### 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*

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| **Concept** | **Description** |
| Artificial Intelligence | Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions : thinking , perception , communication , manipulation and moving objects. |
| Machine Learning | Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy. |
| Deep Learning | Deep learning is a subset of [machine](https://www.ibm.com/topics/machine-learning) learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to “learn” from large amounts of data. |
| Data Science | Data science is the study of data to extract meaningful insights for business. It is a multidisciplinary approach that combines principles and practices from the fields of mathematics, statistics, artificial intelligence, and computer engineering to analyze large amounts of data. |

**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.

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| * **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.*

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| **Product** | **Level of intelligence** | **Reason** |
| Product 01 | Low/Medium/High  Low | Because streetlights have sensors to know and mesure light intensity shining on it therefrom make a decision to turn on or turn off the streetlights. Therefore, the level of intelligence is low.m |
| Product 02 | Low/Medium/High  Low | Because the RFID card reader chip (sensor) in wall shot will be check if there is a hotel card or not through the touching chip inside the card then make a decision to turn on or turn off the electricity. Therefore, the level of intelligence is low. |
| Product 03 | Low/Medium/High  Medium | Because Deep Nostalgia uses deep learning algorithms to animate any of the faces in any photos to see them move, blink , and smile through several possible sequences of gestures that can be applied to a photo, each originating from a pre-recorded driver video that have been prepared in advance.However, it is a agent that works specifically in the simple environment , the level of intelligence is medium |
| Product 03 | Low/Medium/High  High | Because autonomous drone uses AI for in-flight navigation systems. It host AI solution and use machine learning to train machine learning models.With AI implementated, drones can safely make live, in-flight decisions to deliver packages in a variate of operating environments.Therefore, the level of intelligence is 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*

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| **Factor** | **Specification** |
| Performance measure | The soldier is expected to march in a synchronized manner with his comrades while maintaining a professional bearing and following the prescribed route. |
| Environment | A large square with a lot of audiences |
| Actuators | Using his legs to march with his comrades  Using his hands to hold weapons during the parade |
| Sensors | Using his eyes to perceive his surroundings, the parade route, and the other soldiers in his unit.  Using his ears to listen to any commands given by his superiors. |

**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*

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| **Property** | **Description** |
| Fully observable vs. Partially observable | Fully Observable: The agent knows the game state, including the location of all the players, the amount of gold they have, their level, their health and mana , and the state of all the buildings like turrets and creeps. |
| Single-agent vs. Multi-agents | Multi-agents: this is teamwork game with 5 members in each team |
| Stochastic vs. Deterministic | Deterministic: The game is deterministic in nature, meaning that each action taken by the agent will result in a specific outcome, and there is no randomness involved. |
| Episodic vs. Sequential | Sequential: The game is played in a sequence of turns, with each team taking turns to make their moves. |
| Static vs. Dynamic | Dynamic: Players make decisions and taking actions in real-time, which can affect the game state and the outcome of the game. |
| Discrete vs. Continous | Continuous: The game is continuous in nature, meaning that it has no fixed end point and can go on for an extended period until one team is declared the winner. |

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| **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*

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| **Search concepts** | **Descriptions** |
| (0.5pt) Representation for a state | The state space consists of the locations where Rob can be present (coffee shop, mail room, Sam's office), its movements to different places and whether Rob is carrying coffee or mail. |
| (0.5pt) State-space graph: how many states there are and how they connect together | There are 64 states : pick up coffee or not is 2 cases , deliver coffee or not is 2 cases , pick up mail or not is 2 cases, deliver mail or not is 2 cases and having 4 positions => 4\*2\*2\*2\*2 = 64. And they are connected together to make a directed graph that is connected. |
| (0.5pt) Set of actions | Picking up coffee, delivering coffee, picking up mail, delivering mail, moving clockwise, and moving counterclockwise. |
| (0.5pt) Transition model | The transition model determines the result of applying an action in a given state. For example, if Rob picks up mail at the mail room, the resulting state will be Rob at the mail room with mail. |
| (0.5pt) Path cost | The number of actions taken to reach the goal state. |

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| **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*

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| **Algorithms** | **List of expanded states (in exact order)** | **Path Returned** |
| DFS | a b e | a b e z |
| BFS | a b c e | a b e z |
| UCS | a c b f d e z | a c d e z |
| IDS | Level 0: a  Level 1: a b c  Level 2: a b e f c d e  Level 3: a b e | a b e z |
| GBFS | a c e | a c e z |
| A\* | a c b d e z | a c d e z |