Homework #6: Chapters 14-16

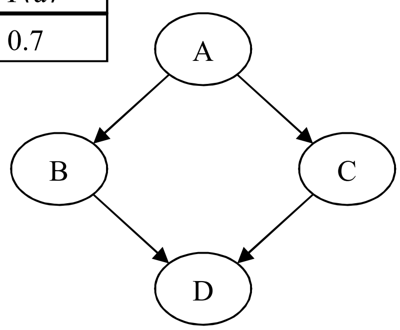
The following exercises are due at the beginning of class on Tuesday, April 21. Note, this homework is continued on the reverse side of the paper.

1. *[25 pts.]* Consider the Bayesian network below, where A, B, C, and D are all Boolean random variables. Compute the following probabilities and probability distributions, using a <true,false> ordering for all Boolean variable probability distributions. You must give computed numeric answers and show all of your work.

   a) $P(a \wedge \neg b \wedge c \wedge d)$
   b) $\mathbf{P}(A \mid b \wedge \neg c \wedge \neg d)$
   c) $\mathbf{P}(B \mid c \wedge \neg d)$

P(a)
0.7

A	P(b|A)
T	0.3
F	0.8



A	P(c|A)
T	0.2
F	0.3

B	C	P(d|B,C)
T	T	0.1
T	F	0.4
F	T	0.9
F	F	0.6

2. *[25 pts.]* Do exercise 14.12 (a-d) from the book (p. 562). Assume the probability that the count is under by one is *e*, and an additional *e* probability that it is over by one. Also, assume the off-by-one counts cannot simultaneously occur with an out-of-focus event.

3. *[20 pts.]* A professor wants to know if a student is getting enough sleep. Each day, the professor observes whether the student slept in class, and whether he/she has red eyes. The professor has the following domain theory:

   - The prior probability of getting enough sleep, with no observations, is 0.7.
   - The probability of getting enough sleep on night *t* is 0.8 given that the student got enough sleep the previous night, and 0.3 if not.
   - The probability of having red eyes is 0.2 if the student got enough sleep, and 0.7 if not.
   - The probability of sleeping in class is 0.1 if he student got enough sleep and 0.3 if not.

   Give a Bayesian network structure (similar to the one in Fig. 15.2, p. 569) for this Markov process, including values for all relevant conditional probability tables. Also include a table for the probability of the state variable(s) at time t=0.

4. *[15 pts.]* After taking this course, you are feeling confident about your knowledge of probabilities, and want to use your newfound skill to win big at the casino next door. Imagine you encounter a slot machine with three independent wheels, each of which produces the four symbols BAR, BELL, LEMON, or CHERRY with equal probability. The slot machine has the following payout scheme for a bet of 1 coin (where "?" denote that we don't care what comes up for that wheel). Note, that in the last two cases, which wheel the CHERRY appears on matters.

   BAR/BAR/BAR pays 20 coins
   BELL/BELL/BELL pays 15 coins
   LEMON/LEMON/LEMON pays 5 coins
   CHERRY/CHERRY/CHERRY pays 3 coins
   CHERRY/CHERY/? pays 2 coins
   CHERRY/?/? pays 1 coin

   a) Compute the expected value of playing the machine one time. Remember it costs 1 coin to play. Show your work.

   b) Compute the probability that playing the slot machine once will result in a win (any of the combinations above).

5. *[15 pts.]* A robot soccer player has the option to dribble, pass, or shoot on the goal. If the robot dribbles, there is a 0.2 probability that the other team will steal the ball; otherwise the robot keeps control of the ball. If the robot passes, there is a 0.2 probability that the other team will intercept the pass and a 0.1 probability that the ball will go out of bounds (giving control to the other team); otherwise the pass succeeds. If the robot shoots on the goal, there is a 0.2 probability that it will score, a 0.6 probability that it will be caught by the opponent's goalie, and a 0.2 probability that the shot will go out of bounds (note, in each of the last two situations the other team gains control of the ball). The utility of the robot maintaining control of the ball is 10, the utility of giving it to a teammate is 20, the utility of scoring a goal is 100, and the utility of losing the ball to the other team is – 30.

   What is the expected utility of each action? To maximize the chance for partial credit, be sure to show your work. 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?