

SAT-Based Approach to Solving Sudoku

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Outline

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Introduction

Introduction

Sudoku is a logic-based puzzle that originated in Japan in 1986 and gained widespread international popularity after 2005.

Research by Lynce and Ouaknine (2006)¹ showed that Sudoku can be encoded as a SAT problem using Conjunctive Normal Form (CNF) and solved using polynomial-time inference techniques such as:

- Unit Propagation
- Failed Literal Rule
- Hyper-Binary Resolution
- Binary Failed Literal Rule

¹Lynce, I., & Ouaknine, J. *Sudoku as a SAT Problem*.

Problem Statement

Research Problem

Problem Statement

To investigate how Sudoku puzzles can be efficiently encoded into CNF and solved using SAT inference techniques, and to determine which encoding–solver combination yields optimal performance.

Objectives

Main Objective

- To design and implement a SAT-based Sudoku solver.

Specific Objectives

- Study CNF encodings (minimal, extended).
- Implement SAT inference procedures such as UP, FLR, HBR, Bin-FLR.
- Convert Sudoku grid to CNF automatically.
- Test solver on benchmark datasets (e.g., Royle's 17-clue puzzles).
- Analyze performance across methods.

Methodology

Methodology Overview

- Literature review on SAT, CSP, CNF encoding.
- Implementation of CNF generator using 729 variables (s_{xyz}).
- Integrate or build a SAT solver with inference algorithms.
- Evaluation on large Sudoku dataset.
- Compare performance of minimal vs. extended encodings.

Expected Results

Expected Outcomes

- Efficient SAT solver capable of solving Sudoku logically (without brute-force search).
- Demonstration that extended encoding + inference rules can solve all puzzles.
- Comparative performance analysis of inference techniques.
- A reusable SAT framework adaptable to other constraint problems.

Timeline

Timeline

| Phase | Duration |
|----------------|-----------|
| Review | Month 1–2 |
| Design | Month 3–4 |
| Implementation | Month 5–6 |
| Testing | Month 7 |
| Report | Month 8 |

References

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Thank You