National University of Computer and Emerging Sciences
Chiniot-Faisalabad Campus

Artificial Intelligence (AI2002)

Sessional-I Exam

Date: February 25th 2025

Course Instructor(s)

Dr. Hashim Yasin, Dr. Rabia Maqsood, Ms. Aqsa Younas, Mr. Ali Raza, Ms. Mahzaib Younas

Total Time (Hrs.): 1
Total Marks: 70
Total Questions: 6

______________________ Roll no ______________________ Section ______________________ Student Signature

Vetted by: ______________________________ **Signature:**______________________

Attempt all the questions.

CLO#	1	3			
Q#	1, 2	3	4,5	6	Total Marks
Marks	20	20	20	10	70
Obtained Marks					

[C1]: To introduce the notion of intelligence and the so-called artificiality associated with it, and how these can be modelled in computational system

Agents, environments & architectures **[10 + 10 = 20 Marks]**

Question No 1:

Consider the following agents, each belonging to a specific agent architecture type. Identify and write the most accurate architecture type for the given description as (a) reflex, (b) model, (c) goal, (d) utility, (e) one of the previous four architectures + learning (i.e., Reflex + Learning).

Agent description	Architecture type
a. **Automated Warehouse Robot** – Plans and executes a sequence of actions to move items to a target location.	**Goal**
b. **Traffic Management System** – Dynamically controls traffic signals to minimize congestion and reduce travel time.	**Utility**

c. **Smart Grid Power Distribution** – Predicts electricity demand using past data to optimize power distribution.	**Model**
d. **Robotic Surgery Assistant** – Plans precise surgical movements based on patient anatomy and real-time feedback.	**Goal + learning**
e. **Elevator Control System** – Uses past and current requests to optimize movement across floors.	**Model**
f. Traffic Light System – Changes the signal light on a predefined timer.	Reflex
g. **Stock Market Trading Bot** – Adjusts its strategy based on historical market trends and new data.	**Utility + learning**
h. **Restaurant Recommendation System** – Suggests dining places based on user preferences and reviews.	**Utility**
i. Spam Email Filter – Classifies each new email as a 'spam' or 'not spam' based on the presence of a specific collection of words.	Reflex
j. **Personalized Healthcare** – Uses a patient's medical history to predict future health conditions and suggest treatments.	**Model**

Question No 02: **[5 + 5 = 10 Marks]**

a. Describe the properties of a Carrom board game in the table below.

Environment property	**Your answer**
Observability (full/partial)	Fully observable
Determinism (deterministic/ stochastic)	Stochastic
Episodic/Sequential	Sequential
Static/Dynamic/Semi-dynamic	Semi dynamic
Discrete/Continuous	Continuous

b. Will a rational agent always win the Carrom board game? Answer 'Yes' or 'No' and briefly provide your justification.

NO.

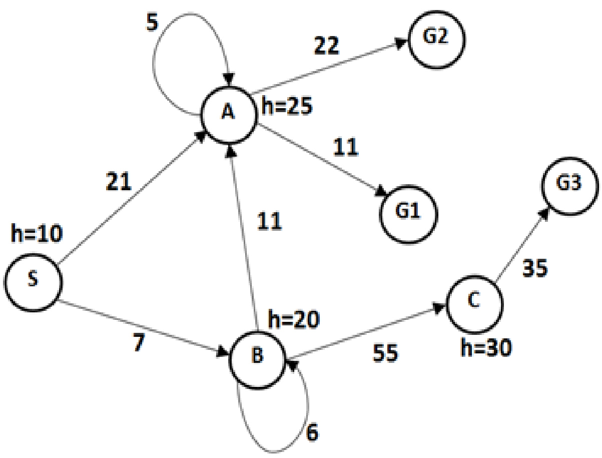
Justification: first turn winning game + continuous & stochastic environment + other factors (e.g., shot angle & speed, board friction, opponent's tricks)

[C3]: To introduce students with computational intelligence theory and techniques used to design and develop intelligent systems.

Uninformed Searches **[20 Marks]**

Question No 03: **[4+4+4+4+4= 20 Marks]**

Consider the search problem given below with start state **S** and goal states **G1, G2,** and **G3**. The transition costs of the arcs are labelled upon the arcs, and the heuristic values are next to the states. Each goal state has heuristic value zero. If a node has multiple successors, then we always expand the successors in an *increasing alphabetical order*. The search is terminated as soon as it reaches the **ANY** goal state given as above. *Do not remember or maintain in history the visited/expanded list, except in part (e)*. For each search strategy given below, show the order in which nodes are **explored/expanded (closed list),** the **final path,** and the **final cost** up to the goal state.



a) Depth First Search (2+1+1)

Order of Expansion: ______________________________

Final Path: ______________________________

Final Cost: ______________________________

b) Iterative Deepening Search (2+1+1)

Order of Expansion: ______________________________

Final Path: ______________________________

Final Cost: ______________________________

c) Breadth First Search (2+1+1)

Order of Expansion: ____

Final Path: ____

Final Cost: ____

d) Uniform Cost Search (without Expanded list) (2+1+1)

Order of Expansion: _S B B A B A A A B A A A G1 _____________

Final Path: _______S B A G1_______________________

Final Cost: ___________29____

e) Uniform Cost Search (with Expanded list) (2+1+1)

Order of Expansion: ____S B A G1____

Final Path: ___________________S B A G1______________________________________

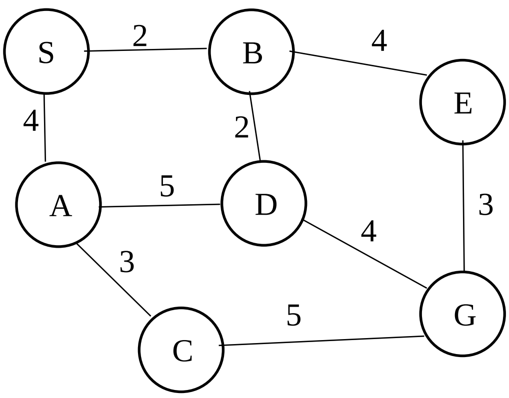
Final Cost: ___________________29_______________________________

[C3]: To introduce students with computational intelligence theory and techniques used to design and develop intelligent systems.

Informed Searches **[10 + 10 + 10 = 30 Marks]**

Question No 04: **[10 Marks]**

A **delivery robot** needs to find the shortest path from its **starting location (S)** to the **delivery point (G)** in a warehouse. The robot can only move along predefined paths with associated costs. Each node represents a warehouse section, and the cost represents the time (in minutes) required to move between sections. The robot must use the *A* search algorithm with a strict expanded list*, meaning nodes that have been expanded once cannot be revisited.



Node	**Heuristics h (n)**
S	7
A	4
B	6
C	4
D	3
E	5
G	0

Part A:

- **a.** *Use A search with the strict expanded list version** to find the shortest path from **S to G**.
- **b.** **Strict Expanded List Rule:** Once a node is expanded, it cannot be revisited.
- **c.** **Show the final shortest path and its cost**.

Formula Used:

$f(n)=g(n)+h(n)$

where:

- $g(n)$ is the actual cost from the start node S to node.
- $h(n)$ is the heuristic (estimated cost) from node to the goal G.
- The node with the smallest $f(n)$ is expanded next.

Step 1: Initialize

- **Open List**: `{S}`
- **Closed List**: `{}`

Step 2: Expand Start Node (S)

- Possible moves:
  - S→A with cost **4** → $f(A)=4+7=11$
  - S→B with cost **2** → $f(B)=2+6=8$
- **Choose node with smallest f(n)+g(n) → Expand B.**

Step 3: Expand Node B

- Open List: `{A, B}`
- Closed List: `{S}`
- Possible moves:
  - B →D with cost **2** → $g(D)=2+2= 4$ $f(D)=4+3=7$
  - B→E with cost **4** → $g(E)=2+4=6$, $f(E)=6+5=11$
- **Choose node with smallest f(n)+g(n) → Expand D.**

Step 4: Expand Node D

- Open List: `{A, E, D}`
- Closed List: `{S, B}`
- Possible moves:
  - D →G with cost **4** → $g(G)=4+4=8$, $f(G)=8+0=8$
- **Goal Reached!**

Final Shortest Path

- **Path:** `S → B → D → G`
- **Total Cost: 8**

Question No 05: **[10 Marks]**

A drone delivery company is developing an AI system to autonomously navigate urban areas to deliver packages. The AI must decide the best route to reach a delivery location while considering real-time traffic conditions, weather impact, and dynamic obstacles like temporary road closures.

The company is evaluating two search algorithms: **Best-First Search (BFS)** and **Recursive Best-First Search (RBFS)**, both using a heuristic that estimates the remaining travel time to the destination.

a. **What is a major flaw in using Best-First Search for navigation in high-traffic zones?**

BFS only considers the heuristic and might get stuck in traffic-heavy areas, ignoring actual travel costs.

b. **How does BFS affect efficiency with redundant node expansions?**

BFS may revisit nodes unnecessarily, causing inefficiency; using a closed list can prevent this.

c. **How does RBFS balance memory efficiency while ensuring a path is found?**

RBFS uses limited memory by storing only the current path and adjusts the threshold dynamically for exploration.

d. **How would RBFS handle overestimated travel times compared to BFS?**

RBFS backtracks when heuristics are inaccurate, while BFS might get stuck following poor paths.

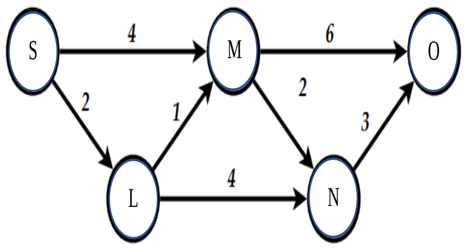
e. **Why is RBFS preferred over BFS in dynamic environments like drone navigation**

RBFS adapts to changing conditions by dynamically adjusting its search path, unlike BFS, which relies on a static heuristic

Question No 06: **[2 + 2+ 6 = 10 Marks]**

Consider the graph **with S as the start node and O as the goal node** with two heuristic values h1 and h2 given in the table. Answer the following question.

Node	H1	H2
S	8	7
L	3	4
M	6	5
N	2	2
O	0	0



a. Is the heuristics value of h1 and h2 are admissible or not? provide the justification.

H1 is not admissible, because the path cost of from M to O is 5 and heuristic is 6. 5 ≤ 6
H2 is admissible.

H1	8	3	6	2
H2	7	4	5	2
Path	PATH S	PATH L	PATH M	PATH N
Path cost	SLMNO = 9 SMO = 10 SLNO = 9 SMNO = 9	LMO = 7 LMNO = 6 LNO = 7	MO = 6 MNO = 5	N = 3

b. Is the heuristic values of h1 dominate h2? Provide the justification.
[Rubrics 1 Marks for Justification and 1 Mark for Yes/No]

No, H1 does not dominate h2 because the h1 is not admissible. For dominance its mandatory that all heuristics must be admissible.

c. Is the heuristic value of h1 is consistent, if not make it consistent and mentioned the updated heuristic values? [Rubrics are highlighted with Yellow Color].

		By changing value of L and N		By changing value of S and M	
S-M	8 – 6 ≤ 4 2 ≤ 4 0.5				
S-L	8 – 3 ≤ 2 5 ≤ 2 0.5	8 – 2 ≤ H(L) 6 ≤ H(L) 1.5	8 – 6 ≤ 2 2 ≤ 2	H(S) = 5	5 – 3 ≤ 2 2 ≤ 2 1.5
L-M	3 – 6 ≤ 1 -3 ≤ 1 0.5				
L-N	3 – 2 ≤ 4 1 ≤ 4 0.5				
M-N	6 – 2 ≤ 2 4 ≤ 2 0.5	6 – 2 ≤ H(N) 4 ≤ h(N) 1.5	6 – 4 ≤ 2 2 ≤ 2	H(M) = 4	4 – 2 ≤ 2 2s ≤ 2 0.5
M-O	6 - 0 ≤ 6 6 ≤ 6 0.5				
N- O	2 – 0 ≤ 3 2 ≤ 3				