### Class 21CLC – Term II/2022-2023

### Course: CSC14003 – Artificial Intelligence

Homework 01

***Submission Notices:***

* *Conduct your homework by filling answers into the placeholders given in this file (in Microsoft Word format). Questions are shown in black color, instructions/hints are shown in italic and blue color, and your content should use any color that is different from those.*
* *After completing your homework, prepare the file for submission by exporting the Word file (filled with answers) to a PDF file, whose filename follows the following format,*

*<StudentID-1>\_<StudentID-2>\_HW01.pdf (Student IDs are sorted in ascending order)*

*E.g.,* ***1852001\_1852002\_HW01.pdf***

*and then submit the file to Moodle directly WITHOUT any kinds of compression (.zip, .rar, .tar, etc.).*

* *Note that you will get zero credit for any careless mistake, including, but not limited to, the following things.*
  1. *Wrong file/filename format, e.g., not a pdf file, use “-” instead of “\_” for separators, etc.*
  2. *Disorder format of problems and answers*
  3. *Conducted not in English*
  4. *Cheating, i.e., copy other students’ works or let the other student(s) copy your work.*

**Problem 1. (1pt)** Briefly describe the concepts of the following research fields: Artificial Intelligence, Machine Learning, Deep Learning, and Data Science. For each concept, the description should be expressive enough to discriminate the corresponding research field from other fields.

*Please write your answer in the table*

|  |  |
| --- | --- |
| **Concept** | **Description** |
| Artificial Intelligence |  |
| Machine Learning |  |
| Deep Learning |  |
| Data Science |  |

**Problem 2. (1pt)** Discuss that, to what extent, the following systems are instances of AI. That is, you first decide its level of intelligence, low, fair/medium, or high, and then give your reasons.

|  |  |
| --- | --- |
| * **Product 01**: Streetlights turn on automatically at night. | Some Common Problems Regarding LED Street Light - AGC Lighting |
| * **Product 02**: The hotel card helps turning on the electricity in a hotel room when being put into a wall slot. | Card Reader and Card Holder for Energy Saving Switch Stock Image - Image of  holder, card: 160527477 |
| * **Product 03**: Deep Nostalgia uses video reenactment technology to animate the faces in still photos and create high-quality, realistic video footage. | A picture containing text, wall, indoor, posing  Description automatically generated |
| * **Product 04**: Autonomous drone delivers packages to customers in a variate of operating environments. |  |

*Please write your answer in the following table.*

|  |  |  |
| --- | --- | --- |
| **Product** | **Level of intelligence** | **Reason** |
| Product 01 | Low/Medium/High |  |
| Product 02 | Low/Medium/High |  |
| Product 03 | Low/Medium/High |  |
| Product 03 | Low/Medium/High |  |

**Problem 3. (1pt)** Consider the following scenario. *The agent is a human soldier. He is marching with his comrades in a parade for National Day. The performance takes place in a large square with lots of audiences.* Give the PEAS description for this activity.

*Please write your answer in the table*

|  |  |
| --- | --- |
| **Factor** | **Specification** |
| Performance measure |  |
| Environment |  |
| Actuators |  |
| Sensors |  |

**Problem 4. (1.5pts)** Describe the task environment properties for the online video game Dota 2, where OpenAI Five agent plays the five-on-five game against the professional players.

Refer to the following link for more information about the game: <https://www.dota2.com/home>

*Please write your answer in the table*

|  |  |
| --- | --- |
| **Property** | **Description** |
| Fully observable vs. Partially observable |  |
| Single-agent vs. Multi-agents |  |
| Stochastic vs. Deterministic |  |
| Episodic vs. Sequential |  |
| Static vs. Dynamic |  |
| Discrete vs. Continous |  |

|  |  |
| --- | --- |
| **Problem 5. (2.5pts)** Consider a delivery robot world with mail and coffee to deliver.  Assume a simplified domain with *four locations* as shown aside. This domain is quite simple, yet it is rich enough to demonstrate many of the problems in representing actions and in planning. | Diagram  Description automatically generated |

The robot, called Rob, can *pick up coffee* *at the coffee shop, pick up mail in the mail room, move, and deliver coffee and/or mail*.Delivering the coffee to Sam's office will stop *Sam from wanting coffee*.There can be *mail waiting at the mail room* to be delivered to Sam's office.

Rob can *move clockwise (mc)* or *move counterclockwise (mcc)*. Rob can *pick up coffee (puc)* if Rob is at the coffee shop and it is not already holding coffee. Rob can *deliver coffee (dc)* if Rob is carrying coffee and is at Sam's office. Rob can *pick up mail (pum)* if Rob is at the mail room and there is mail waiting there. Rob can *deliver mail (dm)* if Rob is carrying mail and at Sam's office. Assume that it is only possible for Rob to do one action at a time.

Formulate the task above as a search problem by determining the primary concepts.

*Please write your answer in the table*

|  |  |
| --- | --- |
| **Search concepts** | **Descriptions** |
| (0.5pt) Representation for a state |  |
| (0.5pt) State-space graph: how many states there are and how they connect together |  |
| (0.5pt) Set of actions |  |
| (0.5pt) Transition model |  |
| (0.5pt) Path cost |  |

|  |  |
| --- | --- |
| **Problem 6. (3pts)** You are given a graph as shown below.   * The start and goal states are **a** and **z**, respectively. * Numbers in orange are the heuristic values. * For each of the following graph search strategies, work out *the order in which states are expanded*, as well as *the path returned*.   In all cases, assume ties resolve in such a way that states with earlier alphabetical order are expanded first. | A-Star-Search-Algorithm |

For each of the following search strategies, work out order in which states are expanded, as well as the path returned. In all cases, assume ties resolve in such a way that states with earlier alphabetical order are expanded first.

1. Tree-search depth-first search (DFS)
2. Breadth-first search (BFS)
3. Uniform cost search (UCS)
4. Iterative deepening search (IDS)
5. Graph-search greedy best first search (GBFS) with the heuristic h shown on the graph
6. Graph-search A\* with the same heuristic.

Note that

* A state is expanded at most once in graph search, while it may be expanded more than once in tree search.
* Tree-search DFS avoids repeated states by checking new states against those on the path from the root to the current node.
* For DFS, BFS, and GBFS, the goal test is applied to each node when it is generated rather than when it is selected for expansion

*Please write your answer in the table*

|  |  |  |
| --- | --- | --- |
| **Algorithms** | **List of expanded states (in exact order)** | **Path Returned** |
| DFS |  |  |
| BFS |  |  |
| UCS |  |  |
| IDS | Level 0:  Level 1:  Level 2:  Level 3: |  |
| GBFS |  |  |
| A\* |  |  |