CS610: Advanced Artificial Intelligence

Winter 2013, Midterm Assignment

Due 18:00 EST 2013-02-27 via BbLearn

Exercise 0. 100 points

You are working in the VIS-O-MATIC television factory. You need to produce two types of TVs: In one country (country A), televisions are required to have a chip that blocks out any kind of polka music. Another country (country B) requires that the chip not be present. So each TV comes down a conveyor belt and either has the anti-polka chip installed, or a dummy chip installed.

For the first problem, you can assume that you can tell with 100% accuracy what chip is installed. In the control room, there is a switch that controls what type of chip is installed; at the start of the day there's a 70% chance that it's in anti-polka mode and a 30% chance that it's in dummy mode. When the system is turned on, it starts installing chips into TVs on the conveyor belt. (You can assume that the state of the switch for any time t is the same as the kind of chip installed at time t—that is, they are the same variable. *This is a significant hint! It makes the problem much simpler!*)

Moreover, some devious professor has let a Xanax-drugged chimpanzee into the control room, who starts flipping the switches. The switch can only be flipped between TVs (*i.e.*, we don't install half of a chip). There is a 30% chance between every installation that the switch will be flipped, changing the type of chip installed.

Additionally, a second chip that controls the language is installed in each TV. There are three chips (`LanguageA`/`LanguageB`/`LanguageC`), and a set of push-buttons that control them as well. Pushing a button for a particular language will exclusively set the chip to that language—only one button is active at a time. The probability of the buttons being in `LanguageA` mode at the beginning of the day is 60%, and `LanguageC` is 20%. Again, the probability of the switch being flipped by the chimp is 30% between every TV (evenly divided between the other languages—when in state "`LanguageA`" there's a 15% chance of `LanguageB` and 15% of `LanguageC` button pushing). The probability of the polka switch being flipped and language buttons being pushed is independent.

30 points (a) What is the probability that *at the beginning of the day* the machine will produce chips in the following order: {`LanguageA`/Anti-Polka, `LanguageB`/Anti-Polka, `LanguageB`/Dummy}?

Now assume that you do not know what kind of chip is in each TV. You can, however, weigh the TVs, and the chips will probabilistically affect the TVs' weight. Use the following table for $P(\text{weight}|\text{chip}_1, \text{chip}_2)$:

chip_1	chip_2	$P(\text{weight} = \text{heavy} \mid \text{chip}_1, \text{chip}_2)$	$P(\text{weight} = \text{medium} \mid \text{chip}_1, \text{chip}_2)$	$P(\text{weight} = \text{light} \mid \text{chip}_1, \text{chip}_2)$
Anti-Polka	`LanguageA`	0.7	0.2	0.1
Anti-Polka	`LanguageB`	0.5	0.3	0.2
Anti-Polka	`LanguageC`	0.4	0.3	0.3
Dummy	`LanguageA`	0.3	0.5	0.2
Dummy	`LanguageB`	0.1	0.6	0.3
Dummy	`LanguageC`	0.1	0.4	0.5

60 points (b) You start up the system and observe that the first TV is heavy and the second TV is light. What is the probability for each type of chip being in each TV?

Xanax-chimp is from country B and he really likes polka music! He's a smart chimp: He realizes that TVs with the anti-polka chip are usually heavier than TVs without the anti-polka chip. Therefore, every time three heavy TVs drop off of the conveyor belt in a row, the chimp will flip the switch with 100% probability.

10 points (c) *Without resorting to Monte Carlo simulation*, what technique might you use to calculate the expected value for the percentage of TVs that have anti-polka chips at the end of the day? You may assume that a significantly large number of TVs were produced throughout the day. (Hint: Try creating a Markov Decision Process for the state of the system.)

10 points (d) **Extra Credit:** Actually perform the calculation from the previous step.