**Week 1: Backtracking and the 8 queen’s problem**

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**Statement of the problem**

Basic terminologies:

* 8 queen’s problem: Given chess board. A chess board has 8x8 fields. Is it possible to arrange 8 queens on the board so that no two queens can attack each other? This eight queen s problem can be generalized as N queen’s problem in an N x N chessboard.
* Backtracking: Backtracking is a kind of solving a problem by trial and error. However it is well organized trial and error. We make sure that we never try the same thing twice. We also make sure that if the problem is finite we will eventually try out all the possibilities (assuming there is enough computing power to try all possibilities).

**Input:**

A 8x8 chess board and 8 queens. Queens can move horizontally, vertically and diagonally.

**Output:**

A chessboard with 8 queens arranged on the board in such a way that no two queens can attack each other.

**Intermediate Processes:**

In order to describe the steps involved in solving the 8 queens problem using the backtracking algorithm. We can take a smaller example of 4 queen’s problem in a 4x4 chessboard and then generalize this approach for 8 queen’s problem.

Steps for solving 4 queens problem using backtracking algorithm:

|  |  |  |
| --- | --- | --- |
| Steps | Remarks | Chessboard |
| 1 | Begin with an empty chessboard with single queen place in first row, first column. | |  |  |  |  | | --- | --- | --- | --- | | Q |  |  |  | |  |  |  |  | |  |  |  |  | |  |  |  |  | |
| 2. | Add another queen to first row, second column. If it is under attack then move it to another row (keeping the column same) until it is at safe position. | |  |  |  |  | | --- | --- | --- | --- | | Q | Q |  |  | |  | ↓ |  |  | |  | Q |  |  | |  |  |  |  | |
| 3. | Add third queen to first row, third column, and move it down the row until it is at safe position. If the queen reaches to last row and is still under attack then backtrack to second column and move the second queen down the row to next safe position. Repeat this backtracking step with the first queen if the second queen reaches to the end of the row. Finally replace the third queen with same process described above. | |  |  |  |  | | --- | --- | --- | --- | | Q |  |  |  | |  |  | Q |  | |  |  |  |  | |  | Q |  |  | |
| 4. | Add the fourth queen to first row, fourth column and repeat the steps mentioned above to find the solution to the problem. | |  |  |  |  | | --- | --- | --- | --- | |  | Q |  |  | |  |  |  | Q | | Q |  |  |  | |  |  | Q |  | |

Solving the 8 queen’s problem is similar to 4 queen’s problem in the latter case we have 8 queens’ to place on an 8x8 chessboard. As a matter of fact this problem can be generalized as N queen’s problem on an N x N chessboard. Thus backtracking is essentially a recursive algorithm which involves repeating same process each time with new queen to place and also tracking back to previously placed queens if required.

**References:**

1. A brief introduction to Backtracking and 8 queens problem with a step by step solution to 4 queens problem: from: <http://cpe.njit.edu/dlnotes/CIS/CIS114/video14.pdf> [Referenced on: April 19, 2012]
2. A simple simulator to solve 8 queens problem, from: <http://www.hbmeyer.de/backtrack/achtdamen/eight.htm> [Referenced on April 19,2012]
3. The Animation of Recursion, from: <http://www.animatedrecursion.com/advanced/the_eight_queens_problem.html> [Referenced on April 23, 2012]
4. Backtracking, The n queen problem, from: <http://www.roard.com/docs/cookbook/cbsu6.html> [Referenced on April 23, 2012]