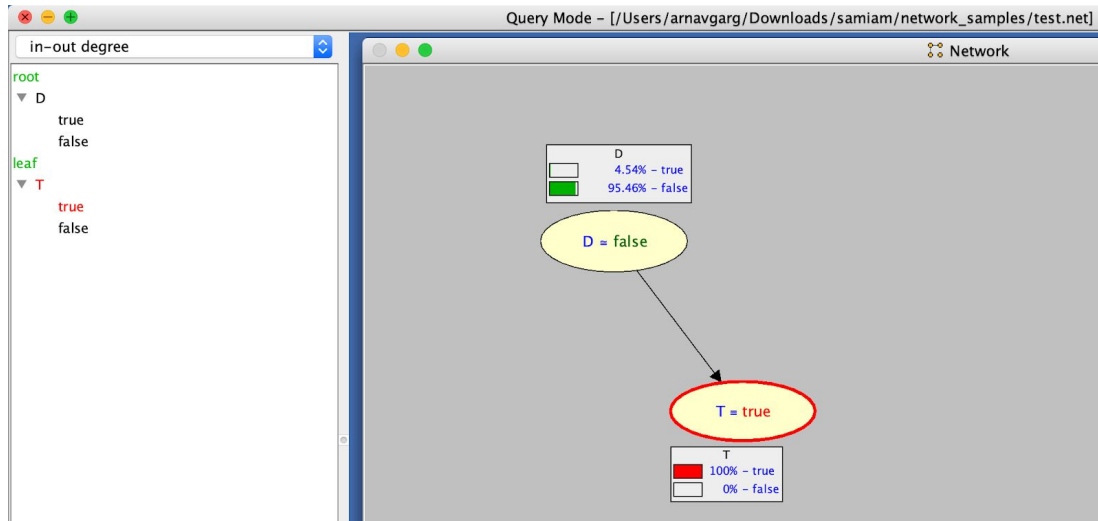


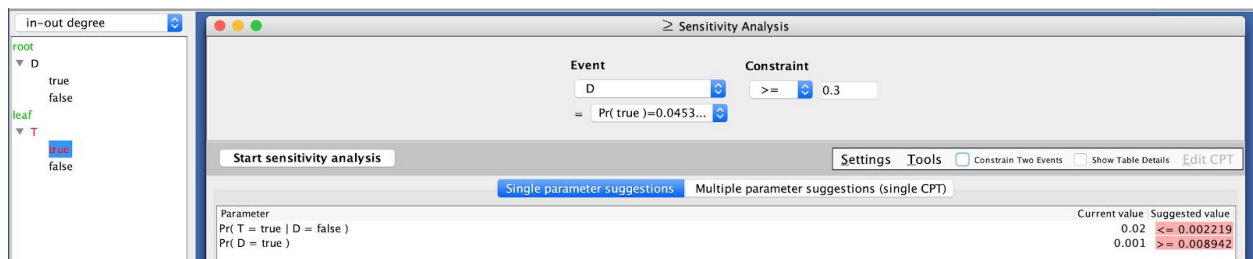
Question 1

$P(D/T) \approx 0.0454$



For $\Pr(D|T) \geq 0.3$, we can add any of the following constraints:

- $\Pr(D = \text{true}) \geq 0.8942\%$
- $\Pr(T = \text{true} | D = \text{false}) \leq 0.2219\%$
- $\Pr(T = \text{false} | D = \text{true})$: No constrain possible



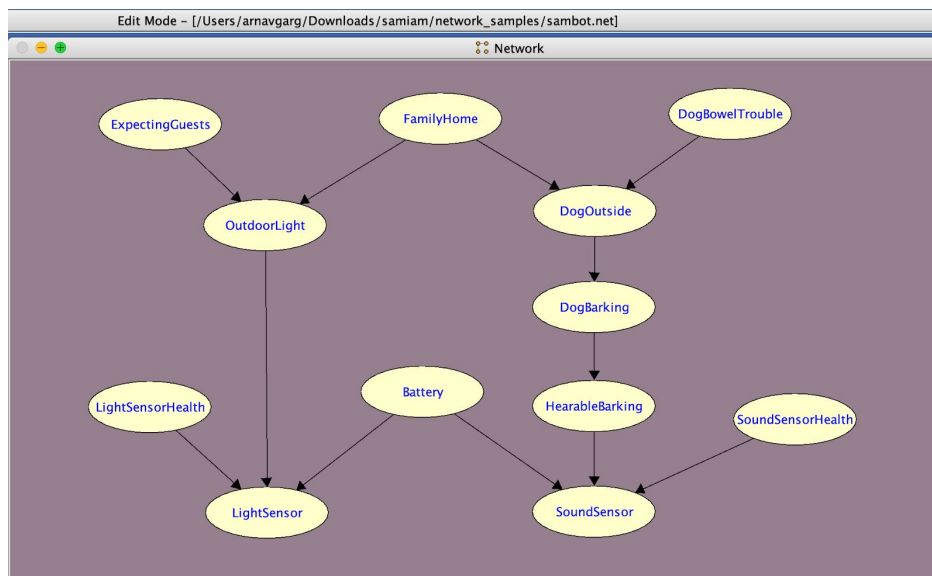
Question 2

a) Set of variables and values:

ExpectingGuests	Yes/No
FamilyHome	Yes/No
SoundSensor	On/Off
LightSensor	On/Off
HearableBarking	No/Yes

Battery	Ok/Dead
SoundSensorHealth	Ok/Broken
LightSensorHealth	Ok/Broken
DogBarking	No/Yes
DogOutside	No/Yes
OutdoorLight	On/Off
DogBowelTrouble	No/Yes

b) Basic causal structure

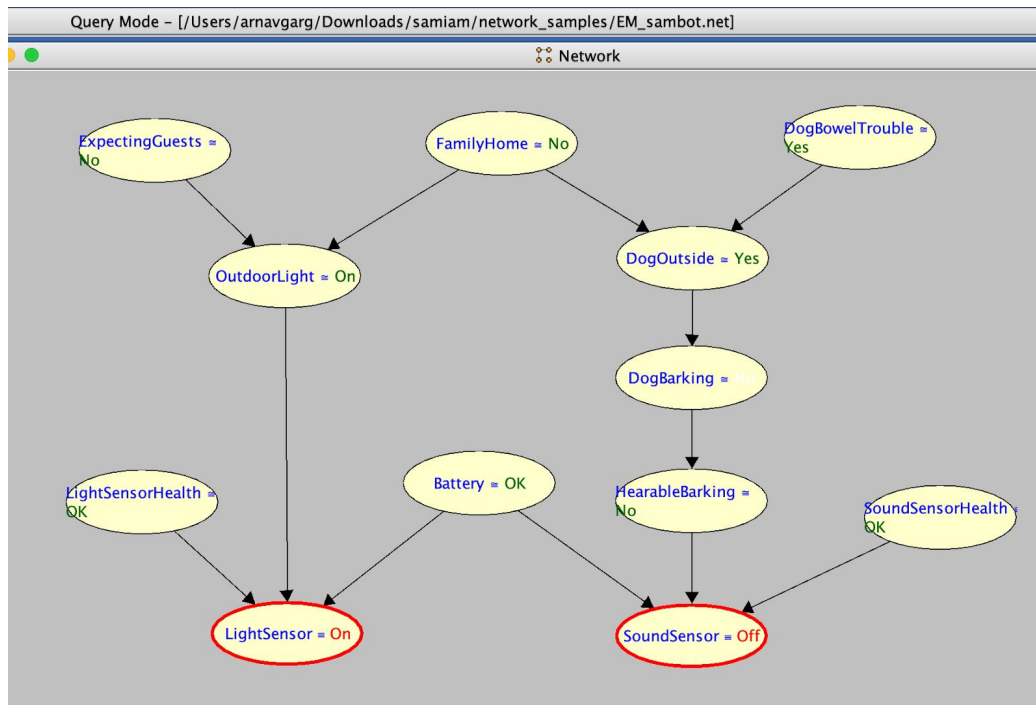


c) For EM:

- Algorithm: Shenoy-Shafer
- Log-likelihood threshold: 0.05
- Max iterations: 5
- Use bias to prevent divide by zero: Yes
- Uniform parameters (0.5 probability) for initial network.

Learned results can be seen in EM_sambot.net

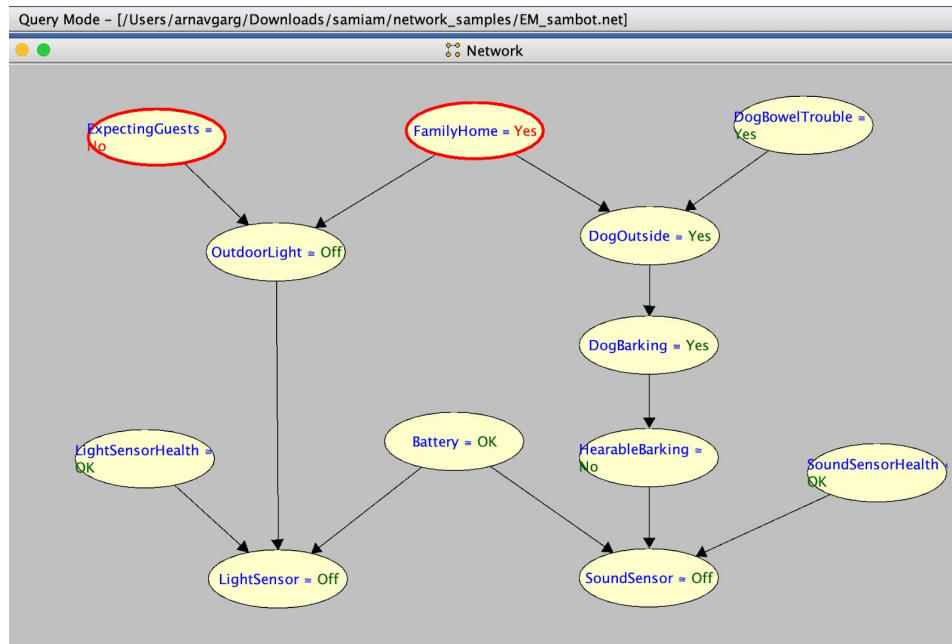
Answer 2.1



I switched to query mode on EM_sambot.net and set LightSensor to ON and SoundSensor to OFF after constructing the network and learning using sambot.dat. Likely Instantiations:

ExpectingGuests	No
FamilyHome	No
DogBowelTrouble	Yes
OutdoorLight	On
Battery	Ok
DogOutside	Yes
LightSensorHealth	Ok
SoundSensorHealth	Ok
HearableBarking	No
DogBarking	No

Answer 2.2



I switched to query mode on EM_sambot.net and set ExpectingGuests to NO and FamilyHome to YES after constructing the network and learning using sambot.dat. Likely Instantiations:

DogBowelTrouble	Yes
OutdoorLight	Off
Battery	OK
DogOutside	Yes
LightSensorHealth	OK
SoundSensorHealth	OK
HearableBarking	No
DogBarking	Yes
LightSensor	Off
SoundSensor	Off

Answer 2.3

From the causal structure, we can see that:

1. There are two paths from SoundSensor to LightSensor. The Battery node is on a divergent path (and is the only one). So, Battery must be in Z.
2. On the other path, all nodes are either divergent or sequential. Therefore, if we add any one of HearableBarking, DogBarking, DogOutside, or FamilyHome into Z, we would block this path from the two sensors.

So, $Z = \{\text{Battery}, \text{FamilyHome}\}$ is the smallest set of variables Z in the network such that the two sensors are independent.

Answer 2.4

The network constructed is a multiply-connected network. This is because there is at least one pair of nodes that have more than one path between them. This can be seen from the causal structure posted at the beginning of question 2.