hw1_search_q13_a*_cscs

Question 13: A*-CSCS

0.0/2.0 points (graded)

Recall that a dictionary, also known as a hashmap, works as follows:
Inserting a key-value pair into a dictionary when the key is not already in the dictionary adds the pair to the dictionary:

```
dict ← an empty dictionary
dict["key"] ← "value"
print dict["key"]
→ "value"
```

Updating the value associated with a dictionary entry is done as follows:

```
dict["key"] ← "new value"
print dict["key"]
→ "new value"
```

We saw that for A^* *graph* search to be guaranteed to be optimal the heuristic needs to be consistent. In this question we explore a new search procedure using a dictionary for the closed set, A^*-graph-search-with-Cost-Sensitive-Closed-Set (A^*- CSCS).

```
function A*-CSCS-GRAPH-SEARCH(problem, fringe, strategy) return a solution, or failure
    closed ← an empty dictionary
    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 or COST[node] < closed[STATE[node]] then
            closed[STATE[node]] ← COST[node]
            for child-node in EXPAND(node, problem) do
                fringe ← INSERT(child-node, fringe)
            end
    end
```

Rather than just inserting the last state of a node into the closed set, we now store the last state paired with the cost of the node. Whenever A^*- CSCS considers expanding a node, it checks the closed set. Only if the last state is not a key in the closed set, or the cost of the node is less than the cost associated with the state in the closed set, the node is expanded.

For **regular A^* graph search** which of the following statements are true?

- [ ] If h is admissible, then A^* graph search finds an optimal solution.
- [x] If h is consistent, then A^* graph search finds an optimal solution. ✔

Consistency ensures that the first time we expand a state, the cost to that state is optimal. This is important for A* graph search, because the first time a state is expanded, it will go in the closed set, and it will NEVER be expanded again.

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ℹ Answers are displayed within the problem

problem

0.0/2.0 points (graded)

In each of the following parts, select all true statements about A^***-CSCS**

- [x] If h is admissible, then A^*- CSCS finds an optimal solution. ✔
- [x] If h is consistent, then A^*- CSCS finds an optimal solution. ✔

There are two changes between A*-CSCS and normal A* graph search.
1) The closed set of states is now a dictionary: (key, value) = (state, cost of state)
2) We will expand a state S if S is not in the closed set OR the current cost of S is better than the last best cost of S we've found

We do not need consistency for A*-CSCS, because we can expand a state once suboptimally, and then expand it again in a more optimal way. So both are true.

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problem

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- [x] If h is admissible, then A^* - CSCS will expand at most as many nodes as A^* **tree** search. ✔
- [x] If h is consistent, then A^* - CSCS will expand at most as many nodes as A^* **tree** search. ✔

A* tree search will expand every state that comes off of the fringe, while A*-CSCS will only expand the states that meet both conditions. Therefore, A* tree search will always expand more nodes than A*-CSCS, regardless of the heuristic value. So both are true.

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problem

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- [ ] If h is admissible, then A^* - CSCS will expand at most as many nodes as A^* **graph** search.
- [x] If h is consistent, then A^* - CSCS will expand at most as many nodes as A^* **graph** search. ✔

When we have a consistent heuristic, the new condition in A*-CSCS (the current cost of S is better than the last best cost of S we've found) will never be true, because every time we expand a state S, the cost to that state would be optimal. Therefore, given a consistent heuristic, A*-CSCS will expand the same states as A* graph search.

When we have an admissible heuristic, A*-CSCS may re-expand some of the states in the closed set, while A* graph search will never re-expand any states, so A*-CSCS will expand more states.

So admissible is false, consistent is true.

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