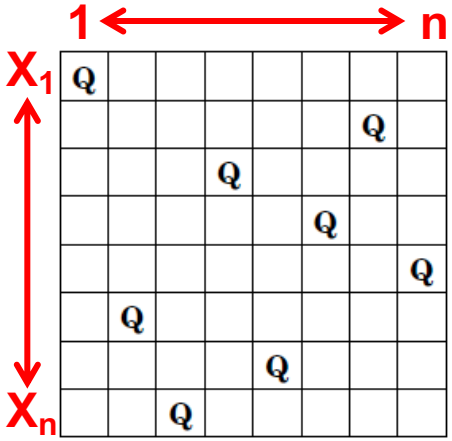
Modelling and Solving Exercises in MiniZinc -1

Before Starting

- Create a project (.mzp) for each problem.
  - Add the model files (*.mzn)
  - Add the data files (*.dzn)
- Configure the solver to obtain the solution statistics, to search for one or all solutions, and to set a time limit when needed.

Row Model of N-Queens



- Variables and Domains
  - A variable for each row $[X_1, X_2, ..., X_n]$ → no row attack
  - Domain values {1,...,n} represent the columns:
    - $X_i = j$ means that the queen in row i is in column j
- Constraints
  - alldifferent($[X_1, X_2, \ldots, X_n]$) → no column attack
  - for all i<j $|X_i - X_j| \neq |i-j|$ → no diagonal attack

Alldiff Model of N-Queens

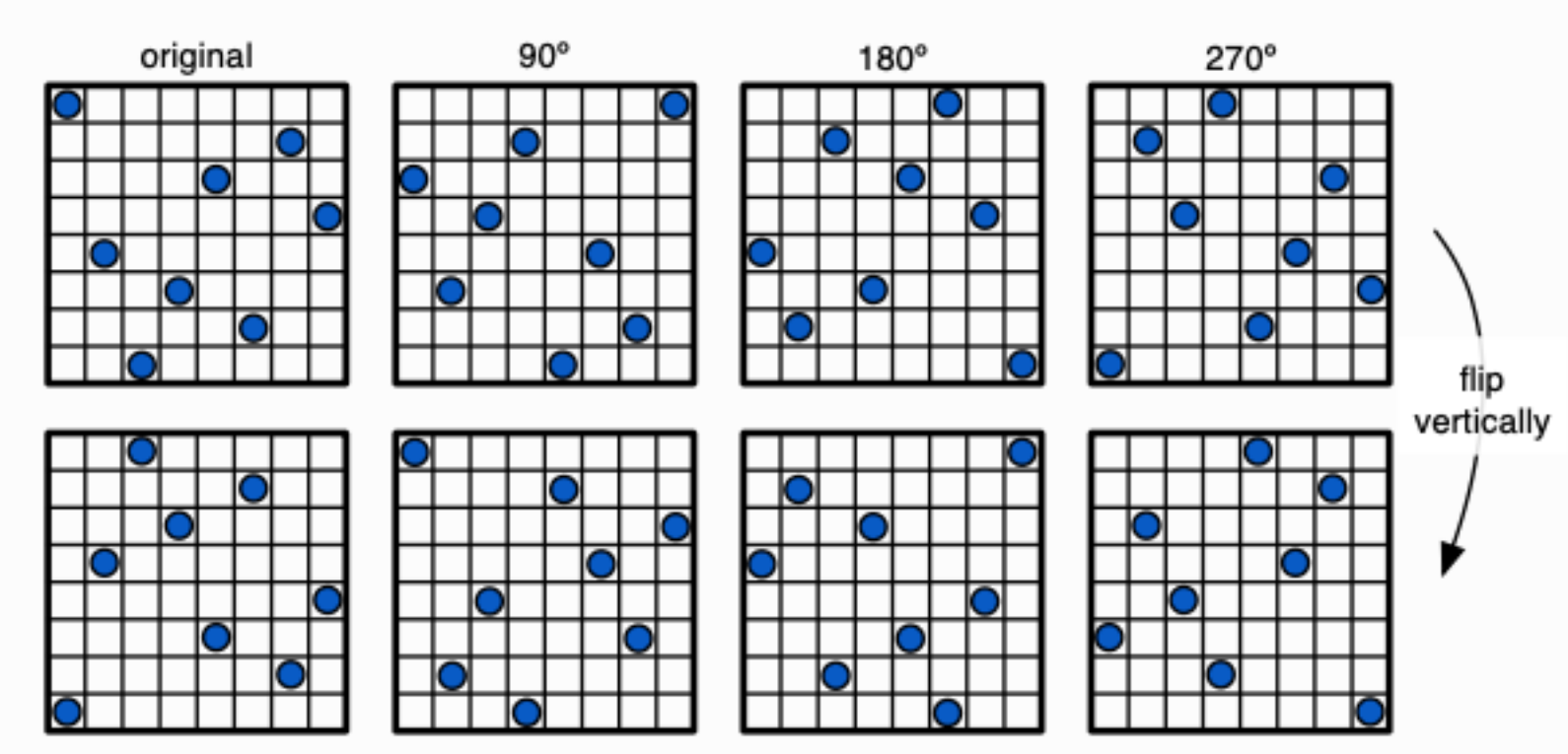
- Diagonal attack constraints
  - for all $i<j$ $X_i + i \neq X_j + j \wedge X_i - i \neq X_j - j$

    $\equiv$ alldifferent($[X_1 + 1, X_2 + 2, \ldots, X_n + n]$)

    $\equiv$ alldifferent($[X_1 - 1, X_2 - 2, \ldots, X_n - n]$)

- Alldiff Model
  - alldifferent($[X_1, X_2, \ldots, X_n]$)
  - alldifferent($[X_1 + 1, X_2 + 2, \ldots, X_n + n]$)
  - alldifferent($[X_1 - 1, X_2 - 2, \ldots, X_n - n]$)

Symmetries of N-Queens



Symmetry breaking in N-Queens

- Alldiff Model + Boolean Model
  - alldifferent([X_1, X_2, …, X_n])
  - alldifferent([$X_1 + 1$, $X_2 + 2$, …, $X_n + n$])
  - alldifferent([$X_1 - 1$, $X_2 - 2$, …, $X_n - n$])
  - for all i, j $B_{i,j} \in \{0,1\}$
  - Channelling constraints
    - for all i,j $X_i = j \leftrightarrow B_{ij} = 1$
  - Symmetry breaking lexicographic ordering constraints
    - Study Section 2.6.6 of the MiniZinc Tutorial.

To Do – 1

- Implement 3 models:
  - the row model;
  - the alldiff model;
  - the alldiff_sym model (alldiff + Boolean models).
- Search for **all solutions** for N = 8, 9, 10, 12 using the default search of Gecode.
- Record the number of solutions and the failures in each experiment.

To Do – 2

- Using the alldiff model, search for a solution for N = 10, 15, 20, …., 45, using the following 5 variable - value ordering heuristics of Gecode:
  - input order – minimum value
  - smallest domain – minimum value
  - domWdeg – minimum value
  - input order – random value
  - domWdeg – random value
- Record the number failures in each experiment.

Optimal N-Queens

- Add an objective to the alldiff model:
  - minimize the total distance of the queens to the main diagonal.
- Search for the optimal solution to the 50-queens problem using Gecode, with a time limit of 5 mins (300 secs).
- Experiment with the default search and the domWdeg-rand heuristic.
- Experiment with restarting (employing the Luby strategy with L = 250), using the domWdeg-rand heuristic.
- Record the number of failures and the objective value in each experiment.