

Assignment Seven: Probabilistic Inference Solutions

Question One

- (a) To compute $P(e)$, you can sum out D and F , and the factors created are just 1's (that is why they can be pruned). I'll ignore these factors.

You start off with the factors $f_0(A)$, $f_1(B)$, $f_2(A, B, C)$, $f_3(C, E)$.

Eliminating A , you multiply f_0 and f_2 , and sum out A , creating a factor $f_4(B, C)$.

Eliminating B , you multiply f_1 and f_4 , sum out B , and create a factor $f_5(C)$.

Eliminating C , you multiply f_5 and f_3 , sum out C , and the resulting factor $f_6(E)$ represents $P(E)$.

- (b) To compute $P(e | \neg f)$, you create a factor (lets call it f_7 to avoid confusion with the previous part) $f_7(C)$.

You can prune D . Eliminating A and B acts exactly as before, creating the same factors.

Eliminating C , you multiply f_5 , f_3 and f_7 , sum out C , with the resulting factor $f_8(E)$. To get the answer, you need to divide each element of f_8 by $\sum_E f_8(E)$. This creates $f_9(E)$ which represents $P(E | \neg f)$.

- (c) Load into AIspace Bayes tool:

<https://www.cs.ubc.ca/~poole/cs322/2020/as7/as7q1bn.xml>

i) $P(a) = 0.1$

ii) $P(a | d) = 0.1$

iii) $P(a | \neg f) = 0.197$

iv) $P(a | \neg f \wedge d) = 0.176$

v) $P(a | \neg f \wedge b \wedge d) = 0.207$

vi) $P(a | \neg f \wedge b) = 0.207$

- (d) Observing d affects the probability of A when C , E or F are observed and B isn't observed.

Question Two

- (a) Chris is right, the fact that a user did not use a particular word is important information that should not be ignored. For example, if people who want to know about printer problems almost always use the word "print" (or a derivative), the fact that someone did not use the word "print" is evidence that it is not a printer problem. This is different from not knowing whether they used the word "print".

- (b) The words are independent of each other given the help page. (But they are dependent on each other if the help page is not observed.) The help pages are exclusive; only one help page is meant.
- (c) The words probably should not be independent of each other, there are some words that are likely to go together (such as “I” and “am”) and some that are not likely to go together (such as “folder” and “directory” — someone is likely to use only one of these depending on which system they use).
- (d) The topics are independent of each other given no words observed (but are dependent given words). The words are independent of each other given the topics (but are dependent of each other given no topics observed).
- (e) If one topic is a superset of another (e.g., shirt and clothes, or hockey and sport) or are unlikely to go together (e.g., fashion and science, even they are both associated with “model”) or are likely to go together (e.g., fashion and shirts). There are many possible answers.

Question Three

It should not have taken more than a few hours. Most of this should have been in understanding the material and playing, not in doing busy work. I hope it was reasonable, and you learned something.