On the Social Behavior of Biological Populations: Nature Inspired Algorithms

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Abstract: Particular attention is being paid these days to the mathematical modelling of the social behavior of individuals in a biological population, for different reasons; on one hand there is an intrinsic interest in population dynamics of herds, on the other hand agent based models are being used in complex optimization problems (ACOs, i.e. Ant Colony Optimization). Further decentralized/parallel computing is exploiting the capabilities of discretization of nonlinear reaction-diffusion systems by means of stochastic interacting particle systems. These systems lead to self-organization phenomena exhibiting interesting spatial patterns. As an example, here an interacting particle system modelling the social behavior of ants is proposed, based on a system of stochastic differential equations, driven by social aggregating/repelling forces. Extensions to models of chemotaxis, such as angiogenesis related to tumor growth, will be presented, in which the so called organization process is driven by an underlying field strongly coupled with the spatial structure of the population of interacting individuals/agents/cells.

Suitable laws of large numbers are shown to imply convergence of the empirical spatial distributions of interacting individuals to nonlinear reaction-diffusion equations, as the total number of individuals becomes sufficiently large.

A variety of mathematical problems arise in this framework, some of which are not yet completely solved.

Here we present the modelling of the stochastic system of interacting individuals, the convergence to a partial-integral differential equation and the analysis of existence and uniqueness of a solution for such PIDE. We may exploit also the problem of the existence of an invariant measure for the stochastic system.

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