Kalinga Institute of Industrial Technology

School of Computer Engineering

Subject: Artificial Intelligence [CS30002]

Semester: 6th | Branches: CSE, CSSE, CSCE, IT

Spring Mid Semester Examination - 2025

Full Marks: 20 | Time: 1 1/2 Hours

Q1. Answer All the Questions [1x5=5]

a) Components in the Node of a Search Tree:

- State
- Parent node
- Action taken
- Path cost (g(n))
- Depth or level

b) Bidirectional Search:

It performs two simultaneous searches-one forward from the start node and the other backward from the goal node. It reduces time complexity significantly.

c) Why DFS is Incomplete:

DFS can follow a path infinitely if there's a loop or infinite depth and may never reach the goal even if it exists.

d) Best Algorithm for Grid with Obstacles:

A* search is preferred as it uses cost from start (g) and heuristic to goal (h) to find the optimal path while avoiding obstacles.

e) Optimality of Greedy Best First Search:

Greedy BFS is not optimal. It uses heuristic only and may miss cheaper paths in favor of apparently better heuristics.

Q2. Prove or Counter Examples [5 Marks]

a) BFS is a Special Case of Uniform Cost Search:

True. When all edge costs are equal, UCS behaves exactly like BFS.

b) UCS is a Special Case of A* Search:

True. When the heuristic function h(n) = 0 for all nodes, A* reduces to UCS.

Q3. A* Algorithm with Example [5 Marks]

Steps of A* Algorithm:

1. Initialize Open and Closed Lists.

2. Add start node to Open list.

3. Repeat:

- Pick node with lowest f(n) = g(n) + h(n)

- Move it to Closed list

- Generate its successors

- Update costs and parents

4. Stop when goal is reached.

Data Structures Used:

- Open list: Priority Queue

- Closed list: Set

Example Graph:

S -> A (cost 1), A -> C (cost 1), S -> B (cost 4), B -> C (cost 1), C -> G (cost 1)

Heuristic h: S=3, A=2, B=1, C=1, G=0

Path chosen: S -> A -> C -> G with total cost = 3

A* switches from longer path via B to shorter path via A when f(n) is better.

Q4. Water Jug Problem Formulation [5 Marks]

Jugs: 12, 8, and 3 gallons

Goal: Get exactly 1 gallon

State Representation: (x, y, z)

Initial State: (0, 0, 0)

Goal Test: x = 1 or y = 1 or z = 1

Actions:

- Fill a jug

- Empty a jug

- Pour water from one jug to another

Path Cost: Number of steps taken

Q5. N-Queen using Genetic Algorithm [5 Marks]

(a) 4-Queen Problem - GA Steps (2 Iterations):

Initial Chromosomes:

C1 = [1, 3, 0, 2]

C2 = [2, 0, 3, 1]

(Each number represents queen position in that column)

Fitness: Count of non-attacking pairs

Selection: Choose best 2

Crossover: Combine parts -> [1, 0, 3, 1]

Mutation: Random change -> [1, 0, 2, 1]

(b) GA vs Search Techniques:

- GA uses fitness, crossover, and mutation-population-based.
- Search algorithms (like backtracking) are deterministic and exhaustive.
- GA does not explore every path-uses heuristics and probability.