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Homework Problem: Alien Leaders

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Homework Problem: Alien Leaders

10/10 points (graded)

Your spaceship has made contact with an alien race! They send a delegation of a red, a blue and a green alien. One of the aliens is the leader, the other two are followers. Your goal is to identify which is which from their answers to your yes-or-no questions. Let X_R , X_G , and X_B be Bernoulli random variables that take on values **y** ('yes') and **n** ('no') and represent the answers of the red alien, the blue alien and the green alien, respectively.

From your study of the alien protocols, you know that the leader is equally likely to answer 'yes' or 'no.' Based on the telepathic communications with the leader, the follower's answer is identical to that of the leader with probability q , independently of the other follower, where $q > 1/2$.

Your first interaction involved four questions and resulted in the following four sets of responses for (x_R, x_G, x_B) respectively: (n, n, n) , (n, n, y) , (n, y, y) , (y, y, y) .

Part I. Suppose we know that the red alien is the leader.

- **(a)** What is the tree-structured graphical model that corresponds to the joint distribution of variables X_R , X_G , and X_B ?

Please specify your answer by selecting which edges are present.

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**Week 10: Homework 7**

due Nov 24, 2016 03:30 IST

☒ (X_R, X_G) ☒ (X_R, X_B) ☐ (X_B, X_G) 

For this problem, suppose the node potentials are all just functions that always output 1. For the edges present, in this problem, they actually have the exact same pairwise/edge potential table.

For this edge potential table, what is the entry for yes/yes, and for yes/no? (There are a total of four entries for yes/yes, yes/no, no/yes, no/no; we are asking for just two of them. Please specify your answer here in terms of q and such that the sum of these two entries we are asking for is 1.)

In this part, please provide your answer as a mathematical formula (and not as Python code). Use \wedge for exponentiation, e.g., x^2 denotes x^2 . Explicitly include multiplication using $*$, e.g. $x*y$ is xy .

Edge potential entry for yes/yes:

q

 q

Edge potential entry for yes/no:

1-q

 $1 - q$

- **(b)** Determine a maximum likelihood (ML) estimate \hat{q}_{ML} of the parameter q from the aliens' answers.

Keep in mind that for this problem, the edge potential tables are the same for all the edges present, meaning that the parameters are "shared" across different edges! (This is unlike in the video where every edge was associated with its own table.)

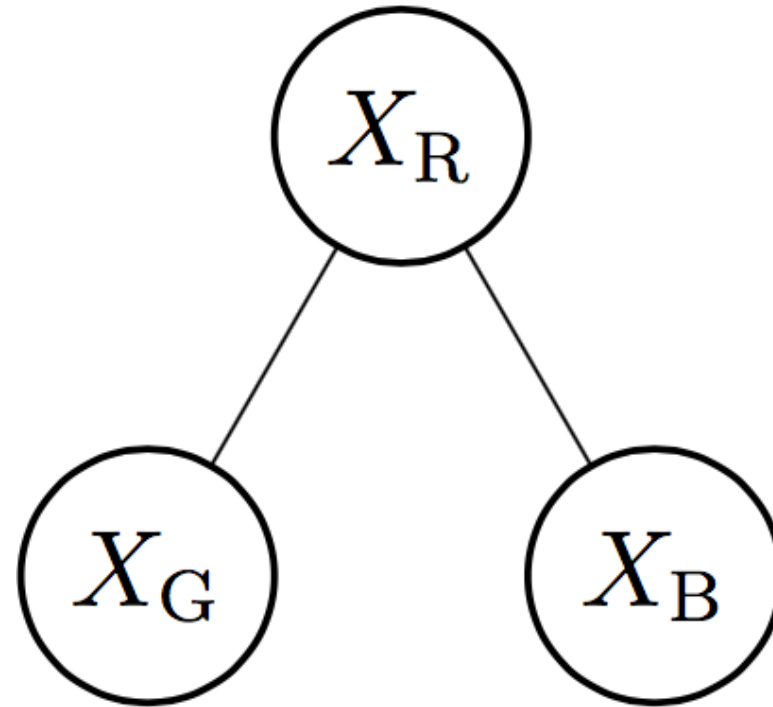
(Please be precise with at least 3 decimal places, unless of course the answer doesn't need that many decimal places. You could also put a fraction.)

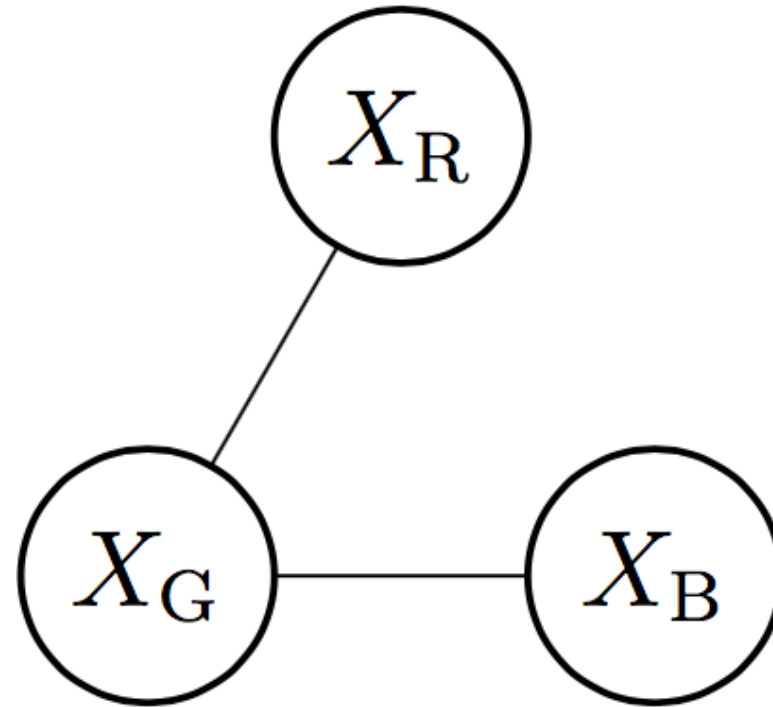


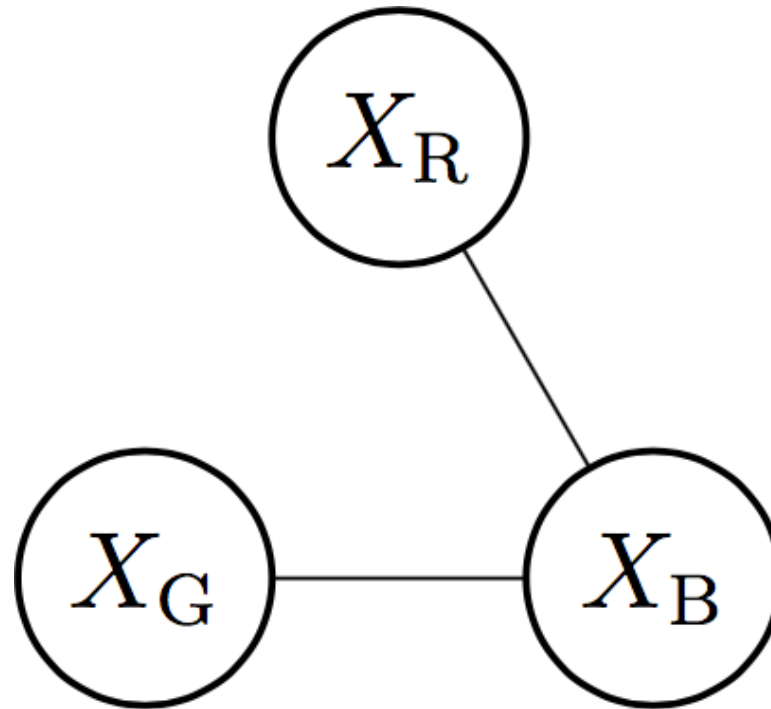
Part II. Now suppose we do not know the leader.

- **(c)** What is the set of tree-structured graphical models that describe all possible joint distributions of X_R , X_G , and X_B ?

Specify this set by selecting the graphical models that belong to this set.







- **(d)** If $q = 4/5$, determine the ML model (and, in turn, the ML estimate of the leader) from the aliens' answers.

While we are asking you to specify your answer via a multiple choice prompt, you should be able to rigorously justify your answer.

☐ The ML leader is red

☒ The ML leader is green ✓

☐ The ML leader is blue

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I still didn't try it, but I think in general case you can compute mutual information in the graph (it's relative pairwise correlation, isn't it), but to incorporate leader information (already known transition table, given q and conditional independence of subordinates) you'll need to do it for all legal leaders.



Edit: I would say CL could give you the most probable graph according to observed answers. But you want to impose additional leaders constraints.

posted 2 days ago by Mark_B2 **Community TA**

I think you're right; and hence, Edit 1 of my OP is somewhat pertinent in this case. I'll see if I can validate this thinking.



posted 2 days ago by avonmoll

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