Logic and Constraint Programming
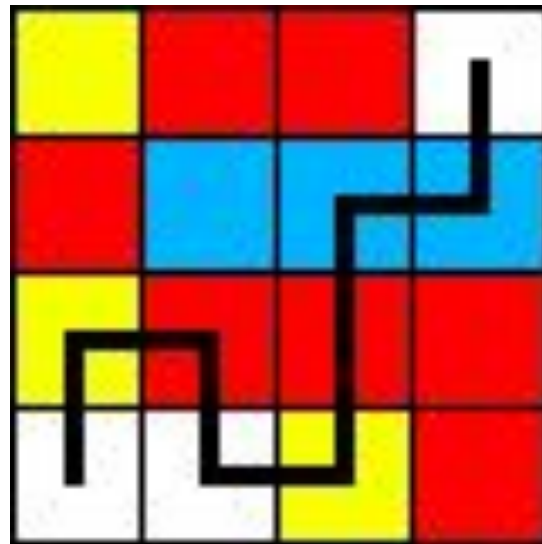
Color Maze

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The Problem

Find a path from the bottom left to the top right that passes through an equal number of squares of each (non-white) color.

Each puzzle below has a unique solution.

Solve Maze Model

- Two models were developed: PROLOG and DOCPLEX

- Modeled the **Maze** list using the index as the position and the value as the color,

- Used *subcircuit* constraint to generate a list of positions that give the **Path** from the **Start** to the **Finish** positions;

- Added **Path** constraints to valid neighbors of each position;

- Assert **Color** constraints: The count of each value in the **Path** must be the same;

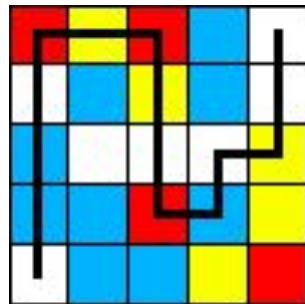- To optimize the labeling process, *[ff, bisect, down]* was used.
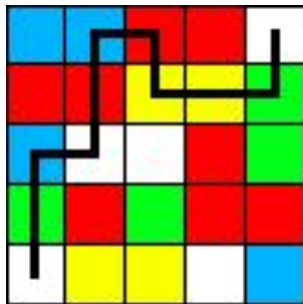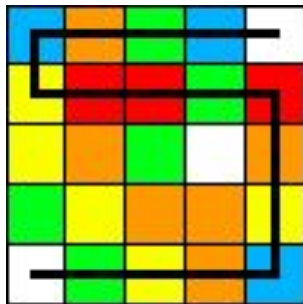
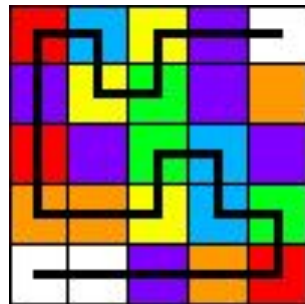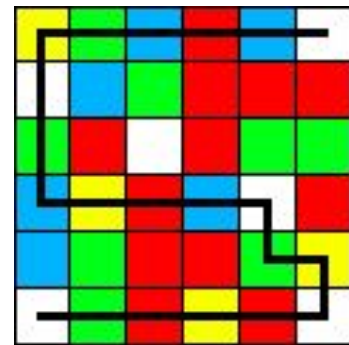# Mazes tested, with solutions

Maze 1
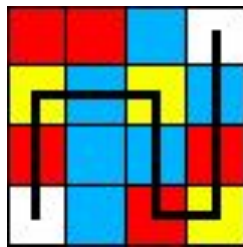
Maze 2

Maze 3

Maze 4

Maze 5

Maze 6

Maze 7

Prolog Model Results

MAZE	TIME (s)	RESUMPTIONS	ENTAILMENTS	PRUNINGS	BACKTRACKS	CONSTRAINTS
1	0.15	8.83E+05	1.58E+05	3.65E+05	6.77E+03	506
2	0.07	1.19E+06	2.15E+05	4.87E+05	8.82E+03	523
3	3.75	2.38E+07	3.71E+06	9.25E+06	1.64E+05	829
4	14.45	9.35E+07	1.51E+07	3.62E+07	6.23E+05	855
5	10.78	6.96E+07	1.19E+07	2.75E+07	4.70E+05	881
6	3.85	2.49E+07	4.37E+06	9.85E+06	1.65E+05	907
7	?	?	?	?	?	?

Docplex Model Results

MAZE	TIME (s)	BRANCHES	FAILS
1	0.09	2.59E+04	1.29E+04
2	0.07	1.89E+04	9.43E+03
3	0.11	4.36E+04	2.14E+04
4	0.11	4.19E+04	2.07E+04
5	0.15	7.90E+04	3.90E+04
6	0.08	1.24E+05	6.12E+04
7	1.9	2.46E+06	1.21E+06

Time vs Maze charts
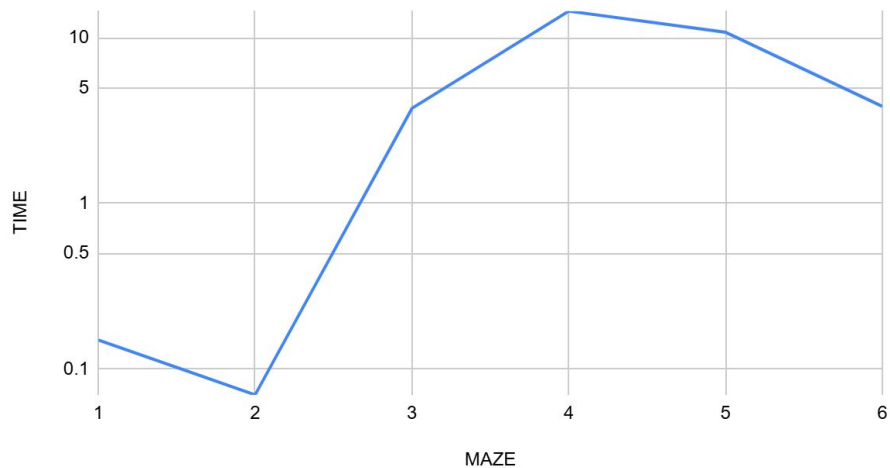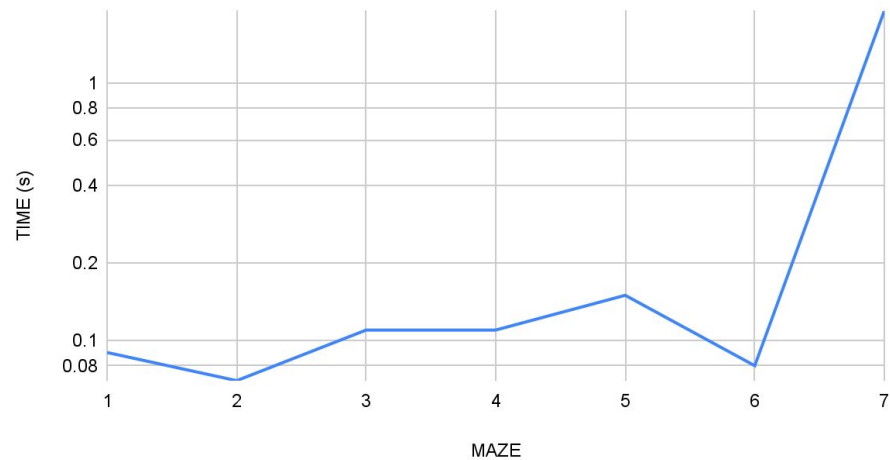
Create Maze Model

- Two models were developed: PROLOG and DOCPLEX

- Marked the **Maze** start and end with 0;

- Modeled the **Maze** list using the index as the position and the value as the color;

- Assert **Color** constraints: The count of 0 must be less than N + 2;

- **Maze** must have at least one of each color;

- Confirm **unique** solution by solving the maze.

Conclusions

- The model in DOCPLEX <u>solves</u> mazes faster;

- In smaller scale, PROLOG <u>generates</u> mazes faster; however DOCPLEX IS better with mazes of greater dimension;

- Because of the *bisect* option in labeling, the solutions in the PROLOG model were obtained much faster, mainly when the path passed through the central position of the maze;

- The generator we created produces some questionable results, and we intend to improve and optimize the search process to make them clearer.