

DM22 Programming Languages

Spring 2005

Project 2

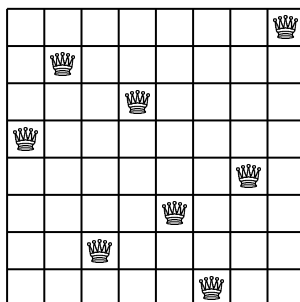
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April 25, 2005

The purpose of this project is to implement in Prolog a program finding solutions to the N -queens chess problem. The project is to be done in groups of up to two persons.

The N -Queens Problem

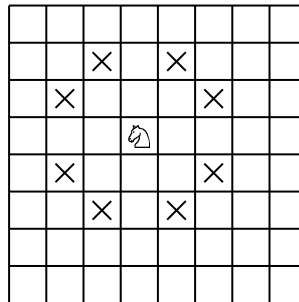
The 8-queens problem is a classic chess puzzle. The goal is to position 8 queens on a standard 8×8 chess board such that no queen threatens another. A queen can move unrestricted horizontally, vertically, and diagonally, hence a queen threatens any piece on the same row, column, or diagonal line as itself. The figure below shows one possible solution to the 8-queens problem.



The N -queens problem is the obvious generalization of positioning N queens on an $N \times N$ board with no queen threatening another.

Super-Queens

The allowed movements of a queen is a superset of the allowed movements of any other chess piece, except the knight. A knight's move is one step horizontally and two steps vertically, or vice versa. The positions threatened by a knight is illustrated below.



Let us define a *super-queen* as a new chess piece whose allowed movements are those of the standard queen *and* those of the knight.

The N -super-queens problem is defined analogously to the N -queens problem: positioning N super-queens on an $N \times N$ board with no super-queen threatening another.

Task

The task is to implement a Prolog program which can find the number of solutions as well as the actual solutions of the N -queens problem and the N -super-queens problem. More specifically, implement in Prolog predicates

```
queenCount(N,Result)
queenSolutions(N,Result)
superqueenCount(N,Result)
superqueenSolutions(N,Result)
```

such that the first is true iff `Result` is the number of solutions to the N -queens problem, the second is true iff `Result` is an actual solution to the N -queens problem, and the last two are defined similarly, but for the N -super-queens problem.

Here, a solution is a list where the i th element gives the row of the (super-)queen in the i th column (this format is based on the observation that there must be exactly one queen in each column). For example, the list [4,2,7,3,6,8,5,1] describes the solution in the figure above.

Formalities

A printed report of two to five pages should be handed in. Prolog code and any test data should be given as appendices. The main aim of the report should be to describe the modeling and program design choices made during development, the reasoning behind these choices, and the structure of the final solution. Also, give a table showing the number of solutions to the N -queens problem for N ranging from 1 to 10, and state what is the smallest N for which the N -super-queens problem has a solution.

A copy of the Prolog code should be handed in using the `aflever` command on the Imada system: Move to the directory containing your code and issue the command `aflever DM22`. This will copy the contents of the directory to a place accessible by the lecturer. Repeated use of the command is possible (later uses overwrites the contents from earlier uses).

In the directory, you must for identification purposes have an ASCII file named `names.txt` containing the names of the group members, with one name per line.

You must hand in the report and the code by

<i>Monday, May 23, 2005</i>
