

50.021 – AI

Week 1: Search

1 Environment Types

There are six characteristics (Observable, Deterministic, Episodic, Static, Discrete, Single-agent) when describing a task environment.

TASK: For the following activities, describe the task environment using these six characteristics and state any assumptions you may have.

1. Playing a massively multiplayer online game, such as World of Warcraft (https://en.wikipedia.org/wiki/World_of_Warcraft)

Characteristics:

- Partially Observable – Fog of war covers everything that is not within sight range of units and buildings, thus the agent may not have access to the complete state of the environment at each point in time.
- Stochastic – The next state of the environment is not completely determined by the current state and the action executed by the agent. Actions from other agents and random factors such as critical hits and loot drops that are dependent on probabilistic chances can also change the next state of the environment.
- Sequential – The choice of the agent's action may be dependent on the previous states and not just the current state
- Dynamic – The environment is changing even when there are no action inputs by the agent since there other agents can execute their own actions to change the state of the environment
- Continuous – The agent can perform many actions and percepts. Some of these actions can include character movement, buying of items and performing character skills.
- Multi-agent – It is an online multiplayer game thus it consists of multiple agents within the same environment.

Assumptions:

- The game is being played in real-time, where actions from the other players can directly affect the environment
- Action performed by each player is independent of the action performed by other players

2. Buying a movie ticket online

Characteristics:

- Fully Observable – Current state of ticket sales is fully transparent to the customers via the online platform
- Strategic – The status of the ticket sales is deterministic but the decisions of other agents are not
- Sequential – Decision made beforehand can affect the future state of the environment (e.g. selecting gold class tickets will result in higher prices during payment)
- Dynamic – The environment can change when the agent is deliberating as other agents can also purchase tickets which changes the state of the environment
- Discrete – There is only a limited number of buttons that an agent can press on the online webpage to purchase movie tickets
- Multi-agent – The online platform that sells movie tickets supports multiple customers, thus this model is a multi-agent one

Assumptions:

- The sales of tickets occur concurrently between customers. (i.e. customers can buy tickets at the same time and it is on a first come first serve basis)
- Tickets are sold over an online platform

3. Planning a holiday itinerary with your friends

Characteristics:

- Fully Observable – All plans within the holiday itinerary would be fully transparent to all agents via online platforms (e.g. Google Docs)
- Strategic – The next state of the environment is deterministic, however, actions of other agents are not
- Sequential – Decisions made beforehand can limit the planning of activities in the later dates
- Dynamic – The environment can change as the agent is deliberating as the other agents can make changes to the environment
- Discrete – Actions taken by the agents are limited by the buttons in the webpage
- Multi-agent – Planning of the holiday itinerary is a collaborative process with other agents.

Assumptions:

- The travel itinerary is being planned via online tools such as Google Docs.
- The holiday requires multiple activities to be planned instead of a single activity
- All agents can plan the holiday itinerary at the same time
- Decisions made by each agent are independent of those made by other agents

2 Problem Formulation

Missionaries and cannibals is a classical formal problem, and is generally stated as follows. Three missionaries and three cannibals are on one side of the river. They all need to cross in a boat that only holds two people at once. There must never be a situation where there is a group of missionaries in one place who are outnumbered by cannibals.

TASK: Formalise the missionaries and cannibals problem in terms of its state space, initial state, goal test, actions and path cost.

- State Space: (M, C, B) where M , C , and B represents the current number of missionaries, cannibals and boat respectively on the original side of the river.
- Initial State: $(3, 3, 1)$
- Goal Test: $(0, 0, 0)$
- Actions: From each state, bring either one missionary, one cannibal, two missionaries, two cannibals, or 1 missionary and 1 cannibal to the opposite side of the river.
- Path Cost: Number of boat trips to achieve goal state (e.g. 1 unit cost per boat trip)

3 General Search

TASK: Answer the following questions:

1. Describe the difference between a node and state

A node is a data structure constituting part of a search tree, where it comprises of the state, parent node, child-node(s), action, path-cost, and depth.

A state is a representation of a physical configuration, and unlike nodes, it does not have parent, children, depth, or path-cost.

2. Briefly describe what is a search strategy

A search strategy is the approach taken to solve a particular search problem. By picking the order of node expansion, different search strategies may be formulated, and these strategies are evaluated based on its completeness, optimality, time-complexity and space-complexity.

3. Describe the difference between Tree Search and Graph Search

Both the Tree Search and Graph Search attempts to iteratively expand on the leaf nodes of the frontier to search for the goal state and return the corresponding solution. The main difference between Tree Search and Graph Search is such that the latter uses a closed list or an explored set to keep track of the previously visited nodes, so that they are not revisited and expanded again. On the other hand, Tree Search do not use this closed list, thus this means that the same node can be visited multiple times.