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.*
  - *Wrong file/filename format, e.g., not a pdf file, use "-" instead of "_" for separators, etc.*
  - *Disorder format of problems and answers*
  - *Conducted not in English*
  - *Cheating, i.e., copy other students' works or let the other student(s) copy your work.*

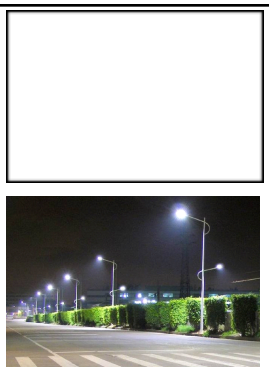
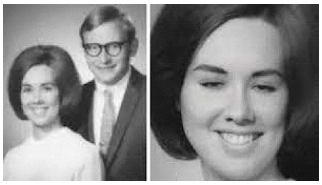
Problem 1. (1pt) Briefly describe the concepts of the following research fields: Artificial Intelligence, Machine Learning, Deep Learning, and Data Science. For each concept, the description should be expressive enough to discriminate the corresponding research field from other fields.

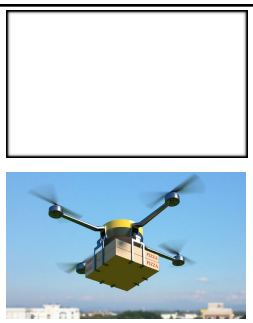
Please write your answer in the table

Concept	**Description**
Artificial Intelligence	*Develops human intelligence to solve tasks. The research expands in many fields such as AGI, planning, computer vision, and machine learning,...*
Machine Learning	*Focusing on fundamental research, including AI robustness, adversarial machine learning, anti-spoofing, domain adaptation, and federated learning*

Deep Learning	*A branch of machine learning, founded on a complex concept, mostly work with man-made neurons to simulate the ability to think like a human brain.*
Data Science	*Using interactive knowledge capture, intelligent user interfaces, semantic workflows, provenance, and collaboration*

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.	
• **Product 02**: The hotel card helps turn on the electricity in a hotel room when being put into a wall slot.	
• **Product 03**: Deep Nostalgia uses video reenactment technology to animate the faces in still photos and create high-quality, realistic video footage.	

• **Product 04**: Autonomous drone delivers packages to customers in a variety of operating environments.	

Please write your answer in the following table.

Product	Level of intelligence	Reason
Product 01	Low	The agent is only given information about time and the light around it as stimulus and reflex in a simple action
Product 02	Low	The agent scan the signal from the hotel card and authorizes it, if approved then the electricity is turned on. The logic of this agent is simple.
Product 03	Medium	The agent analyzes the image and identifies the face and its structure. Then simulate the motion of the face. Even more, they can learn from many images to improve their performance.
Product 04	High	The agent have to gather all the information about their surroundings and have a lot of execution to do to handle the environment and finish the task successfully.

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 audience.* Give the PEAS description for this activity.

Please write your answer in the table

Factor	Specification
Performance measure	

	The stance and action have to be precise and the synergy of the soldier with his comrades during the parade
Environment	The square, audience, and other soldiers.
Actuators	Legs (to walk), hands (1 to hold the gun and 1 to swing while walking)
Sensors	Eyes (to see the surroundings and the path), ears (to listen and follow the command)

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

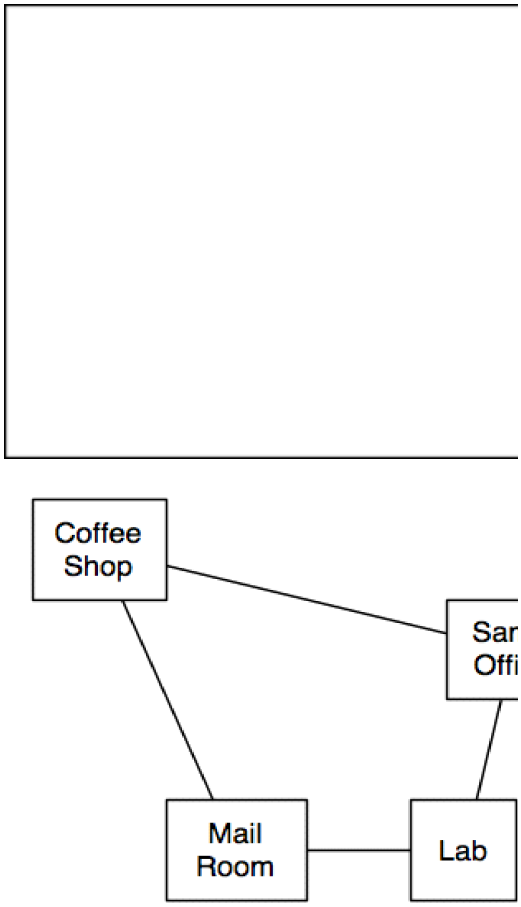
Please write your answer in the table

Property	**Description**
Fully observable vs. Partially observable	Partially observable (Example: During a match, players can only see some parts of the maps that are in the vision range, which means they do not know what the opposing teams or monsters are doing in areas they can't see
Single-agent vs. Multi-agents	Multi-agents (Dota 2 is a multiplayer game, with each player controlling a different character, with distinctive skills and abilities)
Stochastic vs. Deterministic	Stochastic (There are many different random factors during a match, like a character's Critical Hit chance and Dodge chance)
Episodic vs. Sequential	Sequential (Actions taken from players will affect the future actions from both teams)
Static vs. Dynamic	Dynamic (While playing, the game conditions will continually change, for example, new bosses spawn)
Discrete vs. Continuous	The match between OpenAI and the players can be both Discrete and Continuous for the following reasons: Discrete (When each player controls a character, there is a set of pre-defined commands to use, like click on a spot to move, press a

	button to activate an ability, attack or use an item, and they can only be activated at a specific area and time) Continuous (The game state and game environment are constantly changing, including how much gold each character have, the position of each character, HP (Health Points) and MP (Mana Points) of each character… and OpenAI has to process the continuous data to make decisions)

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.



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

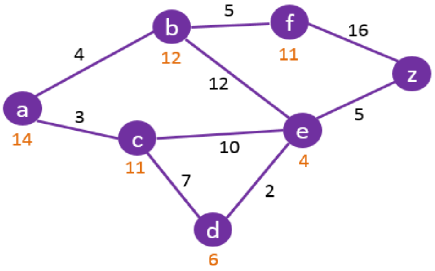
Search concepts	**Descriptions**
(0.5pt) Representation for a state	Rob's location, Rob's holding item
(0.5pt) State-space graph: how many states there are and how they connect together	There are 4 locations: Coffee shop, Mailroom, Lab and Sam's office. Coffee: Rob can be holding or not holding coffee Mail: Rob can be holding or not holding mail Mail room: can have mail or don't have mail Sam has 2 states: Wanting coffee and not wanting coffee (when Rob is holding coffee and is at the office) So there are 4x2x2x2x2 = 64 possiblea states All of these states are possible, and there are some cases that lead to another state when there is a change
(0.5pt) Set of actions	mc, mcc, puc, pum, dc, dm
(0.5pt) Transition model	The change of Rob's location and the item that he picked up in some room. - move clockwise: Go to the next room clockwise from the room Rob is currently staying in with this order: Coffee shop > Sam's office > Lab > Mail room (> Coffee shop) - move counterclockwise: Go to the next room counterclockwise from the room Rob is currently staying in with this order: Coffee shop > Mail room > Lab > Sam's office (> Coffee shop) - pick up coffee: Pick up coffee if Rob is in the coffee shop and not currently holding coffee - deliver coffee: Deliver coffee to Sam if Rob is holding coffee while in Sam's office - pick up mail: Pick up mail if Rob is at the mailroom and there is mail waiting there

	- deliver mail: Deliver mail to Sam if Rob is holding mail and in Sam's office Connection: Each transition model is affected by the previous model and the next model
(0.5pt) Path cost	Each action cost 1.

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* Search Algorithm

What is the shortest path to travel from A to Z?
Numbers in orange are the heuristic values, distan
straight line (as the crow flies) from a node to nod

For each of the following 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.

- Tree-search depth-first search (DFS)
- Breadth-first search (BFS)
- Uniform cost search (UCS)
- Iterative deepening search (IDS)
- Graph-search greedy best-first search (GBFS) with the heuristic h shown on the graph
- 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	a -> b -> e -> c -> d -> d -> c	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 -> c ->d -> z	a -> b -> e -> z
GBFS	a -> c -> e	a -> c -> e -> z
A*	a -> c -> b -> d -> e -> z	a -> c -> d -> e -> z