Practical Exam Sample Question: Neural Network and A* Search for Shortest Path

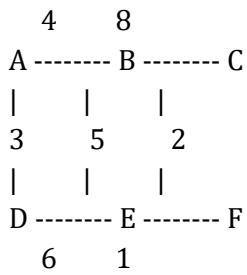
This practical exercise combines a feedforward neural network and the A* search algorithm to find the shortest path in a graph. The neural network predicts heuristic values, which are used to guide the A* algorithm in selecting the optimal path.

Scenario

You are given a weighted graph where nodes represent locations and edges represent paths between them. The goal is to find the shortest path from Node A to Node F using the A* search algorithm. The heuristic values represent the estimated distance to the goal (Node F).

Graph Representation

Consider the following graph:



Heuristic Values

The heuristic values (straight-line distance to the goal, Node F) are as follows:

Manual Heuristic:
- A: 10
- B: 8
- C: 5
- D: 7
- E: 4
- F: 0

Neural Network Predicted Heuristic:
- A: 9.8
- B: 7.9
- C: 5.2
- D: 7.1
- E: 4.3
- F: 0.1

Tasks

1. **Shortest Path Calculation (Manual Heuristic):**

- Use the given graph and manual heuristic values to calculate the shortest path from Node A to Node F. For each node visited, compute the following:
  - Path cost (g(n)) from the starting node.
  - Heuristic value (h(n)) from the table above.
  - Total cost (f(n) = g(n) + h(n)).

Node	Path Cost (g(n))	Heuristic (h_manual)	Total Cost (f(n))

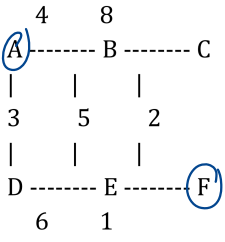
2. **Shortest Path Calculation (NN Predicted Heuristic):**

- Repeat the shortest path calculation using the neural network's predicted heuristic values.

Node	Path Cost (g(n))	Heuristic (h_manual)	Total Cost (f(n))

3. **Comparison:**

- Compare the shortest paths obtained using the manual heuristic and the NN-predicted heuristic.
- Identify if the NN-predicted heuristic resulted in a more efficient path.



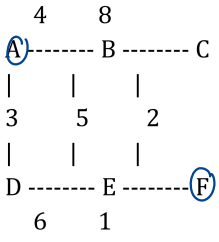
Manual Heuristic:

- A: 10
- B: 8
- C: 5
- D: 7
- E: 4
- F: 0

1) Shortest path from A – F (manual heuristic)

Node	Path Cost (g(n))	Heuristic (h_manual)	Total Cost (f(n))
× A	0	10	10
× B – A	4	8	12
× D – A	3	7	10
× E – D – A	6 + 3 = 9	4	13
E – B – A	8 + 5 = 13	4	17
C – B – A	8 + 4 = 17	5	17
B – E – D – A	9 + 2 = 10	8	18
√ F – E – D – A	9 + 1 = 10	0	10

Visited: A, D, E, B, F Path: A – D – E – F



Neural Network Predicted Heuristic:

- A: 9.8
- B: 7.9
- C: 5.2
- D: 7.1
- E: 4.3
- F: 0.1

2) Shortest path from A–F (NN Predicted Heuristic):

Node	Path Cost (g(n))	Heuristic (h_manual)	Total Cost (f(n))
× A	0	9'8	9'8
× B-A	4	7'9	11'9
× D-A	3	7'1	10'1
× E-D-A	3+6=9	7'1	16'1
C-B-A	8+4=12	5'2	17'2
E-B-A	8+5=13	4'3	17'3
√ F-E-D-A	9+1=10	0'1	10'1
B-E-D-A	9+5=14	7'9	21'9

visited: A, D, B, E, F