges with unprecedented efficiency and accuracy, opening up new possibilities for hobbyists and researchers. Expand, there are no limits to the future of Sudoku solving, thanks to constant innovation and collaboration between humans and machines, driven by the constant search for the best solutions in an environment of constant competition.