

## CSC384 Winter 2009- Test 4 Sample Questions (Decision Making)

1. Consider the following STRIPS actions. Assume start state  $S_0 = \{c\}$ , and goal  $G = \{a, b, c\}$ .

Name	Pre	Adds	Del
T	c	b,a	c
S	b	a,c	b
R	a	b,c	

- (a) Show the reachability graph from  $S_0$  grown until the final state layer includes goal  $G$ .
- (b) If CountActions is being used as heuristic, what is the heuristic value of  $S_0$  (i.e. the value of  $\text{CountActions}(G, S_f)$  in the reachability graph, where  $S_f$  is the final state layer).
2. Consider the following STRIPS actions:

Name	Pre	Adds	Del
A	m	n	m
B	n	o	n
C	o	n,m	
D	p	q	

The first 4 state/action layers of the **graphplan** structure from the initial state  $\{m\}$  is shown below . Each item shows the fact or actions in the particular layer as well as the mutex pairs.

**State1:**  $m$ .

**Action1:**  $A, NoOp(m)$ :  $[A, NoOp(m)]$ .

**State2:**  $m, n$ :  $[m, n]$ .

**Action2:**  $NoOp(m), NoOp(n), B, A$ :  $[NoOp(m), NoOp(n)], [NoOp(m), A], [NoOp(m), B], [NoOp(n), B], [NoOp(n), A], [B, A]$ .

**State3:**  $o, m, n$ :  $[o, n], [o, m], [n, m]$ .

**Action3:**  $NoOp(m), NoOp(n), NoOp(o), B, A, C$ : ?

**State4:**  $o, m, n$ : ?

- (a) Fill in the following table indicating the actions in layer 3 that are mutex. Each entry in the table is indexed by a pair of actions. Place an **X** in the entry if the pair is mutex in action layer 3. Only the top half of the table needs to be filled in.

	<i>NoOp(m)</i>	<i>NoOp(n)</i>	<i>NoOp(o)</i>	<i>B</i>	<i>A</i>	<i>C</i>
<i>NoOp(m)</i>	–					
<i>NoOp(n)</i>	–	–				
<i>NoOp(o)</i>	–	–	–			
<i>B</i>	–	–	–	–		
<i>A</i>	–	–	–	–	–	
<i>C</i>	–	–	–	–	–	–

(b) Fill in the following table indicating the facts that are mutex in state layer 4.

	<i>o</i>	<i>m</i>	<i>n</i>
<i>o</i>	–		
<i>m</i>	–	–	
<i>n</i>	–	–	–

- (c) If we want to find a plan for the goal  $\{o, m, n\}$  what would we do after growing the graphplan to state layer 4.
- (d) If we want to find a plan for the goal  $\{o, q\}$  what would we do after growing the graphplan to state layer 4.

3. Consider the following STRIPS actions:

Name	Pre	Adds	Del
A	m	n,o	m
B	n	o,m	n
C	o	n,m	

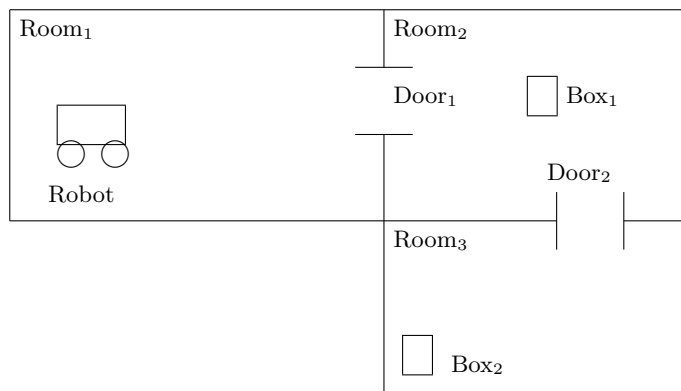
The first layers of the graphplan grown from the initial state  $\{m\}$  are as follows (all actions, facts, and mutexes are shown).

- State1:  $m$ .
  - Action1:  $A, NoOp(m)$ :  $[A, NoOp(m)]$ .
  - State2:  $m, n, o$ :  $[m, n], [m, o]$ .
  - Action2:  $NoOp(m), NoOp(n), NoOp(o), A, B, C$ :  $[NoOp(m), NoOp(n)], [NoOp(m), NoOp(o)], [NoOp(m), A], [NoOp(m), B], [NoOp(m), C], [NoOp(n), A], [NoOp(n), B], [NoOp(n), C], [NoOp(o), A], [NoOp(o), B], [A, B], [A, C], [B, C]$ .
  - State3:  $o, m, n$ ; no mutexes.
- (a) Given the goal  $\{o, n, m\}$  show how the search for a plan in this graphplan structure proceeds. Starting with the given goal  $\{o, n, m\}$  show each step of the search by specifying
- For each goal fact show the action from the previous action layer that you have selected to achieve that goal.
  - Show the new set of goal facts you obtain after regressing the goals through the selected actions. (You do not need to show the details of the regression, just show the new goals).
  - Now repeat.

The format of our answer must be like the following:

- Goal0: foo, apple
- Actions0: act1  $\rightarrow$  foo; NoOp(apple)  $\rightarrow$  apple.
- Goal1: baz, apple.
- Action1: act3  $\rightarrow$  baz, act3  $\rightarrow$  apple.
- Goal2: ....
- $\vdots$
- Goalk: foo, baz, apple; all present in the initial state.

4. Consider the following planning domain consisting of a robot pushing boxes between connected rooms.



We will represent this domain with the following symbols

- $b_1, b_2$  the two boxes;  $r_1, r_2, r_3$  the three rooms,  $d_1, d_2$  the two doors.
- $open(X)$ —door  $X$  is open.
- $in(X, Y)$ —box  $X$  is in room  $Y$ .
- $robin(X)$ —the robot is in room  $X$ .
- $join(X, Y, Z)$ —door  $X$  joins rooms  $Y$  and  $Z$ .

- (a) Give a STRIPS representation of the following actions. In all cases use the above symbols to specify sensible preconditions and effects for each of the actions.
- i.  $gothru(D, R1, R2)$  the robot goes from room  $R1$  to  $R2$  via door  $D$ .
  - ii.  $pushthru(B, R1, R2, D)$  the robot pushes box  $B$  from room  $R1$  to  $R2$  via door  $D$ .
  - iii.  $close(D)$  the robot closes door  $D$ .
  - iv.  $open(D)$  the robot opens door  $D$ .

5. Suppose that you are trying to decide whether to study hard for the CSC384 test 4. You'd be happy if you got a good mark, but you know that your mark will depend not only on how hard you study but also on how hard the test 4 is and your background from prerequisite courses (which indicates how well prepared you are for the subject). Consider the influence diagram shown in Figure 1 that reflects this problem, with estimated utilities and probabilities. In the diagram square boxes are decisions, rounded boxes are probabilistic variables, and the

diamond is the utility or value node. The tables give the probability of each value of each variable given each setting of values for its parents.

Compute the decision (study hard or not) that maximizes expected utility.

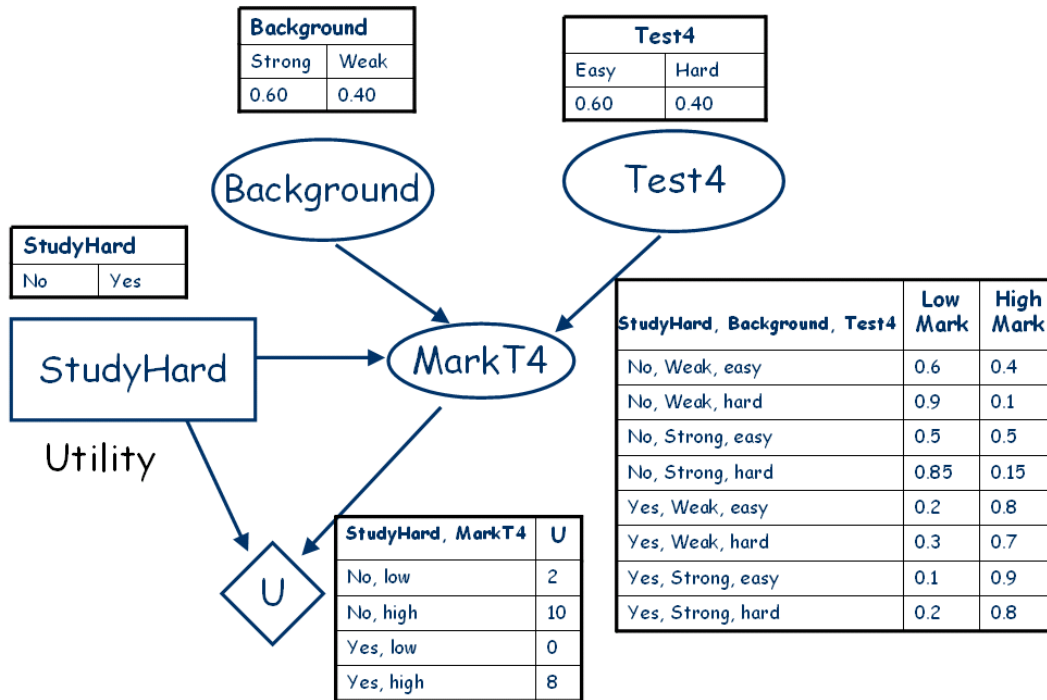


Figure 1: Influence Diagram

6. You are planning a trip, and according to the weather you want to use tires for wet or dry road. If you go for a dry road tire and the road is wet, your chances of an accident are higher, but if you pick a wet road tire and the road is dry, your performance decreases (fuel/tire consumption). Before leaving on your trip, you can consult a weather report to help you make your decision, however this report may not be totally accurate. In order to maximize the utility of your trip (i.e., having a safe and economical trip) you decide to use the decision tree shown in Figure 2. Squares are choice nodes and circles are chance nodes. Arcs going out of a chance node are labeled with a probability and the numbers in bold at the leaves are the utility values.
  - (a) Fill in the choice and chance nodes with their expected utility values.
  - (b) What is the policy that maximizes expected utility?
  - (c) What is the accuracy of the weather report. That is what is the probability that the forecast is accurate?
  - (d) How valuable is the weather report? In other words, up to how much utility would you be willing to pay to get the forecast?

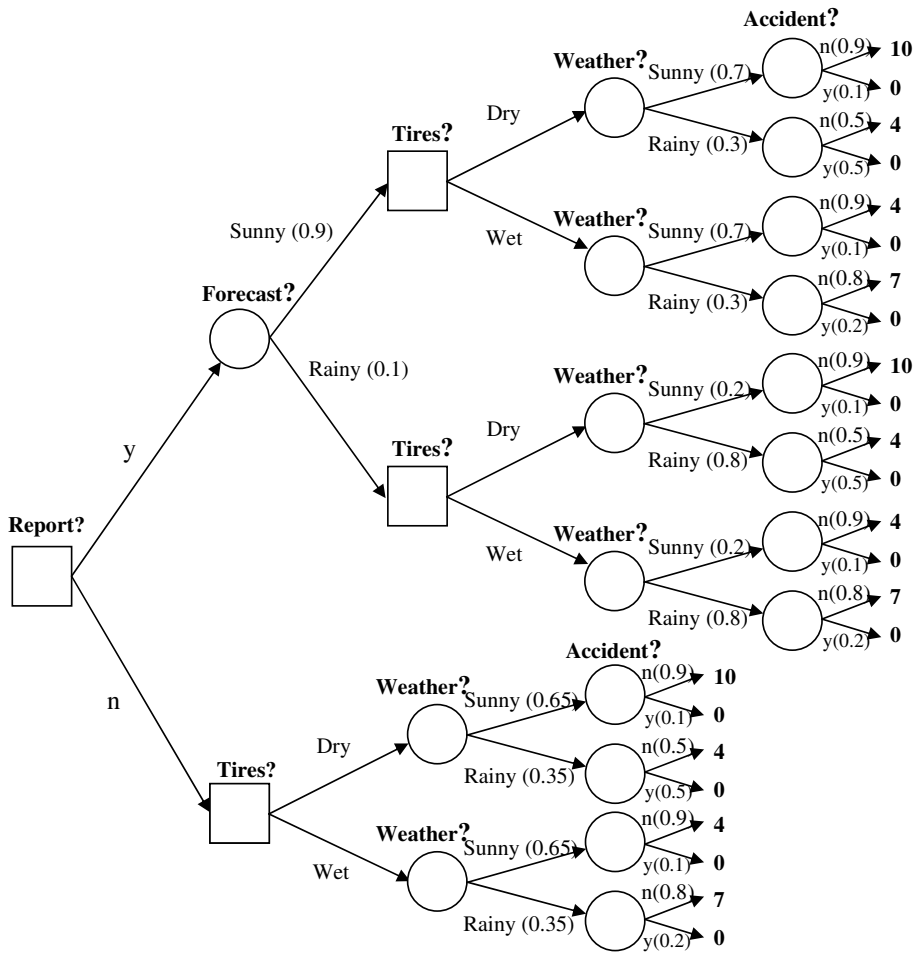


Figure 2: Decision Tree