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# Evolution of density of interacting agents for the two species irreversible reaction A+B->2A in complex networks

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We use Monte-Carlo simulations to study the dynamics of the irreversible A+B->2A two species reaction on regular lattices, Erdos-Renyi (ER) and scale-free (SF) networks. The problem we study is an analogue to the spread of a virus in computer networks and other epidemiological models, such as information diffusion (i.e. rumor spreading) in social networks, and information propagation among stations in ad hoc mobile networks. We monitor the density of the species with respect to time, which we find to be an exponential function of time in the long time regime.

## Detailed analysis

We study the dynamics of the irreversible A+B->2A reaction where A and B represent agents of two species that move randomly on a lattice or a network topology. Besides the one dimensional lattice case we show that the agent density follows an exponential function of time in the long time regime. We also study the transition mechanism from the short to the long time regimes and estimate the crossover time as a function of initial densities and network topology. In order to perform our numerical simulations in a robust manner and to leverage the underlying Grid resources we have implemented a three phase workflow. In the first phase we have constructed the networks (both ER and SF) and stored them on SEs. In the second phase we dispatched a series of Monte Carlo simulations that used the networks designed in the first phase along with the distinct initial parameters. Our results were joined together in the third phase with a program that accumulated the data produced in the second phase. Post processing of the results was performed on local workstations.

## Conclusions and Future Work

Our results show that with the right immunization strategies we can limit infection spreading on normal lattices and ER networks where a transition mechanism from a short time to a long time regime is evident. We plan to further continue our studies by examining cases of reversible species interaction and recovery phenomena.

## Impact

We have developed a model to study the A+B->2A two species irreversible reaction, which is related to epidemiological modes, such as the spread of a virus in networks, the spread of rumors in social networks and information propagation in ad-hoc mobile networks. While the 1D lattice presents the most trivial case with a linear dependence of the density from time, 2D and 3D lattices as well as ER networks can be described with an exponential decay in the long time regime. The crossover time from short to long time scales as a power law in these systems, with ER networks characterized by a different exponent than 2D and 3D lattices. The connectivity of ER networks was shown to have little or no influence to the infection process. In SF networks the crossover is almost completely absent and the infection is spread immediately, with the highly connected nodes acting as the infection centers. The behavior of density in SF networks is more complex than their ER

counterparts. For small initial density in SF networks, the connectivity of the network is shown to severely influence the infection process, which proceeds much faster in well connected networks.

## Keywords

SI model, Monte Carlo

## URL for further information

http://kelifos.physics.auth.gr

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