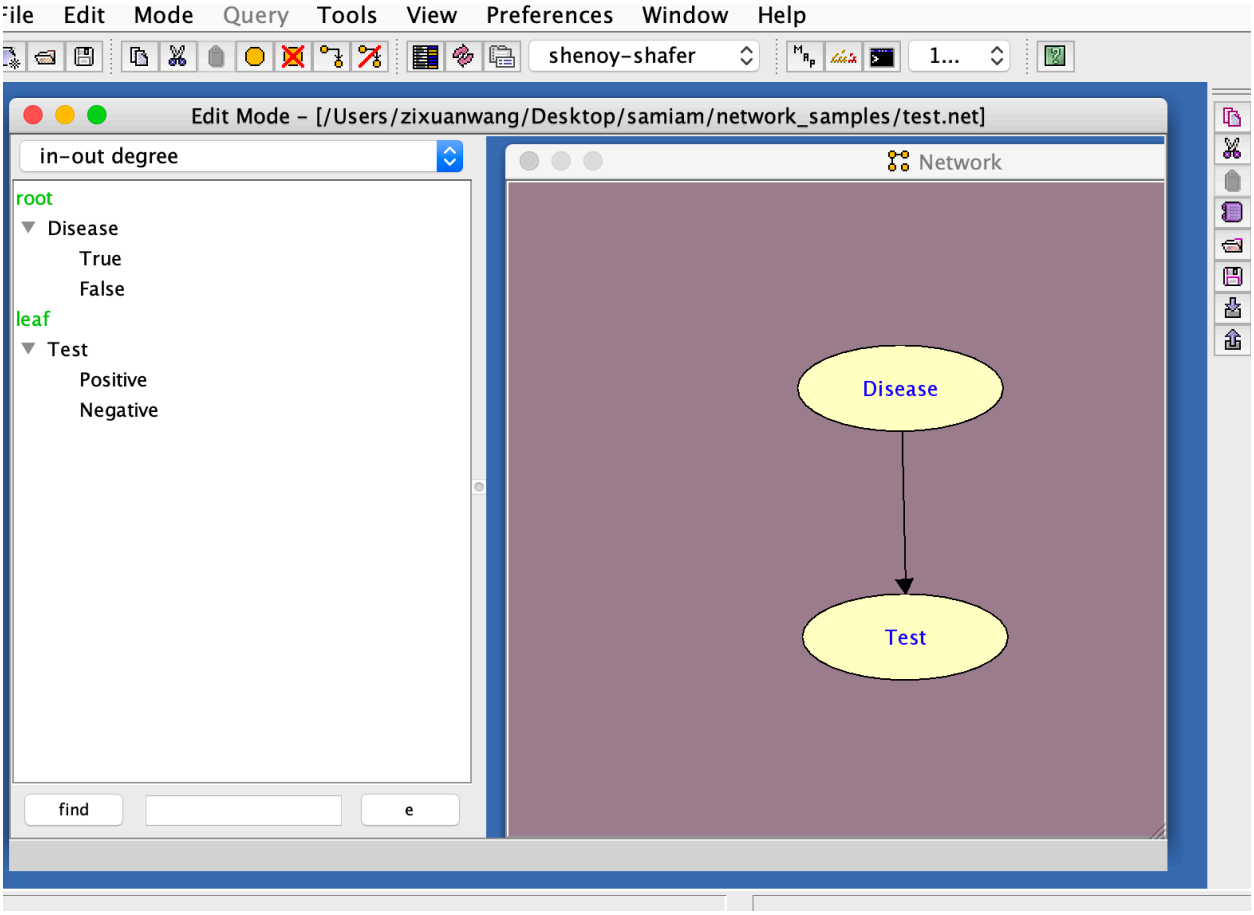
Zixuan Wang
304546929
May 29, 2020

Assignment 8

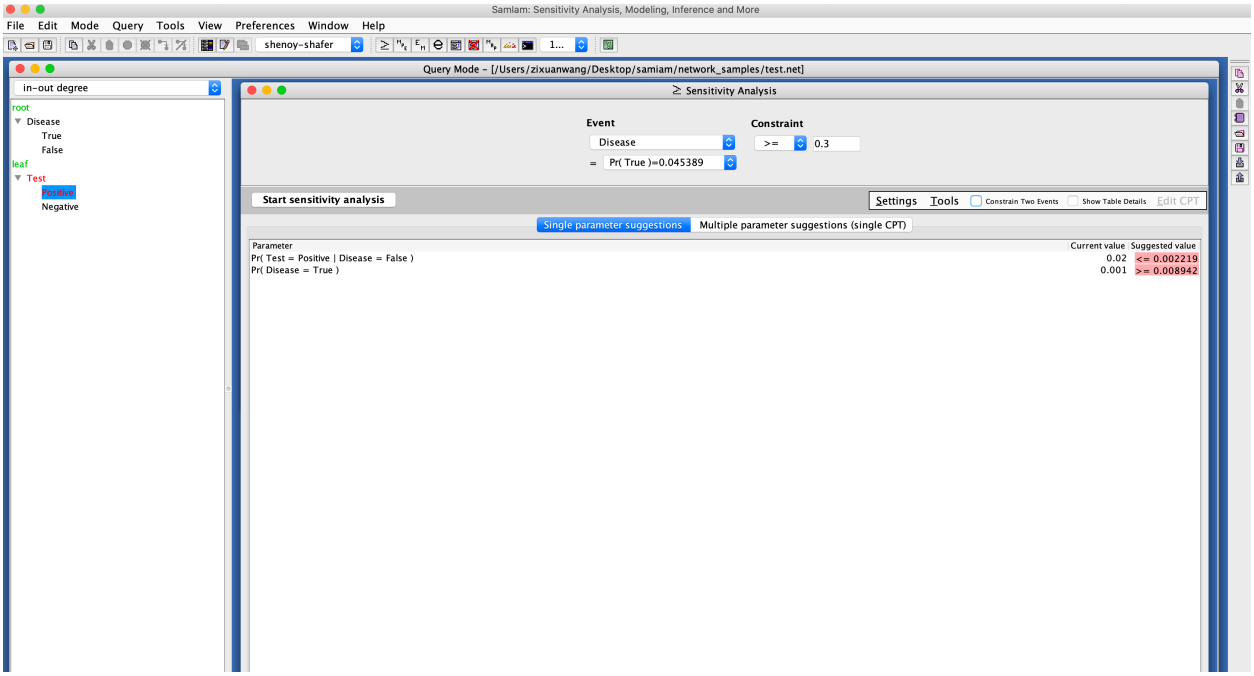
1. We construct our Bayesian network as follows because the disease has a direct effect on the test result.



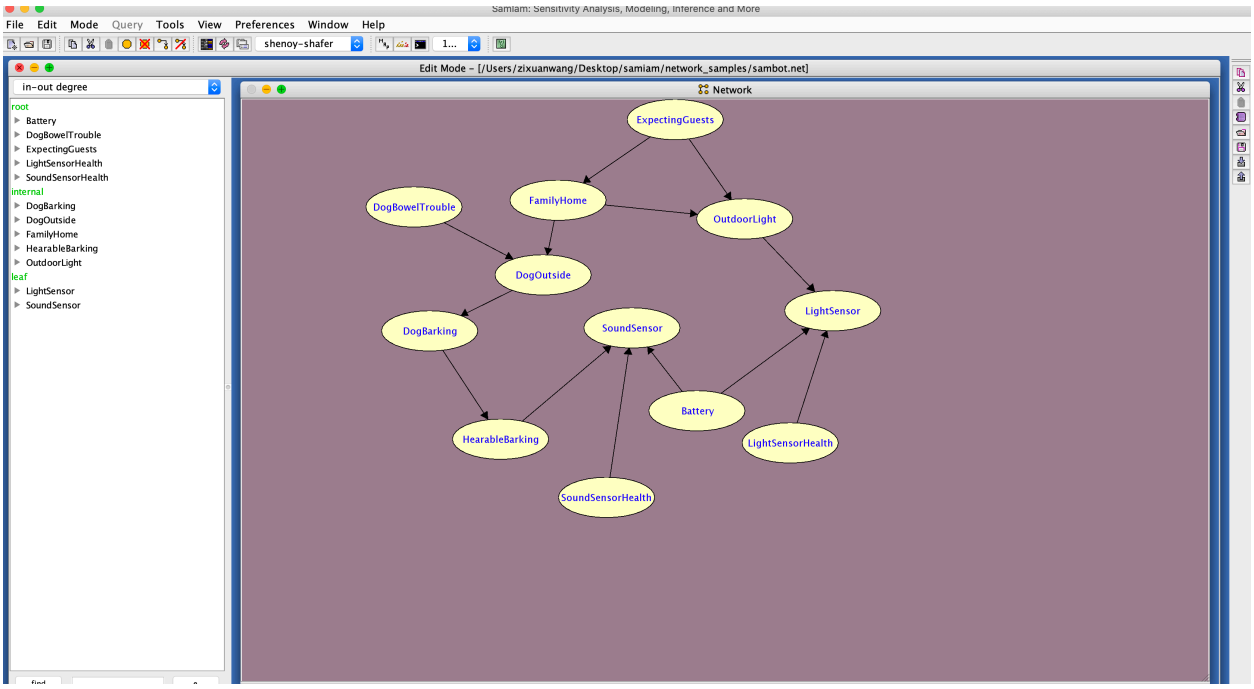
Our CPT for Disease is Pr(True) = 0.001 because one in every thousand people has this disease. We then construct CPT for Test. Because the test has a false positive rate of 2%, this means even though the person does not have this disease, there is still a probability of 0.02 that the test result is positive. Because the test has a false negative rate of 5%, this means even though the person has this disease, there is still a probability of 0.05 that the test result is negative.

Now, choosing the shenoy-shafer algorithm to run the sensitivity analysis, we can conclude that to ensure that Pr(D|T) >= 0.3, our suggestions are the prior probability of

having the disease is Pr(Disease = True) >= 0.008942 and the probability of the false positive for the test is Pr(Test = Positive | Disease = False) <= 0.002219. There is no suggestion for the probability of the false negative for the test.

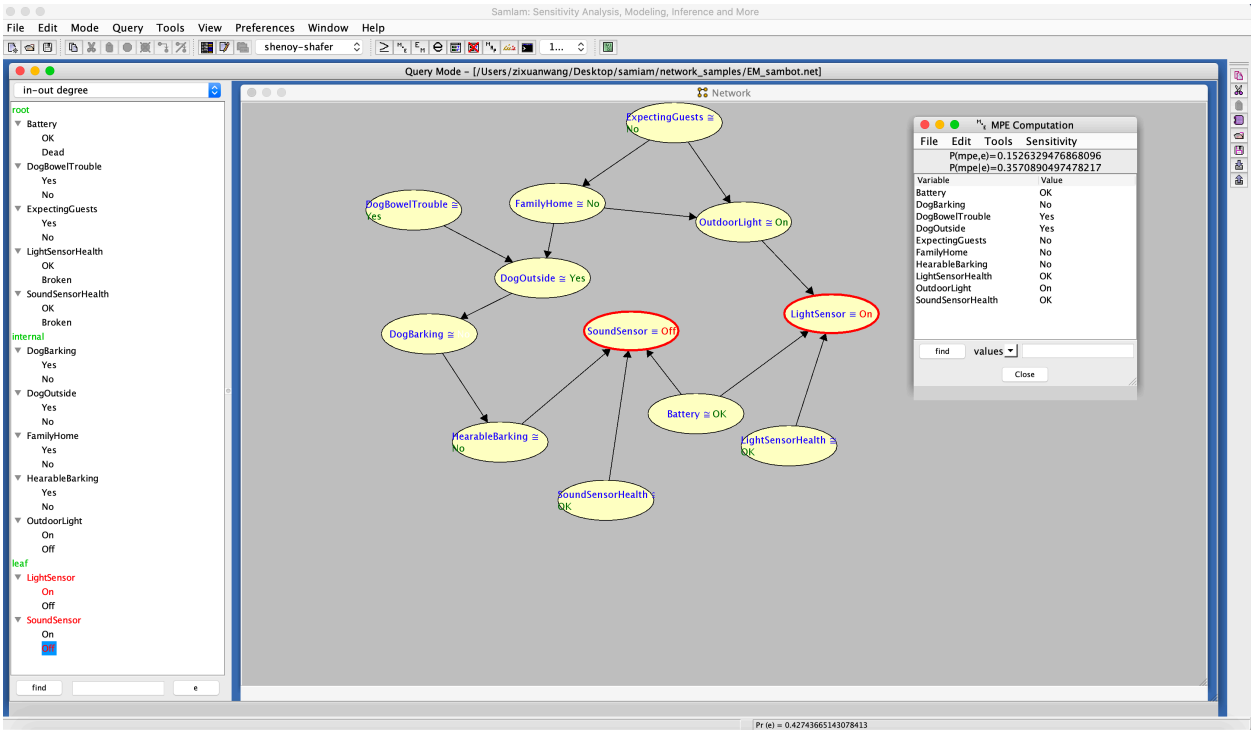


2. We construct the causal structure as follows, using the same variable names and values as in the given sambot.dat. For ExpectingGuests, it can be Yes or No and has a direct effect on FamilyHome and OutdoorLight; For FamilyHome, it can be Yes or No and it has a direct effect on OutdoorLight and DogOutside; For OutdoorLight, it can be On or Off and it causes the response of the LightSensor; For LightSensor, it can be On and Off and this is what Sambot use to detect outdoor lights; For DogOutside, it can be Yes or No and it has a direct effect on DogBarking; For DogBowelTrouble, it can be Yes or No and this directly influences DogOutside; For DogBarking, it can be Yes or No and it has a direct effect on HearableBarking; For Hearable Barking, it can be Yes or No and this causes the response of the SoundSensor; For SoundSensor, it can be On and Off and this is what Sambot use to detect the barking of dogs; For both SoundSensorHealth and LightSensorHealth, they can be OK or Broken and they only directly influences SoundSensor and LightSensor, respectively; For Battery, it can be OK or Dead and directly influences both SoundSensor and LightSensor.



Now, we use uniform parameters for our initial network (0.5 in all CPTs) and use the EM algorithm with the provided sambot.dat to learn the network CPTs.

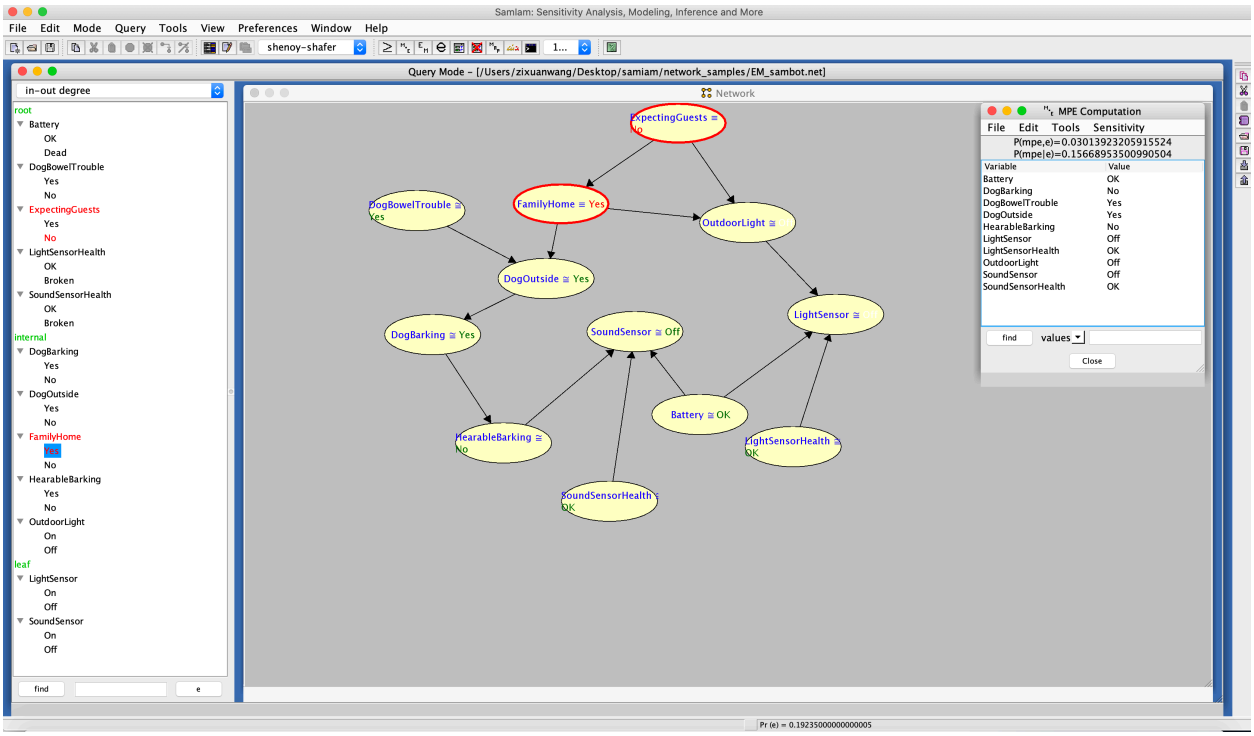
To get the the most likely instantiation of all variables given that Sambot has sensed the lights to be on, but has sensed no bark, we set the LightSensor to On and the SoundSensor to Off. Then, we use the MPE and get the following result:



Thus, we have other ten variables as:

Variables	Values
Battery	OK
DogBarking	No
DogBowelTrouble	Yes
DogOutside	Yes
ExpectingGuests	No
FamilyHome	No
HearableBarking	No
LightSensorHealth	OK
OutdoorLight	On
SoundSensorHealth	OK

To get the most likely instantiation of the sensors given that the family is home and no guests are expected, we set the FamilyHome to Yes and the ExpectingGuests to No. Then, we use the MPE and get the following result:



Thus, we have our two sensors as:

Variables	Values
LightSensor	Off
SoundSensor	Off

We claim that the smallest set of variables Z in our network such that the two sensors are independent give Z is: {Battery, DogBarking}. Using d-separation, since Battery is divergent and is in Z, this is closed and thus the path SoundSensor-Battery-LightSensor is blocked. All the other paths that can connect the two sensors must pass DogBarking. Since DogBarking is sequential and is in Z, this is closed and all left paths are blocked. Thus, the two sensors are d-separated given Z and are independent.

Our Constructed network is a multiply-connected network. This is not a tree because clearly there are two vertices that are connected by more than one path. This is not a polytree because if we replace all the directed edges with undirected edges, the graph is not acyclic. It is a multiply-connected network because there exist one pair of nodes having more than one path.