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The real-time growth rate of stochastic epidemics on random intersection graphs

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Abstract

This paper is concerned with the growth rate of SIR (Susceptible-Infectious-Recovered) epidemics with general infectious period distribution on random intersection graphs. This type of graph is characterized by the presence of cliques (fully connected subgraphs). We study epidemics on random intersection graphs with a mixed Poisson degree distribution and show that in the limit of large population sizes the number of infected individuals grows exponentially during the early phase of the epidemic, as is generally the case for epidemics on asymptotically unclustered networks. The Malthusian parameter is shown to satisfy a variant of the classical Euler-Lotka equation. To obtain these results we construct a coupling of the epidemic process and a continuous-time multitype branching process, where the type of an individual is (essentially) given by the length of its infectious period. Asymptotic results are then obtained via an embedded single-type Crump-Mode-Jagers branching process.

Keywords: Stochastic SIR epidemic; Random Intersection graph; Cliques; Branching process approximation; Malthusian parameter; Regenerative branching processes.

1 Introduction

In the earliest epidemic models, it is assumed that the disease spreads in a population consisting of homogeneous individuals exhibiting homogeneous mixing. Since the advent of those early models, there has been considerable interest in incorporating realistic elements from real-world social structures that depart from the simplistic assumption of homogeneity. Such realistic features may take the form both of heterogeneity in social behaviour (some individuals may have a higher proclivity to be socially active than others, or the population may exhibit a more complex social structure than ho-

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