SOE 9: Physics of Contagion Processes

Time: Tuesday 10:15–11:15 Location: H11

SOE 9.1 Tue 10:15 H11

Emergence of synergistic and competitive pathogens in a coevolutionary spreading model — •Philipp Hövel[1], Alessio Cardillo[2], Kai Seegers[3], and Fakhteh Ghanbarnejad[4] — [1]University College Cork, Ireland — [2]Universitat Rovira i Virgili, Tarragona, Spain — [3]Technische Universität Berlin, Germany — [4]Sharif University of Technology, Iran

Cooperation and competition between pathogens can alter the amount of individuals affected by a coinfection giving rise to phenomena like comorbidity and cross-immunity. However, the evolution of the pathogens' behavior has been underexplored. We present a coevolutionary model where the simultaneous spreading is described by a two-pathogen susceptible-infected-recovered model in an either synergistic or competitive manner. At the end of each epidemic season, the pathogens species reproduce according to their fitness following a replicator equation. The fitness depends on the payoff accumulated during the spreading season in a hawk-and-dove game. We demonstrate that the proposed coevolutionary model displays a rich set of features and emergent behavior. For example, the evolution of the pathogens' strategy induces abrupt transitions in the epidemic prevalence. Furthermore, we observe that the long-term dynamics results in a single, surviving pathogen species, and that the cooperative behavior of pathogens can emerge even under unfavorable conditions.

SOE 9.2 Tue 10:45 H11

Assessing the effectiveness of COVID intervention measures in small communities using agent-based simulations — •Jana Lasser — Graz University of Technology, Graz, Austria — Complexity Science Hub Vienna, Vienna, Austria

The necessity of intervention measures like the wearing of masks, preventive testing and vaccinations to prevent the spread of COVID-19 have been vigorously in our societies. At the centre of these discussions is the effectiveness of these measures in suppressing large outbreaks. With our research, we contribute the necessary facts to the discussion by simulating the spread of COVID-19 using agent-based simulations that are calibrated to empirical outbreak data. Here we present three application cases of our simulations: (i) the development of a preventive testing strategy in nursing homes in a situation where no vaccinations are available yet, (ii) the assessment of the effectiveness of different combinations of measures in schools and (iii) an evaluation of the feasibility of preventing large outbreaks while requiring in-presence teaching in universities under the condition of community spreading of the Omicron variant.

SOE 9.3 Tue 11:00 H11

Epidemic processes on self-propelled particles — •Jorge P. Rodriguez[1], Matteo Paoluzzi[2], Demian Levis[2], and Michele Starnini[3] — [1]IMEDEA, CSIC-UIB, Esporles, Spain — [2]Departament de Física de la Matèria Condensada,Universitat de Barcelona, Barcelona, Spain — [3]ISI Foundation, Torino, Italy

Most spreading processes require spatial proximity between agents. The stationary state of spreading dynamics in a population of mobile agents thus depends on the interplay between the time and length scales involved in the epidemic process and their motion in space. We analyze the steady properties resulting from such interplay in a simple model describing epidemic spreading on self-propelled particles. The epidemic dynamics is described by a Susceptible-Infected-Susceptible model, while the movement of each particle is ruled by Run-and-Tumble motion. The interactions are given by the proximity between particles, with the particles' movement modifying the relative distances between themselves. We analyze this problem from a continuum description of the system, and validate those results by numerical simulations of an agent-based model. Focusing our attention on the diffusive long-time regime, we find that the agents' motion changes qualitatively the nature of the epidemic transition characterized by the emergence of a macroscopic fraction of infected agents. Indeed, the transition becomes of the mean-field type for agents diffusing in one, two and three dimensions, while, in the absence of motion, the epidemic outbreak depends on the dimension of the underlying static network determined by the agents' fixed locations.