Constraint Satisfaction Problem

- Constraints means rules.
- N Queen, Graph coloring, cryptarithmetic are some of the examples of Constraint Satisfaction Problem.

1.) N-Queen Problem:-

Problem:-
- Place n-queens on n * n chessboard such that no two queens should attack each other.

Rule - Two Queens attack each other if they are placed in - Same row, Same column and diagonally.

Eg.- If n = 4, then.

1.) ~~Place~~

	1	2	3	4
1	Q_1			
2				
3				
4				

Place Q_1 at position (1, 1).

Step2:- Check where Q_2 can be placed.

	1	2	3	4
1	Q_1			
2	X	X		
3				
4				

- Q_2 cannot be placed in (2, 1) ⇒ Same column
- Q_2 cannot be placed in (2,2) ⇒ Q_2 will be diagonal to Q_1.
- Q_2 can be placed in (2, 3) ⇒ Safe.
- Hence, we get,

	1	2	3	4
1	Q_1			
2			Q_2	
3				
4				

- Step 3 :- Place Q_3.

- Q_3 cannot be placed in (3, 1), (3,3) since it ~~be~~ will be same column of Q_1 and Q_2 respectively.

	1	2	3	4
1	Q_1			
2			Q_2	
3	×		×	
4				

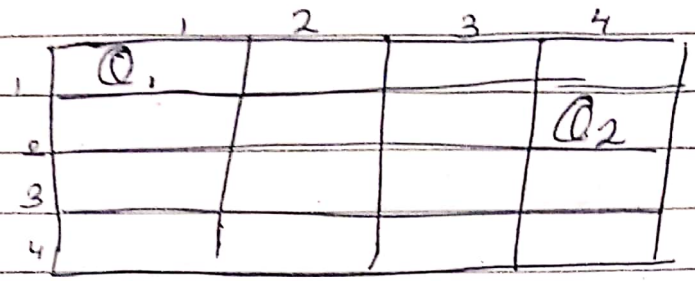
- Q_3 cannot be placed in (3, 2) since Q_2 will be diagonal to it.
- //ly, Q_3 if placed in (3, 4) will be diagonal to Q_2.

	1	2	3	4
1	Q_1			
2			Q_2	
3		×		×
4				

∴ Since Q_3 has reach dead end. Backtrack Q_2.

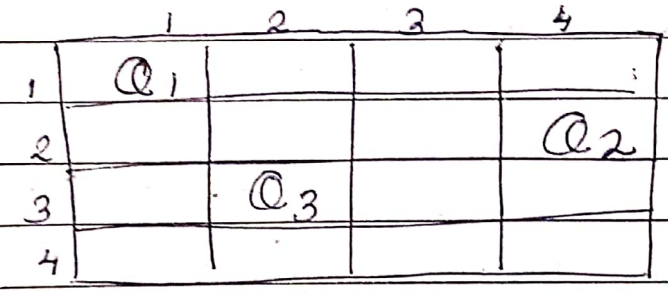
Step 4 :- Backtrack Q_2.

- So now Q_2 will be placed at (2, 4) $\Longrightarrow$ Safe.



- Step 5:- Place Q_3.

- Q_3 cannot be placed in (3, 1) & (3, 4) since it will be in same column.

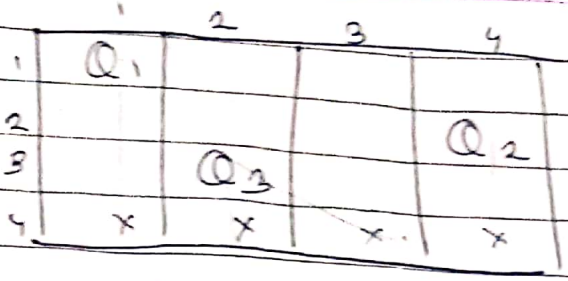


- Check Q_3 for position (3, 2) $\Rightarrow$ Safe.

- Step6 :- Place Q_4.

- Q_4 cannot be placed in (4, 1), (4, 2), (4, 4) since it will be in same column of Q_1, Q_3 & Q_2 respectively.

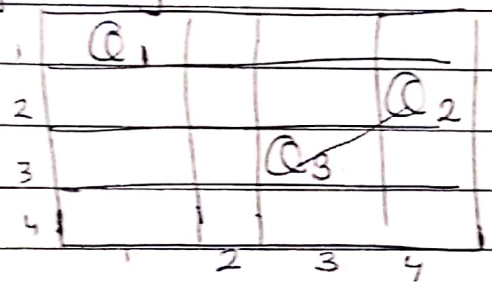
- Check for place (4, 3) $\rightarrow$ Q_3 will then attack diagonally. So unsafe.



- Since no safe place for Q_4 remains it becomes a dead end!

- Hence, backtrack Q_3.

- So Q_3 will be place in (3,3). But then Q_2 will attack it diagonally.



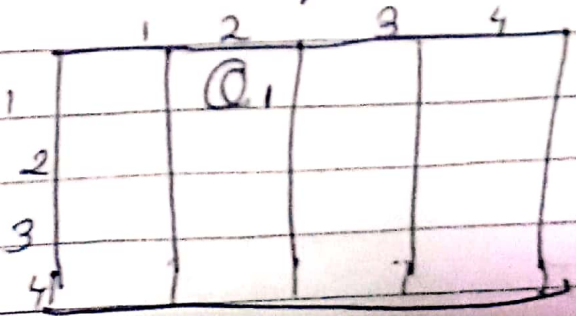
- Q_3 also cannot be placed at (3,4) $\Longrightarrow$ Same column of Q_2.

- Dead end for Q_3. So backtrack to Q_2.

- But dead end also exists for Q_2. So back track Q_1.

- Step 7 :- Backtrack Q_1.

- Q_1 will be placed at (1,2)



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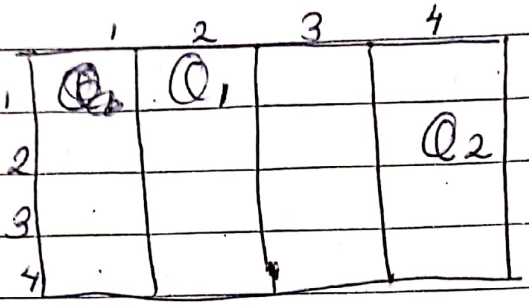
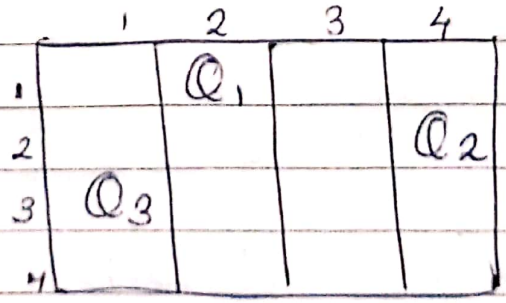
Step 8 :- Place Q_2.

- Q_2 cannot be placed in (2,1), (2,3) since Q_1 will diagonally attack Q_1.
- Q_2 cannot be placed in (2,2) ⇒ Same column.
- So place Q_2 in (2,4) ⇒ Safe.



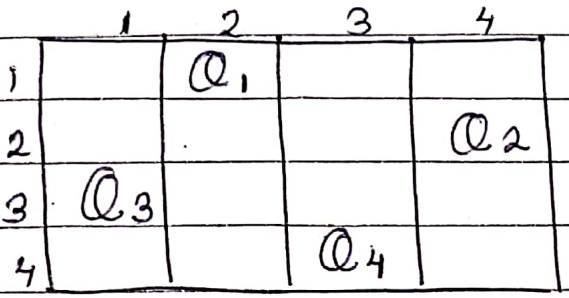
Step 9 :- Place Q_3.

- Q_3 cannot be placed in (3,2) and (3,4) ⇒ Same column
- Place Q_3 in (3,1) ⇒ Safe



Step 10 :- Place Q_4.

- Q_4 cannot be placed in (4,1), (4,2), (4,4) ⟹ ~~Dia~~ Same Column.
- So check for (4, 3). ⟹ Safe!



Final Solution ⟹ (2, 4, 1, 3).

- 4 Queens are placed in 4×4 chess board such that no two queens are placed in same row, same column & diagnally.

5 × 5 Queen.

Q_1				
		Q_2		
×	×	×	×	Q_3
×	×	×	×	×

Q_1				
			Q_2	
×	Q_3	×	×	×
×	×	×	×	Q_4
×	×	Q_5	×	×

(Solution)

Find another solution for 5×5 Queen. Try placing Q_1 at position (1, 2) & then solve.

- Find 1 solution for 8×8 Queen Problem.