A study of network representations for Markov dynamics modelling

Pierre-André Noël, Antoine Allard, Laurent Hébert-Dufresne, Vincent Marceau, and Louis J. Dubé
Département de Physique, de Génie Physique, et d'Optique,
Université Laval, Québec (Québec), Canada G1V 0A6

(Dated: May 9, 2011)

Networks dynamics is considered from the perspective of Markov stochastic processes. We study different ways to represent both the structure of a network and the status of its components under the form of a state vector. For each such representation, the time evolution of a Markov stochastic processes can be specified through transitions probabilities between pairs of state vectors. Monte Carlo simulations assess the validity of the resulting models.

Particular care is given to state vectors based on a "local" perspective. When required, information not directly contained in this description is inferred from the available data. The approach is very general but, for the purpose of demonstration, we have been mostly concerned with propagation dynamics and dynamical changes in the structure of the network itself.

Once a valid Markov process representation of the system is known, a vast array of standard stochastic calculus tools is readily available for further study. Of particular interest is the ease with which one obtains a multi-dimensional Gaussian approximation of the probability distribution, even for problems where one is usually restricted to mean values.