HOMEWORK ASSIGNMENT #5

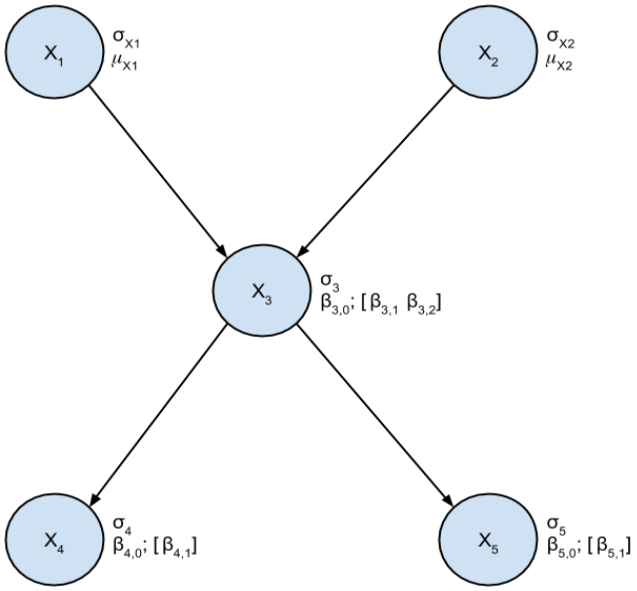
DUE: Monday, March 30, 2015
CSCI573: Probabilistic Reasoning, Prof. Nevatia
Spring Semester, 2015

This assignment consists of two problems.

1. This problem is about inference in Gaussian Bayesian Networks. Consider the network specified in the figure below; the symbols at the nodes indicate conditional distributions (given parents) assuming a linear Gaussian model.

For this network, find answer to the query of p ($X_1|X_4 = x_4, X_5 = x_5$). Use the sum-product variable elimination algorithm, as one would for the discrete case, but applying to Gaussian distributions this time. It is recommended, but not essential, to use the canonical form to represent the distributions. As distributions are not given in numerical form but in symbolic form, your answer will also be in symbolic form. It is not essential to expand all the terms but avoid just stating the operations of sum-product.

As the network is small, it is easy to compute the joint distribution first and then answer any queries from it. Do NOT use this approach as we want to use a technique that will scale to larger networks. However, feel free to use this approach to verify your answer if you wish.



2. Goal of this assignment is to implement the clique-tree **max-product** message passing algorithm and apply it to the network specified in detail in Problem 2 of Assignment #3. You should be able to use many of the functions you may have created in Assignment #4.

Note that you are not being asked to implement a general version of the algorithm but only one sufficient to carry out the calculations for the specific problem. You are also not asked to implement a general input and output representation for the parameters of the problem. You may use any programming language; however, you must not use library packages designed specifically for graphical model inference.

Specifically, do the following:

a) **Create a corresponding clique tree** for the specified network. You need NOT write a program for this part but can carry out the calculations by hand. You can reuse the tree from Assignment #4.

b) **Implement a program for the max-product message passing algorithm** (Algorithm 13.2) given on page 357 of the KF book to *max calibrate* the clique tree assuming that no evidence variables are given and apply it to the tree resulting from part (a) above.

c) Use the algorithm above to compute the MAP estimate without any evidence given. You need not implement the traceback procedure in code but can carry it out by hand.

d) Compute the max-marginal estimate of (Earthquake, Burglary) given the evidence variables to be JohnCalls = True and MaryCalls = False (as in assignment #4). Use the code you implemented for part (b) above to maximize over the query variables and what you implemented for assignment #3 to sum over variables that are neither in evidence nor in the query set. Again, traceback part of computation may be done by hand.

What to Hand In?
For this assignment, it is requested that you submit your answers in electronic form. Problem 1 may be hand-written but scan it in that case (if you don't have access to a scanner, hard copy will be accepted).
For problem 2, turn in all source code you implement. Also show the results of the intermediate steps of the execution of your code, in addition to the final results. Follow the instructions provided for Assignment #4.