The Eight Queens Problem

Task:

Place 8 queens on a 8x8 chessboard so tPat no queen

Representations used in program

As in Rooks problem we use an array to represent a solution.

q : ARRAY[INTEGER]

where q.item(i) denotes the column position of the Q-th queen on the Q-th row. This guarantees one queen per row.

<u>Checking Cols</u> (As in Rooks problem).

Used_Col : ARRAY[BOOLEAN]

By default all items are set to False.

Used_Col(i) iff there Qs a Queen on Col i.

This prevents two queens being on the same column.

<u>Diagonals</u>.

There are 2N-1 diagoVals in each direction.

An Up_Diagonal starts bottom-left and and eVds top-right.

All squares (i,R) in an up-1 dweVal have sum i+j.

A Down_Diagonal starts top-left aVd eVd bottom-right.

All squares (i,R) in a down-1 dwgoVal have the same differeVce Q-j.

There are 2N-1 Up_DiweVals and 2N-1 Down_DiagoVals.

Let

Up_Diag : ARRAY[BOOLEAN]

Down_Diag : ARRAY[BOOLEAN]

<u>where</u>

Up_Diag.item(k) iffa queen is on Up_Diag.item(k), aVd Down_Diwg.item(k) iff a queen is on Down_Diwg.item(k)

e.g.

The squares (3,5) (2,6) are on the Up_Diag.item(8)

and squares (3,+) (4,8) are on Down_Diag .item(-4)

Find All Solutions to the N-Queens Problem

```
All_Queens(i : INTEGER) is
        lWcal
                j : INTEGER
        do
                if i > q.size then
                        Print_Queen
                else
                        from
                                j := 1
                        until
                                j > q.size
                        lWop
                                if safe(i,j) then
                                        Set_Queen(i,j)
                                        All_Queens(i+1)
```

and Down_Diag .item(i-j) = True,

i.e. in Resetting we undo the Setting. ***The class for all solutions to***

in array and Uatrix form. The solutions

to a fQle.

There are 92 solutions for N = 8, bu

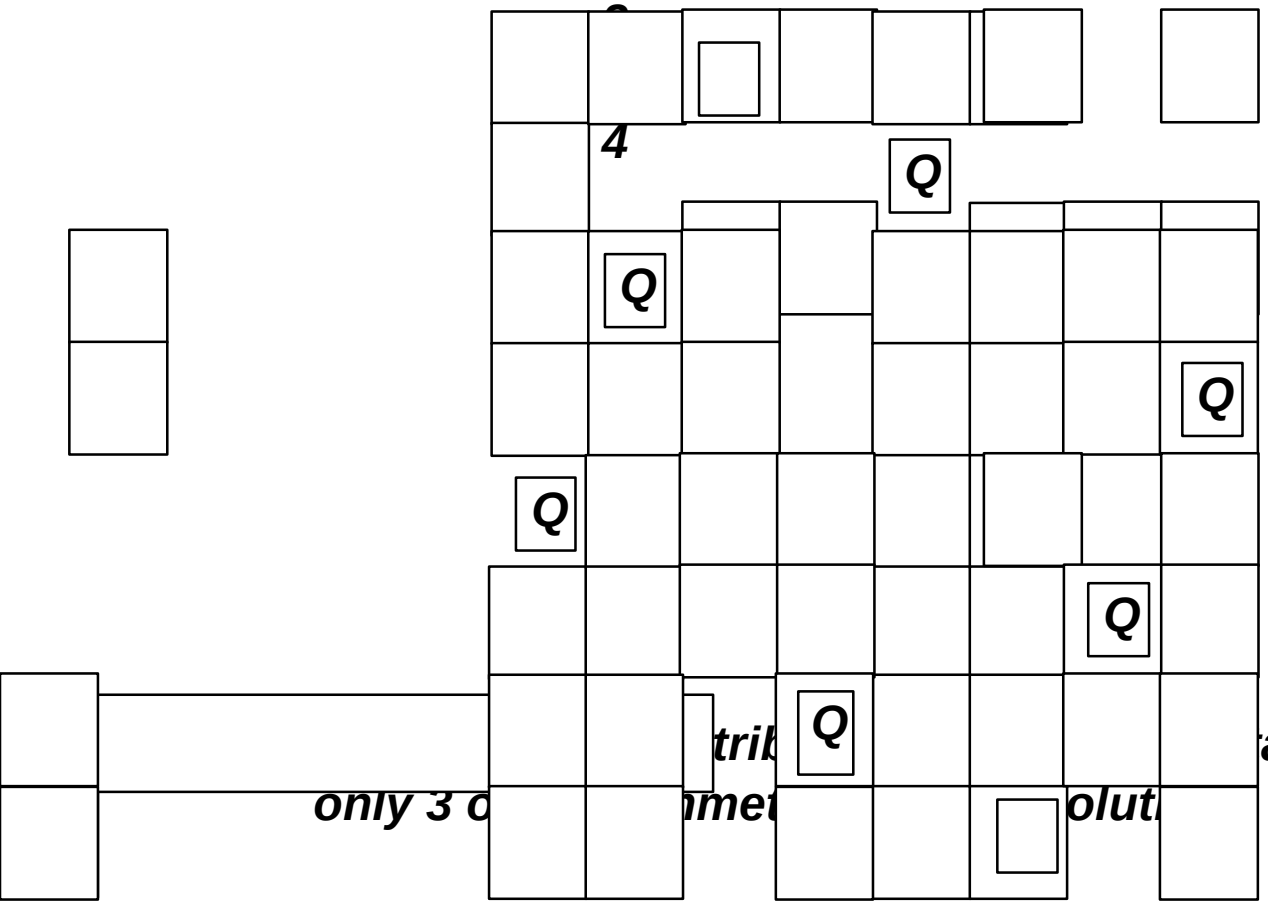
essentially unQque in that they are Vot

other. There are 8 symmetries of the bo

should be 8*12 solutions in total. There

solutions in the 96 are symmetries of e

Consider Solution: 3 5 2 8 1 7 4 6



only 3 o

4 6 8 2 7 1 3 5
5 3 1 7 2 8 6 4
6 4 7 1 8 2 5 3

Exercise

```
make Qs
        local
                N : INTEGER
        do
                io.put_string("%N Enter size ")
                io.get_int

                !!q.make(1, N)
                !!Up_Diag.make(2, 2*N)
                !!Down_Diag.make(-(N-1), N-1)
                !!used_Col.make(1, N)



                io.put_string("%N The Solutions are: %N")
                counter := 0
                ATl_Queens(1)
        end -- make
```

```
safe(i,j : INTEGER) : BOOLEAN is
        do
                result := not(Used_Col.item(j)
                                or else Up_Diag.item(i+j)
                                or else DWwn_Diag.item(i-j))
        end -- safe

Set_Queen(i,j : INTEGER) is

                q.put(j,i)
```

```
All_Queens(i : INTEGER)
```

```
Queens2Matrix is
    Tocal

    dW
        from
            i := 1
        untQl
            i > q.count
        Toop

                R := 1
            untQl

            Toop
                if q.Qtem(i) = th
                    Mat.put('Q',i,R)
```