Date 22/10/24

Program Title: 4 Queens using Hill climbing

Algorithm

ALGORITHM:

function HILL-CLIMBING (problem) returns a state that is a local maximum

current ← MAKE-NODE (problem.INITIAL STATE)

loop do

neighbour ← a highest-valued successor of current

if neighbour.VALUE ≤ current.VALUE then

return current.STATE

current ← neighbor

- State: 4 queens on the board. One queen per column

Variables: x_0, x_1, x_2, x_3 x_i → row position of queen in column i (1 queen per column)

- Domain for each variable: $x_i \in \{0,1,2,3\}, \forall i$

- Initial state: random state
- Goal state: 4 queens on board, none attacking each other
- ~~Neighb.~~ Neighbour relation:

Swap the row positions of two queens

- The number of pairs of queens attacking each other directly or indirectly.

OUTPUT

Code:

```python
import random
def calculate_cost(state):
    attacking_pairs = 0
    n = len(state)
    for i in range(n):
        for j in range(i + 1, n):
            if state[i] == state[j] or abs(state[i] - state[j]) == abs(i - j):
                attacking_pairs += 1
    return attacking_pairs
def get_neighbors(state):
    neighbors = []
    n = len(state)
    for i in range(n):
        for j in range(i + 1, n):
            neighbor = state[:]
            neighbor[i], neighbor[j] = neighbor[j], neighbor[i]
            neighbors.append(neighbor)
    return neighbors
def hill_climbing(initial_state):
    current_state = initial_state
    current_cost = calculate_cost(current_state)
    state_tree = {tuple(current_state): current_cost}  # Dictionary to store state and cost
    step = 0
    while True:
        print(f"\nStep {step}:")
        neighbors = get_neighbors(current_state)
        print("Neighbors:")
        for neighbor in neighbors:
            cost = calculate_cost(neighbor)
            print(f"  {neighbor}: Cost = {cost}")
            state_tree[tuple(neighbor)] = cost  # Store neighbor state and cost
        best_neighbor = None
        best_cost = current_cost
        for neighbor in neighbors:
            cost = calculate_cost(neighbor)
            if cost < best_cost:
                best_cost = cost
                best_neighbor = neighbor
        if best_cost >= current_cost:
            print(f"\nNo better neighbor found. Final state reached.")
            return current_state, current_cost, state_tree
        current_state = best_neighbor
        current_cost = best_cost
        step += 1
initial_state = [3, 1, 2, 0]
final_state, final_cost, state_space_tree = hill_climbing(initial_state)
print("\nInitial state:", initial_state)
print("Final state:", final_state)
print("Final cost (attacking pairs):", final_cost)
```


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import random
def calculate_cost(state):
    attacking_pairs = 0
    n = len(state)
```

```
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            neighbor = state[:]
            neighbor[i], neighbor[j] = neighbor[j], neighbor[i]
            neighbors.append(neighbor)
    return neighbors
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        for neighbor in neighbors:
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            state_tree[tuple(neighbor)] = cost  # Store neighbor state and cost
        best_neighbor = None
        best_cost = current_cost
        for neighbor in neighbors:
            cost = calculate_cost(neighbor)
            if cost < best_cost:
                best_cost = cost
                best_neighbor = neighbor
        if best_cost >= current_cost:
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            return current_state, current_cost, state_tree
        current_state = best_neighbor
        current_cost = best_cost
        step += 1
initial_state = [3, 1, 2, 0]
final_state, final_cost, state_space_tree = hill_climbing(initial_state)
print("\nInitial state:", initial_state)
print("Final state:", final_state)
```

```
print("Final cost (attacking pairs):", final_cost)
```

Snapshot of the output:

```
Step 0:
Neighbors:
  [1, 3, 2, 0]: Cost = 1
  [2, 1, 3, 0]: Cost = 1
  [0, 1, 2, 3]: Cost = 6
  [3, 2, 1, 0]: Cost = 6
  [3, 0, 2, 1]: Cost = 1
  [3, 1, 0, 2]: Cost = 1

Step 1:
Neighbors:
  [3, 1, 2, 0]: Cost = 2
  [2, 3, 1, 0]: Cost = 2
  [0, 3, 2, 1]: Cost = 4
  [1, 2, 3, 0]: Cost = 4
  [1, 0, 2, 3]: Cost = 2
  [1, 3, 0, 2]: Cost = 0

Step 2:
Neighbors:
  [3, 1, 0, 2]: Cost = 1
  [0, 3, 1, 2]: Cost = 1
  [2, 3, 0, 1]: Cost = 4
  [1, 0, 3, 2]: Cost = 4
  [1, 2, 0, 3]: Cost = 1
  [1, 3, 2, 0]: Cost = 1

No better neighbor found. Final state reached.

Initial state: [3, 1, 2, 0]
Final state: [1, 3, 0, 2]
Final cost (attacking pairs): 0
```

OUTPUT

step: 0

neighbours

[1, 3, 2, 0] : cost = 1

[2, 1, 3, 0] : cost = 1

[0, 1, 2, 3] : cost = 6

[3, 2, 1, 0] : cost = 6

[3, 1, 0, 2] : cost = 1

Step1
Neighbors:
[3, 1, 2, 0] : cost = 2
[2, 3, 1, 0] : cost = 2
[0, 3, 2, 1] : cost = 4
[1, 2, 3, 0] : cost = 4
[1, 0, 2, 3] : cost = 2
[1, 3, 0, 2] : cost = 0

Step 2
Neighbors:
[3, 1, 0, 2] : cost = 1
[0, 3, 1, 2] : cost = 1
[2, 3, 0, 1] : cost = 4
[1, 0, 3, 2] : cost = 4
[1, 2, 0, 3] : cost = 1
[1, 3, 2, 0] : cost = 1

Initial State : [3, 1, 2, 0]
Final state : [1, 3, 0, 2]
Final Final cost attacking pairs : 0

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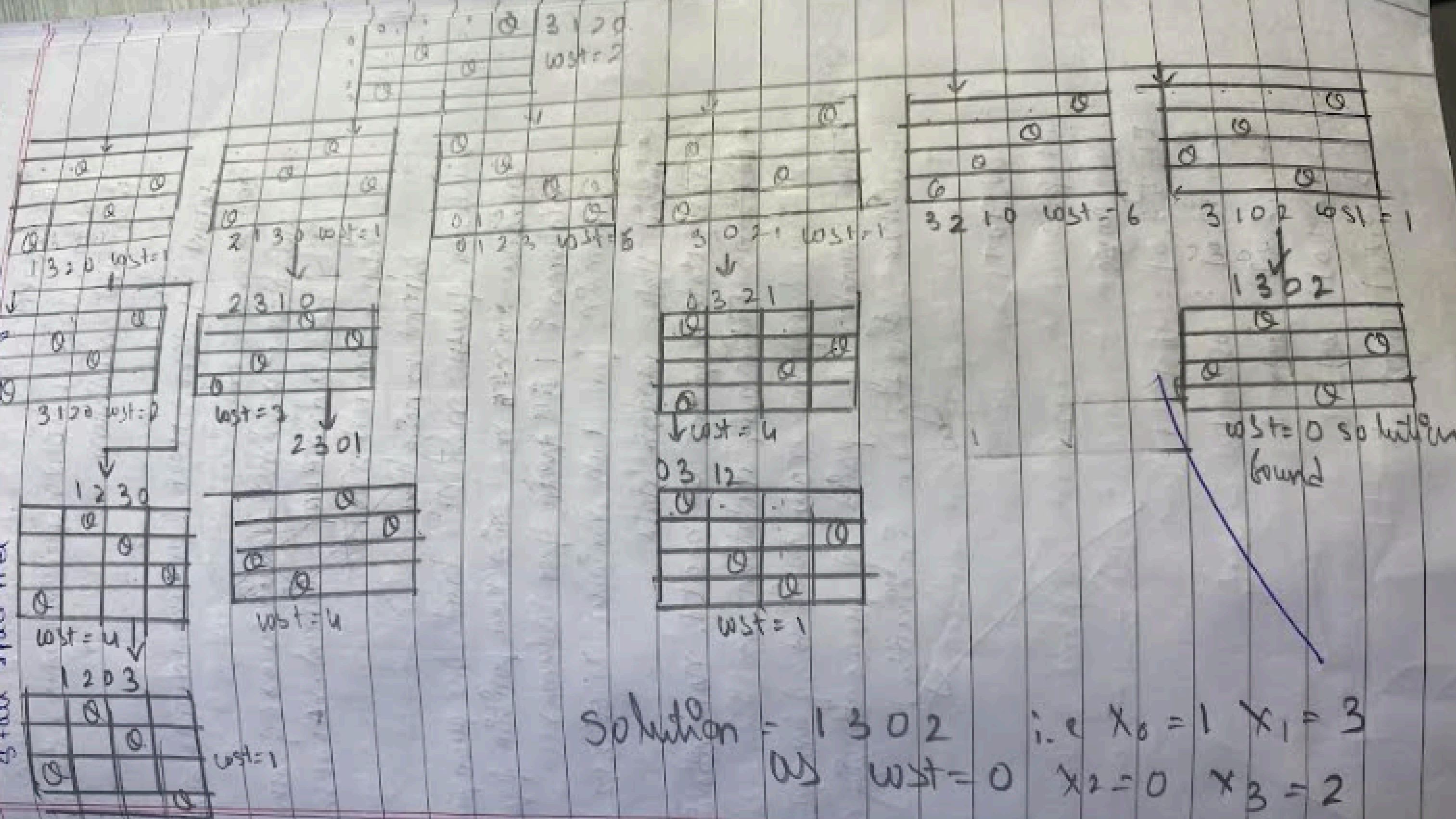
State Space tree-

N-Queens using Hill climbing Algorithm

State space tree



Solution = 1 3 0 2 i.e $x_0 = 1$ $x_1 = 3$

as cost = 0 $x_2 = 0$ $x_3 = 2$