**Co-evolution of Growth and Dynamics on Network**

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To reproduce properties of real complex networks, growth processes often use explicitely emergent features such as preferential attachement [1] disregarding the actual mechanism responsible for the growth. Since the purpose of a network representation is to capture the dynamical interaction of many individuals, it is natural to believe that the underlying mechanism for network growth is related to its inherent activity.

Following this hypothesis, we propose a new model where a given dynamics evolves on a constantly growing network. For simplicity and demonstration purpose, we have chosen a two-state dynamics of the type SIS [2]. The growth events are coupled to the dynamical state of the system by attaching new nodes to $m$ randomly chosen I-state nodes, resulting in a *co-evolutive growth process*. The interplay between the (spreading) dynamics and the growth process is highly dependent upon their respective characteristic time scales, $\tau_D$ and $\tau_G$. We observe that scale independence can emerge from this simple model when the *co-evolutive regime* is considered ($\tau_D \sim \tau_G$), whereas we can show that this feature cannot appear in the *adiabatic regime* ($\tau_D \ll \tau_G$).

Our study reaffirms the importance of considering the interplay between the dynamics and the evolving topology in networks modelling [3]. Our model offers explicitly the possibility to investigate the different regimes of co-evolution where characteristic features simply emerge. By considering growing networks as co-evolving entities, we expect to provide more realistic/accurate representations of real world complex systems.

[1] A. Barabasi and R. Albert, Emergence of scaling in random networks, *Science*, **286**, 509 (1999)
[2] R. Pastor-Satorras, C. Castellano, P. Van Mieghem, and A. Vespignani, Epidemic processes in complex networks, *Rev. Mod. Phys.*, **87(3)**, 925 (2015)
[3] T. Gross and H. Sayama, *Adaptive Networks : Theory Models and Applications*, Springer, 2009

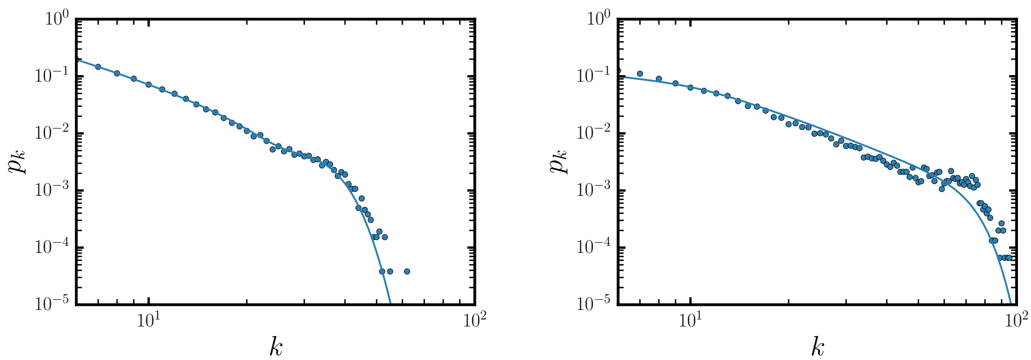


Figure 1: Degree distributions obtained from our co-evolutive growth process for **(left)** the adiabatic regime and **(right)** the coevolutive regime. In both cases, the initial network is an Erdös-Rényi graph of $N_0 = 100$ nodes and $\langle k \rangle = 10$. New nodes are attached to $m = 5$ random I-state nodes and the growth process is stopped after $\Delta N = 2000$ growth events. The solid lines correspond to mean field analytical solutions and the circles correspond to Monte Carlo simulations averaged over 16 realisations.