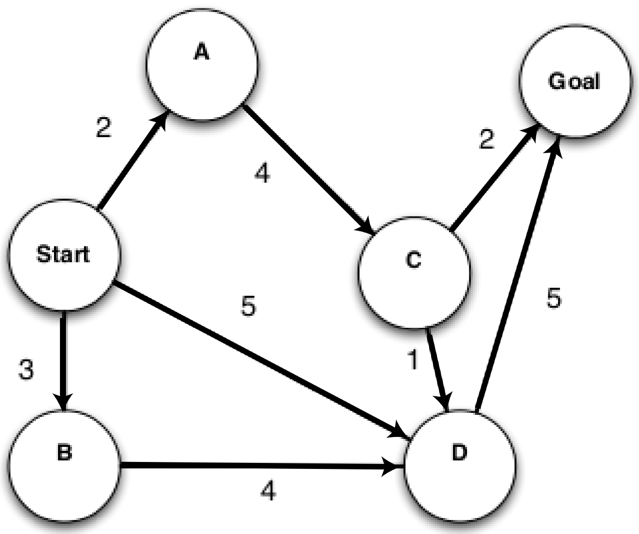
CS 188
Summer 2023

Discussion 1A Solutions

1 Search Algorithms in Action



For each of the graph search strategies, work out the order in which states are expanded, as well as the path returned by graph search. Break ties such that states with earlier alphabetical order are expanded first.

a) Depth-first search.
States Expanded: Start, A, C, D, Goal
Path Returned: Start-A-C-D-Goal

b) Breadth-first search.
States Expanded: Start, A, B, D, C, Goal
Path Returned: Start-D-Goal

c) Uniform cost search.
States Expanded: Start, A, B, D, C, Goal
Path Returned: Start-A-C-Goal

2 Agents and Environments

(a) Below is a list of task environments. For each of the sub-parts, choose all the environments in the list that falls into the specified type.
A: The competitive rock-paper-scissors game
B: The classical Pacman game (with ghosts following a fixed path)
C: Solving a crossword puzzle
D: A robot that removes defective cookies from a cookie conveyor belt

(i) Which of the environments can be formulated as *single-agent*? ☐ A ■ B ■ C ■ D

(ii) Which of the environments are *static*? ☐ A ☐ B ■ C ☐ D

(iii) Which of the environments are *discrete*? ■ A ■ B ■ C ☐ D

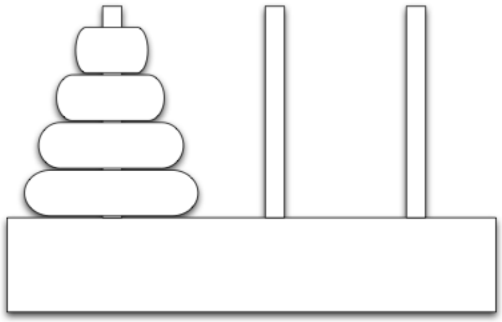
An environment cannot be formulated as a single-agent environment when the other agent's actions can depend on our own choices. An environment is static when the performance measure is invariant to changes in the agent's deliberation time. An environment is discrete when percepts, actions, and states can reasonably be modeled as belonging to a countable set; it would not be reasonable to model a robot's video input as belonging to a countable set, and its actions are effectively continuous.

(b) **(i)** ○ T ● F Reflex agents cannot be rational.

(ii) ● T ○ F There exist task environments in which no pure reflex agent can behave rationally.

(iii) ○ T ● F A perfectly rational poker-playing agent never loses.

3 Towers of Hanoi



The Towers of Hanoi is a famous problem for studying recursion in computer science and recurrence equations in discrete mathematics. We start with N discs of varying sizes on a peg (stacked in order according to size), and two empty pegs. We are allowed to move a disc from one peg to another, but we are never allowed to move a larger disc on top of a smaller disc. The goal is to move all the discs to the rightmost peg (see figure).

In this problem, we will formulate the Towers of Hanoi as a search problem.

(a) Propose a state representation for the problem

One possible state representation would be to store three lists, corresponding to which discs are on which peg. If we assume that the N discs are numbered in order of increasing size $1, ..., n$, then we can represent each peg as an ordered list of integers corresponding to which discs are on that peg.

(b) What is the size of the state space? If there are k pegs and n disks, then the size of the state space is k^n. For this setup, the size is 3^N.

(c) What is the start state? $([1, ..., n], [], [])$

(d) From a given state, what actions are legal?

We can pop the first integer from any list (i.e., peg) and push it onto the front of another list (peg), so long as it is smaller than the integer currently at the front of the list being pushed to (i.e., peg being moved to).

(e) What is the goal test? Is the state the same as $([], [], [1, ..., n])$?