EECS 649: PROBLEM SET #8

Reading:

- R&N, 4e: Sections 13.1, 13.2, 13.3.2-4, 13.4, and page 459
  [you can do PS#8 with this and the Probabilistic Reasoning 1 & 2 lectures]

Total Points: 100

Notes:

- Submitted electronically (via Gradescope)
- This is now back to a usual length homework, including some programming.

Problem 8.1 [10 points] *Probability Warmup*
Problem 19.1 of Nilsson, reprinted below. Hint: Use Bayes' rule.

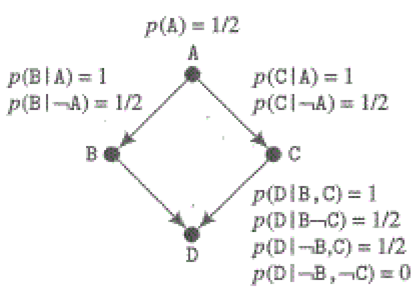
19.1 Suppose that colored balls are distributed in three indistinguishable boxes, $B1$, $B2$, and $B3$, as follows:

	B1	B2	B3
Red	2	4	3
White	3	2	4
Blue	6	3	3

A box is selected at random from which a ball is selected at random. The ball is red. What are the probabilities of the box selected being $B1$, $B2$, or $B3$? Explain your reasoning.

Problem 8.2 [15 points] *Bayes Net for College Admissions*
Problem 19.3 of Nilsson, reprinted below:

19.3 An admissions committee for a college is trying to determine the probability that an admitted candidate is really qualified. The relevant probabilities are given in the Bayes network shown here. Calculate $p(A|D)$.

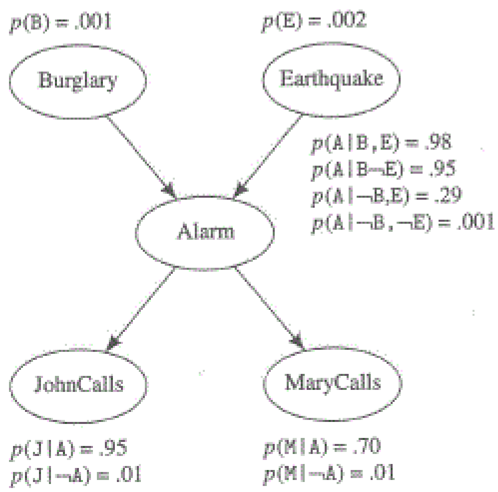


A = applicant is qualified
B = applicant has high grade point average
C = applicant has excellent recommendations
D = applicant is admitted

$p(A|D) = ?$

Problem 8.3 [20 points] *Bayes Net for Earthquakes*
Problem 19.4 of Nilsson, reprinted below.

19.4 (Courtesy of Judea Pearl, a resident of earthquake country.) The belief network shown here formalizes the following situation: you have a new burglar alarm installed at home. It is fairly reliable at detecting a burglary, but also responds on occasion to minor earthquakes. You also have two neighbors, John and Mary, who have promised to call you at work when they hear the alarm. John quite reliably calls when he hears the alarm, but sometimes confuses the telephone ringing with the alarm and calls then too. Mary, on the other hand, likes rather loud music and sometimes misses the alarm altogether.



To exercise your ability to work with joint probabilities as defined by belief networks, calculate the joint probability that neither John nor Mary calls and that there is both an earthquake and a burglary. That is, calculate $p(\neg J, \neg M, B, E)$.

Problem 8.4 [15 points] *Fuzzy Logic*
Define fuzzy sets that can be used to represent the following concepts:

a. Old (domain is real-valued age in years).
b. Not old (domain is real-valued age in years).
c. Young (domain is real-valued age in years).
d. A few (domain is positive integers).

Then answer the following question:

e. Do "Not Old" and "Young" have to be the same?

The following two problems require some programming.

Problem 8.5 [20 points] *Approximate Inference 1*
Check your answer to Problem 8.2 above with a Monte Carlo simulation (using direct or rejection sampling). **Turn in your code and a summary of your results.**

Important Note: you do not have to implement the general algorithm, just solve the specific problem at hand.

An example program using direct and rejection sampling is linked here: Approximate Inference.

Problem 8.6 [20 points] *Approximate Inference 2*
Is a Monte Carlo simulation with direct or rejection sampling practical in verifying the answer to Problem 8.3 above? Why or why not? If not, can you think of any modifications that would make such a simulation practical? **Turn in code and a summary of any results in support of the above.**

Hint: You may wish to consider **likelihood weighting** (R&N, 4e, pp. 439-440).

Important Note: as before, you do not have to implement the general algorithm, just solve the problem at hand.

Here is another hint on this one: Let's say you had the Bayes Net:

p(+a) = 10^{-9}   A *----->* B   p(+b|+a) = 0.3

If you want to estimate p(+b, +a), you can set A to be True, estimate p(+b|+a) with a simulation and then multiply THAT estimate by 10^{-9) to get your final answer.