National University of Singapore
School of Computing

Semester 1, AY2021-22

CS4246/CS5446 AI Planning and Decision Making

Issued: 29 Sep, 2021

Tutorial Week 8: Mid-Term Review

Guidelines

You may discuss the content of the questions with your classmates. But everyone should work on and be ready to present ALL the solutions. Note: Materials in this Tutorial cover only **some** of the topics relevant to the Mid-Term Exam on 8 October 2021.

Problem 1: Classical Planning

Modified from [RN 10.3 Kindle Edition]

$Init(At(C_1,\ SFO)\ \wedge\ At(C_2,\ JFK)\ \wedge\ At(P_1,\ SFO)\ \wedge\ At(P_2,\ JFK)$
$\quad \wedge\ Cargo(C_1)\ \wedge\ Cargo(C_2)\ \wedge\ Plane(P_1)\ \wedge\ Plane(P_2)$
$\quad \wedge\ Airport(JFK)\ \wedge\ Airport(SFO))$
$Goal(At(C_1,\ JFK)\ \wedge\ At(C_2,\ SFO))$
$Action(Load(c,\ p,\ a),$
PRECOND: $At(c,\ a)\ \wedge\ At(p,\ a)\ \wedge\ Cargo(c)\ \wedge\ Plane(p)\ \wedge\ Airport(a)$
EFFECT: $\neg\ At(c,\ a)\ \wedge\ In(c,\ p))$
$Action(Unload(c,\ p,\ a),$
PRECOND: $In(c,\ p)\ \wedge\ At(p,\ a)\ \wedge\ Cargo(c)\ \wedge\ Plane(p)\ \wedge\ Airport(a)$
EFFECT: $At(c,\ a)\ \wedge\ \neg\ In(c,\ p))$
$Action(Fly(p,\ from,\ to),$
PRECOND: $At(p,\ from)\ \wedge\ Plane(p)\ \wedge\ Airport(from)\ \wedge\ Airport(to)$
EFFECT: $\neg\ At(p,\ from)\ \wedge\ At(p,\ to))$

a) Given the action schemas and initial state from the figure above, what are all the applicable concrete instances of $Fly(p, from, to)$ in the state described by

$At(P_1, JFK) \wedge At(P_2, SFO) \wedge Plane(P_1) \wedge Plane(P_2) \wedge Airport(JFK) \wedge Airport(SFO)$?

b) What is the result of executing the action $Load(C_2, P_2, JFK)$ from the initial state?

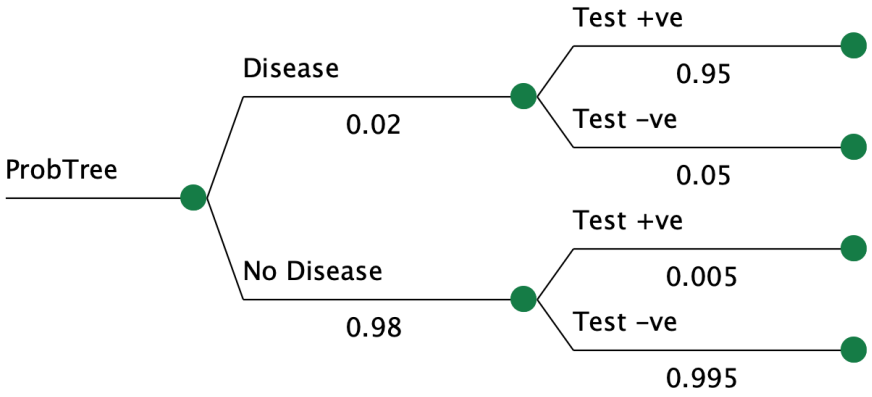
c) In regression or relevant-state search, we use *description* instead of state.
True or false: the goal in STRIPS is a description instead of a state. Why?

d) What actions are relevant to the description $In(C_2, p)$?

e) What is the outcome of regressing the description $At(C_1, JFK) \wedge At(C_2, SFO)$ over action $Unload(C_1, p, JFK)$?

Problem 2: Decision Analysis

Flip the probability tree as show below:



Problem 3: Markov Decision Process

Adpated from [RN 17.10]

Consider an undiscounted MDP having three states, $(1, 2, 3)$, with rewards $-1, -2, 0$, respectively. State 3 is a terminal state. In states 1 and 2 there are two possible actions: A and B. The transition model is as follows:

• In state 1, action A moves the agent to state 2 with probability 0.8 and makes the agent stay put with probability 0.2.

• In state 2, action A moves the agent to state 1 with probability 0.8 and makes the agent stay put with probability 0.2. • In either state 1 or state 2, action B moves the agent to state 3 with probability 0.1 and makes the agent stay put with probability 0.9.

a) Draw the state transition diagram for action a and b respectively.

b) What can be determined qualitatively about the optimal policy in states 1 and 2?

c) Apply policy iteration, showing each step in full, to determine the optimal policy and the values of state 1 and 2. Assume that the initial policy has action B in both states.

Problem 4: Decision Theory

A season investor, Alice, has a utility function $U(x) = ln(x)$, where x is total wealth, has a choice between the following two alternatives:

A: Win $\$10,000$ with probability 0.2
Win $\$1,000$ with probability 0.8
B: Win $\$3,000$ with probability 0.9
Lose $\$2,000$ with probability 0.1

a) If Alice current wealth is $\$2,500$, should she choose A or B?

b) If Alice current wealth is $\$5,000$, should she choose A or B?

c) If Alice current wealth is $\$10,000$, should she choose A or B?

d) Do you think this pattern of choices between A and B is reasonable? Why or why not?