Nonograms

Artificial Intelligence

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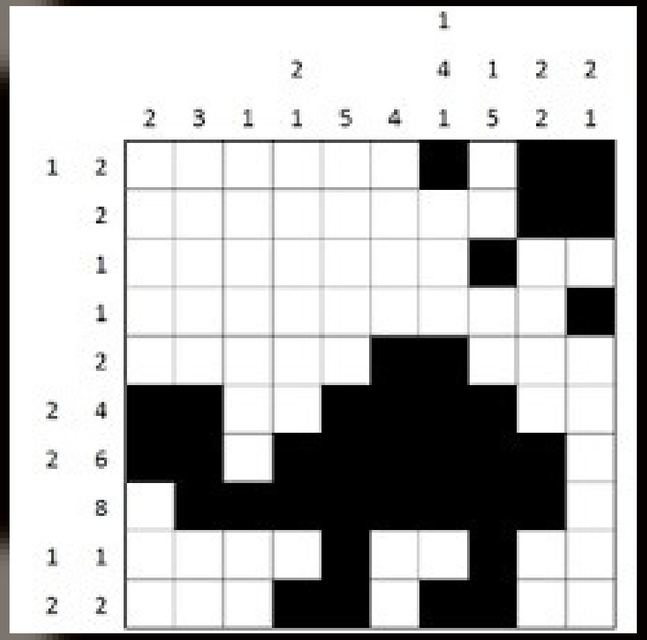
Outline

- Introduction
- Existing solutions
- Numerics
- Results

What is a nonogram?

Nonograms are popular Japanese logic puzzles based on a description that indicates the lengths of the consecutive black segments for each column and row, the cells in the matrix should either be colored black or white.

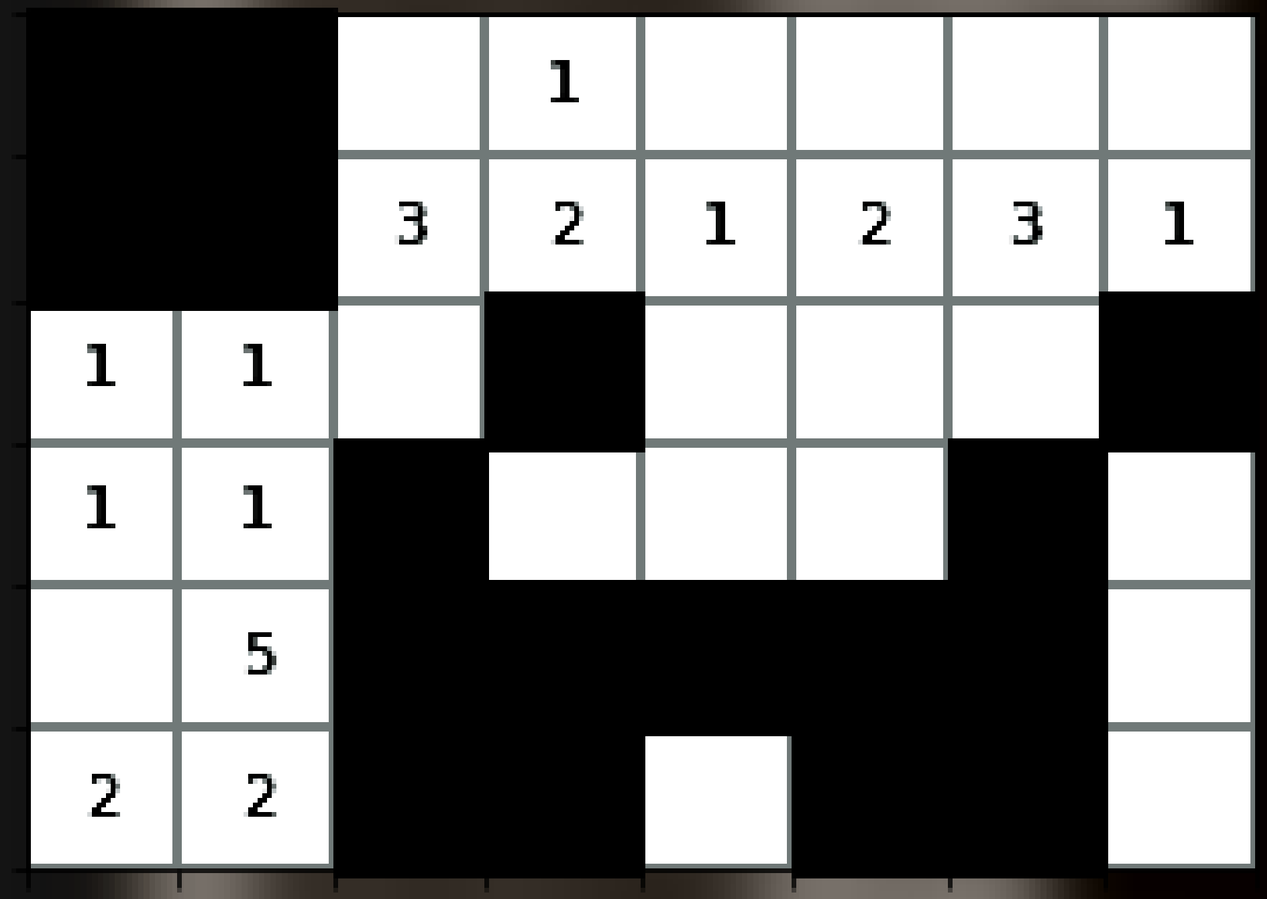


The most well-known approaches to solve uncolored nonograms

- Depth first search
- Iterative search,
- Integer linear programming (ILP),
- Genetic algorithm

Proposed solution

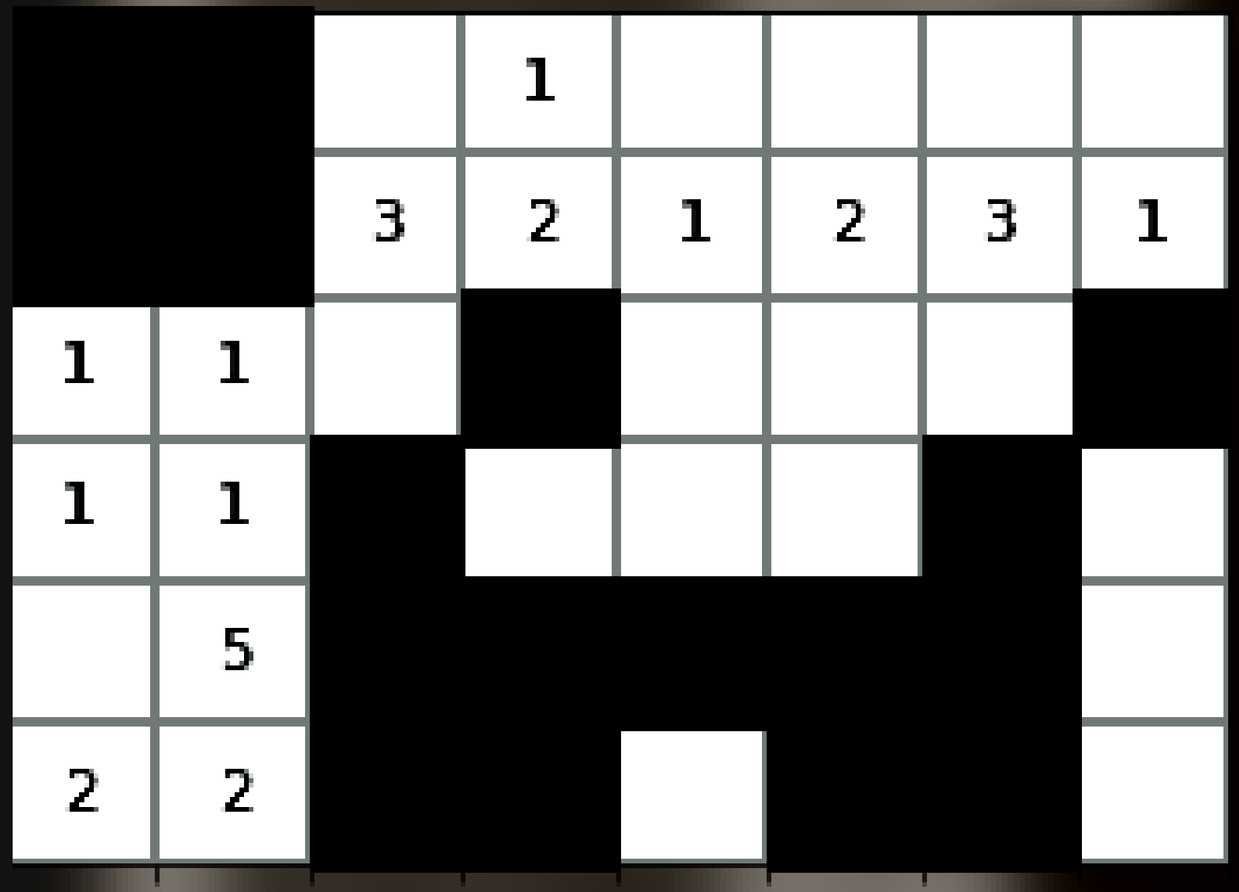
Design the problem as CSP



Variables : descriptive cells from the left panel

Domains : The possible starting positions of the block

Proposed solution



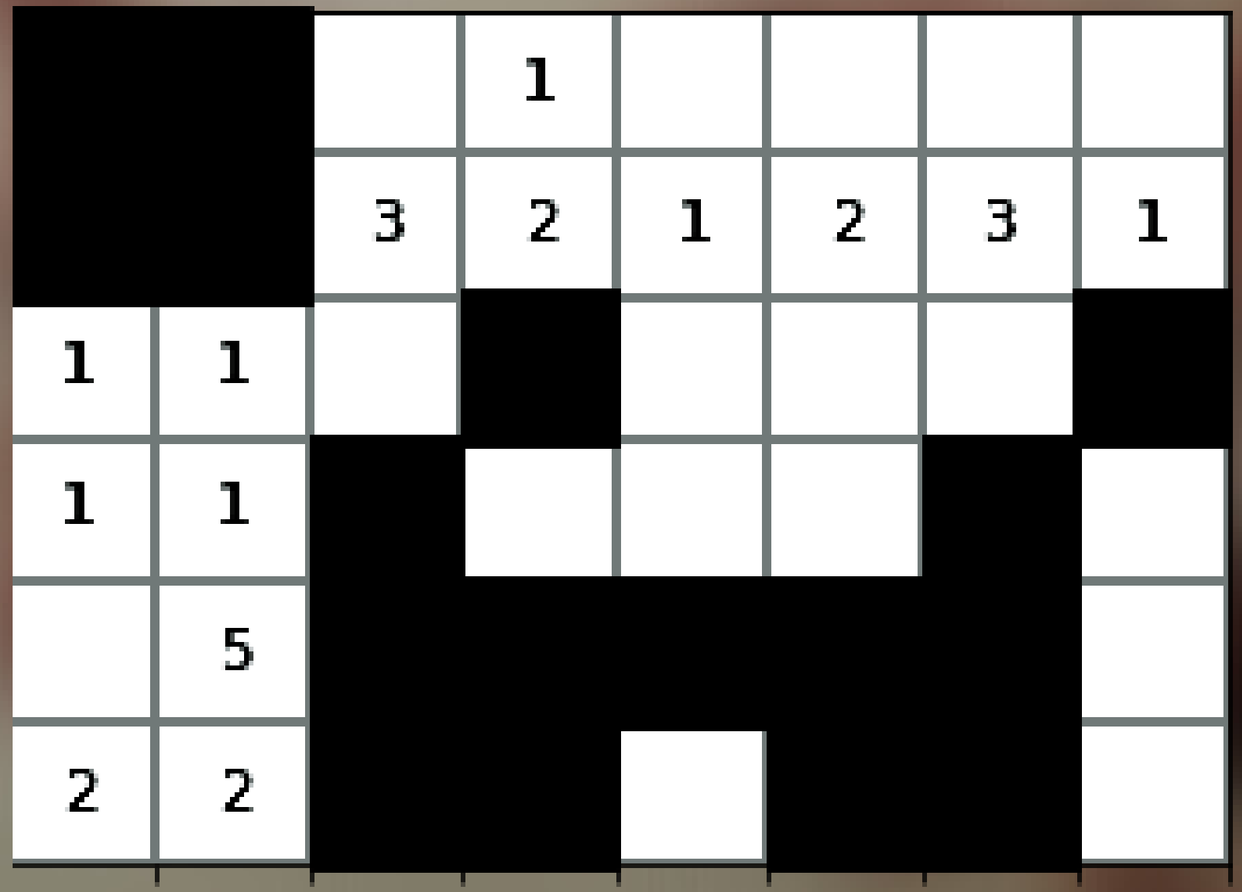
Constraints

- Order/Size of blocks from *left* panel
- Order/Size of blocks from top panel

Algorithm

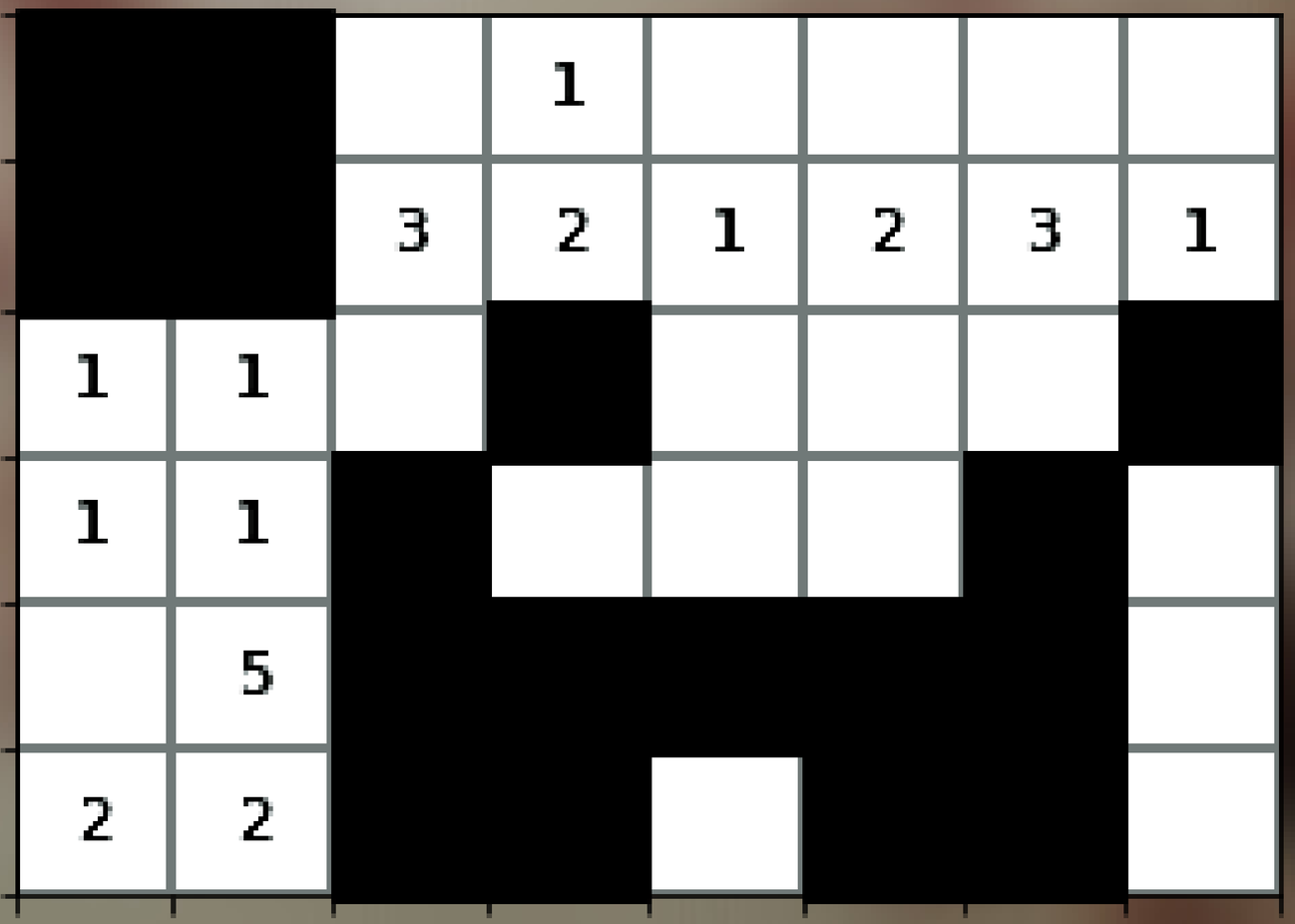
- Initial constraint enforcement
- Backtracking with forward checking

Initial constraint enforcement



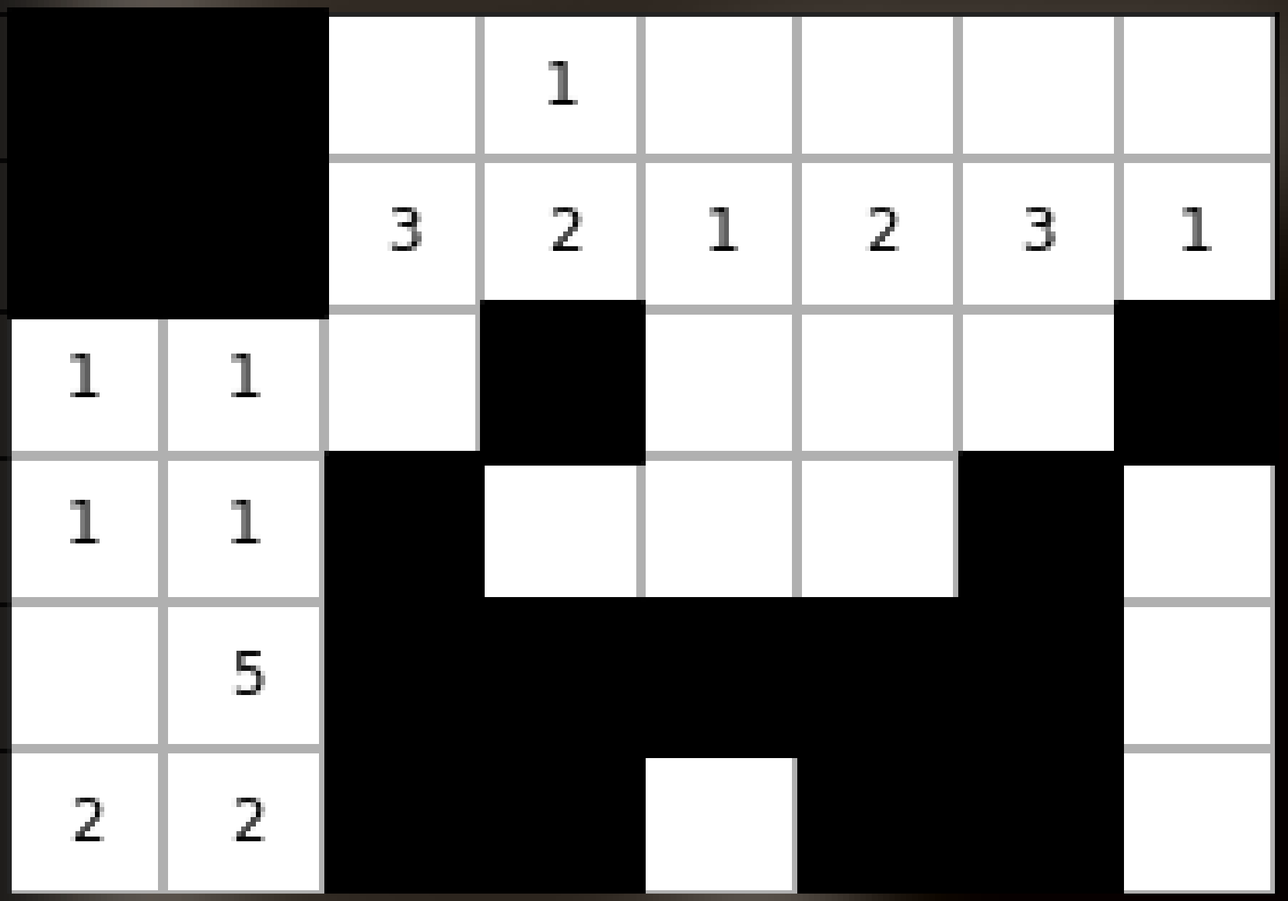
- Remove values not fitting the block in the row
- Remove values not fitting neighbouring block in the row

Backtracking



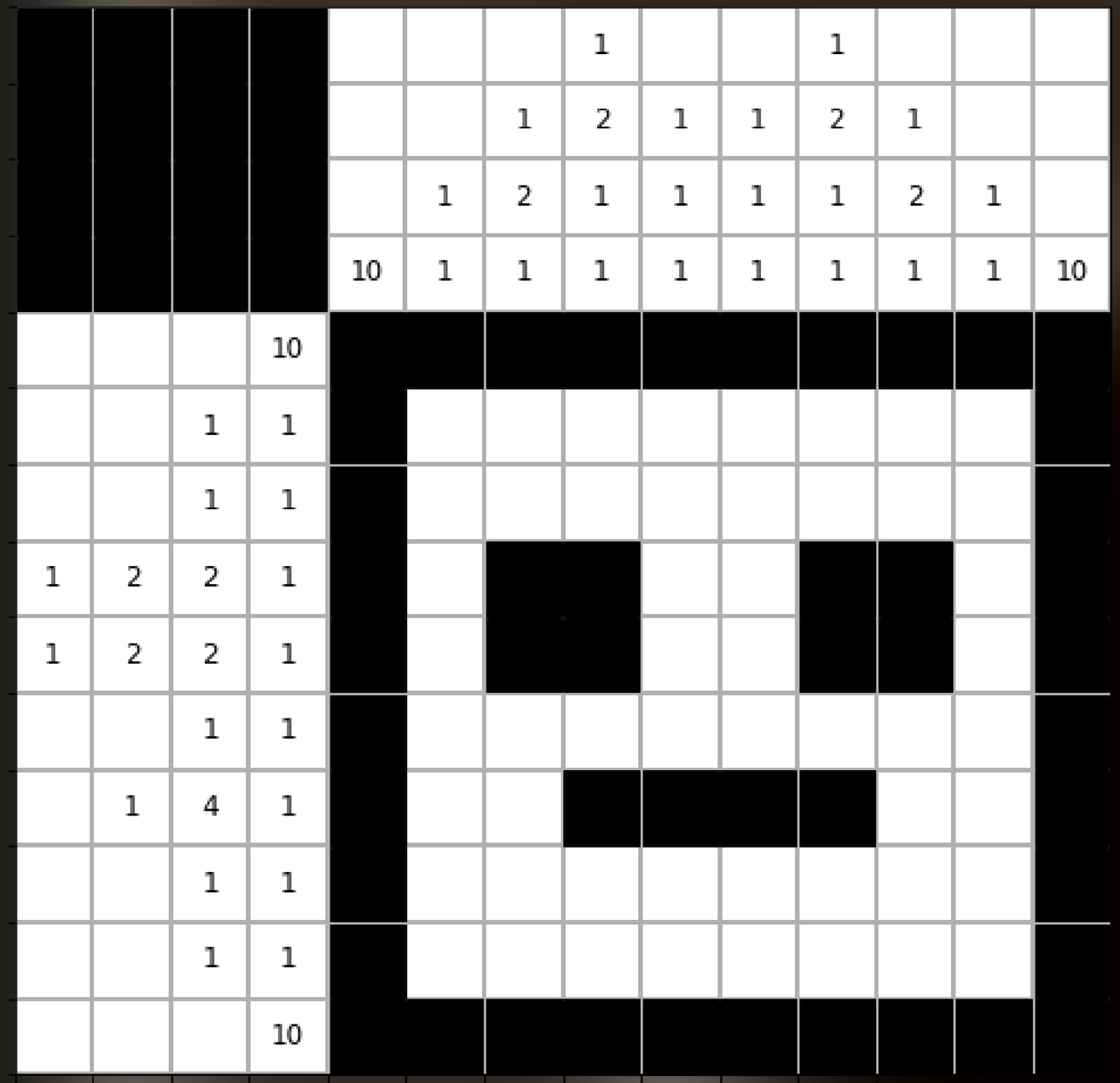
- Start from the variable in the top left corner
- Go from left to right row by row
- Apply forward checking for variables in the same row

Results



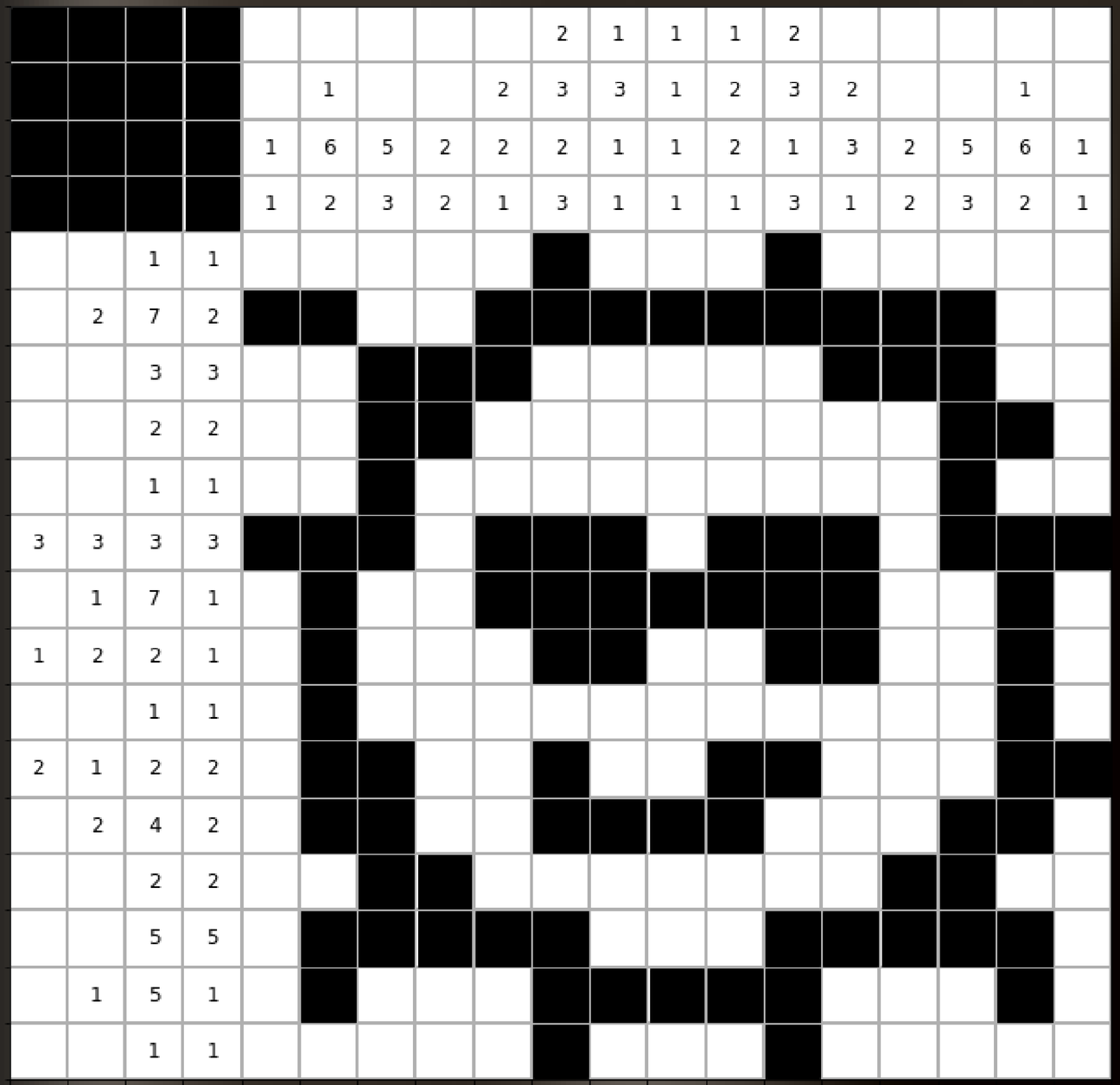
- size: 4x6
- **number of variables: 7**
- execution time: 0.1 seconds

'The initial sample'



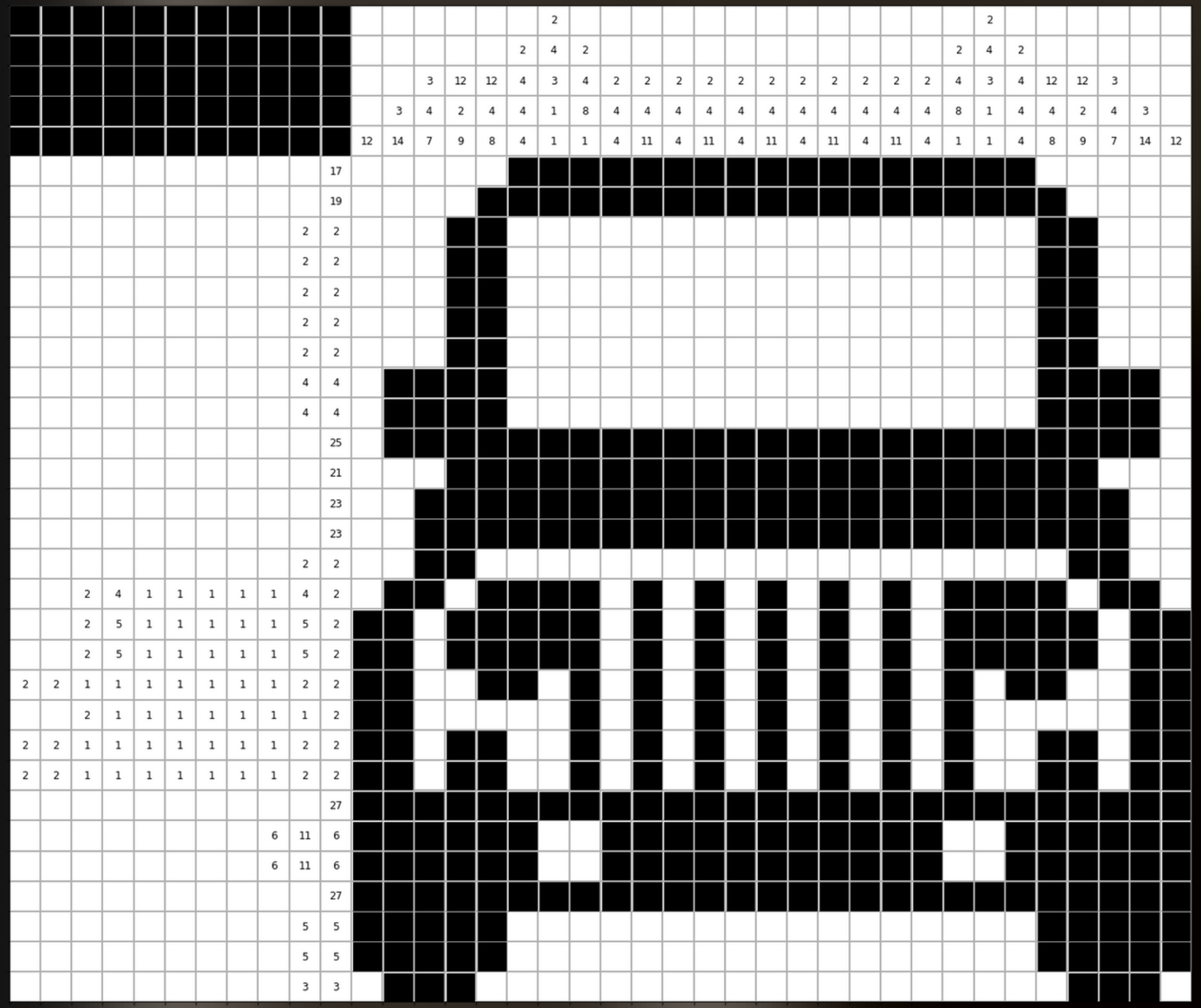
- size: 10x10
- **number of variables: 23**
- execution time: 0.5 seconds

'The face'



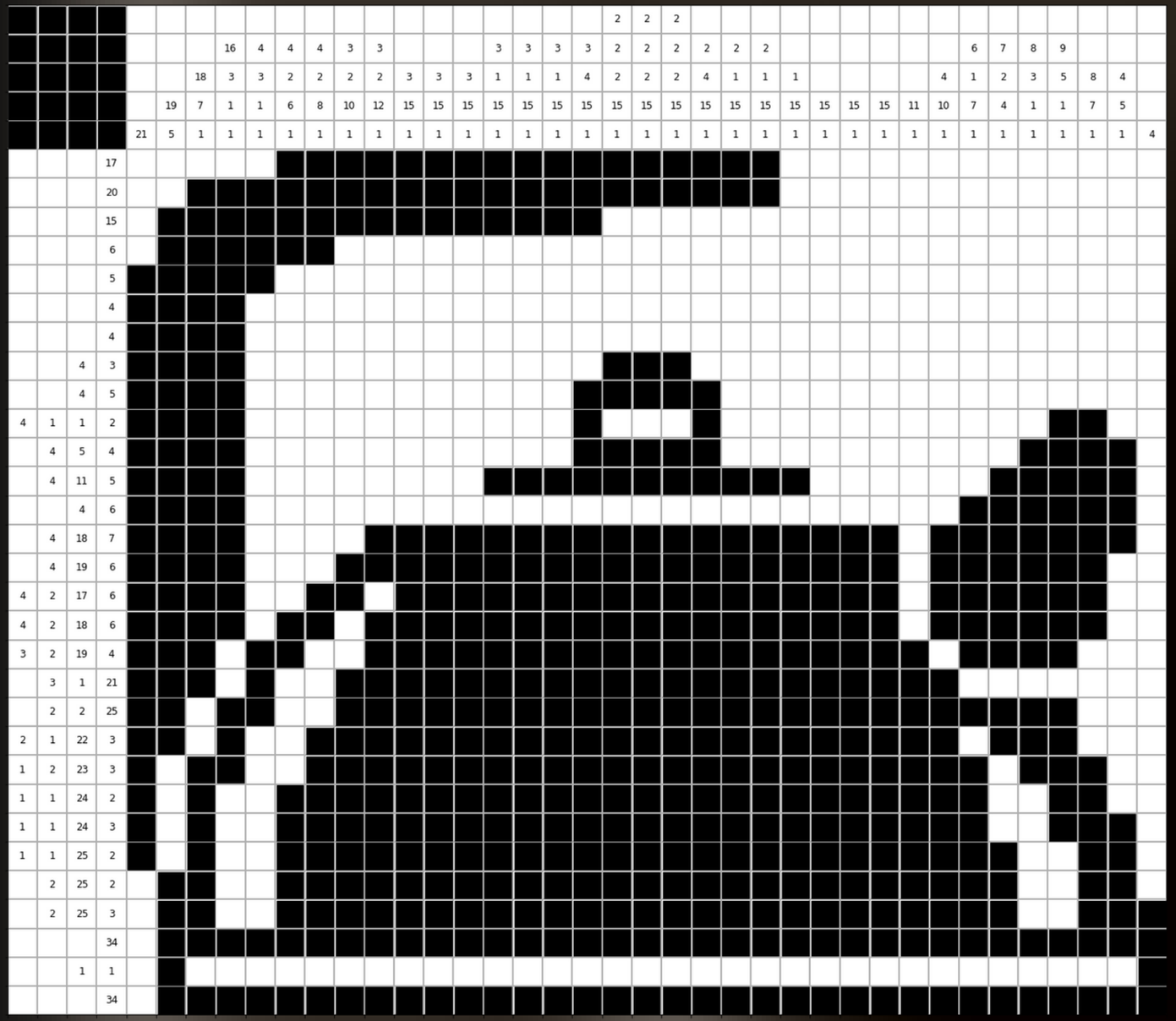
'Sun'

- size: 15x15
- **number of variables: 40**
- **execution time: 0.8 seconds**



'Car'

- size: 28x27
- **number of variables: 105**
- **execution time: 5.8 seconds**



'Kettle'

- size: 30x35
- **number of variables: 77**
- **execution time: 72 seconds**

Further work

Time complexity optimization:

- Backjumping
- Columnwise forward-checking

THANK YOU

Questions?