AI - CSE 643 Quiz-1 Monsoon 2024 Aug. 29, 2024

Time: 30 minutes Max. Marks: 10

Name and Roll No.: ______

Instructions:
- Do not plagiarize. Do not assist your classmates in plagiarism.
- Show your full solution for the questions to get full credit.
- Attempt all questions that you can.
- True / False questions will get full credit only if the justification and answer are both correct.
- A multiple choice question may have one or more correct answers. Credit will only be awarded if all correct answers are marked and none of the incorrect answers are marked.
- Match the following questions will have partial grading.
- In the unlikely case that you find a question ambiguous, discuss it with an invigilating TA/invigilator. Please ensure that you clearly write any assumptions you make, even after clarification from the invigilator.

V. Imp.: If you do not write your **Name and Roll No.**, you will get a zero.

1. (5 points) Consider the unbounded version of the 2D grid. The initial state is at origin $(0,0)$ and the goal state is at some (x,y). The links are connected to the immediate next nodes in the left, right, up and down directions. For each of the following, answer True or False and provide justification.

   (a) $h = |u - x| + |v - y|$ is an admissible heuristic for a state at (u, v).
   True. Since only 4-neighbors (left, right, up & down) are being considered, the smallest distance between two adjacent nodes will be given by h, which will underestimate the total distance. Therefore, it is an admissible heuristic.

   (b) If certain links are removed, the heuristic h still remains admissible.
   True. Removing the links will not affect the smallest distance. Adding links, however, will render this heuristic inadmissible (e.g., if 8-neighbors are considered, the heuristic function will no longer underestimate the Euclidean distance between two states). *Note*: In the 2D grid, we implicitly assume that the Euclidean distance between two states is the default evaluation function that is used.

   (c) If new links are added to connect non-adjacent nodes, the heuristic h still remains admissible.
   False. Diagonal links could result in a shorter path than the heuristic, making it inadmissible.

   (d) Depth-first search always expands at least as many nodes as A* search with an admissible heuristic.
   False: a lucky DFS might expand exactly d nodes to reach the goal. A* largely dominates any graph-search algorithm that is guaranteed to find optimal solutions.

   (e) A reflex-agent does not make use of percepts from the environment.
   False. It does not use a *history of percepts*, but picks an action based on its current percept only.

2. (2 points) Rank the following on how well the entities on the right satisfy the property listed on the left. Write your answer in the form of $X > Y > Z$.

   a) Fully Observable: driving; document classification; tutoring a student

   b) Static: chat room; tennis; chess; tax planning

   a) **Fully Observable: document classification > driving > tutoring a student**
   Document classification is a fairly canonical example of a (non-sequential) observable problem, because the correct classification depends almost entirely on the visible text of the document itself. There might be a slight influence from "provenance" information (date, authorship, etc.) that may not be directly observable. Driving is often considered to be observable because we imagine that we are making decisions based on what we see, but (1) velocity and turn signal status of other vehicles can be judged only from multiple image frames, and (2) assessing the intended actions of

other vehicles may require accumulating information over an extended period—e.g., to determine if a vehicle is stopped or broken down, driving slowly or looking for an address or a parking spot, turning left or has forgotten to turn off the turn signal. Other vehicles, hedges, fog, and so on can obscure visual access to important aspects of the driving environment. Tutoring is almost completely unobservable: what matters is the student's level of understanding, learning style, basic math skills, etc. Clues must be gathered over days, weeks, and months.

b) **Static: tax planning > chess > chat room > tennis**
While no human activity is completely static, given the finite length of our lifetimes, tax planning comes close—the typical "deadline" to get it done is often weeks or months, and the relevant aspects of the environment (life/death, number of offspring, tax law) may change even more slowly. In chess, the world state doesn't change until someone moves, but the clock ticks so the problem is semi-dynamic. In the chat room, long delays in replying are unacceptable, so it is a fairly real-time environment, but not nearly as real-time as tennis, where a delay of a split second often makes the difference between winning and losing a point.

3. (2 points) Match the left & right columns in the table below. Assume that the sports activities are done in the physical world by human agents.

A. Playing Soccer	I. {PO, St, Sq, D, C, MA}
B. Playing a tennis match	II. {FO, St, Ep, D, C, MA.}
C. Practicing tennis against a wall	III. {FO, St, Ep, D, C, SA}
D. Shopping for AI books on the Internet.	IV. {PO, Dt, Sq, S, Ds, SA}

Legend: {[PO: partially observable, FO: fully observable] [Dt: deterministic, St: stochastic], [Sq: sequential, Ep: episodic], [S: static, D: dynamic], [Ds: discrete, C: continuous], [SA: single-agent, MA: multi-agent]}.

Solution:

A. Playing Soccer	I. {PO, St, Sq, D, C, MA}
B. Playing a tennis match	II. {FO, St, Ep, D, C, MA.}
C. Practicing tennis against a wall	III. {FO, St, Ep, D, C, SA}
D. Shopping for AI books on the Internet.	IV. {PO, Dt, Sq, S, Ds, SA}

4. (1 point) Prove each of the following statements by specifying the evaluation function $f(n)$, or give a counterexample.
   (a) (0.25 point) Breadth-first search is a special case of A* search.
   (b) ($3 \times 0.25 = 0.75$ points) Breadth-first search, Depth-first search and Uniform-cost search are all special cases of Best-first search.

Solution:

(a) When all step costs are equal, $g(n) \propto depth(n)$, and $h(n) = 0$, A* search reproduces breadth-first search.

(b) BFS: $f(n) = depth(n)$; DFS: $f(n) = -depth(n)$; UCS:$f(n) = g(n)$.