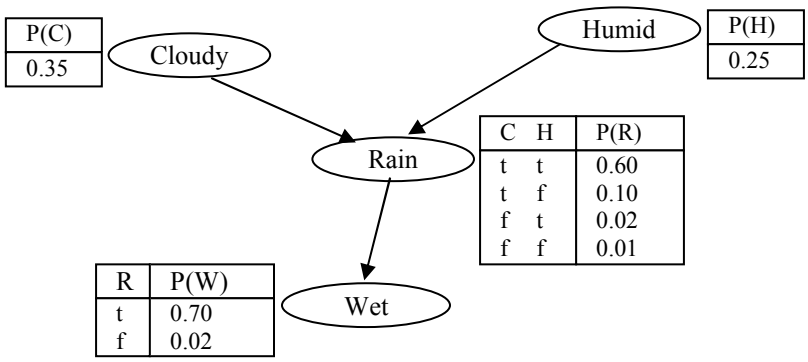
Homework #6: Chapters 14-16

The following exercises are due at the beginning of class on Monday, April 15. Note, this homework is continued on the reverse side of the paper.

1. *[20 pts. total]* Use the Bayesian network and conditional probability tables shown below to compute the following probabilities and probability distributions. All random variables are Boolean, and you should use a <true,false> ordering for probability distributions. You must give computed numeric answers and show all of your work.



   a) *[4 pts]* $P(w \wedge \neg r \wedge \neg c \wedge h)$

   b) *[8 pts]* $\mathbf{P}(W \mid \neg h \wedge c)$

   c) *[8 pts]* $\mathbf{P}(C \mid w)$

2. *[25 pts.]* Do problem 14.6 from the book (p. 559). Note, for part f), genetic equilibrium implies that the probability of the gene in a child is the same as the probability of the gene in his/her parents, i.e., $\mathbf{P}(G_{child}) = \mathbf{P}(G_{mother}) = \mathbf{P}(G_{father})$.

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 at time t=0.

4. *[20 pts. total]* The Surprise Candy Company makes candy in two flavors: 70% are strawberry flavored and 30% are anchovy flavor. All candies are either round or square, and come in either a red or brown wrapper. 80% of the strawberry candies are round and 80% have a red wrapper, while 90% of the anchovy candies are square and 90% have a brown wrapper. Assume that the shape and wrapper are conditionally independent, given the flavor. All candies are sold individually in sealed, identical, black boxes. Assume that a strawberry candy is worth $0.50 and an anchovy candy is worth $0.10.

   a) *[4 pts.]* What is the probability that a candy in an unopened box has a red wrapper?

   b) *[4 pts.]* What is the value of an unopened candy box?

   c) *[6 pts.]* If you open the box, and find a round candy with a red wrapper, what is the value of the candy?

   d) *[6 pts.]* What is the value of a square, unwrapped candy? Assume that a wrapper has no value, that both types of candies are odorless and identical in color, and that people are not adverse to eating unwrapped candies.

5. *[15 pts.]* Consider the following variation of the Wumpus World agent. The agent has determined the probabilities of the outcomes of three different action sequences: A, B and C. The outcomes are defined by two Boolean propositions: *Gold* and *Die*. *Gold* is true if the actions lead to the gold. *Die* is true if the agent loses its life (e.g., by stepping into a pit or encountering the Wumpus). The agent's utility is -100 if the agent dies (regardless if it gets the gold or not), 50 if the agent gets the gold and lives, and 10 if the agent lives but does not get the gold. The probability of the various outcomes are given by the table below:

Action Sequence	**Gold**		**¬Gold**	
	Die	**¬Die**	**Die**	**¬Die**
A	0.6	0.05	0.2	0.15
B	0.05	0.1	0.05	0.8
C	0.25	0.6	0.1	0.05

What is the expected utility of each action sequence? To maximize the chance for partial credit, be sure to show your work. If the agent follows the principle of maximum expected utility, which action sequence will it choose?