# Computer Vision 2
# Assignment 2

Summer Semester 2019
Group 8
Moritz Fuchs & Diedon Xhiha

## 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

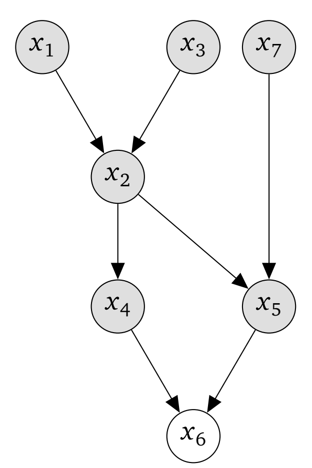


*Figure1*

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
$p(x_1, x_2, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}) = \frac{1}{Z}\phi_0(x_3)\phi_1(x_1, x_4)\phi_2(x_2, x_4, x_5, x_8)\phi_3(x_7, x_{10})\phi_4(x_7, x_{11})$
$\phi_5(x_{11}, x_{14})\phi_6(x_5, x_9)\phi_7(x_8, x_{12})\phi_8(x_9, x_{12}, x_{13}, x_{15})\phi_9(x_6, x_9)$

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## 5. 1 Point

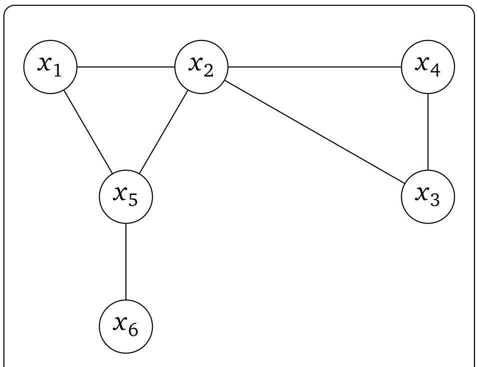


*Figure2*

## 6. 2 Points

| $x_1$ | $x_2$ | $x_3$ | $x_4$ | $p(x_1, x_2, x_3, x_4)$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1*1*1*1=1 |
| 0 | 0 | 0 | 1 | 1*1*0.1*0.1=0.01 |
| 0 | 0 | 1 | 0 | 1*0.1*0.1*1=0.01 |
| 0 | 0 | 1 | 1 | 1*0.1*2*0.1=0.02 |
| 0 | 1 | 0 | 0 | 0.1*0.1*1*1=0.01 |
| 0 | 1 | 0 | 1 | 0.1*0.1*0.1*0.1=0.0001 |
| 0 | 1 | 1 | 0 | 0.1*2*0.1*1=0.02 |
| 0 | 1 | 1 | 1 | 0.1*2*2*0.1=0.04 |
| 1 | 0 | 0 | 0 | 0.1*1*1*0.1=0.01 |
| 1 | 0 | 0 | 1 | 0.1*1*0.1*2=0.02 |
| 1 | 0 | 1 | 0 | 0.1*0.1*0.1*0.1=0.0001 |
| 1 | 0 | 1 | 1 | 0.1*0.1*2*2=0.04 |
| 1 | 1 | 0 | 0 | 2*0.1*1+0.1=0.02 |
| 1 | 1 | 0 | 1 | 2*0.1*0.1*2=0.04 |
| 1 | 1 | 1 | 0 | 2*2*0.1*0.1=0.04 |
| 1 | 1 | 1 | 1 | 2*2*2*2=8 |

## 7. 2 Points

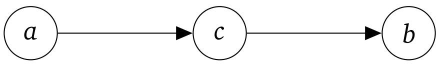
Based on those four record

| 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 $p(b|a,c)$ .

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