Predator-prey and epidemiology models using transport equations

Paulo Amorim

FGV - EMAp, Rio de Janeiro

We present, analyse and simulate models for predator-prey interaction and epidemiology using transport (or structured) equations. The perdator-prey model consists of a nonlocal transport equation for the predator structured by predator hunger, coupled to an ODE for the prey. By taking an asymptotic regime of fast hunger variation, we find that this system provides new interpretations and derivations of several variations of the classical Lotka–Volterra system, including the Holling-type functional responses. We next establish a well-posedness result by means of a fixed-point method. Finally, we show that in the basin of attraction of the nontrivial equilibrium, the asymptotic behaviour of the original coupled PDE-ODE system is completely described by solutions of an ODE system. We introduce a second, related model, which includes ratio-dependent response functions and present some improved results. In the epidemiological model, a healthy population is structured by disease awareness and susceptibilty. This gives rise to a 2d transport equation with nonlocal terms and an associated ODE system related to SIR systems, which we analyze. We show an asymptotic result, numerical experiments, and discuss some epidemiological insights from the model.

In Special Session 33 on Recent Progress in Mathematical Ecology and Epidemiology at the Mathematical Congress of the Americas 2025.

MCA 2025 internal code: SS33-T01