Modeling MTP_2 Gaussian probability distributions using graphical models and their applications in finance

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Abstract

The thesis focuses on probabilistic graphical Gaussian models enhanced with the MTP_2 property. After reviewing the main definitions and theorems of the field, the concept of mutual information is generalized to the Gaussian distribution and its formula is given.

The cherry tree Gaussian distribution was then introduced. A Gaussian probability distribution can be approximated by a cherry tree Gaussian distribution, which uses only k and $k-1$ order marginal distributions. The goodness of the approximation expressed by the Kullback-Leibler divergence depends only on the information of the marginal probability distribution involved in the cherry tree. If the sample size is small relative to the number of variables, the low marginal distribution can be better approximated. Therefore, the cherry tree approximation can be very useful in these cases.

The faithfulness of the graph follows from the MTP_2 property. We gave an algorithm called Pruned cherry tree, that starting from the best fitting regular tree builds a cherry tree of order three in a greedy way. Having the cherry tree, we delete the edges which are not significantly greater than 0. This way we prune the cherry tree. Beside the Pruned cherry tree algorithm, we used another algorithm introduced in a recent work which was constructed also for this purpose. We illustrated and discussed the results of both algorithms on real data containing cryptocurrencies, and also on synthetic data. We found that our algorithm works promising for finding the edges of the Markov network.