Artificial Intelligence for Robots
Homework 5

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1 Define the following search strategies in your own words:

1.1 Uniform Cost Search

Uniform cost search chooses the next node to expand from the frontier-set by smallest total path cost. Considering that, the frontier is a queue ordered by total path cost with smallest valaues in the beginning. The goal-test is applied to a node when it is being expanded, not when it is created (put into the frontier), because a better goal-node (with better total path cost) could be in the frontier at that time. Therefore uniform cost search is optimal and also complete.

1.2 Depth-First Search

Depth-first search chooses the next node to expand from the frontier-set by maximum depth. The frontier is a LIFO-queue that always returns one of the deepest nodes. Depth-first search is not complete and not optimal.

1.3 Limited Depth-First Search

Limited depth-first search is basically depth-first search with the constraint, that nodes with a certain given depth are not further expanded. It is not complete and not optimal.

1.4 Iterative Deepening-Search

Iterative deepening search uses limited depth-first search with iteratively growing depth-limits. It combines the advantages of depth-first search and breadth-first search. It is complete and optimal.

1.5 Informed Search

Informed search is a collective term for search algorithms that use problem specific information to find solutions. The information is given by an evaluation function, which is a cost estimate for a given node. The general approach to informed searches are best-first algorithms which expand the node with the lowest evaluated cost (similar to uniform cost search). The choice of the evaluation function, which can include a heuristic function, determines the search strategy.

1.6 Greedy search

Greedy search is an informed search strategy which only uses an heuristic function as evaluation function. It always expands the node with the lowest evaluation function value, and is therefore called greedy. Greedy search is not optimal.

1.7 A*

A* is an informed best-first search algorithm which uses a heuristic function $h(n)$ that estimates the cost to reach the target from the current node. This heuristic is combined with the cost to reach the current node from the start $g(n)$ to form the evaluation function $f(n) = g(n) + h(n)$. Under some conditions for $f(n)$ A* is complete and optimal.

1.8 Iterative A*

Iterative A* uses A* search with a cutoff value for the evaluation function $f(n)$, that is increased iteratively. In each iteration Nodes that exceed this cutoff value are not put into the frontier set. The cutoff value is the smallest f-value of nodes that exceeded the cutoff value in the previous iteration.

2 What is a heuristic function?

A heuristic function in a search algorithm is a an estimation of the cheapest path from a given node to the goal. The heuristic to a node only depends on the node's state.

3 Greedy search solver

For running instructions see `readme.txt`. As overall result it can be stated, that the algorithm performs much better when using the manhattan heuristic.

3.1 Manhattan heuristic:

```
Goal found visited 159 nodes
Time: 0.092051 s
```

3.2 Misplaced heuristic:

```
Goal found visited 958 nodes
Time: 2.72526 s
```

3.3 Consistency:

Step costs from one state to another are constant with assumed cost $c = 1$. Therefore a heuristic is consistent if $h(n) - h(n') \leq 1$. Since a step can only move one tile onto its right place or one step closer towards its place, both heuristics are consistent.