Mathematics > Statistics Theory

Normality of the three-state toric homogeneous Markov chain model

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Markov chain models had proved to be useful tools in many fields, such as physic, chemistry, information sciences, economics, finances, mathematical biology, social sciences, and statistics for analyzing data. A discrete time Markov chain is often used as a statistical model from a random physical process to fit the observed the data. A time-homogeneous Markov chain is a process that each transition probability from a state to a state does not depend on time. It is important to test if the assumption of the time-homogeneity of the chain fits the observed data.
In 2011, Hara and Takemura suggested a Markov Chain Monte Carlo (MCMC) approach to a goodness-of-fit test using Markov bases on the {\em toric homogeneous Markov chain (THMC) model}. We provide a bound on the degree of the Markov bases for the three-state THMC model (without loops and initial parameters), when the Markov chains are assumed to be independent of the time. Our proof is based on a result due to Sturmfels, who gave a coarse bound on the degree for the generators of toric ideals, provided the normality of the corresponding toric variety. In our setting, we proved the normality of the toric ideal associated to the THMC model by studying the geometric properties of the polytope associated to the design matrix of the model. Moreover, we give a complete description of the facets of this polytope, which does not depend on the time.

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