Problem 1 – State True or False

1. An admissible heuristic function does not underestimate the cost to reach the goal.

False Cost should be exact

2. Turing test can be used to test whether a computer system acts rationally.

False The Turing Test is primarily used to evaluate whether a computer system can exhibit human-like behavior, particularly in natural language conversation.

3. The acronyms PEAS (in agent design) stands for Percepts Environment Actions System.

False

In agent design, PEAS stands for Performance measure, Environment, Actuators, and Sensors.

4. Agent performance measure should be defined based on how the agent should behave but not on what is wanted in the environment.

False

The performance measure of an agent should reflect both how the agent behaves and whether those behaviors lead to desired outcomes in the environment.

5. To a problem solving agent, a solution is a state that satisfies the goal test.

False

Problem 2 – Short answers

1. What are the four major approaches to building AI systems? Select one and briefly discuss this approach.

AI as a system that thinks like humans.
AI as a system that thinks rationally.
AI as a system that acts like humans.
AI as a system that acts rationally.

Student then chooses one to elaborate with no more than 3-4 sentences.

AI as a system that thinks like humans:
Aims to replicate human cognitive processes.
Utilizes techniques such as symbolic reasoning and natural language processing.

AI as a system that thinks rationally:
Focuses on logical reasoning and formal inference.
Relies on techniques like logic programming and theorem proving.

AI as a system that acts like humans:
Seeks to simulate human behavior and capabilities.
Utilizes techniques such as neural networks and robotics.

AI as a system that acts rationally:
Emphasizes achieving optimal outcomes.
Relies on techniques such as search algorithms and decision theory.

2. What are the major agent types?

Simple reflex agents
Model-based reflex agents
Goal-based agents
Utility-based reflex agents
+ 4 advanced agent types by adding learning capability to each of the above 4 agent types

Simple Reflex Agents:
These agents select actions based solely on the current percept, using condition-action rules.
Advanced: Reinforcement Learning Reflex Agents: Learn from rewards or penalties associated with actions to improve decision-making over time.

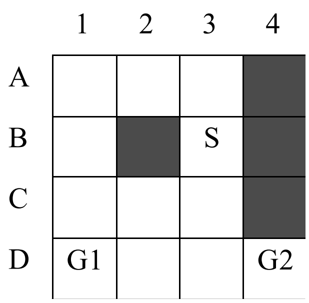
Model-Based Reflex Agents:
Maintain an internal state to track aspects of the world that cannot be directly observed.
Advanced: Deep Q-Network (DQN) Agents: Utilize deep neural networks to approximate the Q-function, enabling more complex state-action mappings.

Goal-Based Agents:
Plan sequences of actions to achieve desired goals using search algorithms.
Advanced: Deep Reinforcement Learning Agents with Planning: Combine deep learning with planning algorithms to handle complex environments and long-term goals.

Utility-Based Reflex Agents:
Make decisions by maximizing a utility function representing preferences over possible outcomes.
Advanced: Multi-Agent Reinforcement Learning Agents: Learn strategies in a multi-agent setting where agents interact and adapt their behavior based on the actions of others.

Problem 3 – Search

Consider the maze below for the robot navigation problem, where S is the robot's current location and being at either G1 or G2 satisfies the goal test. Shaded cells represent the wall. The robot can only travel up, left, down or right.



1. Formulate the problem by providing a suitable representation which includes **state representation, initial state, goal state, operators, and path cost.**

State: Coordinates [x, y] (x = 1 .. 4; y = A .. D)
Initial State: [3, B]
Goal states: [1, D] and [4, D]
Operators: Up, Down, Left, Right
Path cost = Number of steps (i.e., each action costs 1)

2. What would be a useful admissible heuristic for this problem?

MD(s1, s2) = Manhattan distance between cell s1 and cell s2.

An admissible heuristic function h(s) = min{MD(s, G1), MD(s, G2)}

3. For each of the following search strategies, indicate which goal state is reached (if any) and list, ***in order***, all the states associated with the nodes which are expanded. **When all else is equal**, nodes should be expanded according to the following order: the robot would try to go up before attempting left, before attempting down, before attempting right, in that order. When you list the states associated to expanded nodes, if the list is infinite, you can just show the first occurrences of the nodes in a loop.

Priority: ULDR

3.1. Breadth First (**without** repeated state check)

Goal state reached: 4D

States associated with expanded nodes: 3B, 3A, 3C, 2A, 3B, 3B, 2C, 3D, 1A, 3A, 3A, 3C, 3A, 3C, 1C, 2D, 3C, 3C, 2D, 4D

Elaborated by tree diagram:

3B

3A 3C

2A 3B 3B 2C 3D

1A 3A 3A 3C 3A 3C 1C 2D 3C 3C 2D 4D

3.2. Depth First (**with** repeated state check)

Goal state reached: 1D

States associated with expanded nodes: 3B, 3A, 2A, 1A, 1B, 1C, 1D

3.3. Greedy Best First (**without** repeated state check and using the heuristic defined in question 2)

Goal state reached: 4D

States associated with expanded nodes: 3B, 3C, 3D, 4D

3.4. A* (**with** repeated state check and using the heuristic defined in question 2)

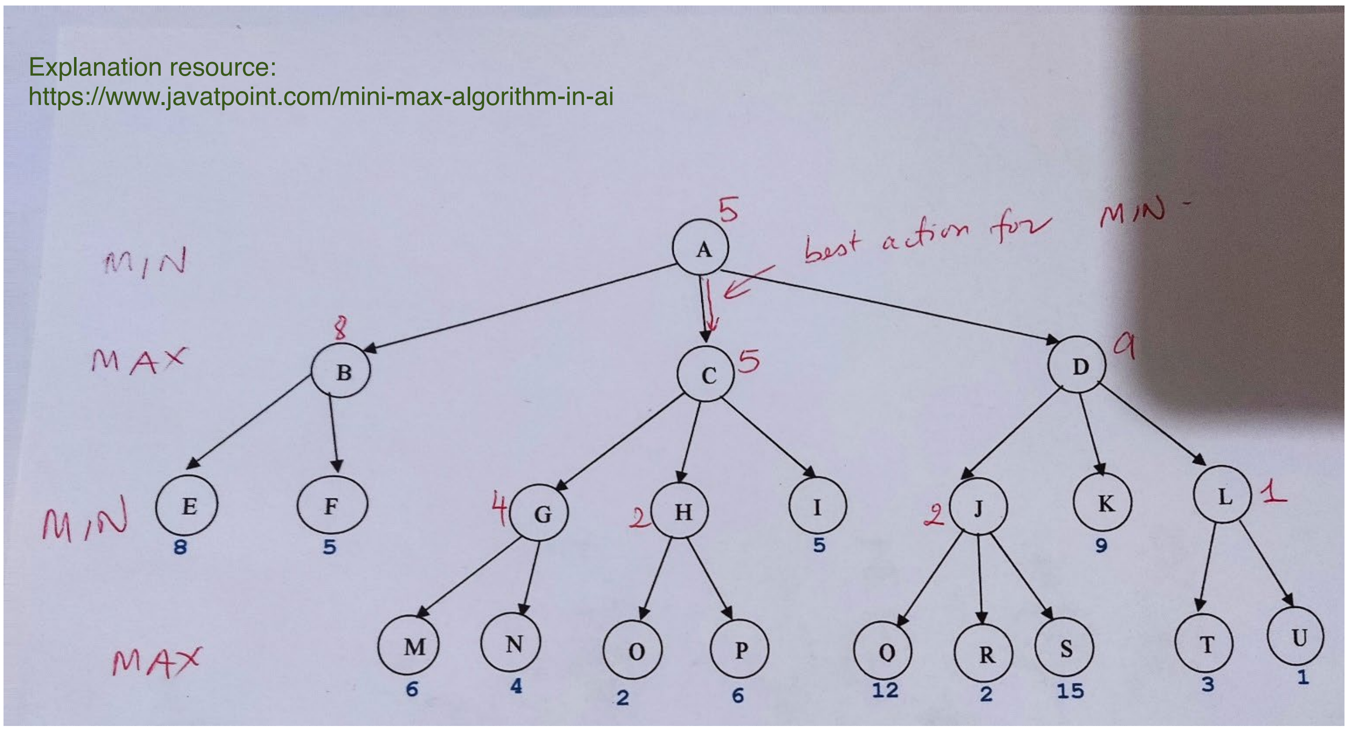
Goal state reached: 4D

States associated with expanded nodes: 3B, 3C, 3D, 4D

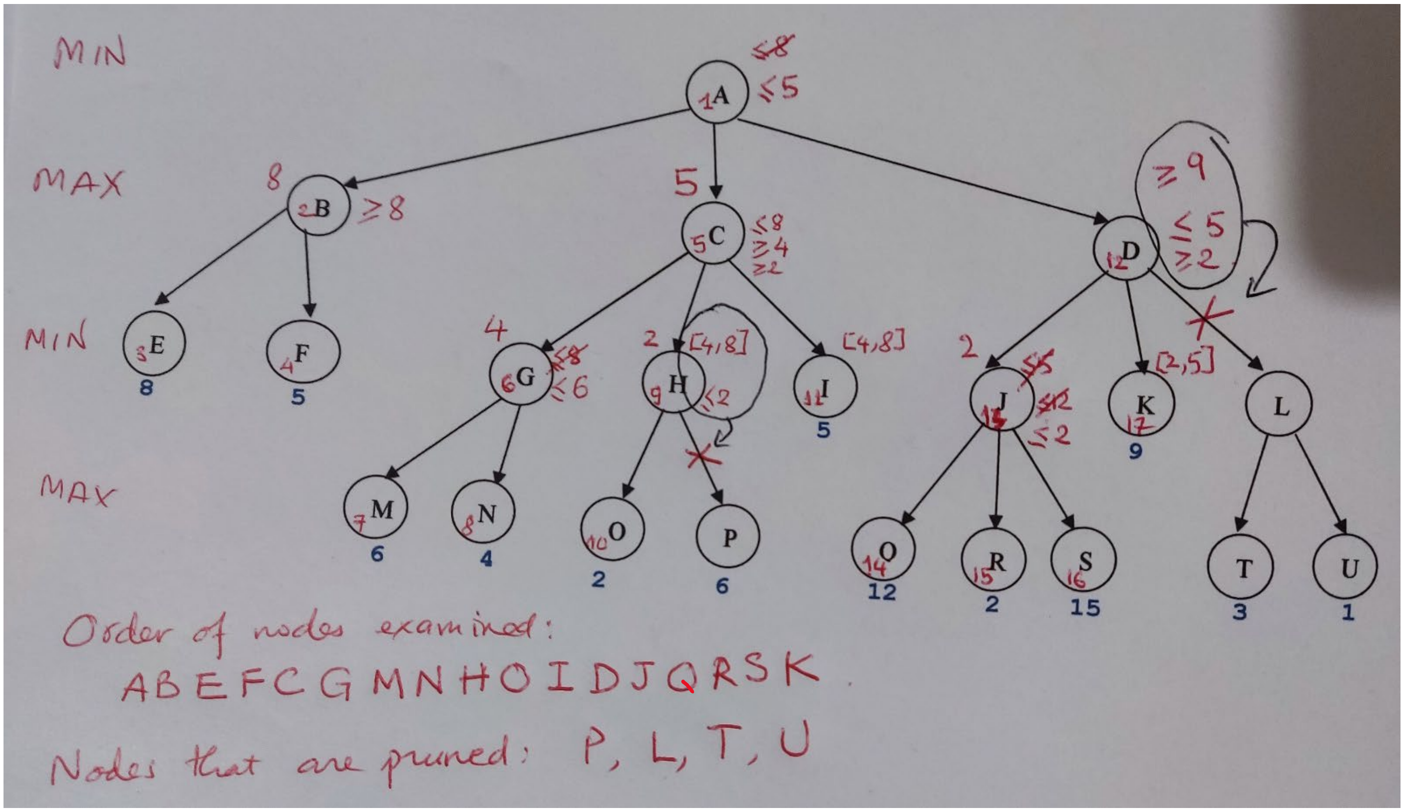
Problem 4 – Game Playing and Expected Values

Consider the following game tree in which the evaluation function values are shown below eachleaf node. Assume that the root node corresponds to the minimising player. That is, the first player(MIN) is trying to minimise the final score. Assume that the search always visits children left-to- right.

1. Clearly indicate the max and min layers of the tree AND use minimax to determine the bestfirst move for MIN.



2. In which order will the nodes be examined by the alpha-beta procedure? Which nodes willbe pruned by the alpha-beta procedure?



Explanation resource:
https://www.javatpoint.com/ai-alpha-beta-pruning