APPLICATION OF STATISTICAL MECHANICAL METHODS TO THE MODELING OF SOCIAL NETWORKS

Abstract

by

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With the recent availability of large-scale social data sets, social networks have become open to quantitative analysis via the methods of statistical physics. We examine the statistical properties of a real large-scale social network, generated from cellular phone call-trace logs. We find this network, like many other social networks to be assortative ($r = 0.31$) and clustered (i.e., strongly transitive, $C = 0.21$). We measure fluctuation scaling to identify the presence of internal structure in the network and find that structural inhomogeneity effectively disappears at the scale of a few hundred nodes, though there is no sharp cutoff. We introduce an agent-based model of social behavior, designed to model the formation and dissolution of social ties. The model is a modified Metropolis algorithm containing agents operating under the basic sociological constraints of reciprocity, communication need and transitivity. The model introduces the concept of a social temperature. We go on to show that this simple model reproduces the global statistical network features (incl. assortativity, connected fraction, mean degree, clustering, and mean shortest path length) of the real network data and undergoes two phase transitions, one being from a "gas" to a "liquid" state and the second from a liquid to a glassy state as function of this social temperature.