

N-Queens using Genetic Algorithm

Using Brute force algorithm for N-queens results in $O(N^N)$ time complexity.

By using Brute force technique for N-queens results in $O(2^N)$ time complexity.

Above mentioned techniques result in exponential time complexity. To improve that and have a good solution in limited time, we use Genetic Algorithm.

Genetic Algorithm (GA) is a search-based optimization technique based on the principles of Genetics and Natural Selection. It is frequently used to find optimal or near-optimal solutions to difficult problems which otherwise would take a lifetime to solve [1].

Here, we will solve classic N-Queen's problem using Genetic algorithm [2].

Population: Initial population size must be optimum, as large population size may lead for genetic algorithm to take more time whereas less population size may not lead to good mating pools

Crossover: Here, parents are selected and off springs are produced, using them. This is used for exploitation of the Search space. Here, crossover probability is entered by user. This probability is generally kept high.

Mutation: Here, a random change in chromosome to make a new solution is known as mutation. This is used for exploration of the Search space. This probability is generally kept less, as High mutation probability leads to random search.

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Some results obtain after conducting several experiments are as follows:

For 6 Number of queens:

```
Enter the value of N : 6
Enter initial population size : 15
Enter crossover probablity:0.9
Enter mutation probablity:0.1
populations generated: 7034
Solution : [3, 6, 2, 5, 1, 4]
-----N queens Board-----
*  Q  *  *  *  *
*  *  *  Q  *  *
*  *  *  *  *  Q
Q  *  *  *  *  *
*  *  Q  *  *  *
*  *  *  *  Q  *
Time Taken in seconds: 11.930944681167603
```

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For 7 Number of queens:

```
Enter the value of N : 7
Enter initial population size : 18
Enter crossover probability:0.85
Enter mutation probability:0.2
populations generated: 1030
Solution : [6, 3, 5, 7, 1, 4, 2]
-----N queens Board-----
*   *   *   Q   *   *   *
Q   *   *   *   *   *   *
*   *   Q   *   *   *   *
*   *   *   *   *   Q   *
*   Q   *   *   *   *   *
*   *   *   *   *   *   Q
*   *   *   *   Q   *   *
Time Taken in seconds: 0.7579755783081055
```

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For 8 Number of queens:

```
Enter the value of N : 8
Enter initial population size : 25
Enter crossover probablity:0.85
Enter mutation probablity:0.15
populations generated: 4850
Solution : [6, 4, 1, 5, 8, 2, 7, 3]
-----N queens Board-----
*   *   *   *   Q   *   *   *
*   *   *   *   *   *   Q   *
Q   *   *   *   *   *   *   *
*   *   *   Q   *   *   *   *
*   Q   *   *   *   *   *   *
*   *   *   *   *   *   *   Q
*   *   *   *   *   Q   *   *
*   *   Q   *   *   *   *   *
Time Taken in seconds: 11.301092624664307
```

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For 9 Number of queens:

```
Enter the value of N : 9
Enter initial population size : 25
Enter crossover probability:0.85
Enter mutation probability:0.2
populations generated: 13270
Solution : [1, 6, 8, 3, 7, 4, 2, 9, 5]
-----N queens Board-----
*   *   *   *   *   *   *   Q   *
*   *   Q   *   *   *   *   *   *
*   *   *   *   Q   *   *   *   *
*   Q   *   *   *   *   *   *   *
*   *   *   *   *   *   *   *   Q
*   *   *   *   *   Q   *   *   *
*   *   *   Q   *   *   *   *   *
*   *   *   *   *   *   Q   *   *
Q   *   *   *   *   *   *   *   *
Time Taken in seconds: 134.1647343635559
```

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For 10 Number of queens:

```
Enter the value of N : 10
Enter initial population size : 30
Enter crossover probablity:0.9
Enter mutation probablity:0.05
populations generated: 18211
Solution : [3, 9, 6, 10, 2, 7, 1, 4, 8, 5]
-----N queens Board-----
*  *  *  Q  *  *  *  *  *  *
*  Q  *  *  *  *  *  *  *  *
*  *  *  *  *  *  *  *  Q  *
*  *  *  *  *  Q  *  *  *  *
*  *  Q  *  *  *  *  *  *  *
*  *  *  *  *  *  *  *  *  Q
*  *  *  *  *  *  *  Q  *  *
Q  *  *  *  *  *  *  *  *  *
*  *  *  *  Q  *  *  *  *  *
*  *  *  *  *  *  Q  *  *  *
```

Time Taken in seconds: 67.8745219707489

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For 11 Number of queens:

```
Enter the value of N : 11
Enter initial population size : 40
Enter crossover probablity:0.9
Enter mutation probablity:0.07
populations generated: 36962
Solution : [11, 6, 3, 10, 2, 4, 9, 1, 8, 5, 7]
-----N queens Board-----
Q  *  *  *  *  *  *  *  *  *  *
*  *  *  Q  *  *  *  *  *  *
*  *  *  *  *  *  Q  *  *  *
*  *  *  *  *  *  *  *  Q  *
*  *  *  *  *  *  *  *  *  Q
*  Q  *  *  *  *  *  *  *  *
*  *  *  *  *  *  *  *  Q  *
*  *  *  *  *  Q  *  *  *  *
*  *  Q  *  *  *  *  *  *  *
*  *  *  *  Q  *  *  *  *  *
*  *  *  *  *  *  *  Q  *  *
```

Time Taken in seconds: 309.43965458869934

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References:

[1]https://www.tutorialspoint.com/genetic_algorithms/genetic_algorithms_introduction.htm

[2]<https://github.com/waqqasiq/n-queen-problem-using-genetic-algorithm>