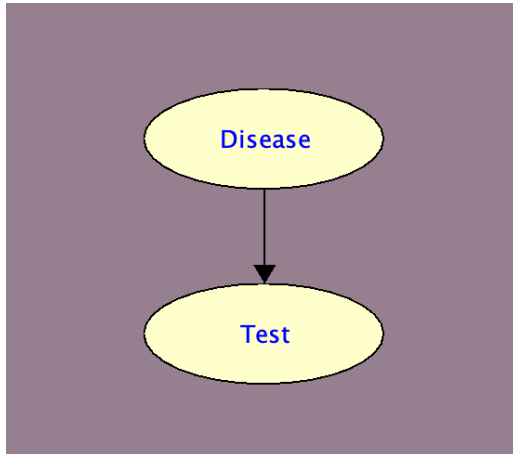


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CS 161 HW 8

## 1. Bayesian Network



## CPTs

Properties Probabilities Attributes		
Conditional Probability Table		
	True	False
Positive	0.95	0.02
Negative	0.05	0.98

## Sensitivity Analysis:

**Sensitivity Analysis**

Event 1: Disease = Pr( True )=0.001

Event 2: Test = Pr( Positive )=0.02093

Constraint:  $\geq 0.3$

Start sensitivity analysis

Settings Tools ☒ Constrain Two Events ☐ Show Table Details [Edit CPT](#)

Single parameter suggestions Multiple parameter suggestions (single CPT)

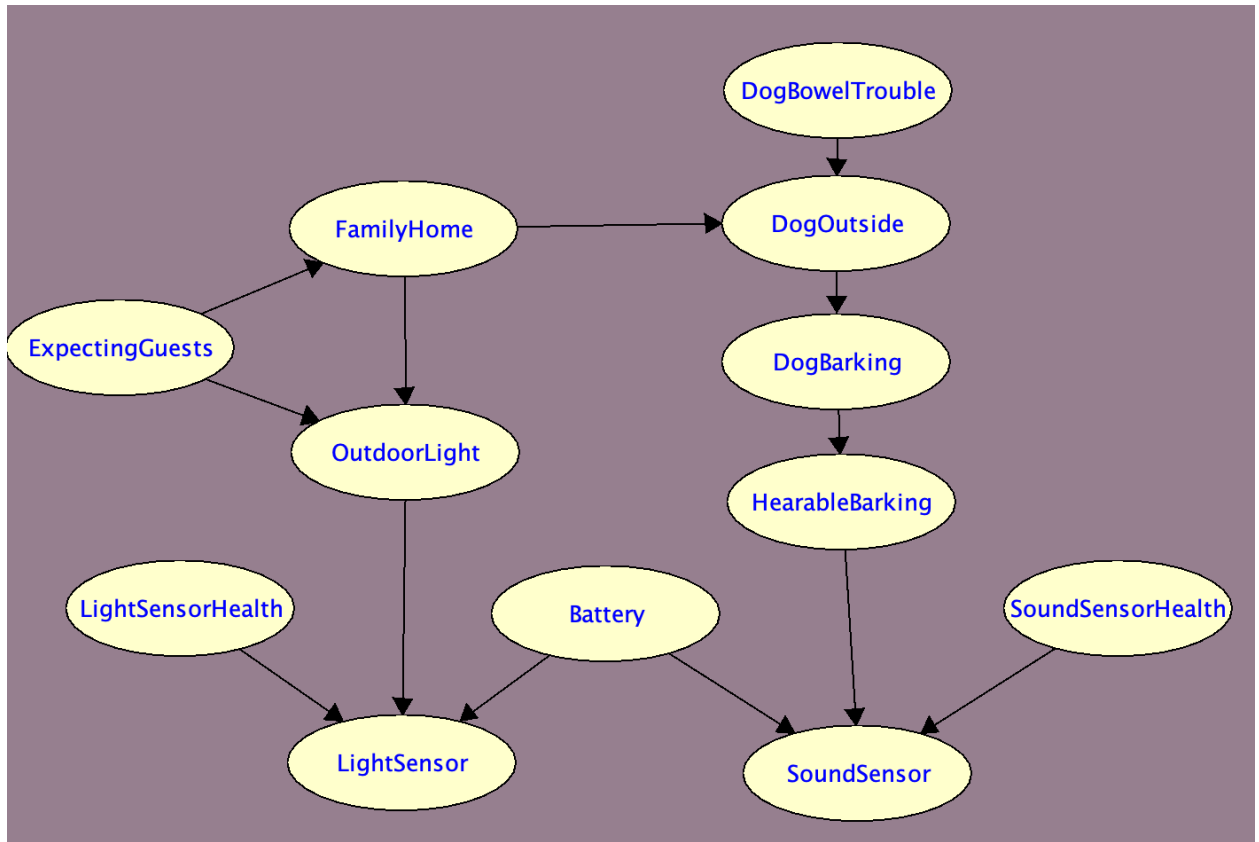
Parameter	Current value	Suggested value
Pr( Test = Positive   Disease = False )	0.02	$\leq 0.002386$
Pr( Disease = True )	0.001	$\geq 0.008322$

The sensitivity analysis suggests probabilities for  $\Pr(T = \text{Positive} \mid \text{Disease} = \text{False})$  and  $\Pr(\text{Disease} = \text{True})$ , but not for false negative  $\Pr(T = \text{Negative} \mid \text{Disease} = \text{True})$  probably because no change in that value can result in meeting the constraint.

2. (a) Set of variables and values:

Variable	Value
FamilyHome	Yes/No
OutdoorLight	On/Off
ExpectingGuests	Yes/No
DogOutside	Yes/No
DogBowelTrouble	Yes/No
DogBarking	Yes/No
HearableBarking	Yes/No
LightSensor	On/Off
SoundSensor	On/Off
LightSensorHealth	OK/Broken
SoundSensorHealth	OK/Broken
Battery	OK/Dead

(b) Causal structure:

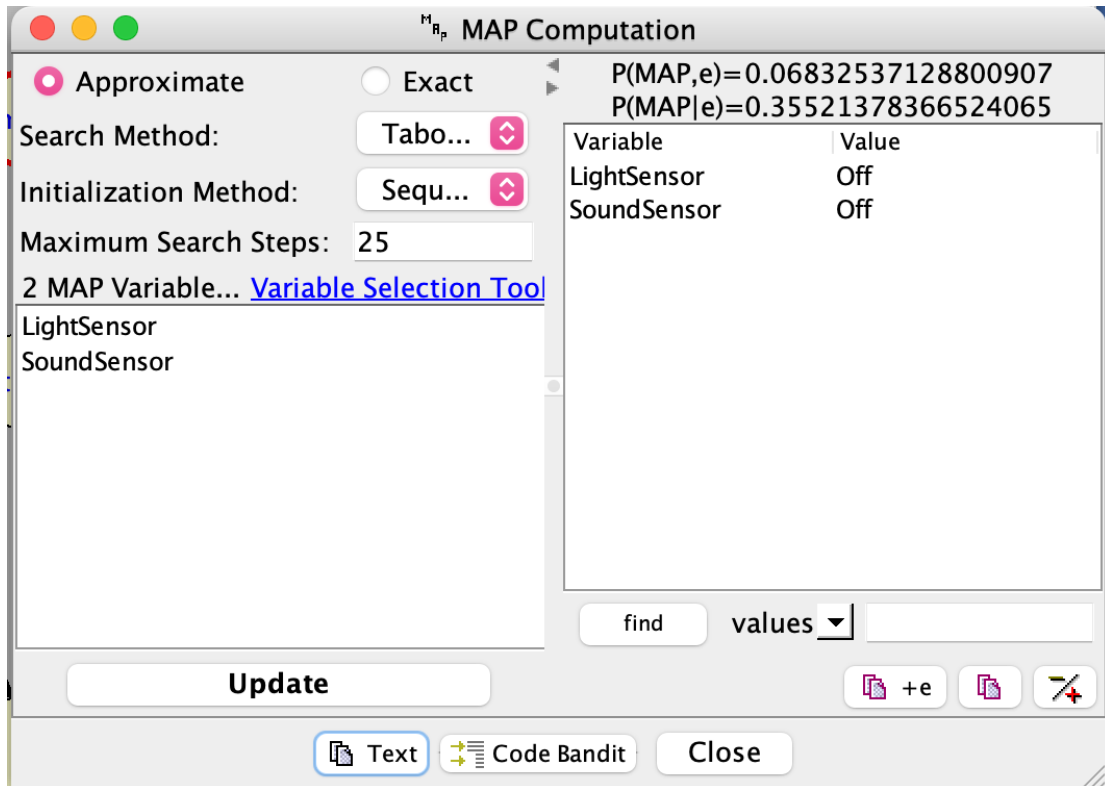


- Given that Sambot has sensed the lights to be on but has sensed no bark, the most likely instantiation of variables is:

MPE Computation	
File	Edit Tools Sensitivity
P(mpe,e)=0.15263294768680957	
P(mpe e)=0.3570890497478217	
Variable	Value
Battery	OK
DogBarking	No
DogBowelTrouble	Yes
DogOutside	Yes
ExpectingGuests	No
FamilyHome	No
HearableBarking	No
LightSensorHealth	OK
OutdoorLight	On
SoundSensorHealth	OK

I obtained this answer by first doing EM learning on the causal structure created in part (b) with the given sambot.dat data file. Then I selected LightSensor to On and SoundSensor to Off on the left sidebar where all the variables are listed. Then I ran the MPE computation tool to see what value the rest of the variables would be.

- Given that the family is home and no guests are expected, the most likely instantiation of the sensors is:



I obtained this answer by first selecting FamilyHome to Yes and ExpectingGuests to No. Then I clicked the Variable Selection Tool and clicked the map variable type. Then I checked off LightSensor and SoundSensor as the map variables. Then I ran the MAP Tool to get the results.

- The smallest set of variables  $Z$  in the network such that the two sensors are independent given  $Z$  is  $Z = \{ \text{FamilyHome}, \text{Battery} \}$ . This is because FamilyHome and Battery cover all the possible paths between the sensors:
  - LightSensor  $\leftarrow$  Battery  $\rightarrow$  LightSensor
    - Battery is divergent, which makes the path blocked if it is in  $Z$ .

- $\text{LightSensor} \leftarrow \text{OutdoorLight} \leftarrow \text{FamilyHome} \rightarrow \text{DogOutside} \rightarrow \text{DogBarking} \rightarrow \text{HearableBarking} \rightarrow \text{SoundSensor}$ 
  - FamilyHome is divergent, which makes the path blocked if it is in Z.
- $\text{LightSensor} \leftarrow \text{OutdoorLight} \leftarrow \text{ExpectingGuests} \rightarrow \text{FamilyHome} \rightarrow \text{DogOutside} \rightarrow \text{DogBarking} \rightarrow \text{HearableBarking} \rightarrow \text{SoundSensor}$ 
  - FamilyHome is sequential, which makes the path blocked if it is in Z.

Since  $Z = \{ \text{FamilyHome}, \text{Battery} \}$  d-separates the sensors, they are independent.

- The type of network I constructed is a multiply-connected network because there is more than one path between nodes (e.g.  $\text{ExpectingGuests} \rightarrow \text{FamilyHome} \rightarrow \text{OutdoorLight} \rightarrow \text{LightSensor}$  and  $\text{ExpectingGuests} \rightarrow \text{OutdoorLight} \rightarrow \text{LightSensor}$ )