CS 188 Introduction to Spring 2019 Artificial Intelligence

Written HW 7

Due: Monday 4/1/2019 at 11:59pm (submit via Gradescope).

Leave self assessment boxes blank for this due date.

Self assessment due: Monday 4/8/2019 at 11:59pm (submit via Gradescope)

For the self assessment, fill in the self assessment boxes in your original submission (you can download a PDF copy of your submission from Gradescope – be sure to delete any extra title pages that Gradescope attaches). For each subpart where your original answer was correct, write "correct." Otherwise, write and explain the correct answer. Do not leave any boxes empty.

If you did not submit the homework (or skipped some questions) but wish to receive credit for the self-assessment, we ask that you first complete the homework without looking at the solutions, and then perform the self assessment afterwards.

Policy: Can be solved in groups (acknowledge collaborators) but must be written up individually

Submission: Your submission 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 1 begins on page 2, etc.). **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	Ran
Last name	Liao
SID	3034504227
Collaborators	None

Q1. Probability

- (a) For the following questions, you will be given a set of probability tables and a set of conditional independence assumptions. Given these tables and independence assumptions, write an expression for the requested probability tables. Keep in mind that your expressions cannot contain any probabilities other than the given probability tables. If it is not possible, mark "Not possible."
 - (i) Using probability tables P(A), $P(A \mid C)$, $P(B \mid C)$, $P(C \mid A, B)$ and no conditional independence assumptions, write an expression to calculate the table $P(A, B \mid C)$.

 $P(A, B \mid C) =$ Not possible.

(ii) Using probability tables P(A), $P(A \mid C)$, $P(B \mid A)$, $P(C \mid A, B)$ and no conditional independence assumptions, write an expression to calculate the table $P(B \mid A, C)$.

(iii) Using probability tables $P(A \mid B), P(B), P(B \mid A, C), P(C \mid A)$ and conditional independence assumption $A \perp\!\!\!\perp B$, write an expression to calculate the table P(C).

 $\mathbf{P}(\mathbf{C}) = \frac{\sum \mathsf{aP}(\mathsf{A} \mid \mathsf{B}) \; \mathsf{P}(\mathsf{C} \mid \mathsf{A})}{\mathsf{X}} \quad \text{Not possible.}$

(iv) Using probability tables $P(A \mid B, C), P(B), P(B \mid A, C), P(C \mid B, A)$ and conditional independence assumption $A \perp \!\!\!\perp B \mid C$, write an expression for P(A, B, C).

Self assessment If correct, write "correct" in the box. Otherwise, write and explain the correct answer.

- (b) For each of the following equations, select the *minimal set* of conditional independence assumptions necessary for the equation to be true.
 - (i) $P(A, C) = P(A \mid B) P(C)$

 \mathbf{X} $A \perp \!\!\!\perp B$

 $\Box \quad B \perp \!\!\!\perp C$

 $\begin{array}{ccc} \square & A \perp \!\!\! \perp B \mid C \\ \overline{\mathbf{X}} & A \perp \!\!\! \perp C \end{array}$

 $\Box \quad B \perp \!\!\!\perp C \mid A$

 $\Box A \perp \!\!\!\perp C \mid B$

 $\hfill \square$ No independence assumptions needed.

(ii) $P(A \mid B, C) = \frac{P(A) \ P(B \mid A) \ P(C \mid A)}{P(B \mid C) \ P(C)}$

 $\square \quad A \perp \!\!\! \perp B$

 $\Box B \perp \!\!\! \perp C$

 \blacksquare $B \perp \!\!\! \perp C \mid A$

 $\ \, \bigsqcup \ \, A \perp\!\!\!\perp C$

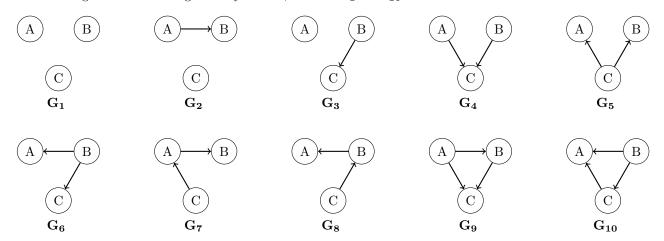
☐ No independence assumptions needed.

 $\Box \quad A \perp \!\!\!\perp C \mid B$

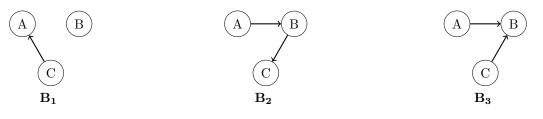
		$\mathbf{A}, \mathbf{B}) = \sum_{\mathbf{c}} \mathbf{P}(\mathbf{A} \mid \mathbf{B}, \mathbf{c}) \ \mathbf{P}(\mathbf{B} \mid \mathbf{c}) \ \mathbf{P}(\mathbf{c})$ $A \perp \!\!\!\perp B$ $A \perp \!\!\!\perp B \mid C$ $A \perp \!\!\!\perp C$ $A \perp \!\!\!\perp C \mid B$	X X	$B \perp\!\!\!\perp C$ $B \perp\!\!\!\!\perp C \mid A$ No independence assumptions needed.
		$\mathbf{A}, \mathbf{B} \mid \mathbf{C}, \mathbf{D}) = \mathbf{P}(\mathbf{A} \mid \mathbf{C}, \mathbf{D}) \ \mathbf{P}(\mathbf{B} \mid \mathbf{A}, \mathbf{C}, \mathbf{D})$ $A \perp \!\!\!\perp B$ $A \perp \!\!\!\perp B \mid C$ $A \perp \!\!\!\perp B \mid D$ $C \perp \!\!\!\perp D$		$C \perp\!\!\!\perp D \mid A$ $C \perp\!\!\!\!\perp D \mid B$ No independence assumptions needed.
	Self as	sessment If correct, write "correct" in the box. Oth	erwise	e, write and explain the correct answer.
(c)	(i) Mai	rk all expressions that are equal to $P(A \mid B)$, gi	ven	no independence assumptions.
	X	$\sum_{c} P(A \mid B, c)$		$\frac{P(A,C B)}{P(C B)}$
		$\sum_{c} P(A, c \mid B)$		$\frac{P(A C,B) \ P(C A,B)}{P(C B)}$
		$\frac{P(B A) \ P(A C)}{\sum_{c} P(B,c)}$		None of the provided options.
	X	$\frac{\sum_{c} P(A, B, c)}{\sum_{c} P(B, c)}$		
	(ii) Mai	rk all expressions that are equal to $P(A, B, C)$,	given	that $\mathbf{A} \perp \!\!\! \perp \mathbf{B}$.
		$P(A \mid C) \ P(C \mid B) \ P(B)$	X	$P(A) P(B \mid A) P(C \mid A, B)$
	X	$P(A) P(B) P(C \mid A, B)$	X	$P(A,C) P(B \mid A,C)$
		$P(C) P(A \mid C) P(B \mid C)$		None of the provided options.
		$P(A) \ P(C \mid A) \ P(B \mid C)$		
	(iii) Ma	rk all expressions that are equal to $\mathbf{P}(\mathbf{A}, \mathbf{B} \mid \mathbf{C})$	give	en that $\mathbf{A} \perp \!\!\! \perp \mathbf{B} \mid \mathbf{C}$.
	X	$P(A \mid C) \ P(B \mid C)$		$\frac{\sum_{c} P(A, B, c)}{P(C)}$
		$\frac{P(A) \ P(B A) \ P(C A,B)}{\sum_{c} P(A,B,c)}$	X	$\frac{P(C,A B)\ P(B)}{P(C)}$
		$P(A \mid B) P(B \mid C)$		None of the provided options.
	not⊠	$\frac{P(C)\ P(B C)\ P(A C)}{P(C A,B)}$		
	Self as	sessment If correct, write "correct" in the box. Oth	erwise	e, write and explain the correct answer.

Q2. Bayes' Nets: Representation

Assume we are given the following ten Bayes' nets, labeled $\mathbf{G_1}$ to $\mathbf{G_{10}}$:



Assume we are also given the following three Bayes' nets, labeled ${\bf B_1}$ to ${\bf B_3}:$



(continued on next page)

Ass		wing Bayes	5 HCts that	arc gu	iarameed to be	CC 20 20 2	cpresent ul.			
		G_1		$\mathbf{G_2}$		G_3	X	$\mathbf{G_4}$	X	G_5
		G_6	X	G_7		G_8	X	G_9	X	G_{10}
		None of t	the above.							
S	elf as	sessment	If correct, w	rite "co	orrect" in the box	x. Otherw	vise, write and ex	xplain th	ne correct answer.	
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		$\mathbf{G_1}$		$\mathbf{G_2}$		G_3		${f G_4}$		G_5
	X	$\mathbf{G_6}$		G_7	X	G_8	X	G_9	X	G_{10}
		None of t	the above.							
S	elf as	sessment	If correct, w	rite "co	orrect" in the box	x. Otherw	rise, write and ex	xplain th	ne correct answer.	
								1		
					oution $\mathbf{d_3}$ (over				ed by Bayes' ne	et B 3. N
	of the	following	Bayes' nets	that a	are guaranteed_	to be ab	le to represent	d_3 .	ed by Bayes' ne	
	of the \Box	following $\mathbf{G_1}$	Bayes' nets	that a $\mathbf{G_2}$	are guaranteed	to be ab G_3	le to represent	$\mathrm{d_{3}}.$ $\mathrm{G_{4}}$		G_5
	of the	following ${f G_1}$ ${f G_6}$	Bayes' nets	that a	are guaranteed_	to be ab	le to represent	d_3 .	ed by Bayes' ne	
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all	of the	following $\mathbf{G_1}$ $\mathbf{G_6}$ None of t	Bayes' nets Che above.	that a G ₂ G ₇	are guaranteed	to be ab G ₃ G ₈	le to represent	$egin{aligned} ext{d}_3. \ ext{G}_4 \ ext{G}_9 \end{aligned}$	□ X	G_5
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