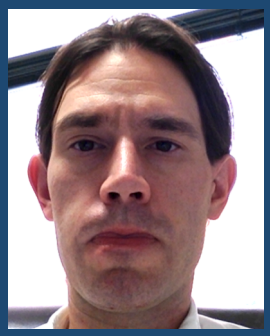
Department of Applied and Computational Mathematics and Statistics Colloquium



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Exponential-family random graph models with local dependence

Dependent phenomena, such as relational, spatial, and temporal phenomena, tend to be characterized by local dependence in the sense that units which are close in a well-defined sense are dependent. However, in contrast to spatial and temporal phenomena, relational phenomena tend to lack a natural neighborhood structure in the sense that it is unknown which units are close and thus dependent. An additional complication is that the number of observations is 1, which implies that the dependence structure cannot be recovered with high probability by using conventional high-dimensional graphical models.

Therefore, researchers have assumed that the dependence structure has a known form. The best-known forms of dependence structure are inspired by the Ising model in statistical physics and Markov random fields in spatial statistics and are known as Markov random graphs. However, owing to the challenge of characterizing local dependence and constructing random graph models with local dependence, conventional exponential-family random graph models with Markov dependence induce strong dependence and are not amenable to statistical inference.

We take first steps to characterize local dependence in random graph models and show that local dependence endows random graph models with desirable properties which make them amenable to statistical inference. We show that random graph models with local dependence satisfy a natural domain consistency condition which every model should satisfy, but conventional exponential-family random graph models do not satisfy. In addition, we discuss concentration of measure results which suggest that random graph models with local dependence place much mass on graphs which resemble real-world networks, in contrast to conventional exponential-family random graph models. We discuss how random graph models with local dependence can be constructed by exploiting either observed or unobserved neighborhood structure.

Last, but not least, we show that if the neighborhood structure is unknown, the neighborhood memberships of almost all nodes can be recovered with high probability provided that the random graph is large and the neighborhoods are small but not too small. We present simulation results and applications to two real-world networks with ground truth.

Monday, October 12, 2015
4:00 PM – 5:00 PM
127 Hayes-Healy Center

Colloquium Tea 3:30 PM to 4:00 PM 154 Hurley Hall