Computer Vision 2
Assignment 2

TECHNISCHE UNIVERSITÄT DARMSTADT

Summer Semester 2019
Group 8

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Problem 1 Graphical models (20 Points)

1. 1 Point

Two main ingredients the set of random variables describing the entities involved the problem, and the second ingredient is the set of conditional probabilities, that tell us the relation between a certain variable and another variable or variables from the set.

2. 1 Point

As we know that directed graphs are versatile, but not always appropriate. So they are not always be convenient to provide conditional distributions, and some of certain conditional independence structures that a directed graph can not represent. So for example Loopy graph, it is not possible to express the same conditional independence statements using the a directed graph model.

3. 2 Points

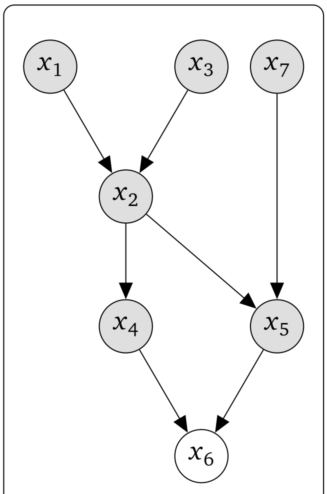


Figure1

The Markov Blanket of variable x_2 is formed from the variables that are filled with gray color.

4. 2 Points

The factorization of the directed graphical model is as follows
$p(x_1, x_2, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}) = p(x_1)p(x_2)p(x_3)p(x_6)p(x_7)p(x_4|x_1, x_2)p(x_5|x_2, x_3)p(x_{10}|x_7)$
$p(x_{11}|x_{10})p(x_8|x_4, x_5)p(x_9|x_3, x_5, x_6)p(x_14|x_{11})p(x_12|x_8, x_9)p(x_{13}|x_9)p(x_{15}|x_{12})$

The factorization of the undirected graphical model is as follows
$p(x_1, x_2, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}) = \frac{1}{Z}\phi_0(x_3)\phi_1(x_1, x_4)\phi_2(x_2, x_4, x_5, x_8)\phi_3(x_7, x_{10})\phi_4(x_7, x_{11})$
$\phi_5(x_{11}, x_{14})\phi_6(x_5, x_9)\phi_7(x_8, x_{12})\phi_8(x_9, x_{12}, x_{13}, x_{15})\phi_9(x_6, x_9)$

5. 1 Point

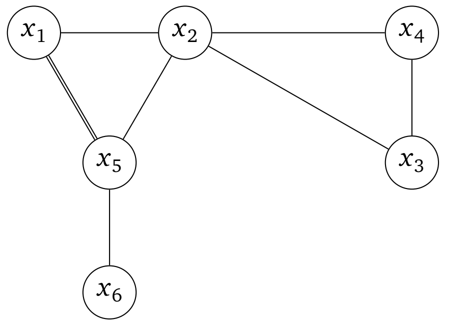


*Figure*2

6. 2 Points

x_1	x_2	x_3	x_4	$p(x_1, x_2, x_3, x_4)$	$\frac{1}{Z}p(x_1, x_2, x_3, x_4)$
0	0	0	0	1*1*1*1=1	0.1077
0	0	0	1	1*1*0.1*0.1=0.01	0.001077
0	0	1	0	1*0.1*0.1*1=0.01	0.001077
0	0	1	1	1*0.1*2*0.1=0.02	0.002155
0	1	0	0	0.1*0.1*1*1=0.01	0.001077
0	1	0	1	0.1*0.1*0.1*0.1=0.0001	0.00001077
0	1	1	0	0.1*2*0.1*1=0.02	0.002155
0	1	1	1	0.1*2*2*0.1=0.04	0.00431
1	0	0	0	0.1*1*1*0.1=0.01	0.001077
1	0	0	1	0.1*1*0.1*2=0.02	0.002155
1	0	1	0	0.1*0.1*0.1*0.1=0.0001	0.00001077
1	0	1	1	0.1*0.1*2*2=0.04	0.00431
1	1	0	0	2*0.1*1+0.1=0.02	0.002155
1	1	0	1	2*0.1*0.1*2=0.04	0.00431
1	1	1	0	2*2*0.1*0.1=0.04	0.00431
1	1	1	1	2*2*2*2=8	0.86206

We have computed Z as the sum of all the probabilities above, and after the calculation we found Z=9.28.

7. 2 Points

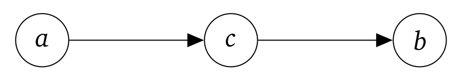
Based on those four records

a	b	c	p(a,b,c)
0	1	0	0.048
1	0	0	0.192
0	1	1	0.216
1	0	1	0.064

The first and second row c remain the same but a and b change and with them the distribution too, the same happens in the third and fourth row. So we can conclude that those variable a and b are marginally dependent, when b=1 and a=0 then the distribution ia 0.048 but in the other hand, when b=0 and a=1 then the distribution is 0.192, so this means knowing event b does help in value of event a and vise versa.

8. 3 Points

Based on the given distributions $p(a)$ $p(b|c)$ $p(c|a)$ we can draw the directed graph as follows :



$Figure 3$

And from the figur above we can write:
$p(a,b,c) = p(a)p(a|c)p(b|a,c) = p(a)p(a|c)p(b|c)$
As we know from directed graph, because 'c' tell us about 'a', we can take away 'a' from $p(b|a,c)$, and therefore we get the desired probability.

9. 2 Points

Markov blanket of variables in undirected graph:
$x_1 -> x_2, x_3$
$x_2 -> x_1, x_4$
$x_3 -> x_1, x_4$
$x_4 -> x_2, x_3$

Markov blanket of variables in directed graph:
$x_1 -> x_2, x_3$
$x_2 -> x_1, x_3, x_4$
$x_3 -> x_1 x_2, x_4$
$x_4 -> x_2, x_3$

10. 4 Points

Based also in the previous question about for Markov blanket for each of the variables, we can conclude that in the figure 2, undirected graph, the first one that says x_1 ïs independent of"x_4 and that x_2 and x_3 are the Markov blanket of x_1, is completely true based also in the definition that, a node is conditionally independent of all other nodes given its Markov blanket. The second one that says x_2 ïs independent of"x_3, because the x_3 is not in the Markov blanket of x_2, and from definition a node is conditionally independent of all other nodes given its Markov blanket, and that x_1 and x_4 are the Markov blanket of x_2, because they are direct node of x_2. And for the directed Graph, first one that says x_1 ïndependent of"x_4, exactly as the definition from above, and that x_2 and x_3 are the Markov blanket of x_1, because x_1 has 2 children and no other parents and also those children have just one parent and its x_1. The second one

Problem 2 Markov random fields with Student-t potentials (10 Points)

Tasks 1-4 within code

5. 3 Points

Problem 3 Stereo with gradient-based optimization (17 Points)

Everything else is in code.

6. 4 Points

Problem 4 Stereo with a generalized robust function (10 Points)

Everything else is in code.

5. ? Point/s

6. ? Point/s