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Epidemics on networks with preventive rewiring

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Abstract

A stochastic SIR (susceptible → infective → recovered) epidemic model defined on a social network is analysed. The underlying social network is described by an Erdős-Rényi random graph but, during the course of the epidemic, susceptible individuals connected to infectious neighbours may drop or rewire such connections. Large population limits of the model are derived giving both convergence results for the early branching process-like behaviour, and, assuming a major outbreak, the main phase of the epidemic process which converges to a deterministic model that is equivalent to a certain pair approximation model. Law of large numbers results are also obtained for the final size (i. total number of individuals infected)of a major outbreak. Two results stand out (valid for a range of parameter set-ups): (i) the limiting final fraction infected may be discontinuous in the infection rate λ at its threshold λ_c (thus making a discrete jump from 0 to a strictly positive number)and (ii) for the situation when rewiring is necessarily to uninfected individuals, if it is discontinuous, the limiting final fraction infected jumps from 0 to 1 as λ passes through λ_c.

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