Cell Populations and Robot Swarms

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Abstract:

In this talk I will mainly address recent work done at my group at the Institute for Systems and Robotics on modeling and control of large-size agent populations which started with the problem of modeling the dynamics of immune system cell populations. We consider each cell as an independent agent whose state is uniquely defined by discrete and continuous variables. This naturally leads to a Hybrid Automata modeling approach. However, for large-size cell populations like this, modeling mathematically the impact of individual agent dynamics on the observed population dynamics is quite complex. Following statistical physics reasoning, we disclosed the form of the mathematical structure behind this relation, while reducing its complexity.

We found that, due to this generality, this approach could be extended to large populations of robotic agents, namely to study the probability density function of the robot locations. Moreover, we also formulated the optimal control problem of maximizing the probability of robotic presence in a given region and explored the application of the Minimum Principle for partial differential equations to the solution of this problem, effectively providing a centralized approach to the control of a robotic swarm.

This problem is an example of how a biologically-motivated problem provided insights for the mathematical modeling and control of large-size robot teams. In the rest of the talk, I will briefly refer other possible sources of biological inspiration for solving robotic problems, as well as how using robots can be useful to test models of biological populations that can not be tested in living creatures.

References:

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