CS 188 Fall 2024 Introduction to Artificial Intelligence Written HW8

Due: Tuesday 11/05 at 11:59pm.

Policy: Can be solved in groups (acknowledge collaborators) but must be submitted individually.

Make sure to show all your work and justify your answers.

Note: This is a typical exam-level question. On the exam, you would be under time pressure, and have to complete this question on your own. We strongly encourage you to first try this on your own to help you understand where you currently stand. Then feel free to have some discussion about the question with other students and/or staff, before independently writing up your solution.

Note: Leave the self-assessment sections blank for the original submission of your homework. After the homework deadline passes, we will release the solutions. At that time, you will review the solutions, self-assess your initial response, and complete the self-assessment sections below. The deadline for the self-assessment is 1 week after the original submission deadline.

Your submission on Gradescope should be a PDF that matches this template. Each page of the PDF should align with the corresponding page of the template (page 1 has name/collaborators, question begins on page 2.). **Do not reorder, split, combine, or add extra pages**. The intention is that you print out the template, write on the page in pen/pencil, and then scan or take pictures of the pages to make your submission. You may also fill out this template digitally (e.g. using a tablet.)

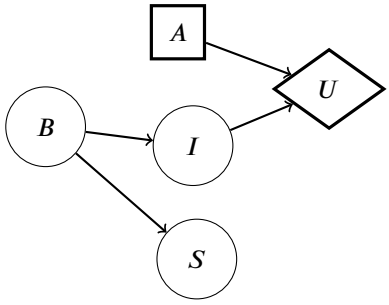
First name	
Last name	
SID	
Collaborators	

Q1. [7 pts] Phase

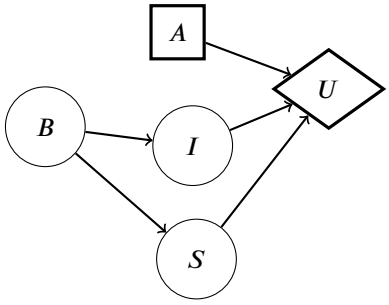
The EECS department decides to offer an exciting new course, CS1888, next semester. You and your friends are deciding if you want to take it or not, and decide to draw inspiration from CS188 and model this using decision networks. For all of the following parts, A represents the action of taking CS1888 or not, and U represents the utility function of a specific student.

(a) [1 pt] Your friend Lexy will only take CS1888 if a specific instructor will be teaching it (I), and doesn't care about the course size or curriculum. However, due to uncertainty in instructor hiring practices in the university, the instructor chosen to teach is affected by the outcome of instructor collective bargaining efforts (B). The collective bargaining outcome will also affect the size of the course (S).

Select all of the decision networks which can represent Lexy's decision.



(1)



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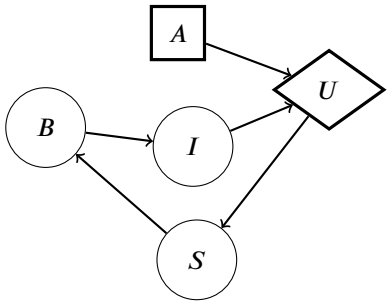

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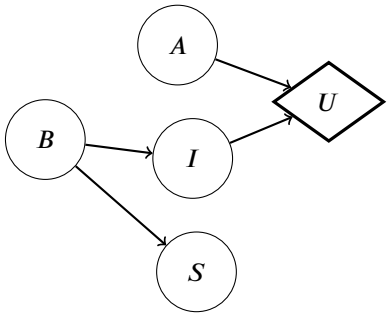


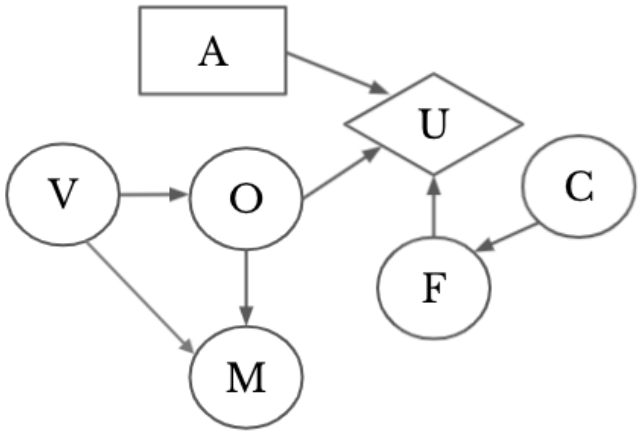
(4)

- [x] **(1)**
- [x] **(2)**
- [ ] **(3)**
- [ ] **(4)**
- ○ None of the above

The first option is correct since it contains edges encoding each dependence between variables in the problem statement.
The second option is correct because it contains all the correct edges but with an additional edge between S and U. This edge does not guarantee independence so the Bayes net can still be used to represent Lexy's decision network.
The third option is false because there is a cycle among B, I, U, and S. This makes the Bayes net invalid.
The fourth option is false because the action is a chance node. However, in decision networks, the action is deterministic since the agent (in this case Lexy) has full control over the action she chooses.

Your friend Varun is also making the same decision. His decision is represented by the following decision network, where the chance nodes correspond to the following random variables:

- O: if classes will be online next semester
- V: the current virus situation
- M: the chancellor's message about how optimistic the university is about the virus situation
- F: whether Varun's friend takes CS1888
- C: whether Varun's friend's crush takes CS1888



Each variable has a binary domain. The conditional probability tables of variables are known, but not represented here.

(b) [2 pts] We want $P(F, O|c)$, where c is a value that C can take on. Which of the following algorithms could be used for calculating this?

- ☐ Forward Algorithm
- ■ Prior Sampling
- ■ Inference by Enumeration
- ☐ Particle Filtering
- ○ None of the Above

Forward algorithm is false since there is no notion in the decision network of time-based sequences with a transition or evidence model.
Prior sampling can be used to sample all variables and then use counting to determine the probability.
Like option 1, particle filtering is false since there is no notion in the decision network of time-based sequences with a transition or evidence model.

(c) Varun wants to reason about the VPI of observing different evidence variables. For the following statements, select if they are always, sometimes, or never true.

(i) [1 pt] $VPI(F) \geq VPI(C)$

- ● Always true
- ○ Sometimes true
- ○ Never true

Since C only affects the utility through F, the VPI of knowing F directly will always be higher than or equal to the VPI of knowing C.

(ii) [1 pt] $VPI(O|V) + VPI(V|O) > VPI(V, O)$

○ Always true ○ Sometimes true ● Never true

VPI(V,O) = VPI(O|V) + VPI(V) = VPI(V|O) + VPI(O). We can see that VPI(V|O) will always be 0, while VPI(V) is not necessarily 0. So it is possible for the left side to be less than or equal to the right, but not greater

(d) [2 pts] Varun peeks at his friend's crush's CalCentral and sees whether she is taking CS1888 ($C = c'$). Which of the following formulas represents the highest utility he has now?

● $\max_a \sum_f \sum_o P(f, o|c')U(f, o, a)$

○ $\sum_c P(c)[\max_a \sum_f \sum_o P(f, o|c')U(f, o, a)]$

○ $\max_a \sum_f P(f|c')U(f, a)$

○ $\sum_c P(c)[\max_a \sum_f P(f|c')U(fa)]$

We have to use the formula for MEU(e, e') instead of that for MEU(e, E'). The new evidence is no longer a random variable because Varun has observed C. Therefore, the last two options are incorrect. There is no such thing as a utility function without O, so the second option is incorrect.

Q1 Self-Assessment - leave this section blank for your original submission. We will release the solutions to this problem after the deadline for this assignment has passed. After reviewing the solutions for this problem, assess your initial response by checking one of the following options:

- ◯ I fully solved the problem correctly, including fully correct logic and sufficient work (if applicable).
- ◯ I got part or all of the question incorrect.

If you selected the second option, explain the mistake(s) you made and why your initial reasoning was incorrect (do not re-iterate the solution. Instead, reflect on the errors in your original submission). Approximately 2-3 sentences for *each* incorrect sub-question.