

## **From Agent-Based Models to PDEs: Coarse-Graining a Host-Pathogen Model**

Agent based models (ABMs) are widely employed in biological settings to study e.g. in-host infection dynamics, animal movement, and disease spread. ABMs are an attractive modelling choice because individual (agent-level) behavior can be encoded directly in these systems through simple stochastic rules. However, to extract meaningful statistics from ABMs, numerous independent simulations are required, which can be computationally expensive for systems with many agents. Additionally, it is often not possible to obtain analytical insight directly. In contrast, many PDE models are easier to analyze numerically and analytically, but individual agent-level behavior is difficult to incorporate.

In this talk, we consider a simple host-pathogen ABM consisting of immune cells and bacteria with interactions governed by a set of stochastic rules. By systematically coarse-graining this discrete ABM, we obtain a novel continuum PDE model that is structured in space, time, and an internal state encoding the ABM rules. We show that the solutions of this PDE model accurately estimate ABM ensemble averages at reduced computational cost. This suggests coarse-graining as a tool to analyze ABMs more efficiently.