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Modul 3: Beyond Classical Search

Classical vs Local Search

Inteligensi Buatan
(*Artificial Intelligence*)

Classical Search

Problem

Known environment (observable, deterministic)

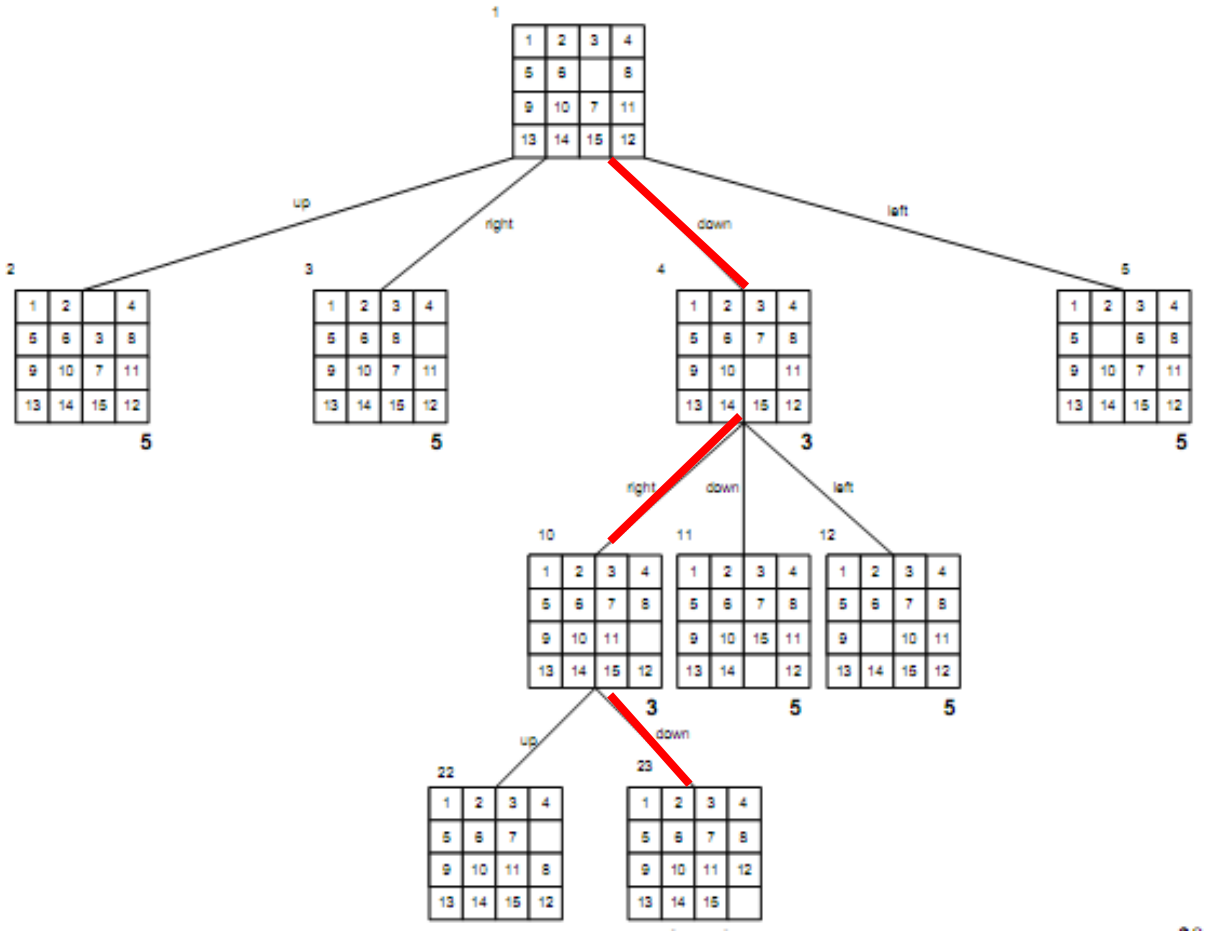
States (initial), operators, path cost, goal test

Explore search space systematically

Solution (path to goal)

Solution: sequence of actions

N-Puzzle Problem

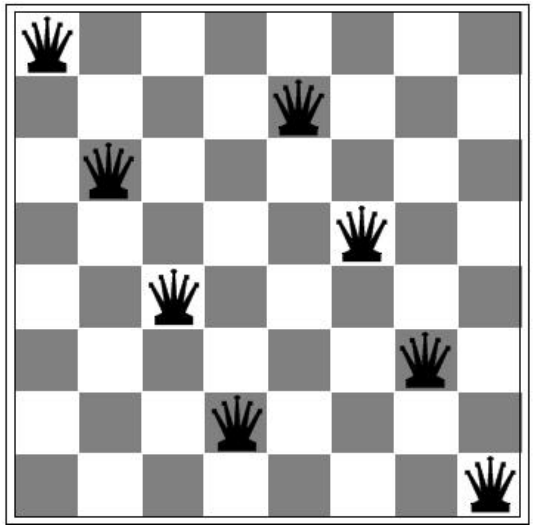


Solution: down → right → down

Path to Goal as Solution

- In many problems, the path to goal is irrelevant.
- Solution: X=(8,6,4,2,7,5,3,1)
- Q1=8 → Q2=6 → … → Q8=1

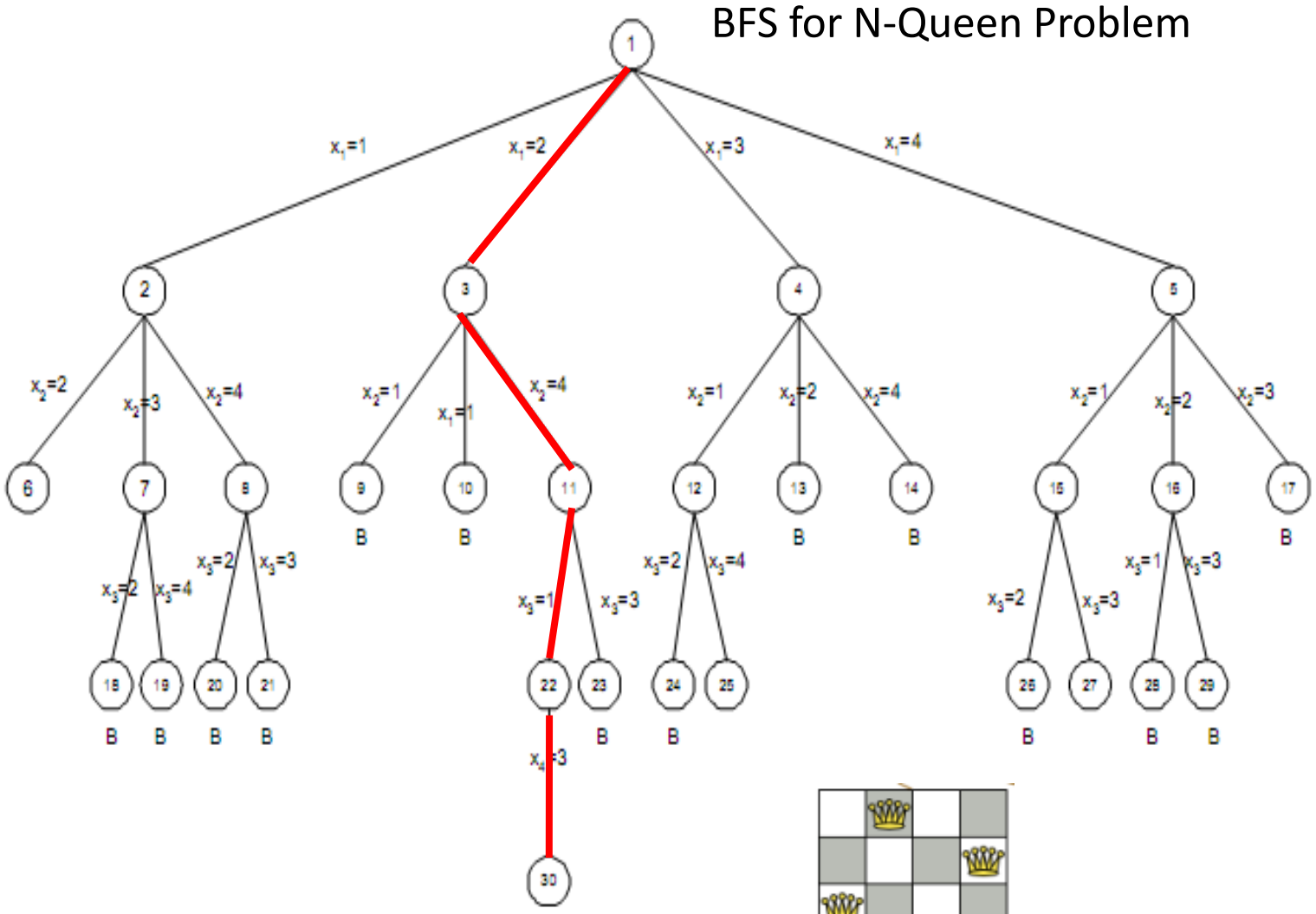
N-Queen Problem



n-queens are on the board, none attacked. one queen per column

Path to Goal as Solution (2)

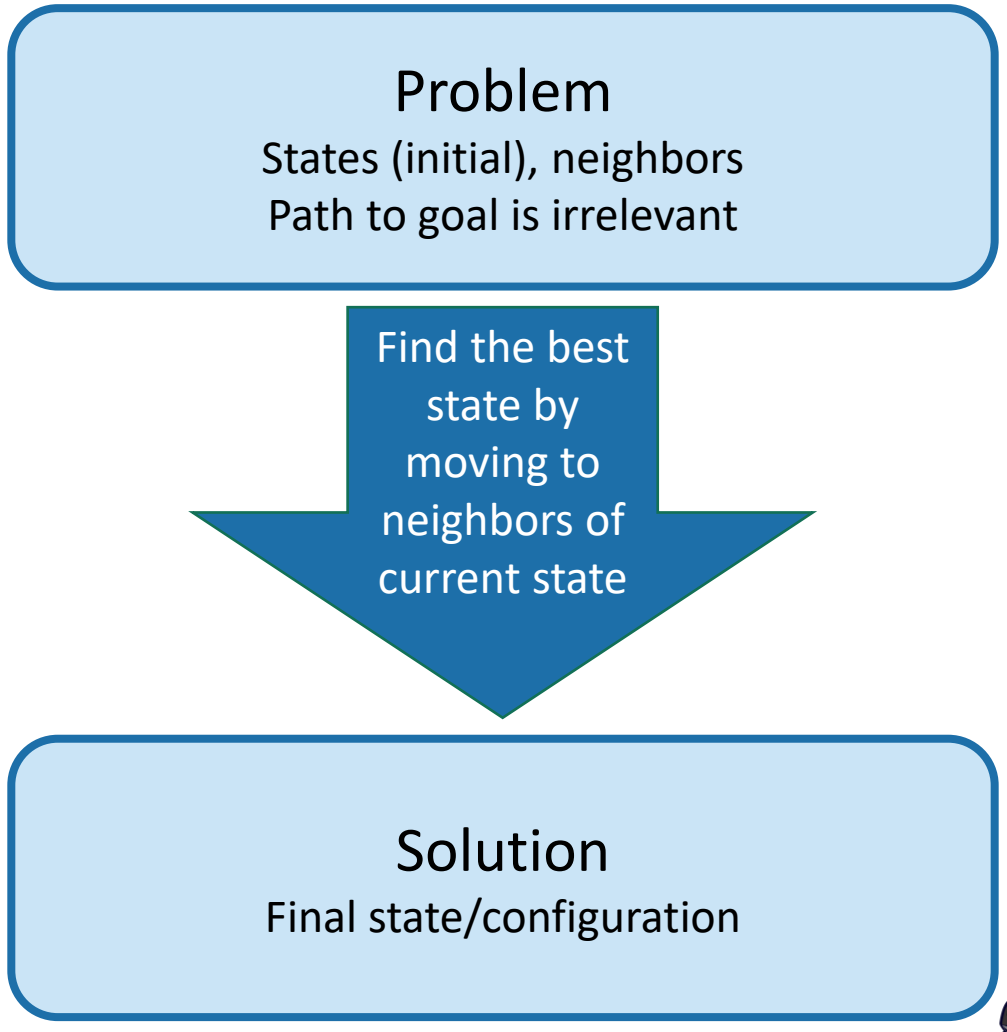
- For example, in n-queen
  - BFS solution: x1=2 → x2=4 → x3=1 → x4=3
- What matters is the final configuration of queens, not the order in which they are added.



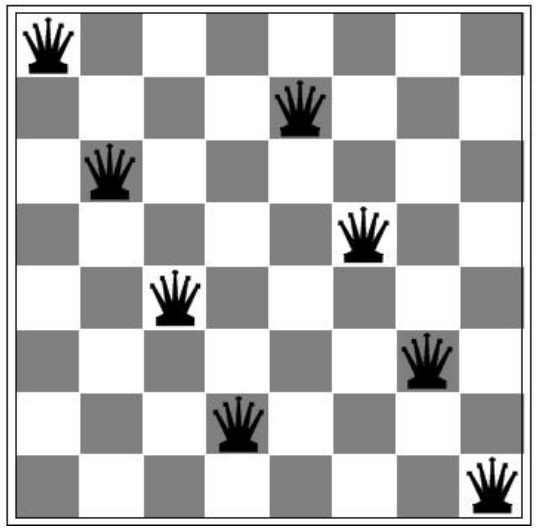
First solution 4-queen: X=(2,4,1,3)

Local Search

- If path to goal does not matter, we might consider different class of algorithms.
- Local search: complete state formulation
  - State: "complete" configurations
  - Keep single current state, not paths.
  - Action: move only to neighbors of current state.
  - No path cost → state value: value according to objective function or heuristic cost function
  - No goal test → maximum state value
  - Solution: final state.

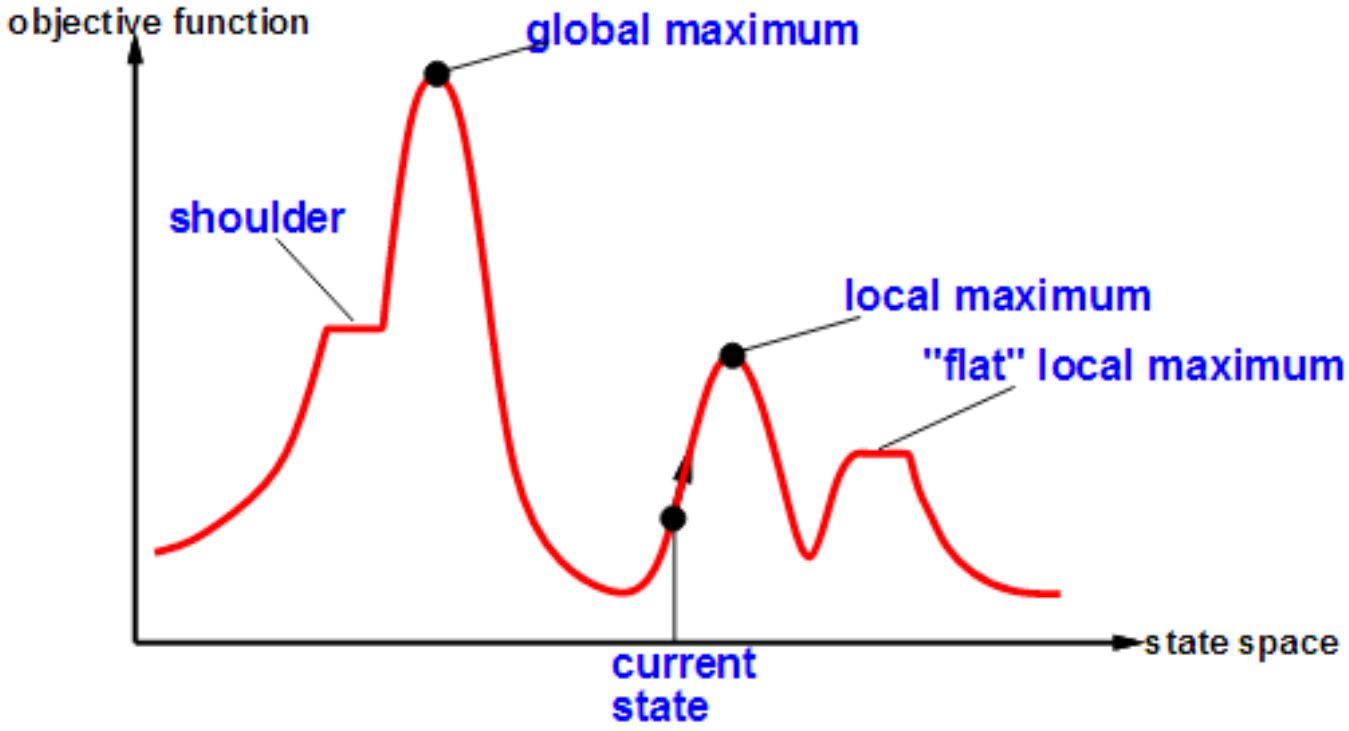


N-Queen: Classical vs Local Search



Classical search	Local search
State: any arrangement of **0 to n** queens on the board (incremental)	State: any arrangement of **n** queens on the board (complete)
Initial state: no queens on the board. Goal test: n-queens are on the board, none attacked	Initial state: a [random] state. Goal test: state value = global maximum
Action: add a queen to any empty square	Action: move a single queen to another square (neighbor)
Solution: path to goal	Solution: final state

Local Search Explore State-space Landscape



A one-dimensional state-space landscape in which elevation corresponds to the objective function. The aim is to find the global maximum. (Russel & Norvig, 2010)

- A landscape has “location” (defined by state) and “elevation” (value of objective or heuristic cost value).
- Local search aims to find global optimum.
- Problem: depending on initial state, can get stuck in local optimum.

Summary: Local Search

Keep single current state
State: "complete" configurations
Complete formulation

Find the best state (global optimum)
Action: move to neighbors

Path to goal is irrelevant
Solution: final state

Next:

- State
- Successor
- Neighbors

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Modul 3: Beyond Classical Search

State: Value, Successor, and Neighbor

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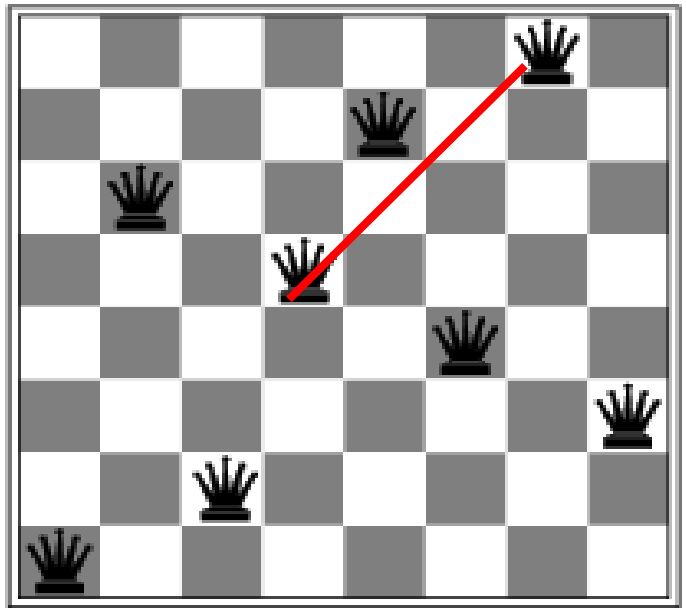
Local Search: State

Keep single current state
State: "complete" configurations (one queen per column)
Solution: final state

Find the best state (global optimum)
Action: move to neighbors

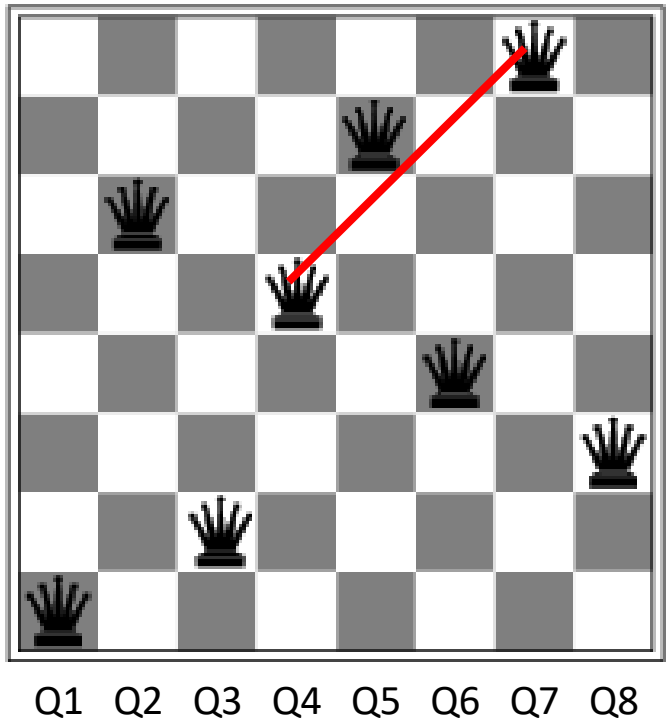
State for 8-queens problem



Each state has state value based on heuristic cost function.

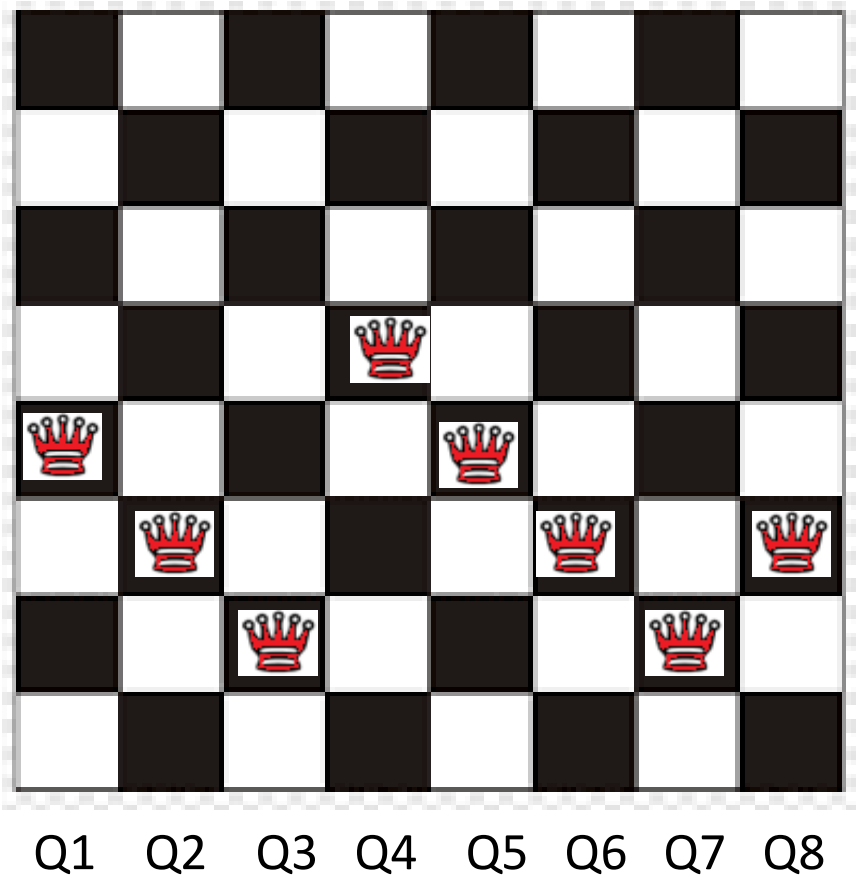
State Value (h) for 8-queens problem

- *h* = - number of pairs of queens that are attacking each other, either directly or indirectly.
- h=-1: only 1 pair of queens (Q4 attacks Q7)
- Optimum solution has global maximum, h=0.



h = *-1* for the above state

Exercise: Determine h



List pairs of queens that are attacking each other, either directly or indirectly.

h = - number of pairs of queens that are attacking each other, either directly or indirectly.

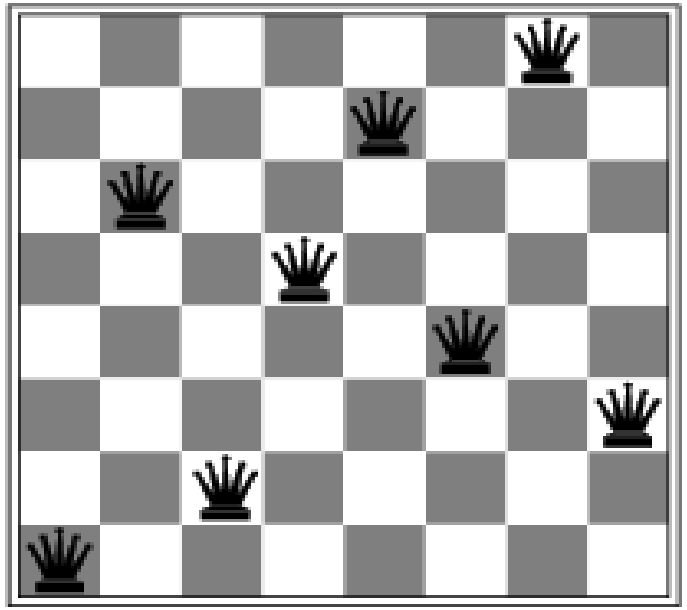
Local Search: Action

Keep single current state
State: "complete" configurations (one queen per column)
Solution: final state

Find the best state (global optimum)
Action: move to neighbor

What is neighbor of a state ?

Neighbor and Successors for 8-queens



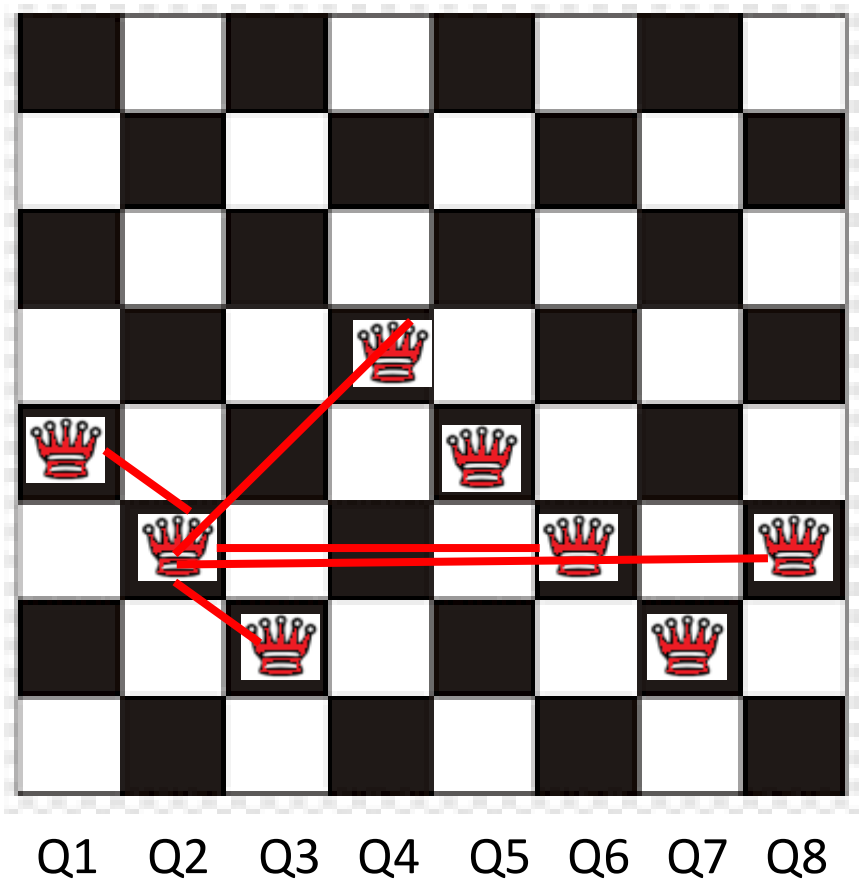
Neighbor: highest-valued successor

- Successor function returns all possible states generated by moving a single queen to another square in the same column.
- Each state has 8*7 = 56 successors
- Choose randomly among the set of best successors if there is more than one.

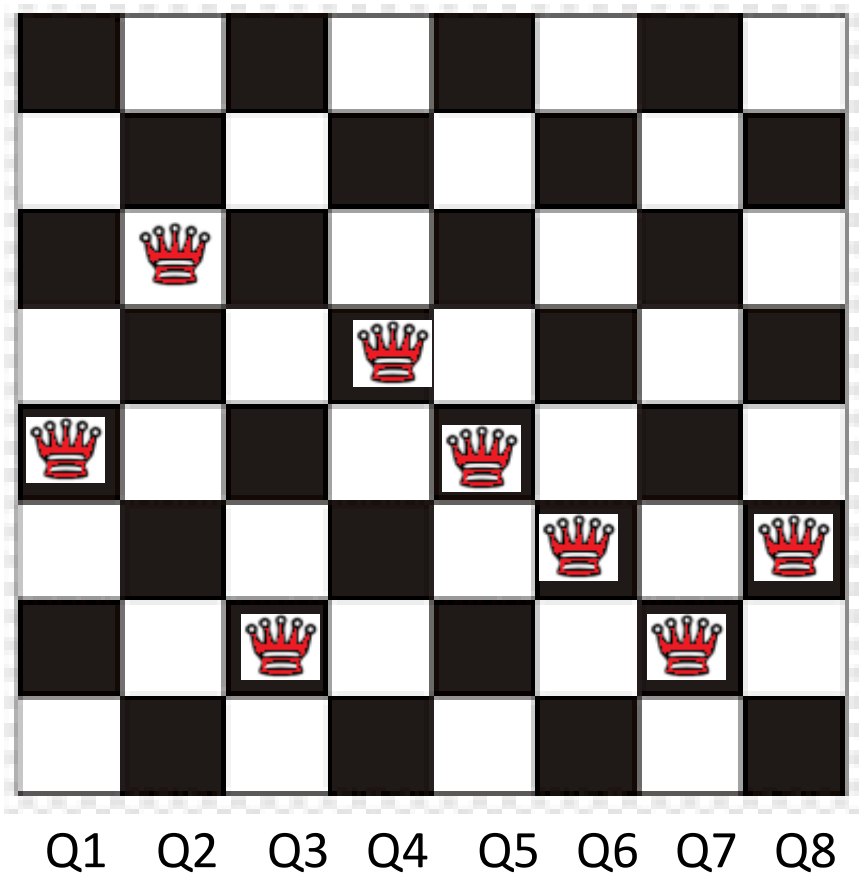
Neighbor: random successor

- Successor function returns a random state generated by moving a random single queen to another square in the same column.

Neighbor: Random Successor



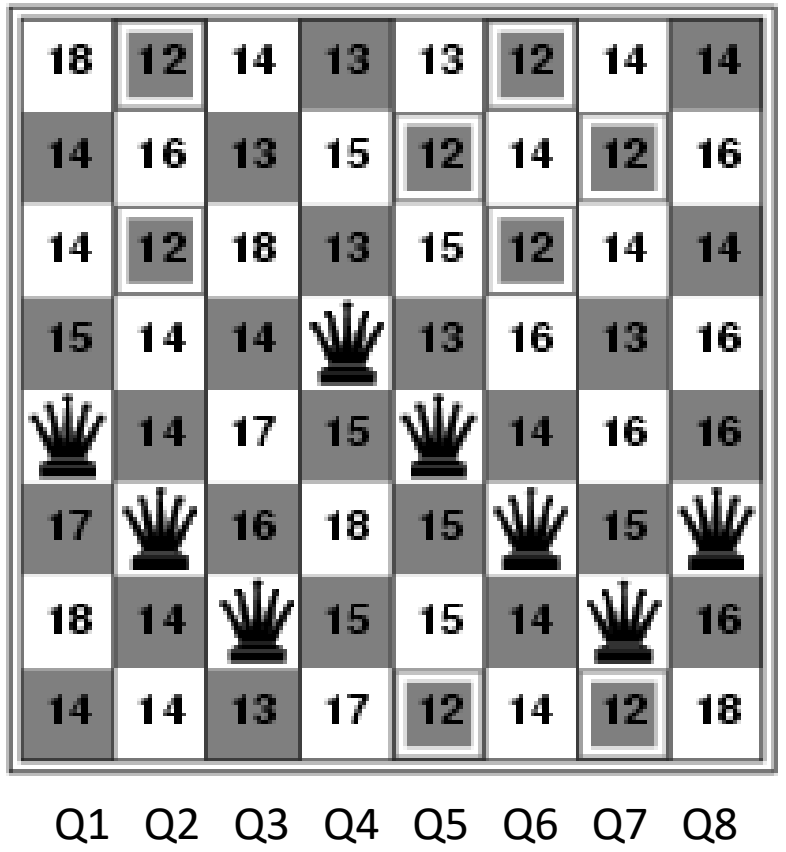
Column: Q2
Row: 3➔6



Neighbor: Highest-valued Successor

Each number indicates h if we move a queen in its corresponding column

State value dari setiap successor belum diberi tanda negative (cost)



Summary: State, Neighbor

Keep single current state
State: "complete" configurations (one queen per column)
Solution: final state

Find the best state (global optimum)
Action: move to neighbors

Next:

- Hill climbing Search
- Simulated annealing
- Genetic algorithm