8-Queens Problem using Simulated Annealing

Simulated annealing algorithm:

The annealing algorithm tries to find the proper solution by taking risks at first and then gradually becoming more conservative.

The method is based on the annealing process, which is utilized in glass blowing and metallurgy in real life. Molten glass, for example, is incredibly hot but quickly cools. The glass will fracture if the room temperature is too chilly. To avoid this, glass is placed in an annealing oven, which gradually reduces the temperature, allowing for a more consistent cooling process. The danger is "cooled" using the algorithm's "temperature" and "annealing rate."

Following are steps included in the simulated annealing process:

1) Make a move
2) If a move gives a lower heuristic value, we will accept this move. Otherwise, take a risk and determine if it should be accepted or not. If a move gives a large heuristic value, then discard it and repeat steps 1 and 2.
3) Decrease temperature by a given annealing rate.
4) Repeat until a solution is found.

Implementation:

Implementation is done using Java.

Functions used:

Main(): This method is a main method from execution of program starts. It accepts a number of queens and gives an internal call to simulated annealing function which provides a solution to given n- Queens.

Displayresult(): This method is used to print n-queens position.

generateNQueensSolution(): This method performs a simulated annealing procedure.

checkMove(): This functions checks, is next move provides better results than the current move or not.

generateRandomState(): It generates random initial states for N-queens.

getHeuristicCost(): This function computes heuristic cost.

Parameters used to run your program:

1. Number of Queens: Number of queens for which solution is expected.
2. Number of iterations: This is a number of times annealing moves occur.
3. Temperature: Initial temperature on which annealing move is dependent. If the temperature is low states act less randomly and vice versa.
4. Cooling factor: Parameter which reduces temperature parameter.

Code:

Please find this github URL for project code.

https://github.com/nehalkathale/NQueensSimulatedAnnealing

Output:

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Enter number of Queens:
Random State generated is as follows:
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 -  Q  -  -  -  -  -  -
 -  -  -  -  -  Q  -  -
 -  -  Q  -  -  -  -  -

Final State is as follows:
 -  -  -  Q  -  -  -  -
 -  -  -  -  -  -  Q  -
 Q  -  -  -  -  -  -  -
 -  -  -  -  -  -  -  Q
 -  -  -  -  Q  -  -  -
 -  Q  -  -  -  -  -  -
 -  -  -  -  -  Q  -  -
 -  -  Q  -  -  -  -  -
```

Experimental results:

As compared to 8-Queen hill-climbing, simulated annealing provides more efficient and optimal solution. The main difference between hill-climbing and simulated annealing is simulated annealing does not stuck at the local optima, it finds global optima. Hill climbing updates solution if the current state is better than previous whereas simulated annealing updates current solution using probability.

Opinion about the experiment:

Simulated annealing performs better than hill-climbing algorithm. In simulated annealing as temperature drop, this algorithm chooses a different value to maximize the current value. This mechanism helps Simulated annealing to optimize solutions.