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Large graph limit for an epidemic evolution process in random network with heterogeneous age, variant and connectivity

We consider a stochastic epidemic model on a random network in which each node corresponds to an individual, and each individual is classed as either Susceptible, Infectious, or Recovered ("SIR"). While the nodes are fixed, the edges evolve randomly. Volz [1] used popular heuristics to derive corresponding deterministic ordinary differential equations as the population size goes to infinity, following the work of Newmann [2]. Later, Decreusefond [3] proved weak convergence to this ODE system in the large-population limit. In this talk, we will present a similar convergence result for a more general model including a "Death" state (compartment) together with some additional variables: degree, age and disease variant. Of particular interest, the continuous nature of the age and variant variables leads to a limiting system of partial differential equations (PDEs) in place of the ODEs considered by earlier authors. In order to prove weak convergence, a rescaled process is used, and the infinitesimal generator and the martingal properties are provided. Finally, we propose several numerical simulations in order to illustrate the convergence of compartment sizes for a large population, the distribution of age variable and the evolution of waves of the disease using the variant variable.