Hierarchical multilevel analysis of network dynamics

Tom A. B. Snijders[1, 2]; Johan Koskinen[3]

[1] University of Groningen, The Netherlands
[2] University of Oxford, United Kingdom ; tom.snijders@nuffield.ox.ac.uk
[3] University of Melbourne, Australia ; jkoskinen@unimelb.edu.au

Abstract:

Multilevel longitudinal network data sets, by which we mean longitudinal network data sets that were collected according to the same design in multiple, disjoint and disconnected groups, are starting to be available more and more. This offers new possibilities for generalization of results of network analysis to populations of networks, and requires new methods of analysis. A multilevel version of the Stochastic Actor-Oriented Model (SAOM) is presented.

In this hierarchical model, there are two sets of parameters: parameters at the highest level, the population of groups, which may be called the population parameters; and parameters at the group (or network) level, determining the network dynamics in each group, modelled by a SAOM. We specify a multivariate normal distribution for the distribution of the group-level parameters conditional on the population parameters. For the joint analysis of group- and population-level parameters, we follow a fully Bayesian approach in which the latter are treated as parameters with a prior distribution and estimation is done by Markov chain Monte Carlo (MCMC) methods. To obtain good convergence of the MCMC algorithm, it is necessary to let only some of the group-level parameters vary across groups and keep the rest fixed, like in Hierarchical Linear Models for regular multilevel analysis. The analysis of each network then borrows strength from the data for the other networks, much like in the Hierarchical Linear Model. This method allows estimation of SAOMs for smaller data sets than is possible for single groups.

We present the method and an application to a co-evolution study of friendship networks and attitudes with respect to school work, for students in a collection of 109 school classes. The model focuses on social influence from the friendship network as well as the school class on students' attitudes with respect to school work.

Keywords:

Social networks; social influence; longitudinal; MCMC

References:

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