

Homework #4: Chapters 12,13,14,16

The following exercises are due at the beginning of class on April 14.

1. [20 points] This problem involves writing a number of different types of STRIPS actions
 - a) [5 pts.] Do exercise 12.10 from the book (p. 460).
 - b) [5 pts.] An agent playing parlor games has an action *ThrowDart*. In order to throw a dart, the agent must have a dart (*HaveDart*) and it must be the agent's turn (*IsMyTurn*). The agent may or may not be close to the dart board (*CloseToDartBoard*) when it throws the dart. If the agent is close to the dart board, then the agent will not only hit the dart board (*HitDartBoard*) but it will also hit the bullseye (*HitBullseye*). If the agent is not close to the dart board, the dart may still hit the dart board but it could also miss the dart board (*MissDartBoard*). Write a *ThrowDart* action for the agent using STRIPS syntax with disjunctive and/or conditional effects.

In parts c and d, the agent is operating in a vacuum cleaner world with some Murphy-effects.

- c) [5 pts.] When a *Suck* action is executed, the vacuum will try to pick up dirt but it may fail (i.e. not pick up the dirt). Therefore, the agent will need to use its local sensing capability to check whether or not dirt was actually removed. Write a *Suck* action description for an automatic sensing agent using knowledge propositions, analogous to Equation 12.2 in the book (p. 440). Do not use disjunctive effects.
- d) [5 pts.] When *Left* and *Right* actions are executed, they may fail to move the vacuum in the desired direction. Therefore, the agent will need to check its location to determine the result of a *Left* or *Right* action. Write a *CheckLocation* action description for an active sensing agent using knowledge propositions, analogous to Equation 12.3 in the book (p. 440).

2. [25 points] Construct an AND-OR graph to find a conditional plan for a Murphy-like vacuum cleaner. Use the following action descriptions:

Action(Left, PRECOND: AtR, EFFECT: AtL \vee AtR)

Action(Right, PRECOND: AtL, EFFECT: AtR \vee (AtR \wedge when CleanL : \neg CleanL))

Action(Suck, PRECOND:, EFFECT: (when AtL : CleanL) \wedge (when AtR : CleanR))

In the initial state, the vacuum is in the left location and dirt is in the right location but not the left location. The goal is to have no dirt in either location. It does not matter where the vacuum ends up. **Warning:** Given the nature of the actions defined, your graph will have cycles. There are only 8 possible states, so if you find yourself with an AND-OR tree having more than 8 states then you have definitely failed to recognize cycles. Cycles should be depicted like in Figure 12.11 on page 436 of the book. Highlight all arcs that are in the solution. Cyclic arcs can be part of the solution.

3. [15 points] Use the full joint distribution given for *Overheats*, *Stalls*, and *Rattles* to compute

a) $P(\textit{rattles})$

b) $P(\textit{stalls} \vee \textit{rattles})$

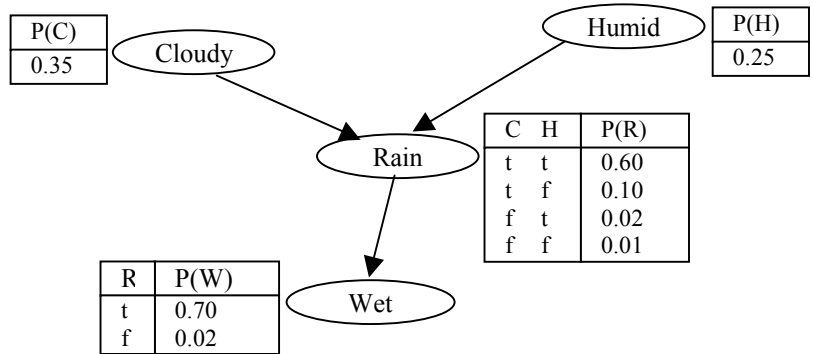
c) $P(\textit{stalls} \mid \textit{overheats})$

d) $P(\textit{Overheats})$

e) $P(\textit{Stalls} \mid \textit{overheats} \vee \textit{rattles})$

	overheats		\neg overheats	
	rattles	\neg rattles	rattles	\neg rattles
stalls	0.032	0.329	0.184	0.036
\neg stalls	0.099	0.082	0.073	0.165

4. [25 points] Use the Bayesian network and conditional probability tables shown to the right to compute the following probabilities and probability distribution.



- [3 pts] $P(w \wedge \neg r \wedge \neg c \wedge h)$
- [7 pts] $P(w|h)$
- [15 pts] $P(C|w)$

All random variables are Boolean. You must give computed numeric answers and show all of your work.

5. [15 points] A basketball player has the ball and is standing right on the 3 point line. There are 4 actions that the player can take: lean back while shooting a shot for 3 points (shoot3point), lean forward while shooting a shot for 2 points (shoot2point), dribble around while a play is set up (dribble), and pass the ball to a teammate (pass). Any of these actions may fail to yield the desired result. A shot can be made, missed, or blocked. While dribbling, the player will either succeed in controlling the ball, lose the ball, or get fouled. A pass can either be delivered successfully to the intended teammate or intercepted by the opposing team.

The agent's utilities for the outcomes of its actions are:

- +12 for making a 3 point shot
- +8 for making a 2 point shot
- 4 for missing any shot
- 3 for having any shot blocked
- +1 for dribbling around while a play is set up (without losing the ball or getting fouled)
- 8 for a turnover caused by either losing the ball while dribbling or having a pass intercepted
- +4 for getting fouled while dribbling
- +2 for successfully passing the ball to a teammate

The probabilities of the outcomes are:

Action	P(make)	P(miss)	P(blocked)
shoot3point	0.30	0.60	0.10
shoot2point	0.40	0.40	0.20

Action	P(lose ball)	P(fouled)
dribble	0.20	0.10

Action	P(intercepted)
pass	0.15

What is the expected utility of each action? If the agent follows the principle of maximum expected utility and only considers single actions (as opposed to action sequences), which action will it choose?