CS 4710: Artificial Intelligence **Spring 2020**

Homework 1

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- You will need to submit your solutions in PDF to UVA-Collab.

1. a. False. DFS can be lucky and find a solution faster than A* sometimes.

   b. True. Its a bad heuristic but it's still admissible because it always underestimates the true cost to the goal.

   c. False. A* search can be used for path finding. A robot could use A* search to solve a maze.

   d. True. Breadth-first search is complete if the tree is finite.

   e. False. If there is a direct path, the rook could move in 1 step but the Manhattan Distance could be 8.

2. If the node in the tree is very deep and on the left most branch.

3. a. True. Breadth-first search is uniform-cost search with all costs equal to 1.

   b. True. The evaluation function for the best-first search would be always prioritize the left most fringe first.

   c. True. Uniform-cost search is A* search with Heuristics h(n) = 0.

4. If a heuristic is admissible then, $0 \leq$ h(x) $\leq$ h*(x) holds. If it is consistent, then h(x) ¡ $\leq$ c(x, x') + h(x').

   Proof:

   We have: h(x) $\leq$ c(x, x') + h(x').

   We need to prove: $0 \leq$ h(x) $\leq$ h*(x).

   Base case: h(goal) $\leq$ c(goal, goal) + h(goal). The cost of getting to the goal from the goal is 0, which means h(goal) is also 0.

   Let X_1 be the a node that connects to the goal. Let X_2 be a node that connects to X_1, that is not the goal. Let X_3 be a node that connects to X_2, and so on.

   $$\begin{aligned} h(X_1) &\leq c(X_1, goal) + h(goal) \\ h(X_1) &\leq c(X_1, goal) \end{aligned}$$

   Since c(X_1, goal) = h*(X_1), $0 \leq$ h(X_1) $\leq$ h*(X_1).

   Assume: $0 \leq$ h(X_n) $\leq$ h*(X_n).

   Prove: $0 \leq$ h(X_{n+1}) $\leq$ h*(X_{n+1}).

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\begin{aligned}
h(X_n) &\leq h^*(X_n) \\
h(X_{n+1}) &\leq c(X_n, X_{n+1}) + h(X_n) \\
h^*(X_{n+1}) - h^*(X_n) &= c(X_{n+1}, X_n) \\
h(X_{n+1}) &\leq h^*(X_{n+1}) - h^*(X_n) + h(X_n) \\
h(X_{n+1}) + h(X_n) &\leq h^*(X_n) + h^*(X_{n+1}) - h^*(X_n) + h(X_n) \\
h(X_{n+1}) &\leq h^*(X_{n+1})
\end{aligned}
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We have shown, through induction, that if a heuristic is consistent, it must also be admissible.

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If you have a perfect heuristic with some missing values that are filled with 0s, the 0s will cause inconsistency.