SEARCH TREE METHODS

CS340

Search Tree Methods

- How to solve hard combinatorial problems?
- Exhaustive search (enumerating all candidate solutions and identifying the one with a desired property) takes too long.
- The set of all possible choices is called the “state space”.

Search Tree Methods

- Construct a **state-space tree**
- Construct partial candidate solutions one step at a time
- If a candidate cannot possibly lead to a complete solution, stop and try something else

Backtracking

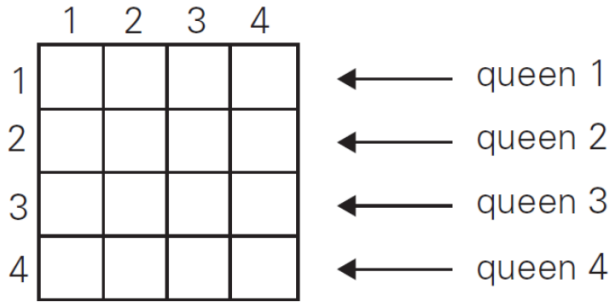
- Use when there's no good way of ranking partial solutions
- Construct partial solutions one component at a time
- While a component can be added without violating the problem's constraints, keep adding
- If the addition of a component violates the problem's constraints, *backtrack.* Remove the violating component and try a different component.

Backtracking

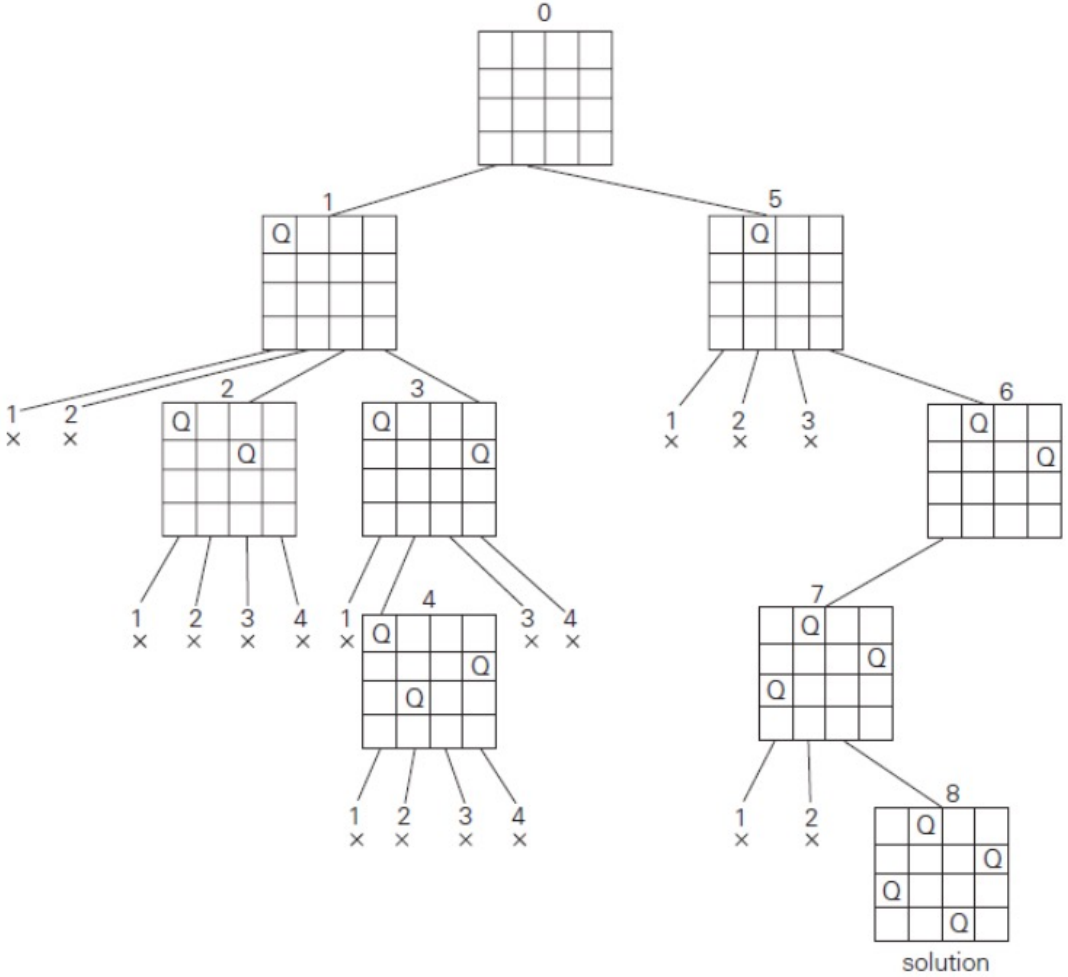
- State Space Tree
  - Keeps track of choices made in an organized way
- Promising
  - A node is *promising* if it represents a partial solution that may lead to a complete solution.
- Nonpromising
  - A partial solution that will never lead to a complete solution.
  - Backtrack on nonpromising nodes.

N-Queens

- Place n queens on a nxn chessboard such that no queen is able to attack any other (up-down, left-right, diagonally).
- One queen must be placed in each row…
- The question is which column to put it in



N-Queens


0
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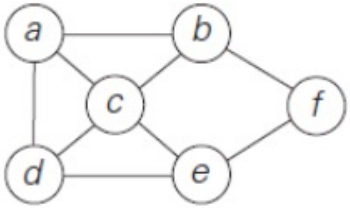
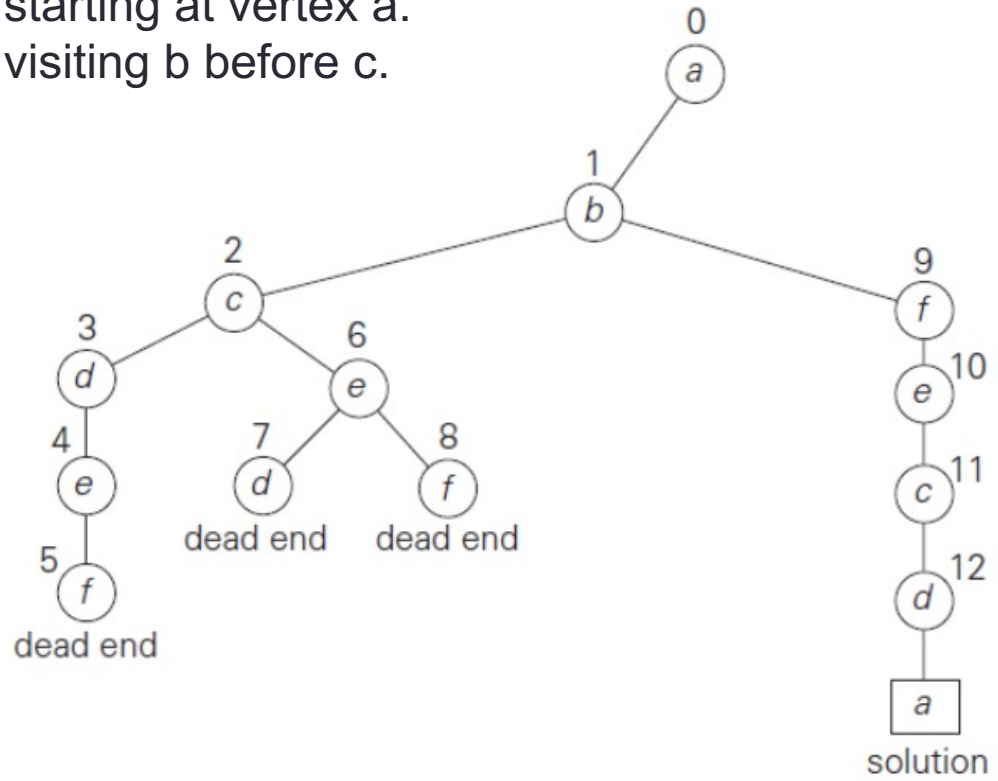
solution

Hamiltonian Circuit

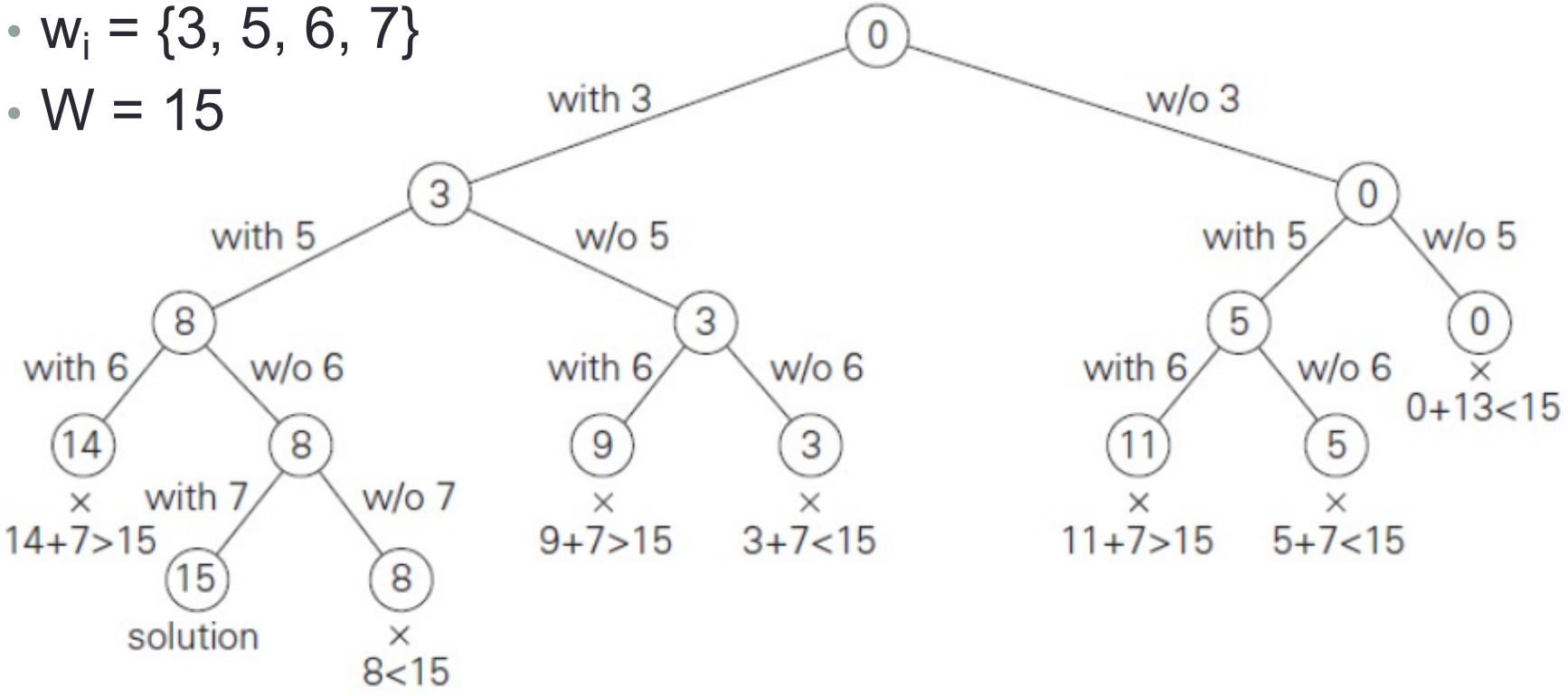
Reduce options by always starting at vertex a.
Reduce options by always visiting b before c.





Subset Sum

- If we sort the input, solutions that go over W can be pruned.
- $w_i = \{3, 5, 6, 7\}$
- W = 15



Backtracking

- What kind of search are we doing?
- What is the worst possible case?

- Tricks to reduce the state space
  - Symmetry (think of n-queens)
  - Pre-assign values (Hamiltonian Circuit always starts at node a)
  - Sort the input (Subset sum input in ascending order)