

Backtracking

- Backtracking is a general algorithm for finding all (or some) solutions to some computational problem.
- Incrementally builds candidates to the solutions, and backtracks each partial candidate c as soon as it determines that c cannot possibly be completed to a valid solution / complete solution
- Backtracking is an algorithmic paradigm that tries different solutions until finds a solution that “works” (i.e) valid or complete solution.
- Once it reaches one complete solution, it continues searching for other possible solutions
- State space tree – tree that represents all candidate solutions. Constructed in DFS manner.
- Promising node – node has possibility to reach valid or complete solution
- Non-promising node – node that do not have possibility to reach valid or complete solution.

n queens problem

- Let $n = 4$
- Placing 4 queens on 4x4 chessboard
- Such that, no two queens can occur in same row, column or diagonal
- $4 \times 4 \times 4 \times 4 = 256$ candidate solutions (each path from root to leaf)
- 44 valid solutions

State space tree for 4 queens problem

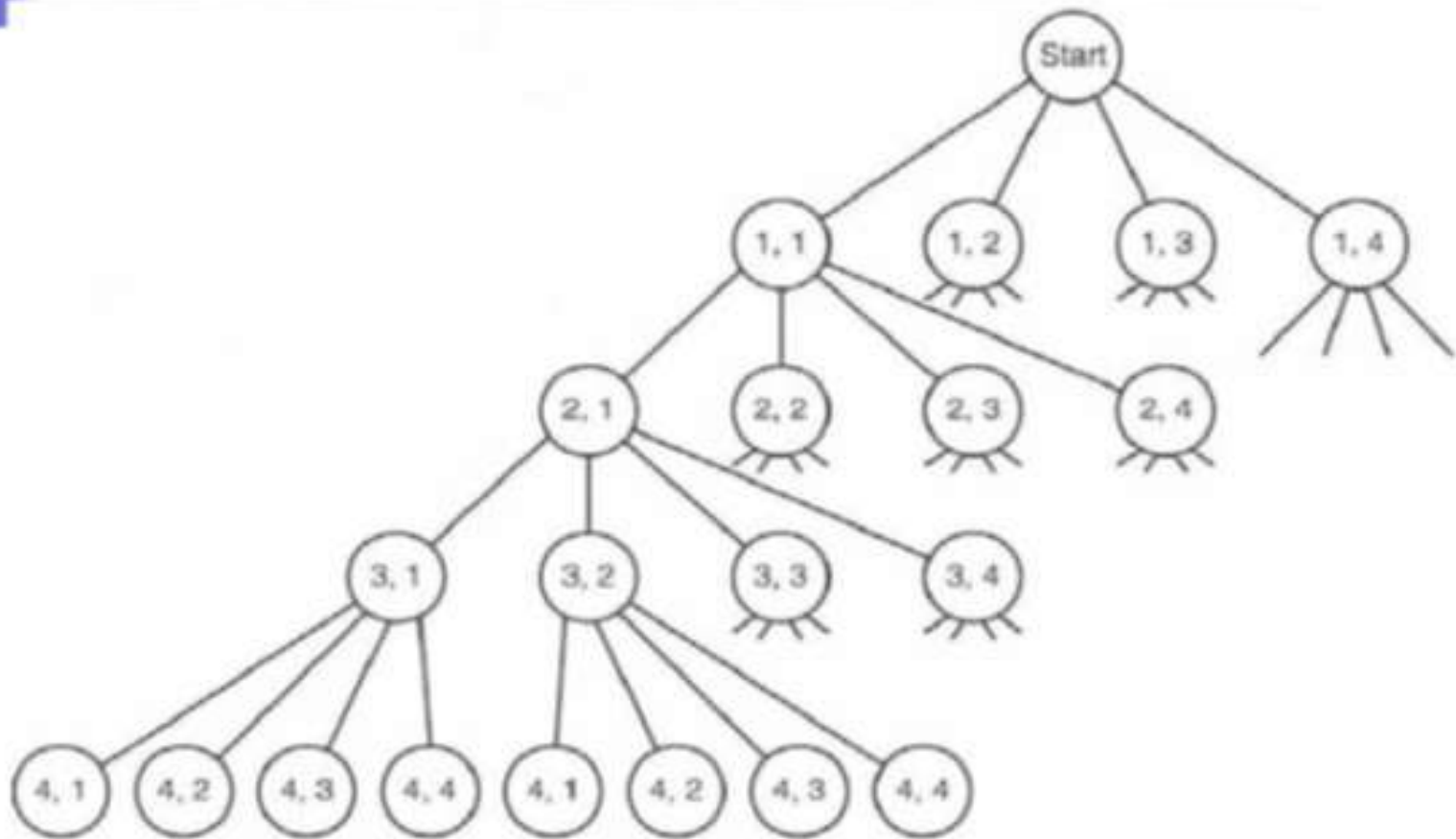


Figure 5.2 • A portion of the state space tree for the instance of the n -Queens problem in which $n = 4$. The ordered pair $\langle i, j \rangle$, at each node means that the queen in the i th row is placed in the j th column. Each path from the root to a leaf is a candidate solution.

State space tree for 4 queens problem with one valid solution

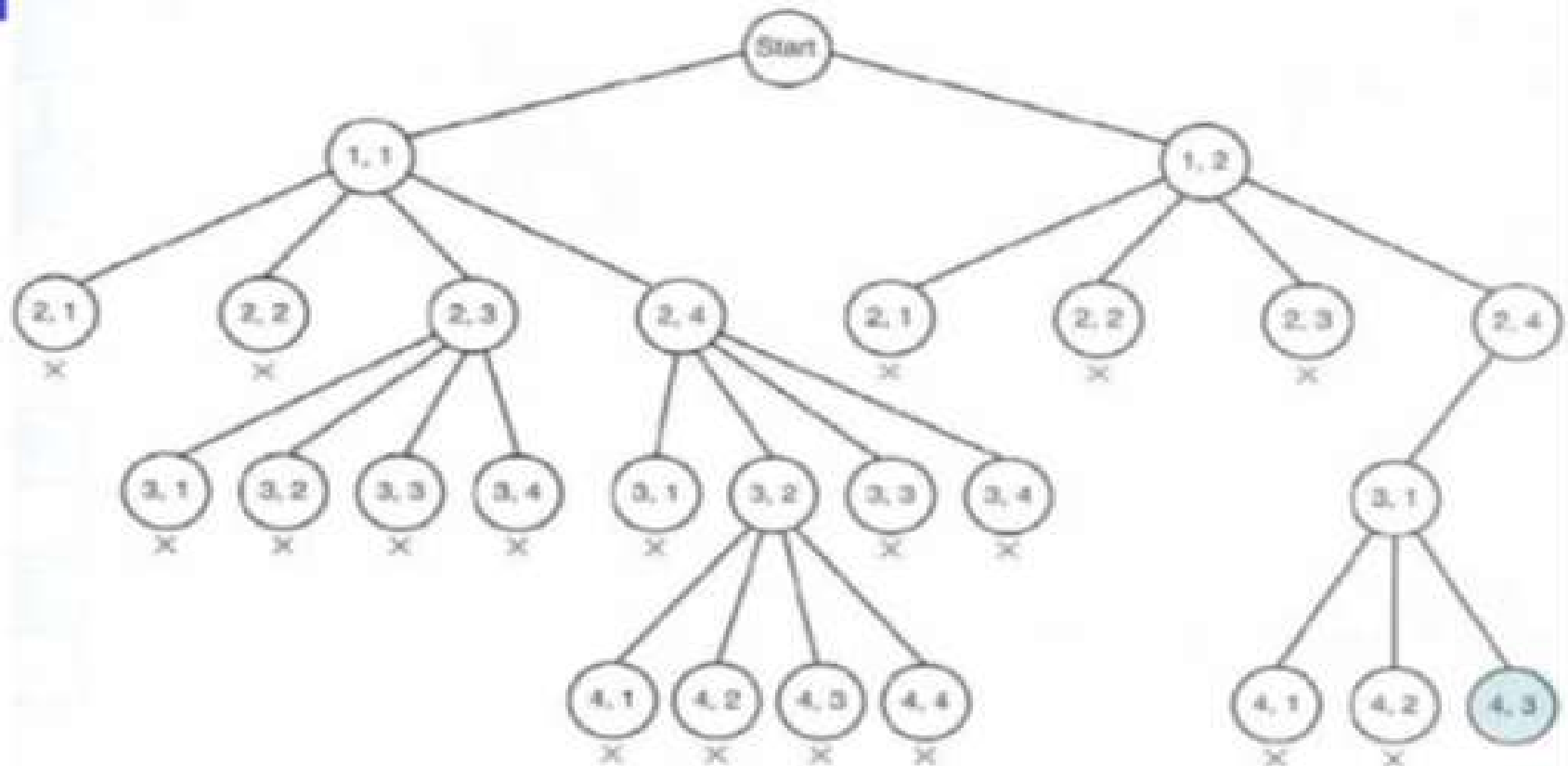


Figure 3.4 • A portion of the pruned state space tree produced when backtracking is used to solve the instance of the n -Queens problem in which $n = 4$. Only the nodes checked to find the first solution are shown. That solution is found at the color-shaded node. Each nonpromising node is marked with a cross.

Algorithm

Algorithm:

- Place the queens column wise, start from the left most column
- If all queens are placed.
 - return true and print the solution matrix.
- Else
 - Try all the rows in the current column.
 - Check if queen can be placed here safely if yes mark the current cell in solution matrix as 1 and try to solve the rest of the problem recursively.
 - If placing the queen in above step leads to the solution return true.
 - If placing the queen in above step does not lead to the solution , BACKTRACK, mark the current cell in solution matrix as 0 and return false.
- If all the rows are tried and nothing worked, return false and print NO SOLUTION.

Supplementary Exercise

- 8 queens problem