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Correct formulation of the A* algorithm

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- I'm looking at definitions of the A* path-finding algorithm, and it seems to be defined somewhat differently in different places.
- The difference is in the action performed when going through the successors of a node, and finding that a successor is on the closed list.
- One approach (suggested by [Wikipedia](#), and [this article](#)) says: if the successor is on the closed list, just ignore it
 - Another approach (suggested [here](#) and [here](#), for example) says: if the successor is on the closed list, examine its cost. If it's higher than the currently computed score, remove the item from the closed list for future examination.

I'm confused - which method is correct ? Intuitively, the first makes more sense to me, but I wonder about the difference in definition. Is one of the definitions wrong, or are they somehow isomorphic ?

algorithm artificial-intelligence path-finding a-star dijkstra

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edited May 22 '10 at 22:16
Jon Seigel
11.5k 8 52 89

asked Jan 3 '09 at 11:38
Eli Bendersky
210k 73 321 389

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1 Answer

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The first approach is optimal only if the optimal path to any repeated state is always the first to be followed. This property holds if the heuristic function has the property of **consistency** (also called **monotonicity**). A heuristic function is consistent if, for every node n and every successor n' of n , the estimated cost of reaching the goal from n is no greater than the step cost of getting to n' from n plus the estimated cost of reaching the goal from n' .

The second approach is optimal if the heuristic function is merely admissible, that is, it never overestimates the cost to reach the goal.

Every consistent heuristic function is also admissible. Although consistency is a stricter requirement than admissibility, one has to work quite hard to concoct heuristic functions that are admissible but

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However, even though the second approach is more general, and it seems that a strictly larger subset of heuristic functions, the first approach is usually sufficient in practice.

Reference: the subsection *A* search: Minimizing the total estimated solution cost* in section 4.1 *Informed (Heuristic) Search Strategies* of the book *Artificial Intelligence: A Modern Approach*.

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edited Jan 3 '09 at 12:30

answered Jan 3 '09 at 12:22
namin
32.6k 8 50 70

Sorry, but could you elaborate? I see no connection to replacing items in the closed list. After all, returning to the closed list makes sense only for loops, or negative weights. Or doesn't it ? – [Eli Bendersky](#) Jan 3 '09 at 14:47

The connection is that you don't need to replace states in the closed list if the first path to a state is the cheapest. The consistency property guarantees this condition holds. – [namin](#) Jan 3 '09 at 16:43

Note that if your items in the closed list are just the nodes as is usually the case, then you can return to the closed list even if you don't have loops: e.g. if a node can be reached by more than one path. – [namin](#) Jan 3 '09 at 17:04

Great answer. I was struggling for days with that same question. Finally something that makes sense! – [Thiago Chaves](#) Nov 28 '12 at 21:45

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