SEIRS epidemic spreading model in complex networks with mortality and resetting

Thomas M. Michelitsch*, Bernard Collet[1], Michael Bestehorn[2], Alejandro P. Riascos[3], Andrzej F. Nowakowski[4]

[1] Sorbonne Université, CNRS, Institut Jean Le Rond d'Alembert, F-75005 Paris, France
[2] Institut für Physik, Brandenburgische Technische Universität Cottbus-Senftenberg, 03046 Cottbus, Germany
[3] Departamento de Física, Universidad Nacional de Colombia, Bogota, Columbia
[4] School of Mechanical, Aerospace and Civil Engineering, University of Sheffield, Sheffield United Kingdom
*presenting, michel@lmm.jussieu.fr

In this work we investigate an epidemic compartment model [1,3,4,5,6] where we account for mortality caused by the disease. We exclude demographic birth and death processes. Each individual is represented by a random walker which is in one of the states (compartments) S (susceptible for infection), E (exposed: infected but not infectious corresponding to the latency period), I (infected and infectious), R (recovered, immune), D (dead). In order to mimic human mobility patterns in real world structures such as cities we implement this model into a multiple random walker's approach. Each random walker performs an independent simple (Markovian) random walk on a connected complex random graph. The mortality is assumed such that a walker can only die when being in compartment I. We consider here direct transmission of the disease where an I walker infects an S walker with a certain probability when they meet on the same node of the network. We explore the effects of stochastic relocations (stochastic resetting – SR [2]) of walkers to randomly selected nodes, mimicking the effects of long-range journeys on the spreading of the disease. We perform these simulations for some kinds of random graphs (such as Barabasi-Albert (BA), Erdös-Rényi (ER) and Watts-Strogatz (WS)) to explore the complex interplay of the network topology and SR on the propagation of the disease. Animated simulation videos of the spreading in a Watts-Strogatz graph without SR with mortality can be viewed online here and for the same setting without mortality here. For further information consult supplementary materials. Our model has a large potential of generalization with various interpretations in interdisciplinary contexts, for instance in the dynamics of certain chemical reactions, the propagation of wood fires, and in population dynamics.

References

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