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LOCAL ASYMPTOTIC PROPERTIES OF COMPLEX NETWORKS AND THEIR APPLICATIONS TO INFECTIOUS DISEASES

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Abstract. Using the theory of random graphs and the theory of Galton-Watson branching process, we rigorously prove that under some conditions the random graphs with given arbitrary degree distributions are locally tree-like, and hence the corresponding results of Newman et al. [12] are available. We then apply the results to the study of infectious diseases.

Keywords. complex network, degree sequence, branching process, epidemic spreading, SIR model.

1 Introduction

Recently, there has been increasing interest in the study of real-world networks using random graph theory. It is well known that the classical random graph $G_{n,p}$ has a Poisson distribution of vertex degrees; however, the degree distributions of most real-world networks turn out to be measurably different from a Poisson distribution. Therefore, there have been various generalized random graphs other than the classical random graph. A class of important generalized random graphs are those with given arbitrary degree distributions. Newman et al. [12] described such graphs as follows.

> *In all respects other than their degree distribution, these graphs are assumed to be entirely random. This means that the degrees of all vertices are independent identically distributed random integers drawn from a specified distribution. For a given choices of their degrees, also call the "degree sequences", a graph is chosen uniformly at random from the set of all graphs with that degree sequence.*