

ModRef 2022: Model and Solve Competition

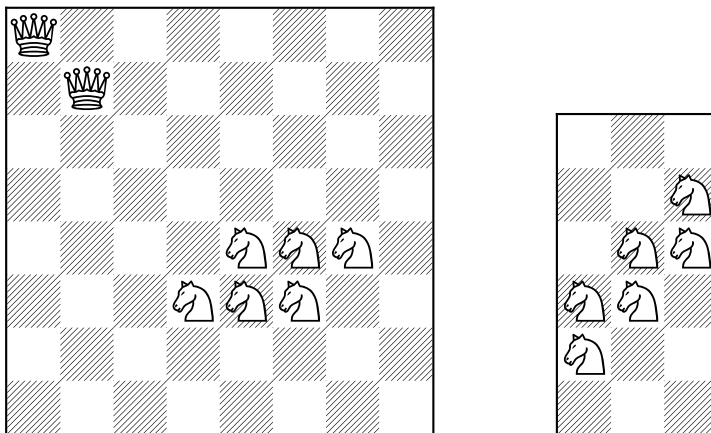
Queens Knights

1 Problem Statement

You are given an $n \times m$ “chessboard” grid. You need to place queens and knights on the board so that each square is threatened by a placed piece. A queen threatens all squares on the same row, column or diagonal as the queen, including the square the queen is placed on. A knight threatens all squares a knights move away (2 horizontally then 1 vertically, or 2 vertically and one horizontally). It does not threaten the square it is placed in.

The aim is to place queens and knights on the chessboard so that each square is threatened by at least one piece. The aim is to minimize 9 times the number of queens used + 3 times the number of knights used.

For example, for an 8 x 8 chessboard and a 6 x 3 ($n = 6, m = 3$) chessboard some optimal solutions are



In the 8 x 8 board note how every square is threatened by the queens in the top left, or one of the knights in the bottom right. In the 6 x 3 each square is threatened by a knight.

The data is available in JSON format

```
int: n; % no of ROWS
int: m; % no of COLS
```

For example, the data for the 6 x 3 example above is given as

```
{
  "n" : 6,
  "m" : 3,
}
```

The output of your model should be a JSON format with a 2d array where blank squares are 0, knights are 1, and queens are 2. The above 8 x 8 solution is represented as:

```
{
  "board" : [[2, 0, 0, 0, 0, 0, 0, 0],
              [0, 2, 0, 0, 0, 0, 0, 0],
              [0, 0, 0, 0, 0, 0, 0, 0],
              [0, 0, 0, 0, 0, 0, 0, 0],
              [0, 0, 0, 0, 1, 1, 1, 0],
              [0, 0, 0, 1, 1, 1, 0, 0],
              [0, 0, 0, 0, 0, 0, 0, 0],
              [0, 0, 0, 0, 0, 0, 0, 0]]
}
```

while for the 6 x 3 is is given by

```
{
  "board" : [[0, 0, 0],
              [0, 0, 1],
              [0, 1, 1],
              [1, 1, 0],
              [1, 0, 0],
              [0, 0, 0]]
}
```