CS 471/571: Introduction to Artificial Intelligence, Fall 2023

Written Assignment 1
Deadline: Oct 11th, 2023

Instruction: You may discuss these problems with classmates, but please complete the write-ups individually. (This applies to BOTH undergraduates and graduate students.) Remember the collaboration guidelines set forth in class: you may meet to discuss problems with classmates, but you may not take any written notes (or electronic notes, or photos, etc.) away from the meeting. Your answers must be **typewritten**, except for figures or diagrams, which may be hand-drawn.

Q1. Word Ladder (30 points)

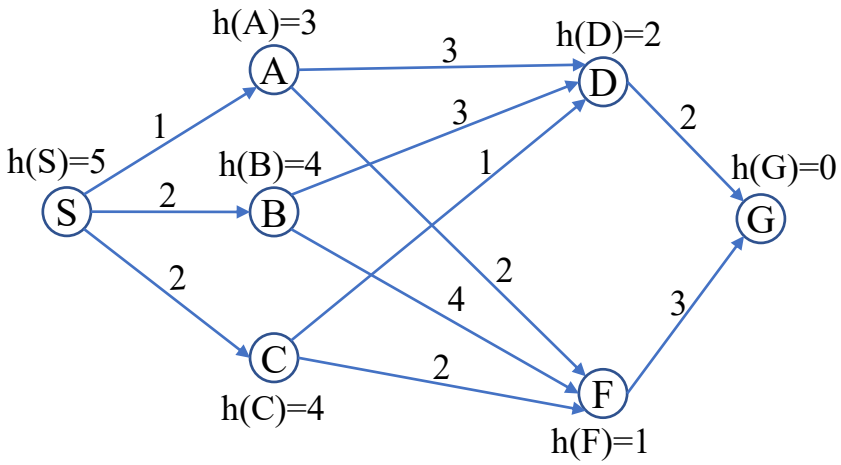
Wikipedia describes the rules for the word game Word Ladder as: The player is given a start word and an end word (of equal length). In order to win the game, the player must change the start word into the end word progressively, creating an existing word at each step. Each step consists of replacing a single letter. For example, the following is a solution to the Word Ladder puzzle between words "Cold" and "Warm": COLD $\rightarrow$ CORD $\rightarrow$ CARD $\rightarrow$ WARD $\rightarrow$ WARM

1. (10 pts) Formulate the problem of solving word ladders as a search problem.
2. (10 pts) Consider a restriction where the words can only use the first seven letters (a-g). Draw the state space graph for converting "bee" to "dad".
3. (10 pts) (Tree Search) Which part of the search tree is expanded by DFS?

Q2. Graph Search (50 points)

Q2.1. Search Algorithms. (30 points) Consider the following graph. The start node is S and the goal node is G. For the following sub-questions, ties are broken in alphabetical order.

1. (10 pts) In what order are states expanded by UCS? What path would UCS return?
2. (10 pts) In what order are states expanded by Greedy? What path would Greedy return?
3. (10 pts) In what order are states expanded by A^*?What path would A^* return?



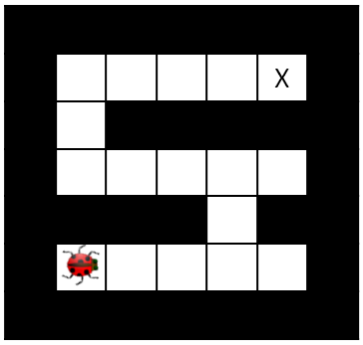
Q2.2. Admissibility/Consistency. (20 points)

- (10 pts) Is the above heuristic function h admissible? Explain your answer.
- (10 pts) For which TWO states (S, A, B, C, D, F, or G) could you change the heuristic values to make everything consistent? What range of values are possible to make this correction?

Important note. For graph search, we never expand a state type twice.

Q3. Hive Minds: Lonely Bug (20 points)

You control a single insect in a rectangular maze-like environment with dimensions $M \times N$. Figure below is an example of such environment. The insect must reach a designated target location X, also known as the hive. There are no other insects moving around. At each time step, an insect can either (a) move into an adjacent square if that square is currently free, or (b) stay in its current location. Squares may be blocked by walls, but the map is known. Optimality is always in terms of time steps; all actions have cost 1 regardless of the number of insects moving or where they move.



1. (10 pts) Provide a minimal correct state space representation? What is the state-space size?

Important note. Your computation should be for the general rectangular maze-like environment (not for the example provided).

2. (10 pts) Provide two heuristics which are admissible.