

CS 520 Final: Question 4 - GoatDiscoveryBot

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a) Logically, how could you (LogicalGoatDiscoveryBot) model this information? Probabilistically, how could you (ProbabilisticGoatDiscoveryBot) model this information? Hint: Consider the statements In A, In B, In C.

The logical model:

$$(InA \wedge \neg InB \wedge \neg InC) \vee (\neg InA \wedge InB \wedge \neg InC) \vee (\neg InA \wedge \neg InB \wedge InC)$$

The probabilistical model:

$$P(InA) = P(InA \wedge \neg InB \wedge \neg InC) = \frac{1}{3}$$

$$P(InB) = P(\neg InA \wedge InB \wedge \neg InC) = \frac{1}{3}$$

$$P(InC) = P(\neg InA \wedge \neg InB \wedge InC) = \frac{1}{3}$$

At this point, you want to search a location for the goat. How can you determine which location to select?

b) Under the logical formulation, how can you compare the value/results of actions ‘Select A’, ‘Select B’, ‘Select C’? Is there an obvious choice of best action?

$$\text{Select A: } (InA) \vee (InB \wedge \neg InC) \vee (\neg InB \wedge InC)$$

$$\text{Select B: } (InB) \vee (InA \wedge \neg InC) \vee (\neg InA \wedge InC)$$

$$\text{Select C: } (InC) \vee (InA \wedge \neg InB) \vee (\neg InA \wedge InB)$$

Since there must be a goat in any of 3 locations, every above statements would be true finally. Even we know if one of symbols is false, we still can not know which action is better. Therefore there is not a obvious choice of best action.

c) Under the probabilistic formulation, how can you compare the value/results of actions ‘Select A’, ‘Select B’, ‘Select C’? Is there an obvious choice of best action?

$$P(\text{findInA}) = \frac{P(\text{find})P(\text{InA}|\text{find})}{P(\text{InA})P(\text{InA}|\text{InA}) + P(\neg\text{InB})P(\text{InA}|\neg\text{InB}) + P(\neg\text{InC})P(\text{InA}|\neg\text{InC})} = \frac{1}{3}$$

$$P(\text{findInB}) = \frac{1}{3}$$

$$P(\text{findInC}) = \frac{1}{3}$$

No matter whichever choice you take, the probabilities of find a goad by these choice are $\frac{1}{3}$. So there is also not an obvious choice of best action.

Suppose, for argument's sake, you select location A. Before you search location A, you consult your friend, CouldBe- MoreHelpfulBot (who knows where the goat is, but will only tell you where the goat isn't). CBMHBot will look at the two locations you didn't pick, and name one of them that does not have the goat. CBMHBot tells you the goat is not in location B. Given this new information:

d) Update your logical formulation to reflect this new information.

Since the CBMHBot help us to eliminate a choice, the new logical formulation should be $(\text{InA} \wedge \neg\text{InC}) \vee (\neg\text{InA} \wedge \text{InC})$

e) Update your probabilistic formulation to reflect this new information. Hint: The CBMHBot's decision to tell you the goat is not in B depended both on which location you selected, and where the goat actually is.

$$P(\text{InA}|\text{InfoNotInB}) + P(\text{InB}|\text{InfoNotInB}) + P(\text{InC}|\text{InfoNotInB}) = 1$$

$$P(\text{InB}|\text{InfoNotInB}) = 0$$

$$P(\text{InA}|\text{InfoNotInB}) + P(\text{InC}|\text{InfoNotInB}) = 1$$

At this point, you want to re-assess your earlier decision of which action to take as you now have more information than you did previously. f) Under the logical formulation, how can you compare the value/results of actions 'Re-Select A', 'Re-Select B', 'Re-Select C'? Is there an obvious choice of best action?

I would never take 'Re-Select B', because the CBMHBot already told me that goat is not in B. From the logical formulation, we could say which choice of 'Re-Select A' and 'Re-Select A' is better. Whether goat in A is true or not, The finally statement can be true. There is no obvious choice of best action.

g) Under the probabilistic formulation, how can you compare the value/results of actions 'Re-Select A', 'Re-Select B', 'Re-Select C'? Is there an obvious choice of best action?

Same as above, I would never take 'Re-Select B', since the probability to find the goat at B is 0. If we don't have the initial selection, the probability of the goat in A or B are 1/2. The values of 'Re-select A' or 'Re-select C' are same. There is still no obvious choice of best action.

Did CouldBeMoreHelpfulBot provide anything of actual value?

h) Under the logical formulation, having initially selected location A, should you stick with location A or change? Justify your choice.

According to the logical formulation, we could not say which action is better. The InA and InC both can be true to satisfy the statement. The CouldBeMoreHelpfulBot did not provide enough information that help determine the result.

i) Under the probabilistic formulation, having initially selected location A, should you stick with location A or change? Justify your choice.

$$P(InA|InfoNotInB) = \frac{P(InfoNotInB|InA)P(InA)}{P(InfoNotInB|InA)P(InA) + P(InfoNotInB|\neg InA)P(\neg InA)}$$

$$P(InA|InfoNotInB) = \frac{1}{3}$$

$$P(InC|InfoNotInB) = 1 - P(\neg InA|InfoNotInB) - P(InB|InfoNotInB) = \frac{2}{3}$$

If we know our initial selection is A, and if we stay in A, the probability to find the goat is still $\frac{1}{3}$. The probability will same as before you know the information given by CouldBeMoreHelpfulBot. However, if we know our initial selection is A and change to C, the probability to find the goat increase to $\frac{2}{3}$. We definitely choose to change our selection.

j) Who is more successful in their mission, LogicalGoatDiscoveryBot or ProbabilisticGoatDiscoveryBot? Justify your answer.

I would say ProbabilisticGoatDiscoveryBot works better than LogicalGoatDiscoveryBot at this mission. Cause we can not take a better choice we until LogicalGoatDiscoveryBot eliminate all wrong answers for us. However, by using ProbabilisticGoatDiscoveryBot, the more we know, the better action we take. We can have a rank of probability of each choice. We just need to take the choice of highest probaility to reach our goal.