

Extra theory notes

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N-Queen Problem (4x4) – Theory Using Backtracking

The **N-Queen problem** is a classic **backtracking** problem where the goal is to place **N queens** on an **N×N chessboard** such that **no two queens** threaten each other. This means:

- No two queens can be in the **same row**, **same column**, or **same diagonal**.

In the **4x4 N-Queen problem**, we have to place **4 queens** on a **4×4 board** without any queen attacking another.

◆ **Backtracking Approach**

Backtracking is a **trial-and-error** method that incrementally builds solutions and **backtracks** when a conflict is detected.

Steps:

1. **Start from column 0**, try placing a queen in each row one by one.
2. For each attempted position, check if it is **safe**:
 - No other queen in the **same row** to the left.
 - No other queen in the **upper left diagonal**.
 - No other queen in the **lower left diagonal**.
3. If safe, **place the queen** and recursively attempt to place the next queen in the next column.
4. If placing a queen leads to no solution, **backtrack**: remove the queen and try the next position.
5. Repeat until all **4 queens** are placed successfully.

◆ **Base Case**

If all 4 queens are placed (i.e., column index = 4), then a valid solution is found.

◆ **Time Complexity**

The worst-case time complexity is **O(N!)**, as we may need to try all permutations.