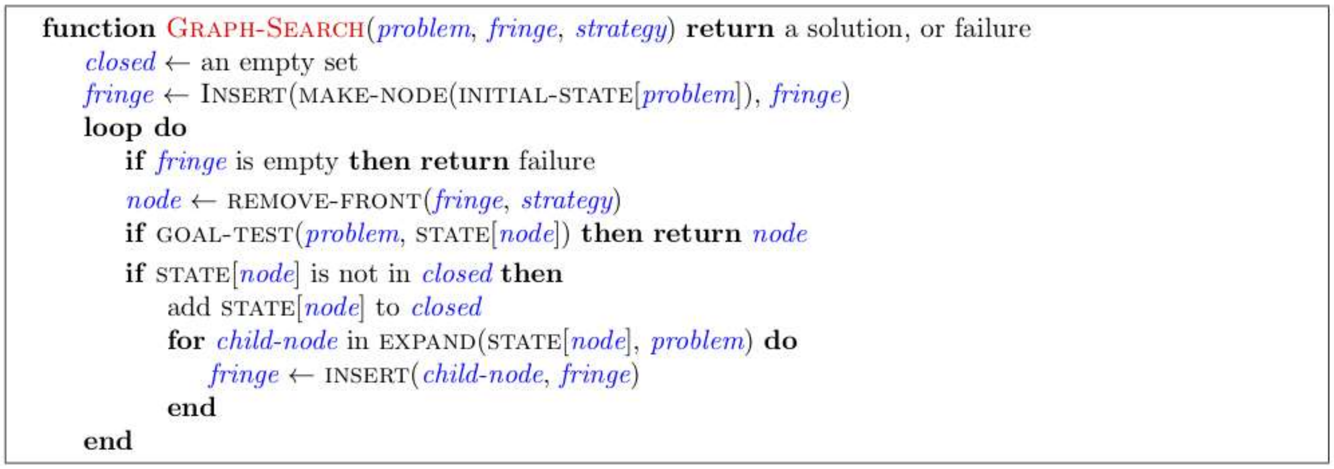
hw1_search_q12_memory_efficient_graph_search

Question 12: Memory Efficient Graph Search

0.0/8.0 points (graded)

Recall from lecture the general algorithm for GRAPH-SEARCH reproduced below.



```
function GRAPH-SEARCH(problem, fringe, strategy) return a solution, or failure
    closed ← an empty set
    fringe ← INSERT(MAKE-NODE(INITIAL-STATE[problem]), fringe)
    loop do
        if fringe is empty then return failure
        node ← REMOVE-FRONT(fringe, strategy)
        if GOAL-TEST(problem, STATE[node]) then return node
        if STATE[node] is not in closed then
            add STATE[node] to closed
            for child-node in EXPAND(STATE[node], problem) do
                fringe ← INSERT(child-node, fringe)
            end
    end
```

Using GRAPH-SEARCH, when a node is expanded it is added to the closed set. This means that even if a node is added to the fringe multiple times it will not be expanded more than once. Consider an alternate version of GRAPH-SEARCH, MEMORY-EFFICIENT-GRAPH-SEARCH, which saves memory by (a) not adding node *n* to the fringe if STATE[*n*] is in the closed set, and (b) checking if there is already a node in the fringe with last state equal to STATE[*n*]. If so, rather than simply inserting, it checks whether the old node or the new node has the cheaper path and then accordingly leaves the fringe unchanged or replaces the old node by the new node.

By doing this the fringe needs less memory, however insertion becomes more computationally expensive.

More concretely, MEMORY-EFFICIENT-GRAPH-SEARCH is shown below with the changes highlighted.

```
function MEMORY-EFFICIENT-GRAPH-SEARCH(problem, fringe, strategy) return a solution, or failure
    closed ← an empty set
    fringe ← INSERT(MAKE-NODE(INITIAL-STATE[problem]), fringe)
    loop do
        if fringe is empty then return failure
        node ← REMOVE-FRONT(fringe, strategy)
        if GOAL-TEST(problem, STATE[node]) then return node
        if STATE[node] is not in closed then
            add STATE[node] to closed
            for child-node in EXPAND(STATE[node], problem) do
                fringe ← SPECIAL-INSERT(child-node, fringe, closed)
            end
    end


function SPECIAL-INSERT(node, fringe, closed) return fringe
    if STATE[node] not in closed set then
        if STATE[node] is not in STATE[fringe] then
            fringe ← INSERT(node, fringe)
        else if STATE[node] has lower cost than cost of node in fringe reaching STATE[node] then
            fringe ← REPLACE(node, fringe)
```

Now, we've produced a more memory efficient graph search algorithm. However, in doing so, we might have affected some properties of the algorithm. Assume you run MEMORY-EFFICIENT-GRAPH-SEARCH with the A* node expansion strategy and a consistent heuristic, select all statements that are true.

[✓] The EXPAND function can be called at most once for each state. ✓

[✓] The algorithm is complete. ✓

[✓] The algorithm will return an optimal solution. ✓

Note that memory-efficient-graph-search is the version Russell and Norvig (Edition 3) presents for uniform-cost-graph-search. For the projects make sure to use the version presented in lecture (reproduced above).

- The EXPAND function can be called at most once per state. Before a node is expanded it is added to the closed set and never expanded again.
- The memory-efficient algorithm is complete. When a node, *n*, doesn't make it onto the fringe it's always the case that there is another node, *m*, which is in the fringe or the closed set with STATE[*n*] = STATE[*m*].

- The memory-efficient algorithm will return an optimal solution path. The original graph search algorithm is guaranteed to return an optimal solution path, and the updates made to the algorithm only remove nodes from consideration when replacing them with a node that ends in the same state and has lower cost.

Submit

Answers are displayed within the problem