Artificial Intelligence

Written Problems

2D Grid Search (3pts)

1. What is the branching factor b in this state space?

There are four possible next moves (up, down, left, and right). The branching factor b in this state space is 4.

2. How many distinct states are there at depth k (for k larger than 0).

At depth k (for k larger than 0), there are 4^k distinct states. This is because at each depth level, there are four possible moves from each state, and the number of states increases exponentially with depth.

3. What is the maximum number of nodes expanded by breadth-first tree search?
For breadth-first tree search, the maximum number of nodes expanded is equal to the total number of nodes in the search tree. The maximum number of nodes expanded is given by the sum of the geometric series: 1 + 4 + 4^2 + 4^3 + ... + 4^(d-1), where d is the depth of the goal state. This sum evaluates to (4^d - 1) / 3

4. What is the maximum number of nodes expanded by breadth-first graph search?
For breadth-first graph search, the maximum number of nodes expanded is equal to the total number of distinct states in the state space, which is finite for this problem since the grid is unbounded. The exact number depends on the location of the goal state (x, y).

.5. Is h = |u - x| + |v - y| an admissible heuristic for a state at (u,v)? Explain.
The heuristic function h = |u - x| + |v - y| is an admissible heuristic for a state at (u, v). This heuristic represents the Manhattan distance between the current state and the goal state, which is a lower bound on the actual cost to reach the goal. Therefore, it never overestimates the true cost.

6.How many nodes are expanded by A* graph search using h?

The number of nodes expanded by A* Graph search using the heuristic h depends on the specific location of the goal state (x, y). However, since h is an admissible and consistent heuristic, A* Graph search is guaranteed to expand the minimum number of nodes necessary to find the optimal solution.

7. Does h remain admissible if some links are removed?

If some links are removed from the grid, the heuristic h = |u - x| + |v - y| may no longer remain admissible. This is because the heuristic assumes that diagonal movements are not allowed, and if certain links are removed.

8. Does h remain admissible if some links are added between nonadjacent states?

If some links are added between non-adjacent states, the heuristic h = |u - x| + |v - y| remains admissible. This is because the heuristic only considers the Manhattan distance between the current state and the goal state, which is still a lower bound on the actual cost, even if additional links are added.