Probabilistic Graphical Models and their Applications
Assignment #3

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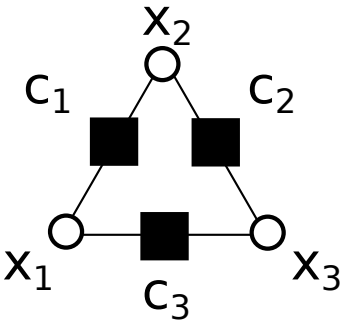
Submission Instructions

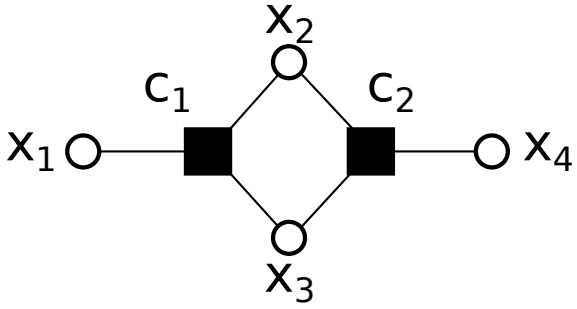
To be submitted on Monday, **Dec 19th**, either during the lecture or to Eldar Insafutdinov (Office 629. `eldar@mpi-inf.mpg.de`). If you submit by email, make sure to start the subject line with "[PGM] ". Make sure to submit only notes and code that you have written, but no data.

Exercises

You can use Matlab to solve this assignment.



(a)



(b)

x_1	x_2	$f_{12}(x_1, x_2)$
0	0	-5
1	0	-2
0	1	-4
1	1	1

x_2	x_3	$f_{23}(x_2, x_3)$
0	0	4
1	0	2
0	1	3
1	1	3

x_1	x_3	$f_{13}(x_1, x_3)$
0	0	0
1	0	2
0	1	3
1	1	0

x_1	x_2	x_3	$g_{123}(x_1, x_2, x_3)$
0	0	0	-2
1	0	0	2
0	1	0	-1
1	1	0	8
0	0	1	-1
1	0	1	1
0	1	1	3
1	1	1	13

x_2	x_3	x_4	$g_{234}(x_2, x_3, x_4)$
0	0	0	1
1	0	0	5
0	1	0	-4
1	1	0	-4
0	0	1	-1
1	0	1	6
0	1	1	-7
1	1	1	-6

1. **(4 points).** State in multilinear polynomial form
   a) the function $f(x) := f_{12}(x_1, x_2) + f_{23}(x_2, x_3) + f_{13}(x_1, x_3)$
   b) the function $g(x) := g_{123}(x_1, x_2, x_3) + g_{234}(x_2, x_3, x_4)$.

2. **(4 points).** Give a quadratic multilinear polynomial form with the same minimizers
   a) as f

b) as g.
Toward this goal, transform the multilinear polynomial forms of part (1) using the algorithm discussed in the lecture.

3. **(2 points).** State the min-term posiform of f. b) Which lower bound on f is given by this posiform?

4. **(8 points).** State a linear program (LP) whose solution is the *floor dual* of f, either with paper and pen or programmatically (encouraged).

5. **(2 points).** Solve this LP using the LP-solver "linprog" of MATLAB's optimization toolbox. State the floor dual value, as well as the coefficients of the posiform defining the floor dual.

Bonus Exercises

(2 points). Answer questions 3-5 for the function g.