算法说明

1.回溯算法:

逐行放置皇后，确保每行只有一个皇后

使用 is_safe()检查列和对角线冲突

递归探索所有可能位置，遇到冲突时回溯

2.优化思路:

使用一维数组存储皇后位置（索引=行，值=列）

提前终止：当找到第一个解时立即返回（如果不需要所有解）

对角线检查优化：仅检查当前行上方的冲突

实验结果

N = 4:

```
Enter board size N (N>=4): 4
Find all solutions? (y/n): y

Found 2 solution(s)

Solution 1:
. Q . .
. . . Q
Q . . .
. . Q .

Solution 2:
. . Q .
Q . . .
. . . Q
. Q . .
```

N = 8

```
Solution 91:
. . . . . . . Q
. . Q . . . . .
Q . . . . . . .
. . . . . Q . .
. Q . . . . . .
. . . . Q . . .
. . . . . . Q .
. . . Q . . . .

Solution 92:
. . . . . . . Q
. . . Q . . . .
Q . . . . . . .
. . Q . . . . .
. . . . . Q . .
. Q . . . . . .
. . . . . . Q .
. . . . Q . . .
```

实验分析

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Run performance experiments? (y/n): y
N=4: 2 solutions, Time: 0.000000s
N=5: 10 solutions, Time: 0.001223s
N=6: 4 solutions, Time: 0.002020s
N=7: 40 solutions, Time: 0.010484s
N=8: 92 solutions, Time: 0.044795s
N=9: 352 solutions, Time: 0.215059s
N=10: 724 solutions, Time: 0.869414s
N=11: 2680 solutions, Time: 2.046520s
N=12: 14200 solutions, Time: 11.901771s
```

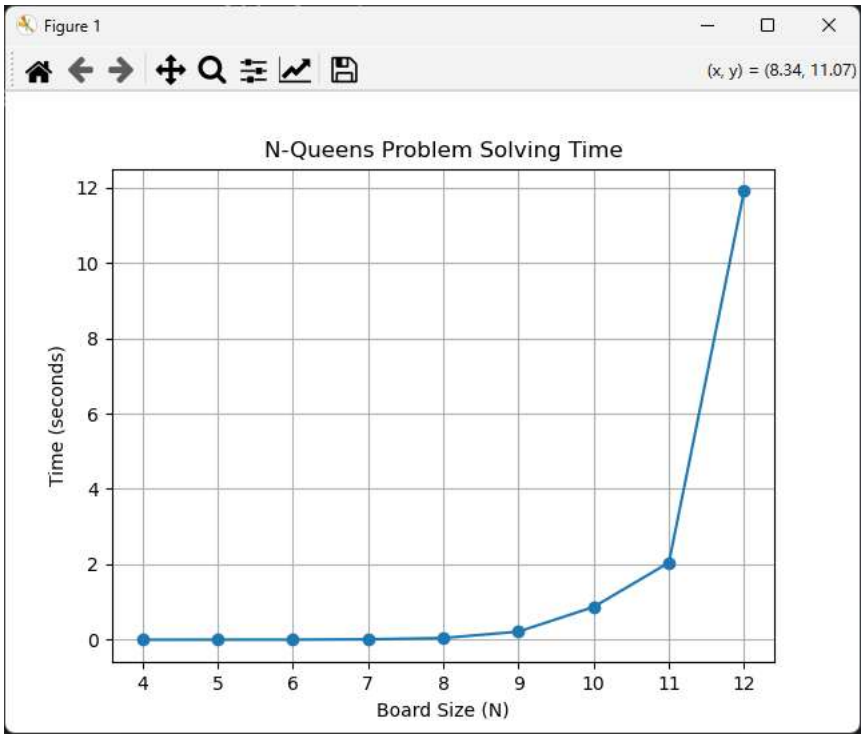
Figure 1
(x, y) = (8.34, 11.07)
N-Queens Problem Solving Time
Time (seconds)
Board Size (N)
0
2
4
6
8
10
12
4
5
6
7
8
9
10
11
12