# Susceptible-infected-susceptible dynamics on the rewired configuration model

Guillaume St-Onge, Jean-Gabriel Young, Edward Laurence, Charles Murphy and Louis J. Dubé

Université Laval, Québec, QC, Canada

The susceptible-infected-susceptible dynamics is one of the canonical models of disease propagation on complex networks. The study of this model on random networks with an arbitrary degree distribution has led to enlighting analytical results, notably regarding the epidemic threshold for the infection rate [1]. In an effort for the unification of the current approaches, we consider a network whose edges are constantly being rearranged (sampling the configuration model) with a tunable rewiring rate to interpolate between the *quasi-static* and the *annealed* regime. We denote this method the rewired network approach (RNA) [2].

We present a detailed stationary state analysis of the process, leading to a closed form expression of the threshold for an arbitrary rewiring rate. In the extreme regimes (annealed and quasi-static), we recover and further improve the results of current approaches [Fig. 1(a)–(d)], and provide a natural interpolation for the intermediate regimes [Fig. 1(e)]. Finally, for any finite rewiring rate, our analysis predicts a vanishing threshold when the maximal degree $k_{\mathrm{max}}$ diverges—a generalization of the behavior predicted by quenched mean-field theory for static networks [3].

[1] R. Pastor-Satorras *et al.*, Rev. Mod. Phys. 87, 925 (2015).
[2] G. St-Onge *et al.*, arXiv:1701.01740 (2017).
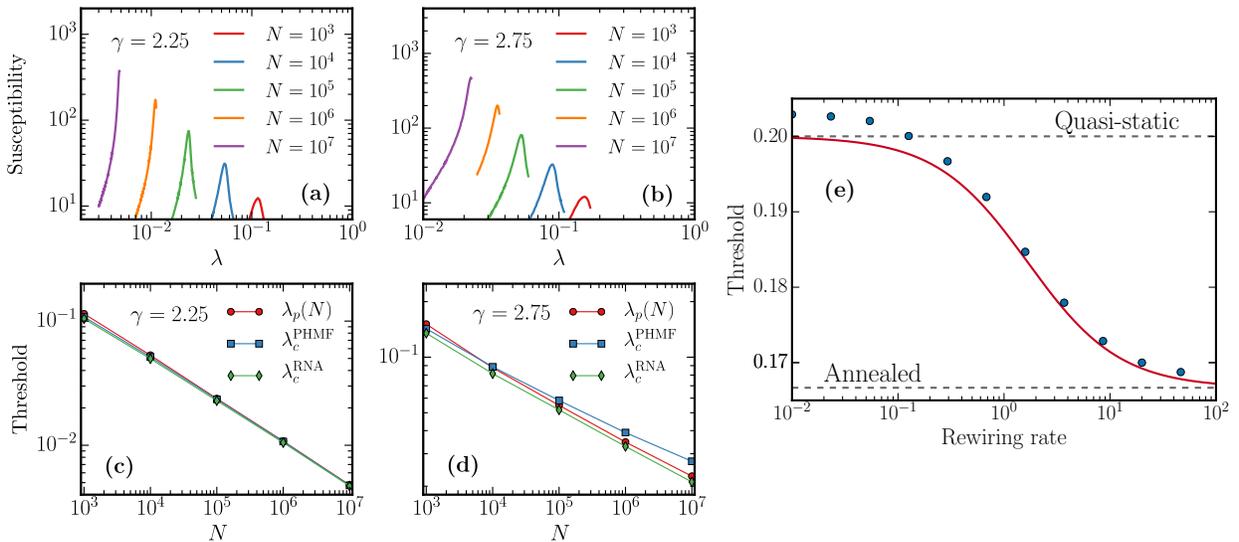[3] C. Castellano and R. Pastor-Satorras, Phys. Rev. Lett. 105, 218701 (2010).

Figure 1: **(a)-(d)** Epidemic threshold against the number of nodes $N$ for static random networks with degree distribution $p_k \sim k^{-\gamma}$. The threshold is estimated by : the position of the susceptibility peak $\lambda_p(N)$, the pair heterogeneous mean-field theory $\lambda_c^{\mathrm{PHMF}}$ and our approach $\lambda_c^{\mathrm{RNA}}$. **(e)** Threshold against the rewiring rate for a regular random network with degree $k_0 = 6$ and network size $N = 10^5$. The solid line represents $\lambda_c^{\mathrm{RNA}}$ and the markers are the susceptibility peaks estimates.