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Models for coupled active–passive population dynamics: mathematical analysis and simulation

Abstract

Abstract: We study models for coupled active–passive pedestrian dynamics from mathematical analysis and simulation perspectives. This work comes in three main parts, in which I adopt distinct perspectives and conceptually different tools from lattice gas models, partial differential equations, and stochastic differential equations, respectively. In part one, we introduce two lattice models for active–passive pedestrian dynamics. In a first model, using descriptions based on the simple exclusion process, we study the dynamics of pedestrian escape from an obscure room in a lattice domain with two species of particles (pedestrians). In a second model, we consider again a microscopic approach based on a modification of the simple exclusion process formulated for active–passive populations of interacting pedestrians. The model describes a scenario where pedestrians are walking in a built environment and enter a room from two opposite sides. In part two, we study a fluid-like driven system modeling active–passive pedestrian dynamics in a heterogenous domain. We prove the well-posedness of a nonlinear coupled parabolic system that models the evolution of the complex pedestrian flow by using special energy estimates, a Schauder's fixed point argument and the properties of the nonlinearity's structure. In the third part, we describe via a coupled nonlinear system of Skorohod-like stochastic differential equations the dynamics of active–passive pedestrians dynamics through a heterogenous domain in the

presence of fire and smoke. We prove the existence and uniqueness of strong solutions to our model when reflecting boundary conditions are imposed on the boundaries. Furthermore, we study an homogenization setting for a toy model (a semi-linear elliptic equation) where later on our pedestrian models can be studied. This is joint work with Emilio Cirillo (Rome, Italy), Matteo Colangeli (L'Aquila, Italy) and Adrian Muntean (Karlstad, Sweden).