COMPSCI 383 – Fall 2020

Homework 3

Due Thursday, October 15th at 11:59pm ET

You are encouraged to discuss the assignment in general with your classmates, and may optionally collaborate with one other student. If you choose to do so, you must indicate with whom you worked. Multiple teams (or non-partnered students) submitting the same code will be considered plagiarism.

1. Alarmist JPT (32 points)

The joint probability distribution table below represents the probabilistic relationships between three variables: Time-of-day (one of *night*, *evening*, *afternoon*, *morning*), Alarm (boolean, indicating whether the alarm is going off), and Burglar (boolean, representing whether someone is breaking into you home). However, the table is missing most of its values.

Using the probabilistic statements below, fill in the missing entries. To do so, you will have to reason using the probability rules and definitions we reviewed in class, such as the definitions of conditional probability, the product rule, Bayes rule, etc.

Hint: the statements below will enable you to generally fill the table out from top to bottom, so don't try and tackle the lower entries until you have answers for the preceding ones.

For the following, we write *alarm* to denote Alarm=true, and ¬*alarm* for Alarm=false. Similarly, values for Burglar are *burglar* and ¬*burglar*. Time-of-day=night will simply be written *night*, Time-of-day=evening as *evening*, etc.

1. Variables Time-of-day and Alarm are marginally independent, but non-independent when conditioned on Burglar
2. The marginal probability of *night* is 0.4
3. The marginal probability of *alarm* is 0.3
4. The joint probability of *alarm* and *evening* is 0.09
5. Given *alarm* and *evening*, the probability of ¬*burglar* is 0.9
6. The joint probability of *burglar* and *evening* is 0.072
7. The probability of *evening* or *night* is 0.7
8. The probability of *alarm* or *afternoon* is 0.475
9. The probability of *burglar* given *afternoon* and ¬*alarm* is 0.2
10. The probability of ¬*burglar* is 0.593
11. Given *burglar*, the probability of *alarm* and *morning* is 0.03
12. Given ¬*burglar* and *alarm*, the probability of *morning* is 0.027972

Time-of-day	**Alarm**	**Burglar**	**P(T, A, B)**
night	true	true	**0.060**
night	true	false	
night	false	true	**0.196**
night	false	false	
evening	true	true	
evening	true	false	
evening	false	true	
evening	false	false	
afternoon	true	true	
afternoon	true	false	**0.068**
afternoon	false	true	
afternoon	false	false	
morning	true	true	
morning	true	false	
morning	false	true	
morning	false	false	**0.007**

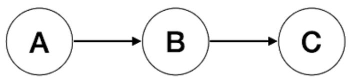
2. All Your Bayes (20 points)

Draw a Bayesian network representing the joint probability distribution described in the preceding question. Be sure to include a directed acyclic graph representing the variable dependence structure, and a conditional probability table filled in for each variable.

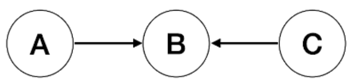
3. Separation Anxiety (24 points)

For each network below, use the rules of d-separation to indicate whether A ⊥ C (*A is marginally independent of C*) and whether A ⊥ C | B (*A is conditionally independent of C given B*).

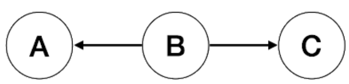
(a)



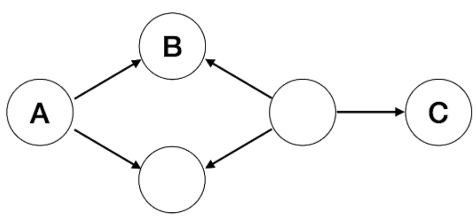
(b)



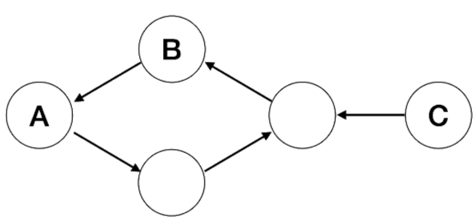
(c)



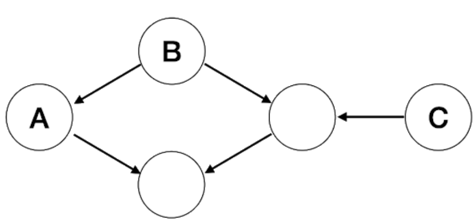
(d)



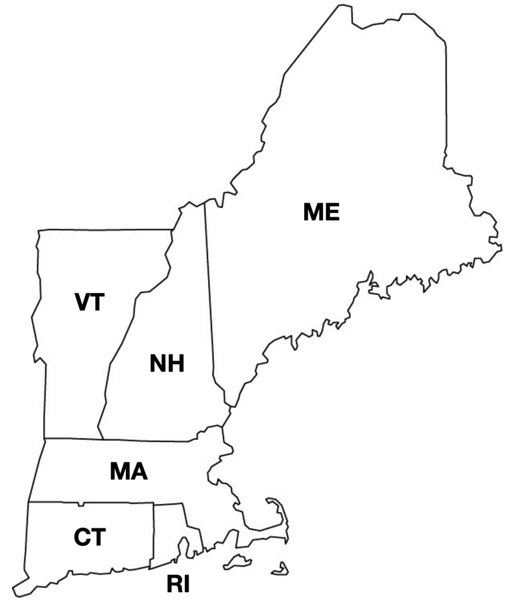
(e)



(f)



4. Graph CSP (24 points)



The map on the right depicts the six New England states. Your job is to color each state on the map (one of three colors: pink, green, or blue), such that no two states that border each other have the same color. Additionally, no state can have a color that comes after it's name alphabetically (for instance, CT cannot be pink).

(a) Show the valid domain for each state variable (VT, NH, ME, MA, CT, RI), taking into account the alphabetical naming restriction above.

(b) Express the map coloring requirements as a set of binary constraints, expressed using ⟨*scope, relation*⟩ format, where *scope* is a pair of variables, and *relation* is a list of all legal value assignments for those variables (see AIMA p. 203 for examples).

(c) After assigning NH=green, show the valid domains for each variable after performing forward checking.

(d) Further reduce the domains of each variable using constraint propagation by enforcing arc consistency.