

A Guide to the Strategies of Queens

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1 History

Queens is an object placement puzzle game popularised by LinkedIn. Given an $n \times n$ grid divided into n connected colour zones, the aim of the game is to place exactly one queen in every row, column and colour zone. The game is a simplified version of the Star Battle puzzle style created by Hans Eendebak for the 2003 World Puzzle Championship. For more information and some useful links to play Star Battle visit gmpuzzles.com.

2 Basic Rules

As introduced the Queen's puzzle grid is $n \times n$ grid divided into n connected colour zones. The object of the game is to place a queen in every row, column and colour zone. So in some sense queens behave similarly to their chess counterparts. Additionally, queens cannot touch diagonally, but this is limited to adjacent diagonal squares.

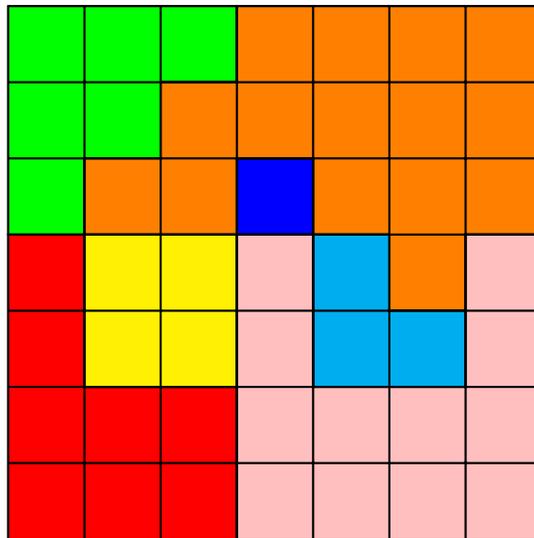
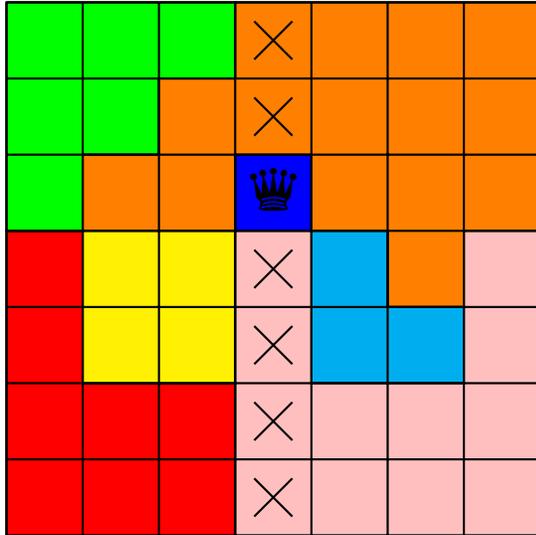
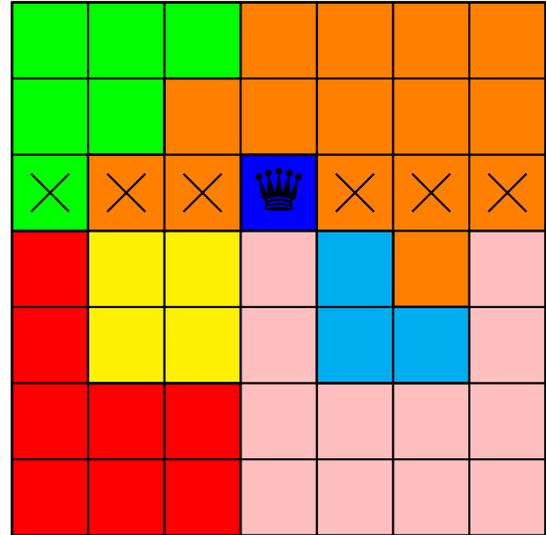


Figure 1: Start Grid

Markers shaped like an \times are used to indicate squares which cannot contain a queen. We set the bottom left corner as the origin, so row 1 is the bottom row, and column 1 is the leftmost column. As shown in Figure 2a, once a queen is placed in the blue zone, no other queen can lie in the same column so we can eliminate those squares. The same applies for the row in Figure 2b.



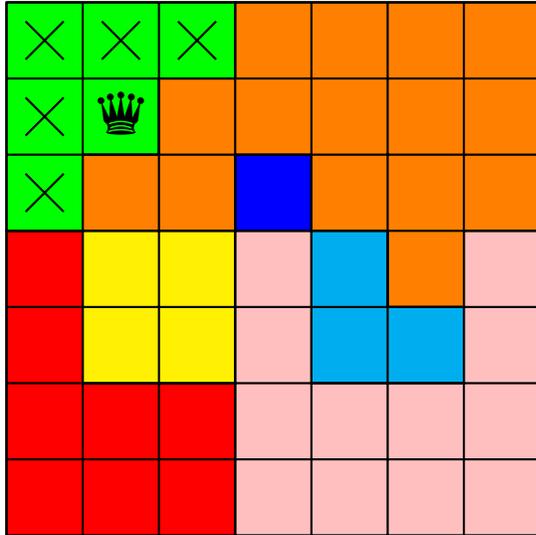
(a) One Queen Per Column



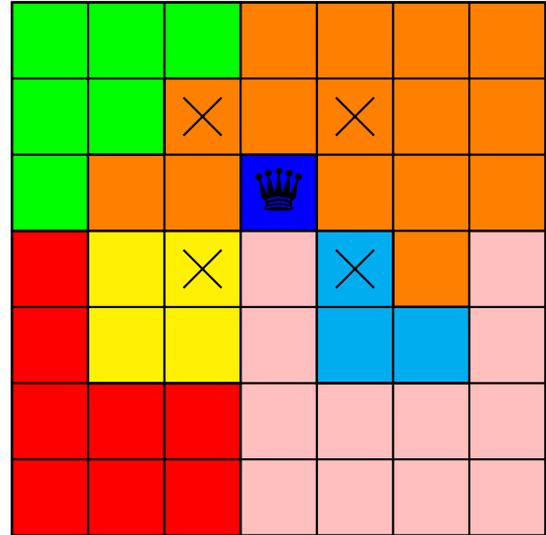
(b) One Queen Per Row

Figure 2

Similarly in Figure 3a, if a queen is placed in the green zone, then we can eliminate all the other squares in that colour zone. Queens also control adjacent diagonal squares, see Figure 3b.



(a) One Queen Per Colour Zone



(b) Queens Control Adjacent Diagonals

Figure 3

3 Common Strategies

In this section, we will discuss common strategies and suggest how to apply them effectively to improve solving speed. Whilst working through them we suggest trying some of the puzzles available at playqueensgame.com.

The main strategies we will discuss are:

- Subsetting
- Recognising shapes

3.1 Subsetting

Subsetting is simply considering a connected subset of the rows or columns and using this to eliminate possible squares. There are two subtly different variants to this. Take a subset of k connected rows or columns, if there are k colour zones wholly contained in this subset, then we can eliminate any additional colours contained in this subset. In Figure 4, we can look at the subset: {row 3, row 4}. The yellow and light blue colour zones are wholly contained in this zone, so we can eliminate any additional colours in this subset. This is an application of the one queen per row and per colour zone rule.

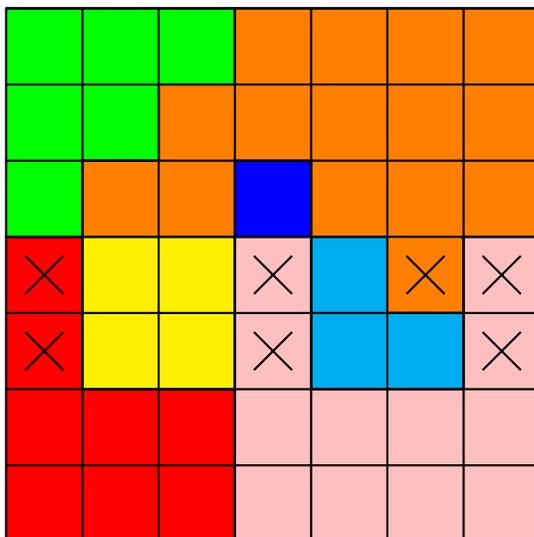


Figure 4: Subsetting Rows Variant A

A slight variant of this technique is to take a subset of k connected rows or columns that contain k colours, then eliminate any of those k colours that lie outside the subset. For example in Figure 5, take the subset {row 1, row 2}, this contains only two colours red and pink. Hence we can eliminate any red and pink lying outside this subset.

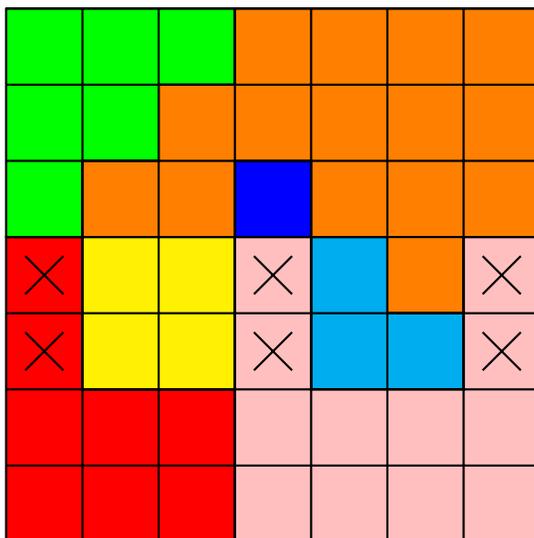


Figure 5: Subsetting Rows Variant B

To make this clear with another example of variant A, take the subset {col 1, col 2, col 3}. There are three colours: red, yellow, green that are wholly contained in this subset so the queens must belong to those colours. Hence we can eliminate the additional orange squares in this subset.

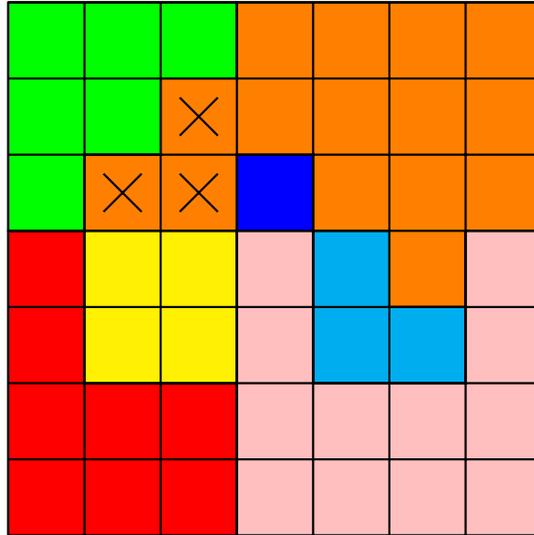
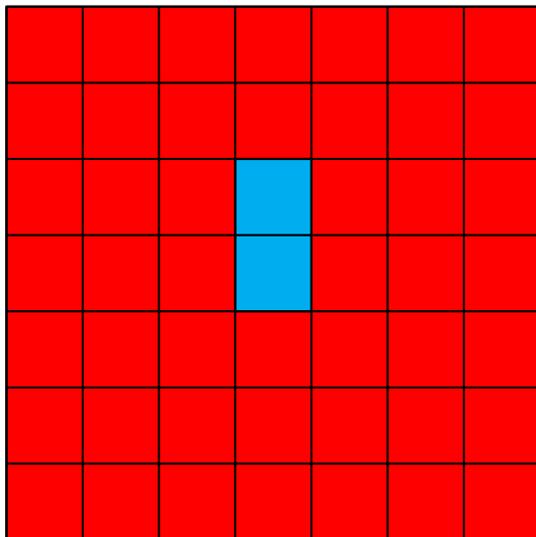


Figure 6: Subsetting Columns Variant A

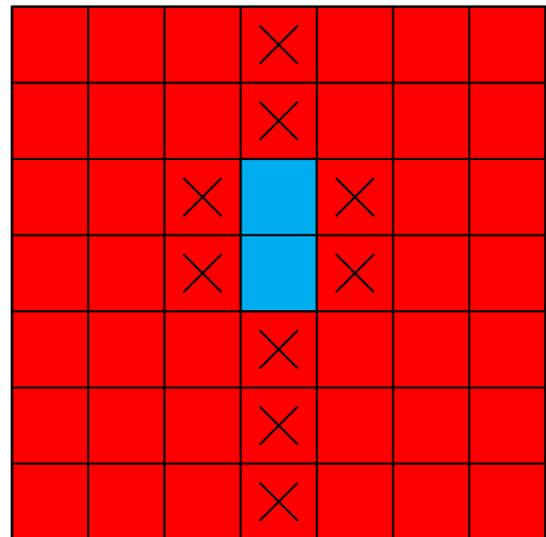
3.2 Recognising Shapes

Another key skill is to quickly deduce which squares are eliminated given a colour zone which is a small and common shape. There are two ways of thinking about this. Either we look in turn at each square in our colour zone, place a queen there and consider the set of points the queen controls outside this colour zone. Then take the intersection over all possible placements of queens. Alternatively, you can find every square outside the colour zone that would eliminate the entire colour zone should a queen be placed there.

Consider Figure 7, the blue zone contains a queen hence that must be the only queen in column 4. Furthermore if a queen was placed in either of the blue squares then the horizontal and diagonal action of the queen eliminates the two squares on either side of the blue zone. Below are examples of most of the common shapes.

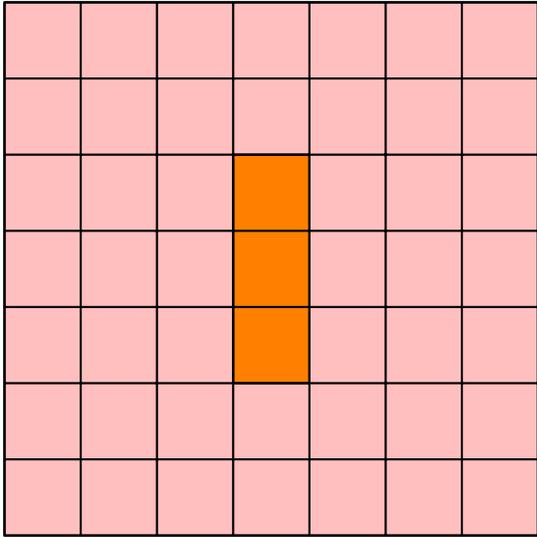


(a) Small Rectangle

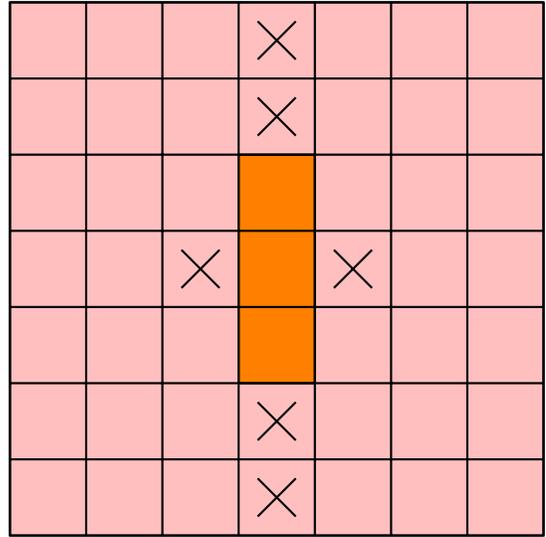


(b) Small Rectangle With Markers

Figure 7

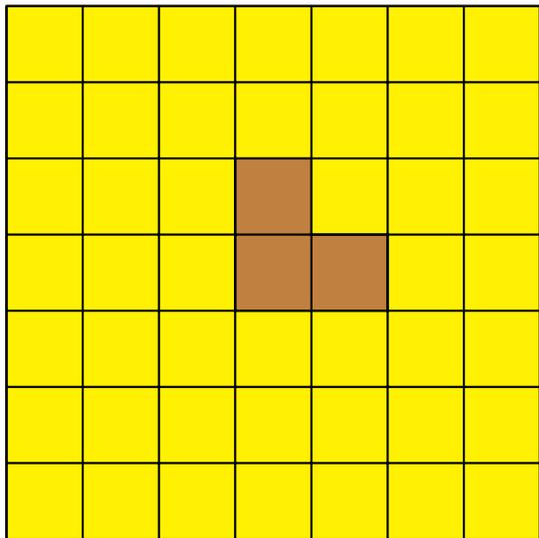


(a) Medium Rectangle

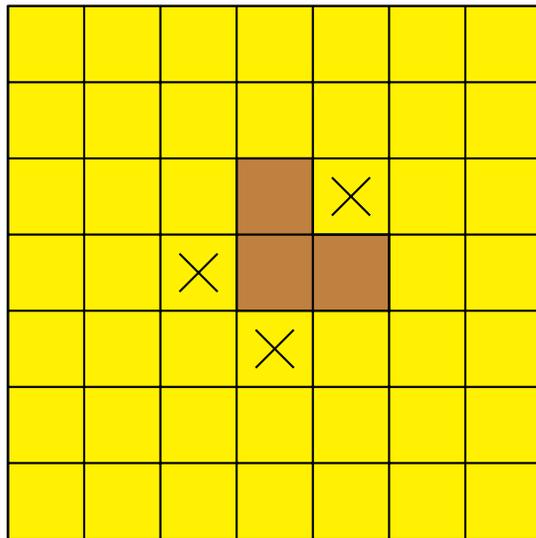


(b) Medium Rectangle With Markers

Figure 8

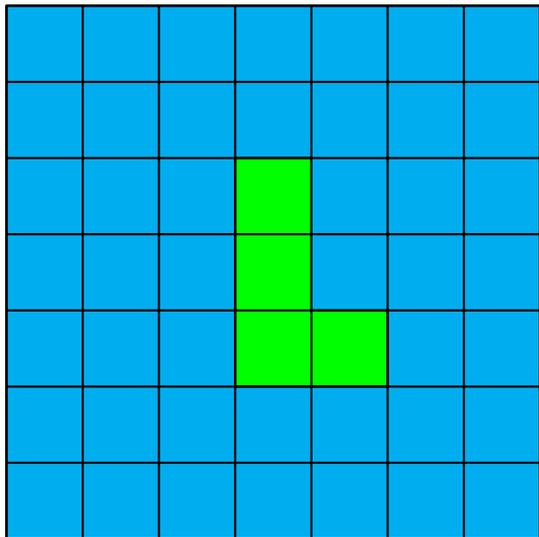


(a) Small Corner

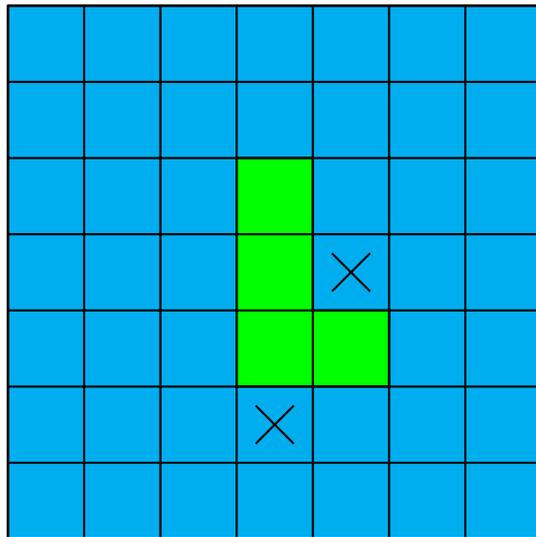


(b) Small Corner With Markers

Figure 9

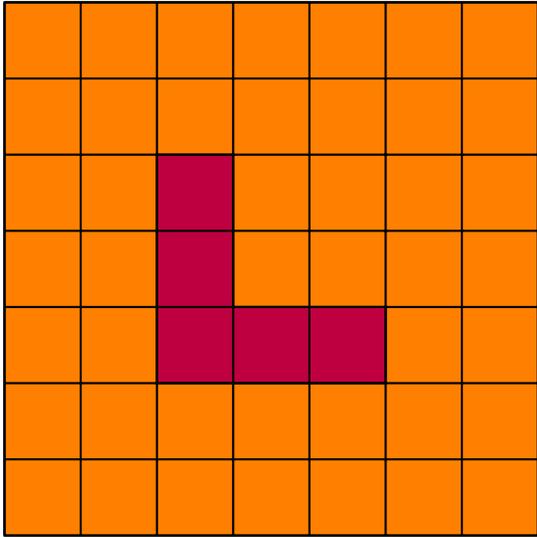


(a) Hook

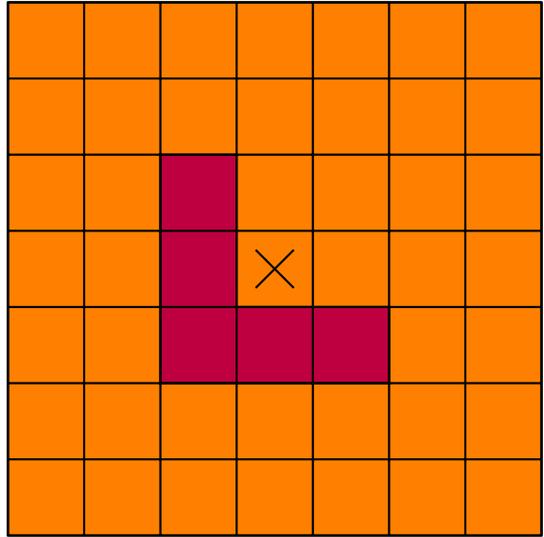


(b) Hook With Markers

Figure 10

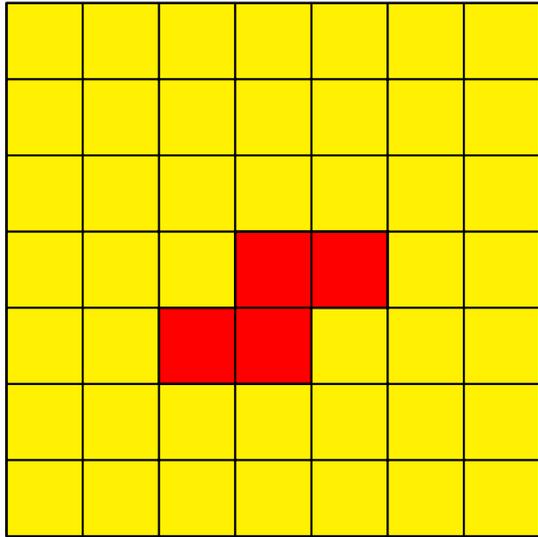


(a) Long Corner

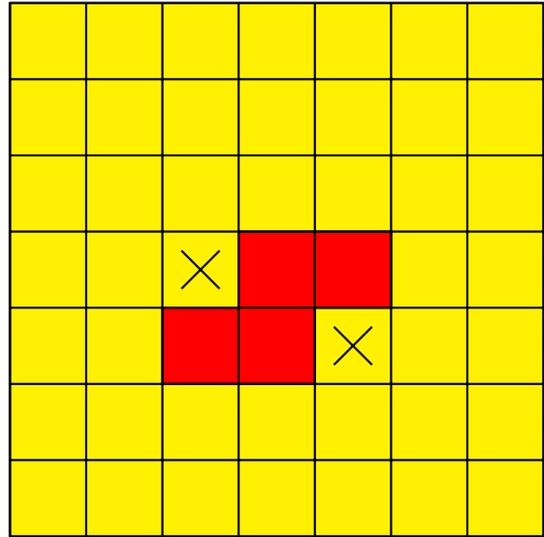


(b) Long Corner With Markers

Figure 11

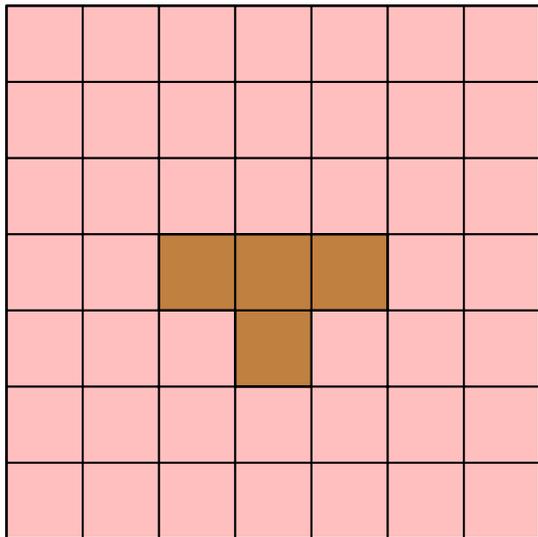


(a) Slant

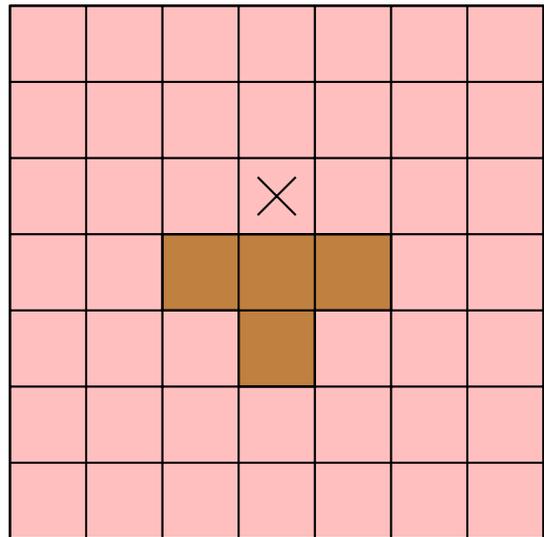


(b) Slant With Markers

Figure 12

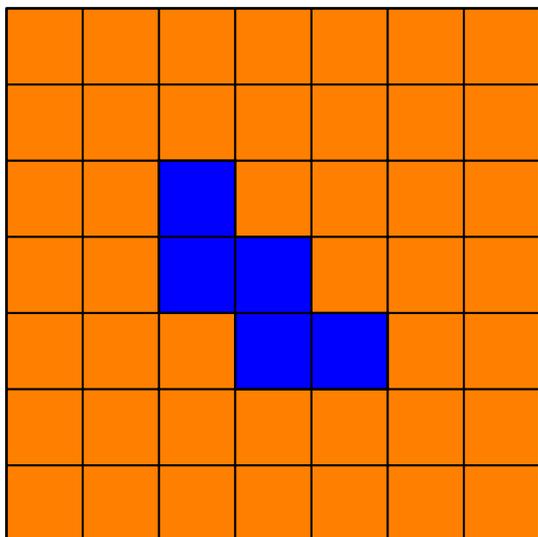


(a) T-shape

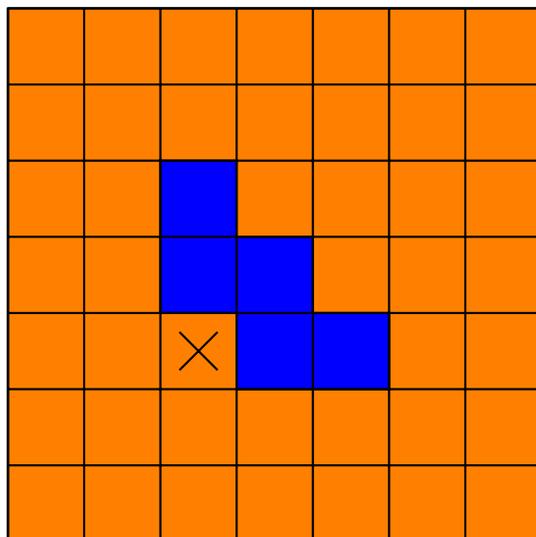


(b) T-shape With Markers

Figure 13



(a) Variant Corner



(b) Variant Corner With Markers

Figure 14

3.3 Summary

When beginning a puzzle, especially for large grids (e.g. 10×10), it is normally most efficient to start by subsetting to eliminate large areas of the grid. From then repeatedly apply the basic rules, subsetting and look for common shapes, in particular $k \times 1$ or $1 \times k$ rectangles. Each time a square is eliminated, go through these strategies again. Eventually, it will become easy to recognise the patterns and do these steps automatically.

4 Worked Example

Let's now try out these techniques on an 8×8 Queen's grid.

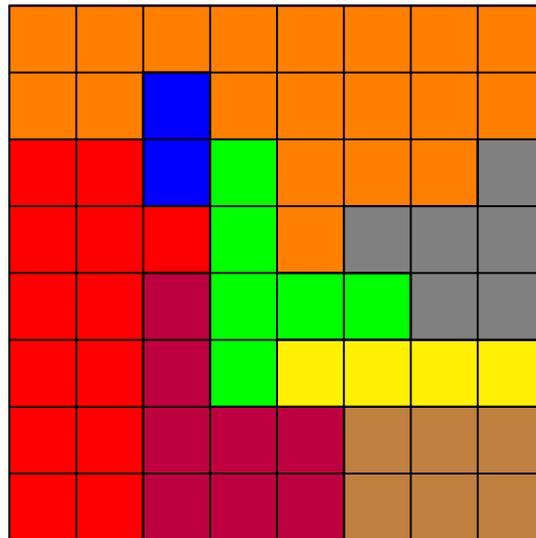


Figure 15

Firstly we can see the subset {column 1, column 2} contains only red and orange colour zones, so we can eliminate any red and orange outside these columns.

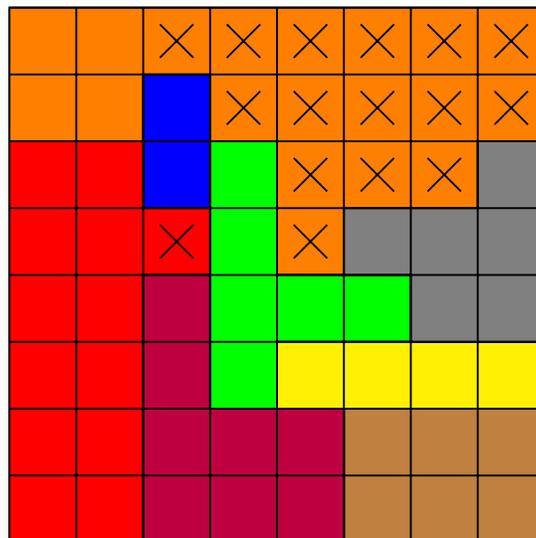


Figure 16

The blue and yellow colour zones are thin rectangles so we can quickly deduce which squares are eliminated by them.

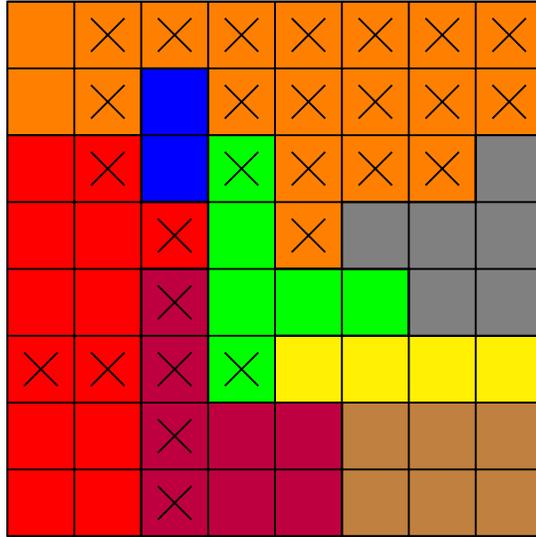


Figure 17

Using the subset {row 1, row 2}, which wholly contain the purple and brown zones we can eliminate the red squares that lie in this subset.

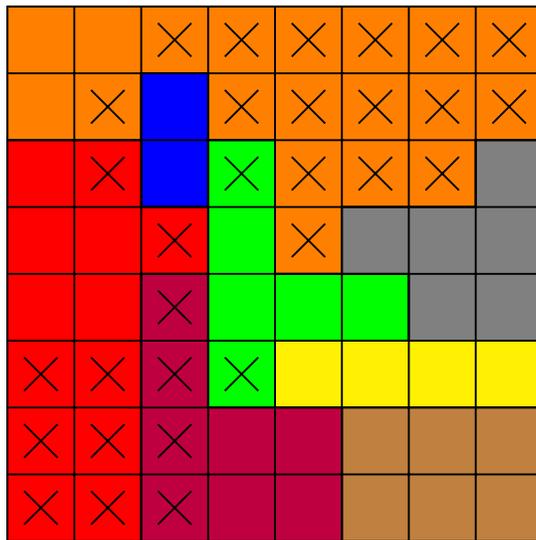


Figure 18

We see that the orange and blue zones are the only colours contained in the subset {row 7, row 8}, hence we can deduce the position of the blue queen.

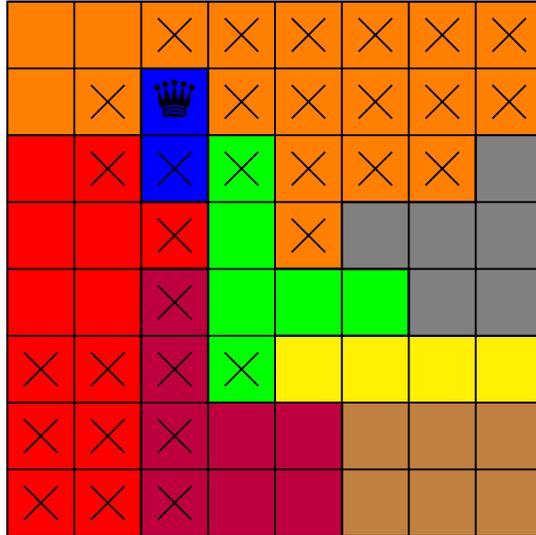


Figure 19

The blue queen eliminates the squares diagonal, horizontal and vertically from it so we are left with only one place for the orange queen.

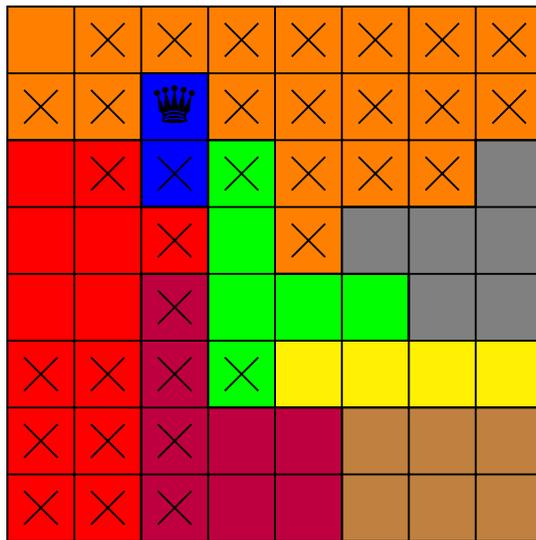


Figure 20

Given the position of the orange queen, this eliminates all squares in column 1, and hence there is only one square remaining in row 6, so we can then add the grey queen, and eliminate the relevant squares surrounding it.

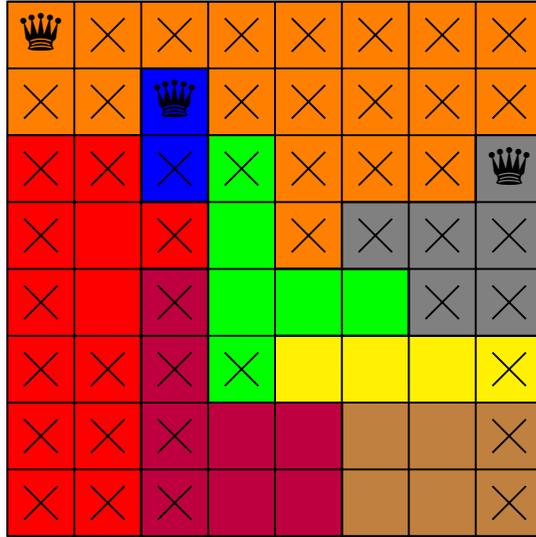


Figure 21

The yellow zone is a 1×3 rectangle so we can eliminate a square above and below it.

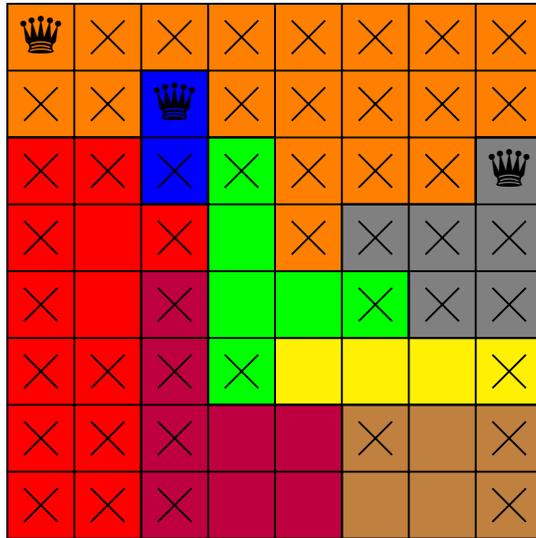


Figure 22

Observe the subset {column 6, column 7} contains only the yellow and brown colour zones, so we can eliminate the yellow square outside this subset.

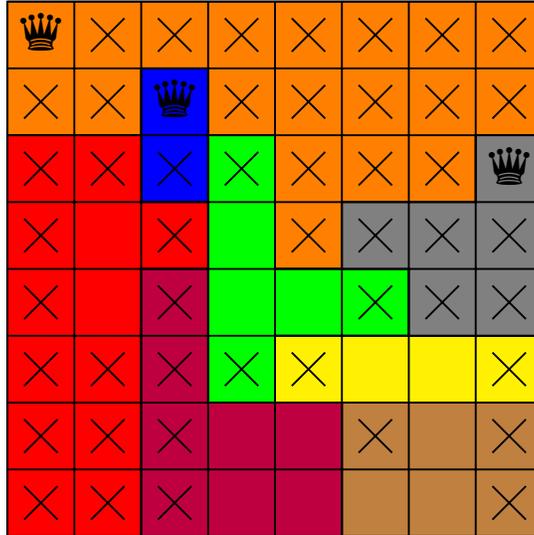


Figure 23

The yellow zone is now a 1×2 rectangle, so we can a brown square below it. This turns the brown zone into a 2×1 rectangle, so we can eliminate the purple squares in row 1.

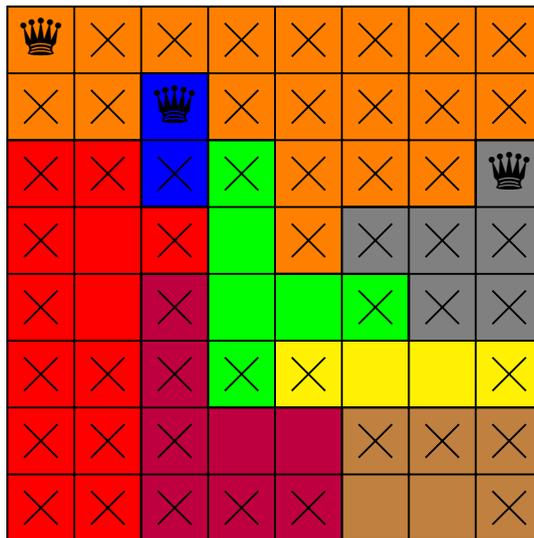


Figure 24

At this point, it makes sense to look at the yellow, brown and purple zones that are close together. If we place a queen in the rightmost purple square then this will eliminate the entirety of column 6, hence we must put the purple queen in the leftmost square.

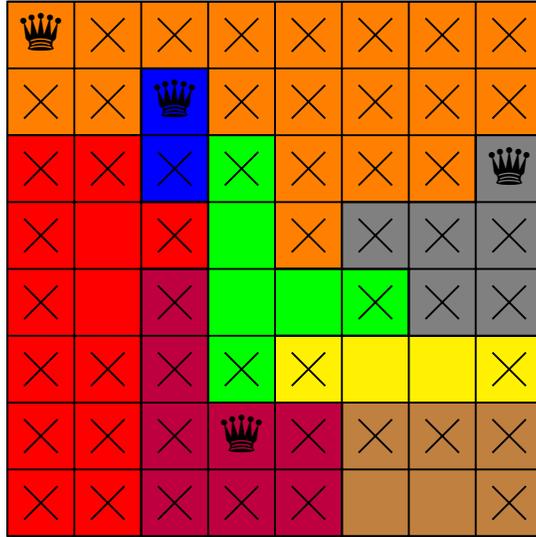


Figure 25

From here, we can quickly deduce the remainder of the puzzle.

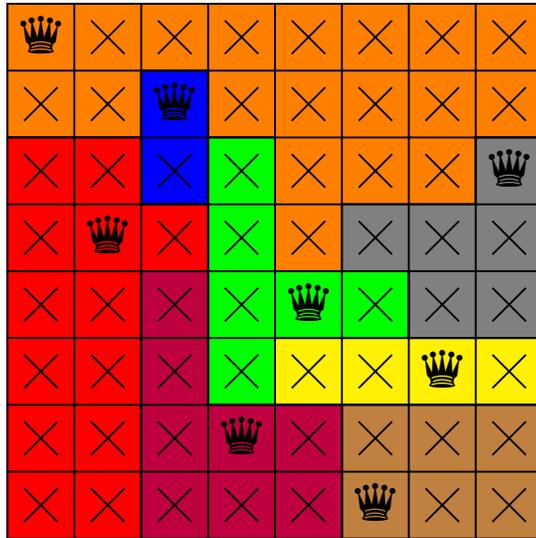


Figure 26