Coursera

Dong-Bang Ts

Probabilistic Graphical Models

- Home
- Quizzes
- Theory Problems
- Assignments
- Assignment Questions
- Video Lectures
- Discussion Forums
- Course Wiki
- Lecture Slides
- Course Schedule
- Course Logistics
- Course Information
- Course Staff
- Octave Installation

Feedback — Inference: Belief Propagation

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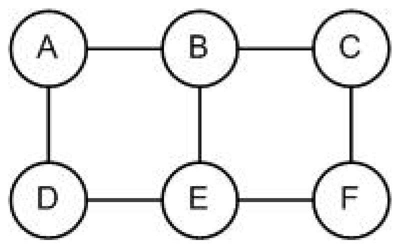
You achieved a score of 10.42 out of 12.00

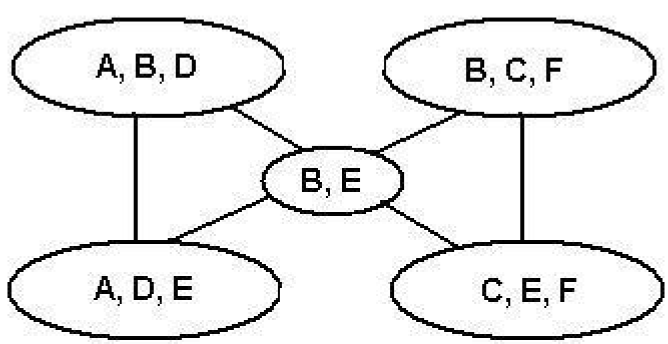
Question 1

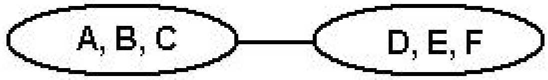
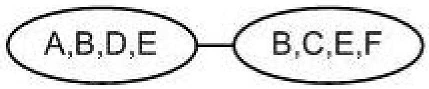
Cluster Graph Construction. Consider the pairwise MRF, H, shown bel {B,C}, {A,D}, {B,E}, {C,F}, {D,E} and {E,F}.



Which of the following is/are valid cluster graph(s) for H? (A cluster graph intersection property and family preservation. You may select 1 or more think none apply.)

Your Answer		Score
✔	✔	0.25

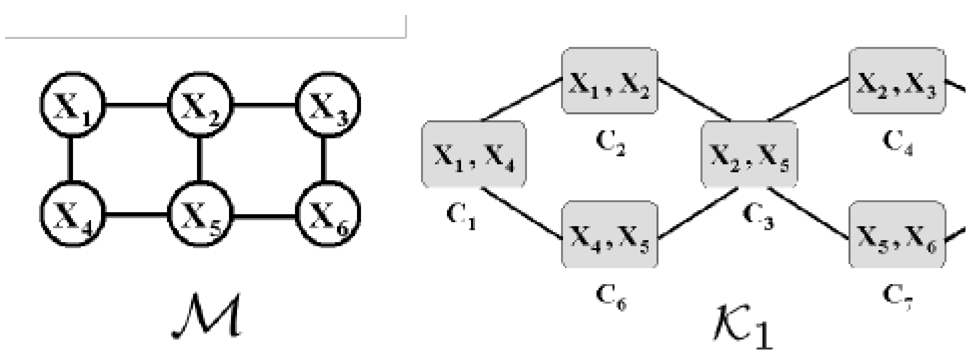


	✔	0.25
	✖	0.00
✔ 	✔	0.25
Total		0.75

Question 2

Message Passing in a Cluster Graph.

Suppose we wish to perform inference over the Markov network M as shown belo binary, and the only potentials in the network are the pairwise potentials $\phi_{i,j}(X_i,$ of variables X_i, X_j connected by an edge in M. Which of the following expressic $\delta_{3\to6}$ that cluster C_3 will send to cluster C_6 during belief propagation? Assume tl equal to the intersection of the variables in the adjacent cliques.



Your Answer
$\delta_{3\to 6}(X_5) = \sum_{X_2} \phi_{2,5}(X_2, X_5)\delta_{2\to 3}(X_2)\delta_{4\to 3}(X_2)\delta_{7\to 3}(X_5)$
Total

Question 3

Message Passing Computation. Consider the Markov network M from initial factors in the Markov network M are of the form as shown in the ta specific value of i, j (we basically wish to encourage variables that are co the same assignment), compute the message $\delta_{3\to 6}$, assuming that it is t in loopy belief propagation. Assume that the messages are all initialized entries are initially set to 1.

You may separate the entries of the message by commas. Order the ent order: for example, if the message is over one variable X_i, then enter in $\delta_{3\to 6}(X_i = 1)$. If the message is over two variables X_i, X_j, where $i <$ order $\delta_{3\to 6}(X_i = 0, X_j = 0)$, $\delta_{3\to 6}(X_i = 0, X_j = 1)$, $\delta_{3\to 6}(X_i = 1$ $\delta_{3\to 6}(X_i = 1, X_j = 1)$.

X_i	X_j	$\phi(X_i, X_j)$
1	1	10
1	0	1
0	1	1

0	0	10

11, 11

Your Answer		Score	E
11	✔	0.50	
11	✔	0.50	
Total		1.00	

Question 4

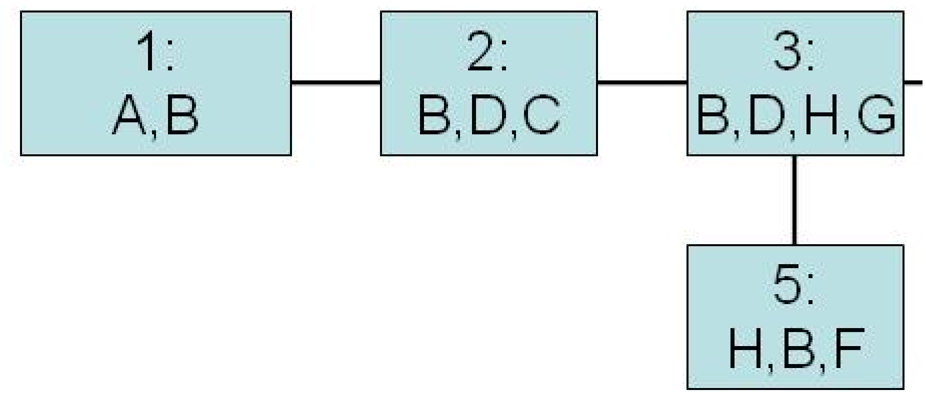
***Extracting Marginals at Convergence.** Given that you can renormalize during belief propagation and still obtain correct marginals, consider the computed. Use this observation to compute the final and possibly approx $P(X_4 = 1, X_5 = 1)$ (X_4 and X_5 are the variables in the previous que convergence (as extracted from the cluster beliefs), giving your answer t

0.45

Your Answer		Score	Explanation
0.45	✔	1.00	Since $\delta_{3\rightarrow 6}$ is proportional to a uniform facto same holds for $\delta_{1\rightarrow 6}$. Thus the final cluster b initial beliefs, giving us a probability of $\frac{10}{22}$.
Total		1.00	

Question 5

Message Ordering. In the clique tree below which of the following startir
is/are valid? (Note: These are not necessarily full sweeps that result in ca
more options, or none of them, if you think none apply.)



Your Answer		Score	Explar
✔ $C_1 \to C_2, C_2 \to C_3, C_5 \to C_3, C_3 \to C_4$	✔	0.25	This is cliques they ar
✔ $C_4 \to C_3, C_5 \to C_3, C_3 \to C_2, C_1 \to C_2$	✔	0.25	This is cliques they ar
$C_1 \to C_2, C_2 \to C_3, C_3 \to C_4, C_3 \to C_5$	✔	0.25	C_3 nee messa pass a
$C_4 \to C_3, C_3 \to C_5, C_3 \to C_2, C_1 \to C_2$	✔	0.25	C_3 nee messa pass a
Total		1.00	

Question 6

Message Passing in a Clique Tree. In the clique tree above, what is the from clique 3 to clique 2, $\delta_{3\rightarrow 2}$, where $\psi_i(C_i)$ is the initial potential of cl

Your Answer		Score	Explanation
$\sum_{G,H}\psi_3(C_3) \times \delta_{4\rightarrow 3} \times \delta_{5\rightarrow 3}$	✔	1.00	This is correct; to co multiply the initial po incoming messages and eliminate the va sepset.
Total		1.00	

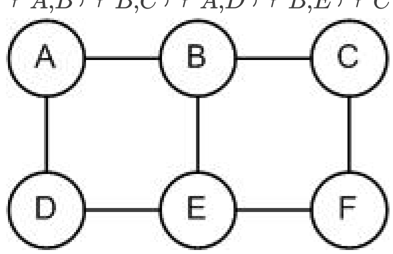
Question 7

Family Preservation. Suppose we have a factor $P(A \mid C)$ that we wish message passing inference. We should:

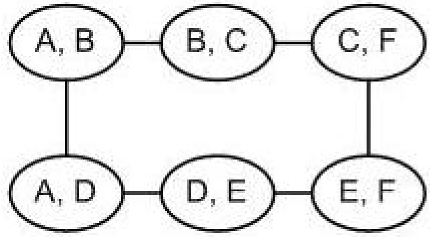
Your Answer		Score	Explanation
Assign the factor to **one** clique that contain A **and** C	✔	1.00	Family Preservation explains tha clique tree (cluster graph) requir cluster whose scope contains th
Total		1.00	

Question 8

Clique Tree Properties. Consider the following Markov Network over pc $\phi_{A,B}$, $\phi_{B,C}$, $\phi_{A,D}$, $\phi_{B,E}$, $\phi_{C,F}$, $\phi_{D,E}$, and $\phi_{E,F}$:



Which of the following properties are necessary for a valid clique tree for satisfied by this graph:



You may select 1 or more options (or none of them, if you think none app

Your Answer		Score	Expl
✔ Family preservation	✔	0.25	Fami beca anyw
Node degree less than or equal to 2	✔	0.25	This a clu
The number of nodes in a clique tree containing a variable should be exactly the number of factors in the Markov network that contain the same variable	✔	0.25	Multi the s provi
Running intersection property	✔	0.25	The inters the s inters adjac
Total		1.00	

Question 9

Cluster Graphs vs. Clique Trees. Suppose that we ran sum-product me graph G for a Markov network M and that the algorithm converged. Whi true **only if** G is a clique tree and is **not** necessarily true otherwise?

Your Answer		Score	Explanation
● If there are E edges in G, there exists a message ordering that guarantees	✔	1.00	This is a property specific to cli of the cliques to be the root clic from the root clique to all other messages from all other clique we are guaranteed to have cali

convergence after passing $2E$ messages.		graph however, depending on t may take longer.
Total	1.00	

Question 10

***Numerical Issues in Belief Propagation.** In practice, one of the issues messages in a *clique tree* is that when we multiply many small numbers, limits of floating-point numbers, resulting in arithmetic underflow. One po this problem is to renormalize each message, as it's passed, such that its we do not store the renormalization factor at each step. Which of the follo consequence of this approach?

Your Answer		Score	Explanatio
This does not change the results of the algorithm: when the clique tree is calibrated, we can obtain from it both the partition function and the correct marginals.	✗	0.00	Think abou messages of the parti compute th case where renormaliz
Total		0.00	

Question 11

***Numerical Issues in Belief Propagation.** The same numerical issues a messages in a *cluster graph with loops*. Which of the following statement this approach? You may select 1 or more options (or none of them, if you

Your Answer		Score	Explanat
At convergence, the marginals that we extract from each of the beliefs in the clusters will now be the marginals of the original joint distribution.	✓	0.33	While rer numerica not true b (when rer the same renormal

			general, v marginals yields on
Assuming nothing else changes (e.g., message passing order), at convergence, the approximate marginals that are obtained from renormalizing the beliefs at each cluster will be the same as in the original algorithm (ignoring differences arising from numerical precision issues).	✖	0.00	This is tru for clique renormal a cluster once we multiplica
✔ At convergence, the cluster graph will (in general) not satisfy the cluster graph invariant, i.e., the product of cluster beliefs divided by the product of sepset beliefs will not be equal to the original unnormalized distribution.	✔	0.33	This is tru written as unnorma can recor the norma function i the cluste change e statemen
Total		0.67	

Question 12

Convergence in Belief Propagation. Suppose we ran belief propagatio

clique tree T for the same Markov network that is a perfect map for a dist

and T are valid, i.e., they satisfy family preservation and the running inter

following statements regarding the algorithm are true? You may select 1

them, if you think none apply).

Your Answer		Score	Explanation
✔ Assuming the algorithm converges, if a variable X appears in two cliques in T, the marginals $P(X)$ computed from the the two clique beliefs must agree.	✔	0.25	This is true due to the ca convergence and the fa satisfy the running inter variable X is in two cliq connected by a path for sepset (by the RIP), and must agree on the belie
✔ Assuming the algorithm converges, if a variable X appears in two clusters in G, the marginals $P(X)$	✔	0.25	This is true due to the ca convergence and the fa satisfy the running inter variable X is in two clus

computed from the two cluster beliefs must agree.			connected by a path for sepset (by the RIP), and must agree on the belie
If the algorithm converges, the final *cluster* beliefs in G, when renormalized to sum to 1, are true marginals of P.	✓	0.25	This is not true, becaus loops. One consequenc about a variable may be cluster graphs only retu
Belief propagation always converges on G.	✓	0.25	This is not always true, strong opposing potenti graph.
Total		1.00	