CS 188 Spring 2019

Introduction to 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.)

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Collaborators	

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 | C), P(B | C), P(C | A, B) and no conditional independence assumptions, write an expression to calculate the table P(A, B | C).

P (AIB, C) P(BIC) P(B,C)A)P(A) $P(A,B|C) = \underline{\Sigma} P(A|C)P(C)$ 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 | A, C).

 $P(B \mid A, C) = \underline{\hspace{1cm}}$ Not possible.

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

> P(C) = P(CIA) P(AIB) Not possible.

(iv) Using probability tables P(A | B, C), P(B), P(B | A, C), P(C | B, A) and conditional independence assumption A II B | C, write an expression for P(A, B, C).

 $P(A,B,C) = \frac{P(A|B,C)P(B|A,C)}{\sum P(C|B,A)P(B)} O \text{Not possible.}$

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) $P(A,C) = P(A \mid B) P(C)$

 $A \perp \!\!\! \perp B$

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

 $A \perp \!\!\!\perp C$

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

- $B \perp \!\!\! \perp C$
- $B \perp \!\!\!\perp C \mid A$
- No independence assumptions needed.

P(A)B)= P(A) = A 11B

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

 $A \perp\!\!\!\perp B$

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

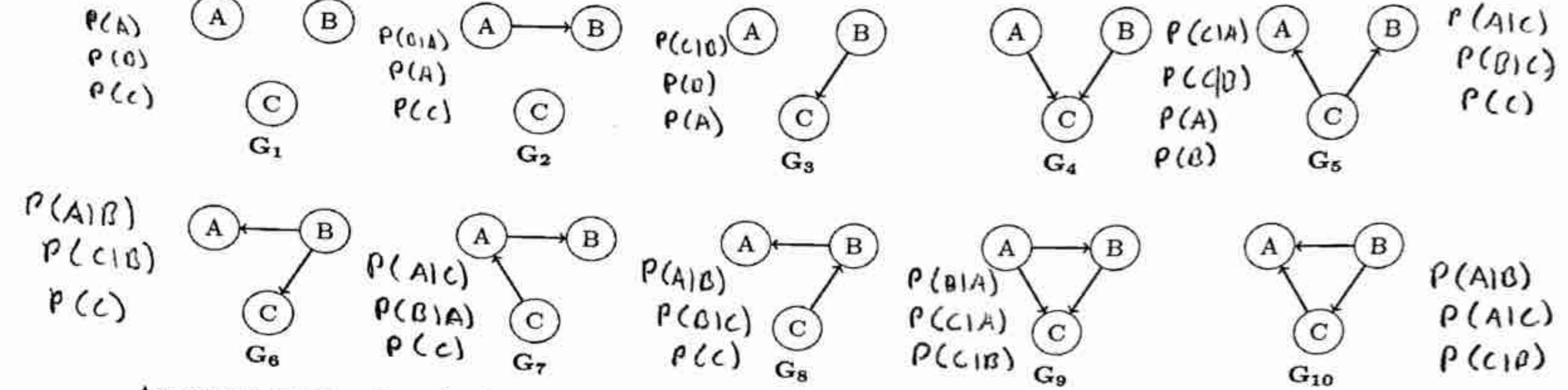
 $A \perp \!\!\!\perp C$ $A \perp \!\!\!\perp C \mid B$

- $B \perp \!\!\!\perp C$
- $B \perp \!\!\!\perp C \mid A$
- No independence assumptions needed.

	$\mathbf{A}, \mathbf{B}) = \sum_{\mathbf{c}} \mathbf{P}(\mathbf{A} \mid \mathbf{B}, \mathbf{c}) \ \mathbf{P}(\mathbf{B} \mid \mathbf{c}) \ \mathbf{P}(\mathbf{c})$		
The second second	$A \perp\!\!\!\perp B \mid C$		$B \perp\!\!\!\perp C$
	$A \perp\!\!\!\perp C$		$B \perp \!\!\! \perp C \mid A$ No independence assumptions needed.
u	$A \perp\!\!\!\perp C \mid B$		
(iv) P(A	$\mathbf{A}, \mathbf{B} \mid \mathbf{C}, \mathbf{D}) = \mathbf{P}(\mathbf{A} \mid \mathbf{C}, \mathbf{D}) \mathbf{P}(\mathbf{B} \mid \mathbf{A}, \mathbf{C}, \mathbf{D})$		
	$A\perp\!\!\!\perp B$		$C \perp\!\!\!\perp D \mid A$
-	$A \perp\!\!\!\perp B \mid C$ $A \perp\!\!\!\perp B \mid D$		$C \perp\!\!\!\perp D \mid B$
	$C \perp \!\!\!\perp D$	024	No independence assumptions needed.
Self as	sessment If correct, write "correct" in the box. Other	erwise	e, write and explain the correct answer.
(i) Ma	rk all expressions that are equal to $P(A \mid B)$, given	en :	no independence assumptions.
	$\sum_{c} P(A \mid B, c)$		$\frac{P(A,C B)}{P(C B)}$
4 23	$\sum_{c} P(A, c \mid B)$		$\frac{P(A C,B) \ P(C A,B)}{P(C B)}$
	$\frac{P(B A) P(A C)}{\sum_{c} P(B,c)}$		None of the provided options.
	$\frac{\sum_{c} P(A,B,c)}{\sum_{c} P(B,c)}$		
	rk all expressions that are equal to $P(A, B, C)$, g	iven	that A $\perp\!\!\!\perp$ B.
	$P(A \mid C) P(C \mid B) P(B)$	E	$P(A) P(B \mid A) P(C \mid A, B)$
	$P(A) P(B) P(C \mid A, B)$		$P(A,C) P(B \mid A,C)$
	$P(C) P(A \mid C) P(B \mid C)$		None of the provided options.
	$P(A) P(C \mid A) P(B \mid C)$		
(iii) Ma	rk all expressions that are equal to $P(A, B \mid C)$,	give	n that A 11 B C.
	$P(A \mid C) P(B \mid C)$		$\frac{\sum_{c} P(A,B,c)}{P(C)}$
	. B M		P(C,A B) P(B)
	$\frac{P(A) \ P(B A) \ P(C A,B)}{\sum_{c} P(A,B,c)}$		$\frac{P(C,A B)}{P(C)}$ None of the provided options
	. B M		P(C,A B) $P(B)$ $P(C)$ None of the provided options.

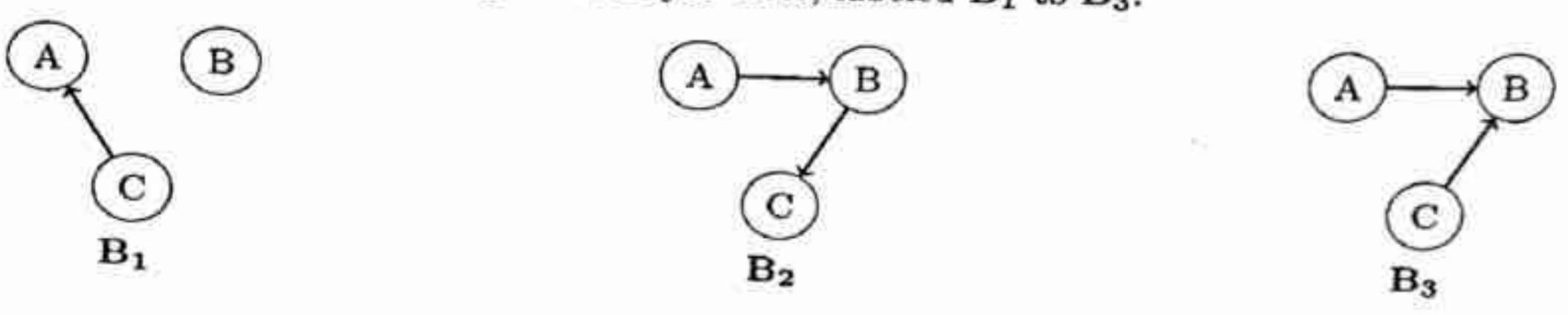
Q2. Bayes' Nets: Representation

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



 G_{10}

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



(continued on next page)

- 1	Assume v	ve know that a jo ving Bayes' nets	oint d	istribu	tion d ₁ (over A	B,C)	can be represent	nted b	y Bayes' net B ₁ .	Mark an or
	10-10-10	G ₁		G ₂		G ₃		G_4		G_5
		G ₆	O al	G ₇		Gs	€ 22	G_9	4.	G10
		\$1550 \$1500		G7		U 8		1.02		
		None of the abo				V255 1		-lain	the correct answer.	
	Self as	sessment If corr	ect, w	rite "co	rrect" in the box	Otherw	ise, write and ex	cpiain	the correct	
										3.61- all of
(b)	Accumo	we know that a j	oint d	listribu	tion d2 (over A	, B, C)	can be represen	ited by	Bayes' net B2.	Mark an or
(6)	the follow	wing Bayes' nets	that	are gua	aranteed to be a		represent d ₂ .	G_4		G_5
		G_1		G_2		G_3	527		. 3	G_{10}
	F 2	G_6		G_7		G_8	321	G_9		
		None of the abo	ve.							
	Self as	sessment If com	rect, w	rite "co	rrect" in the box	Otherw	ise, write and ex	plain	he correct answer.	
	1									
	L						ho rer	recent	ed by Bayes' net	B ₃ . Mark
(c)	Assume	we know that a j	joint	distrib	ution d ₃ (over A	o be ab	le to represent	d3.		
1000	all of the		All the second of the second o	that a	TO UNIXIMILITY OF			G_4		
	A11 01 011	e following bayes	nets	that c		G_3		G4		G_5
		e following Bayes G ₁	nets	G ₂		-		G_9	Ξ_{ℓ}	G ₅ G ₁₀
		e following Bayes G ₁ G ₆		that c		-			□	G ₅
		G ₆ None of the above	ove.	G ₂		G ₈		G ₉		G ₅ G ₁₀
		e following Bayes G ₁ G ₆	ove.	G ₂		G ₈		G ₉		G ₅ G ₁₀
		G ₆ None of the above	ove.	G ₂		G ₈		G ₉		G ₅ G ₁₀
		G ₆ None of the above	ove.	G ₂		G ₈		G ₉		G ₅ G ₁₀
		G ₆ None of the above	ove.	G ₂		G ₈		G ₉		G ₅ G ₁₀
	Selfa	G ₁ G ₆ None of the above seesment if core	ove.	G ₇	orrect" in the box	Ga	ise, write and ex	G ₉	he correct answer.	G ₁₀
	Selfa	G ₁ G ₆ None of the above	ove.	G ₂	orrect" in the box	G8 Otherw	ise, write and ex	plain t	by Bayes' nets B	G ₁₀
	Selfa	G ₁ G ₆ None of the above	ove.	G ₂	orrect" in the box	G ₈ Otherw	ise, write and ex	plain t	by Bayes' nets B	G ₁₀
	Selfa	G ₁ G ₆ None of the above seesment if core	ove.	G ₂	orrect" in the box	G8 Otherw	ise, write and exected to be able to	plain to	by Bayes' nets Bent d4.	G ₅ G ₁₀ G ₅
	Selfa	we know that a rk all of the follow G_1	ove.	G ₇	orrect" in the box	G ₈ Otherw	ise, write and ex	plain t	by Bayes' nets Bent d4.	G ₁₀
	Assume B3. Ma	we know that a rk all of the follow G_1 G_6 None of the above G_1 G_6 None of the above G_1 G_6	joint wing	G ₂ distrib Bayes' G ₂	ution d4 (over nets that are gu	G ₈ G ₈ G ₈ G ₈	ise, write and exected to be able to	plain to	by Bayes' nets Bent d4.	G ₅ G ₁₀ G ₅
	Assume B3. Ma	we know that a rk all of the follow G_1 G_6 None of the above G_1 G_6 None of the above G_1 G_6	joint wing	G ₂ distrib Bayes' G ₂	ution d4 (over nets that are gu	G ₈ G ₈ G ₈ G ₈	ise, write and exected to be able to	plain to	by Bayes' nets Bent d4.	G ₅ G ₁₀ G ₅
	Assume B3. Ma	we know that a rk all of the follow G_1 G_6 G_1 G_6 G_1 G_6	joint wing	G ₂ distrib Bayes' G ₂	ution d4 (over nets that are gu	G ₈ G ₈ G ₈ G ₈	ise, write and exected to be able to	plain to	by Bayes' nets Bent d4.	G ₅ G ₁₀ G ₅
	Assume B3. Ma	we know that a rk all of the follow G_1 G_6 None of the above G_1 G_6 None of the above G_1 G_6	joint wing	G ₂ distrib Bayes' G ₂	ution d4 (over nets that are gu	G ₈ G ₈ G ₈ G ₈	ise, write and exected to be able to	plain to	by Bayes' nets Bent d4.	G ₅ G ₁₀ G ₅
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