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CS161

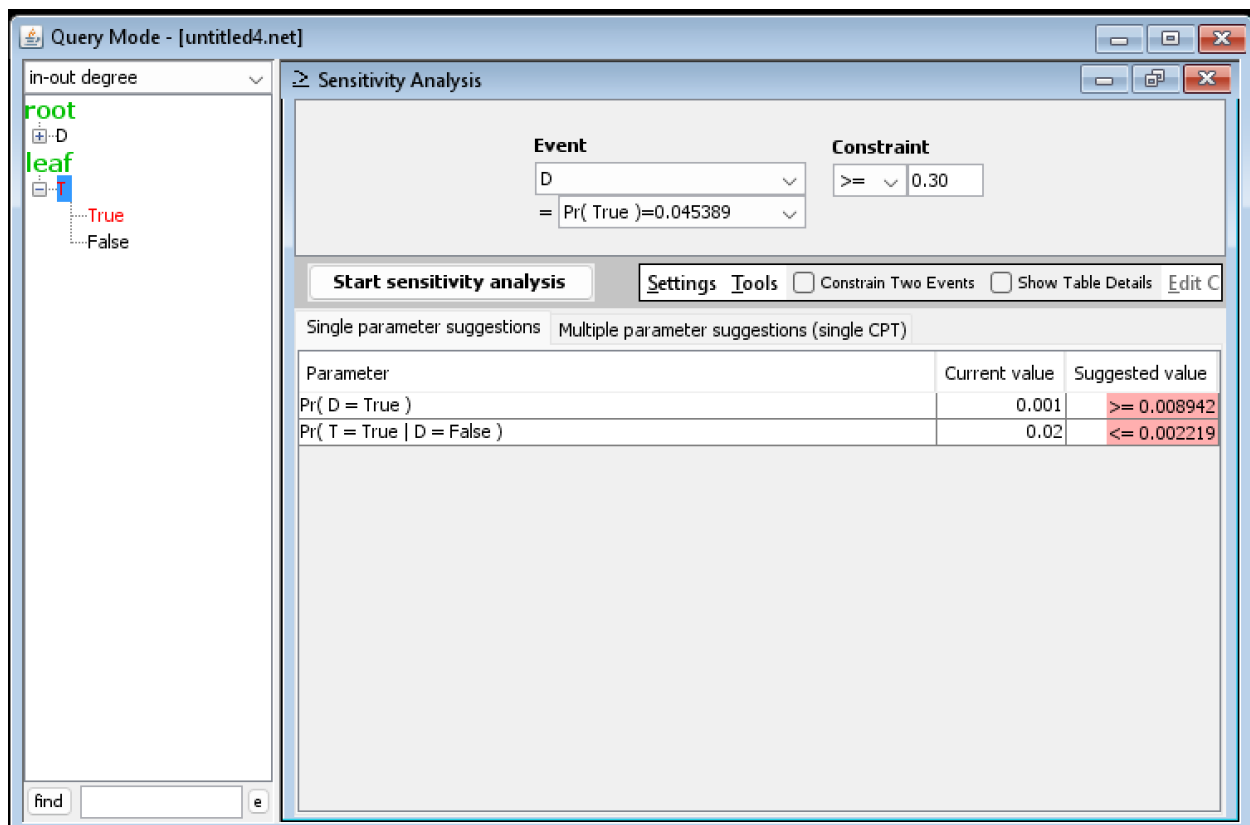
HW8

1)

Complete Bayesian network and CPTs:

In test.net

Constraints:



$$FP = \Pr(T = \text{True} \mid D = \text{False})$$

$$FN = \Pr(T = \text{False} \mid D = \text{True})$$

Constraint on $\Pr(D = \text{True})$ is that it must be at least 0.008942 for $\Pr(D|T)$ to be ≥ 0.3 .

Constraint on FP is that it must be at most 0.002219 for $\Pr(D|T)$ to be ≥ 0.3 .

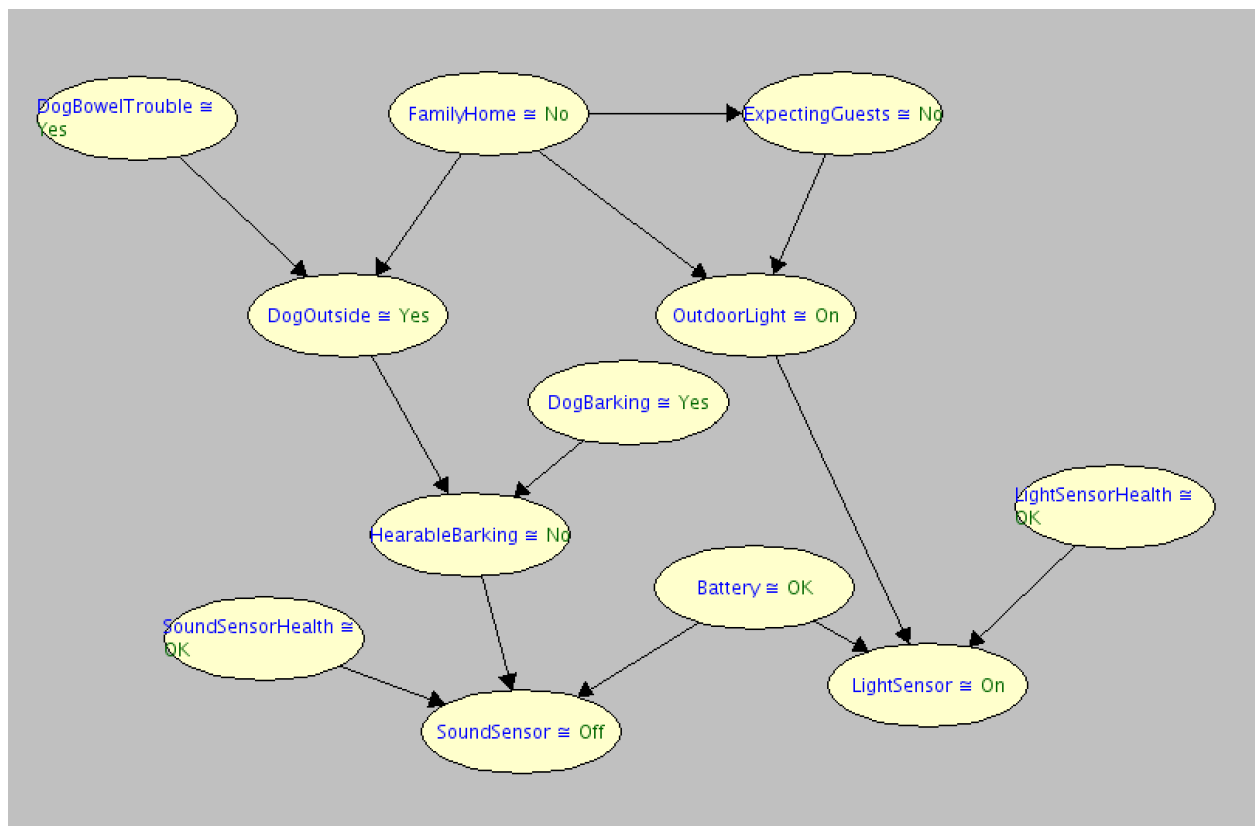
There is no constraint on FN that makes $\Pr(D|T) \geq 0.3$.

2)

(a) The set of variables and their values are:

DogBowelTrouble: Yes, No
FamilyHome: Yes, No
ExpectingGuests: Yes, No
DogOutside: Yes, No
OutdoorLight: On, Off
DogBarking: Yes, No
HearableBarking: Yes, No
LightSensorHealth: OK, Broken
SoundSensorHealth: OK, Broken
Battery: OK, Dead
LightSensor: On, Off
SoundSensor: On, Off

(b) The causal structure is:



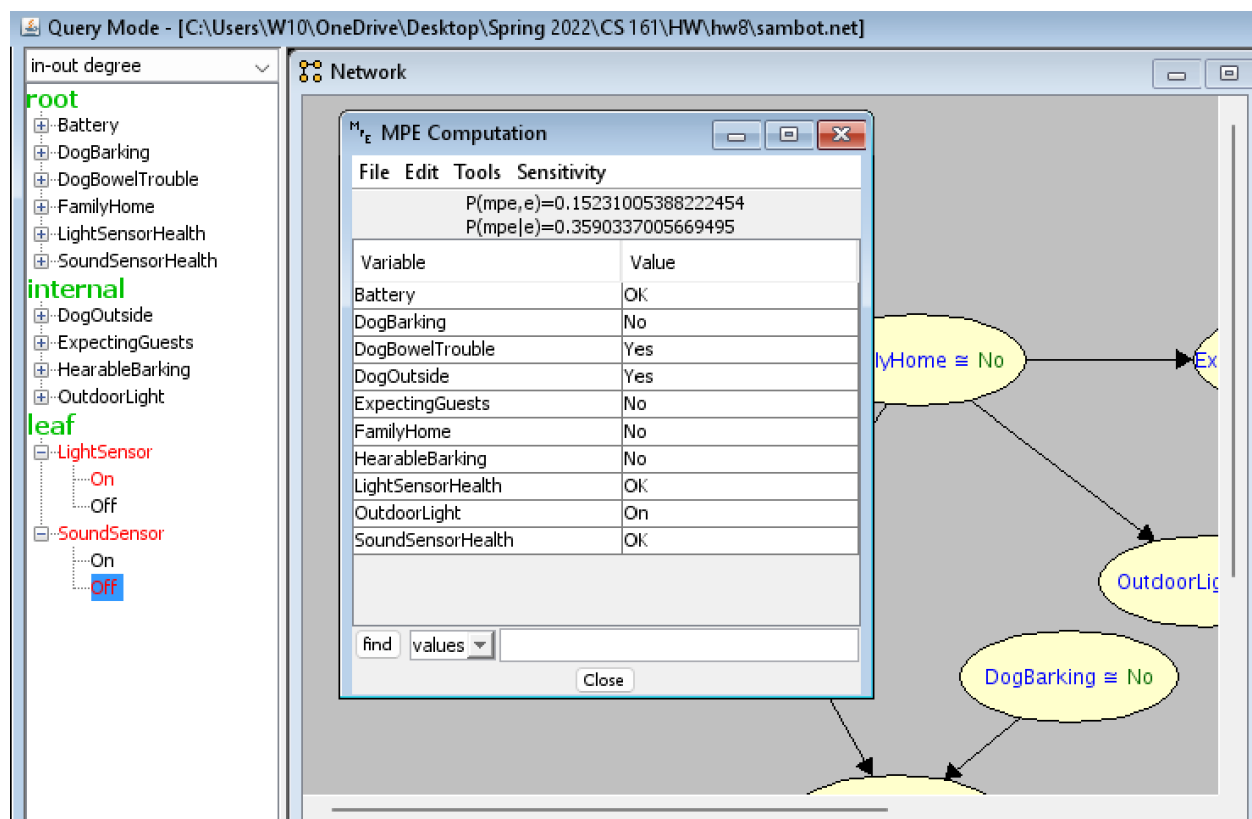
(c) Learned CPTs using EM algorithm:

In sambot.net

Most likely instantiation of all variables given that LightSensor = On and SoundSensor = Off.

The most likely instantiation of the variables given that LightSensor = On and SoundSensor = Off is Battery: OK, DogBarking: No, DogBowelTrouble: Yes, DogOutside: Yes, ExpectingGuests: No, FamilyHome: No, HearableBarking: No, LightSensorHealth: OK, OutdoorLight: On, SoundSensorHealth: OK.

This was done by first going into query mode, then clicking on the EM button to fill the CPT's according to the EM algorithm working on sambot.dat. Next, I clicked on the MPE button to find the most probable explanation of variables that satisfied this.

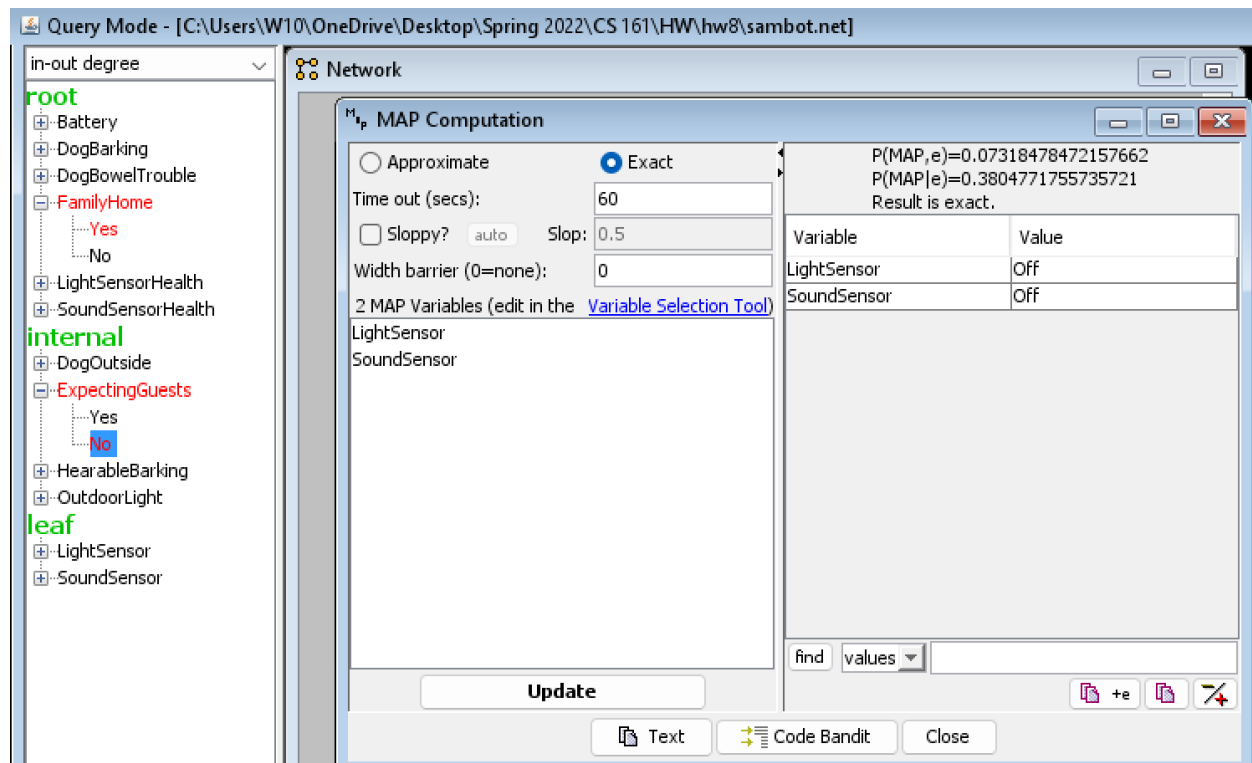


Most likely instantiation of sensors given that FamilyHome = Yes and ExpectingGuests = No:

The most likely instantiation of the sensors given that FamilyHome = Yes and ExpectingGuests = No is LightSensor: Off and SoundSensor: Off.

This was done by first going into query mode and clicking the MAP button. Then I clicked the Variable Selection Tool and selected LightSensor and SoundSensor. Then I clicked the "Update"

button and found that was the most common configuration given that FamilyHome = Yes and ExpectingGuests = No.



The smallest set of Z such that both sensors are independent:

The smallest set of Z such that both sensors are independent is $Z = \{ \text{Battery}, \text{FamilyHome} \}$. This is because there are only three paths from LightSensor to SoundSensor:

- 1: LightSensor \rightarrow Battery \rightarrow SoundSensor
- 2: LightSensor \rightarrow OutdoorLight \rightarrow FamilyHome \rightarrow DogOutside \rightarrow HearableBarking \rightarrow SoundSensor
- 3: LightSensor \rightarrow OutdoorLight \rightarrow ExpectingGuests \rightarrow FamilyHome \rightarrow DogOutside \rightarrow HearableBarking \rightarrow SoundSensor

Since all valves in all three paths are either sequential or divergent, the valves only close when the valve node is an element of Z. Therefore, $Z = \{ \text{Battery}, \text{FamilyHome} \}$ is an instance of the smallest set for Z since Battery closes path 1 and FamilyHome closes paths 2 and 3. Therefore, all paths from LightSensor to SoundSensor are closed for $Z = \{ \text{Battery}, \text{FamilyHome} \}$, meaning they are d-separated given $Z = \{ \text{Battery}, \text{FamilyHome} \}$ and thus are independent given $Z = \{ \text{Battery}, \text{FamilyHome} \}$.

Type of network constructed:

The type of network created is a multiply-connected network.