

Concepts of Programming Languages, Spring 2019
The Helsinki Puzzle
Deadline: 22/3/2019

Project Description

Given a square grid of size N , where the horizontal rows are numbered 1 to N from top to bottom and the vertical columns are numbered 1 to N from left to right. You must place a number in each cell of the N by N grid such that :-

- Each row is unique.
- Each row is exactly equal to one of the columns, however, it must **not** be the column with the same index as the row.
- If X is the largest number you place in the grid, then you must also place $1, 2, \dots, X-1$, where the condition $X \leq N$ is satisfied.

Examples

For a 3×3 grid, you may have the following matrix

	c1	c2	c3
r1	2	1	2
r2	2	2	1
r3	1	2	2

defined by the following equalities

$$\begin{bmatrix} c1 & = & r2 \\ c2 & = & r3 \\ c3 & = & r1 \end{bmatrix}$$

For a 4×4 grid, you may have the following matrix

	c1	c2	c3	c4
r1	1	2	3	1
r2	3	4	4	2
r3	2	4	4	3
r4	1	3	2	1

defined by the following equalities

$$\begin{bmatrix} c1 & = & r4 \\ c2 & = & r3 \\ c3 & = & r2 \\ c4 & = & r1 \end{bmatrix}$$

Predicates to be added

You are going to solve this puzzle purely through Prolog. This means that you are **not allowed to use any clpfd libraries**. Your solution must utilize both techniques, unification and generate-and-test. You may use some or all of the following predicates.

grid_build/2

The predicate `grid_build(N,M)` should succeed only if `M` represents a grid that is `N` by `N` such that each cell in `M` contains an unbound variable.

Hint: `length(L,3)` produces a list of 3 unbound variables.

grid_gen/2

The predicate `grid_gen(N,M)` should succeed only if `M` represents a grid that is `N` by `N` such that each cell in `M` contains a value from the valid range `1 .. N`.

num_gen/3

The predicate `num_gen(F,L,R)` should succeed only if `R` represents a list of consecutive numbers starting from `F` until `L`.

Hint: `numGen(1,3,R)` succeeds when `R = [1,2,3]`.

check_num_grid/1

The predicate `check_num_grid(G)` succeeds if `G` does not contain a number `X` unless all the numbers `1 .. X-1` are there.

acceptable_distribution/1

The predicate `acceptable_distribution(G)` should succeed only if no row is placed in a column with the same index and no column is placed in a row with the same index.

trans/2

The predicate `trans(M,M1)` should succeed only if `M1` represents a transposed version of the matrix `M`.

Hint: This needs to be approached through rows and columns.

distinct_rows/1

The predicate `distinct_rows(M)` should succeed only if `M` represents a matrix `M` where all rows are unique.

distinct_columns/1

The predicate `distinct_columns(M)` should succeed only if `M` represents a matrix `M` where all columns are unique.

helsinki/2

The predicate `helsinki(N,G)` should succeed only if `G` is a square grid of size `N*N` that satisfies all the helsinki puzzle properties.