Reproducing with mathematical models the behavior of cells in biological networks

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Here we deal with the study on the behavior of individuals moving in biological networks.

The first study is about Physarum polycephalum slime mold and its ability to find the shortest path in a maze. Indeed, in [1] we present a PDE chemotaxis model that reproduce its behavior in a network, schematized as a planar graph. In particular, suitable mass preserving transmission and boundary conditions at each node of the network are considered to reproduce the choice of such an organism to move from an arc to another of the graph, motivated by the search for food. Several numerical tests are presented for special network geometries to show the qualitative agreement between our model and the laboratory observed behavior of the mold. As an example see the results on the network in Figure 1.

The second study is about the mathematical modeling of the behavior of cell populations in a microfluidic chip, an environment constructed in laboratory to mimic complex biological systems, see Figure 2. In particular, the developed a macroscopic model consisting of reaction-diffusion-transport equations with chemotaxis: birth/death processes, interaction with chemoattractant, interaction and competition between species. Suitable transmission conditions are included in the algorithm and numerical tests are presented. We are also developing a multiscale description of such phenomena.

Keywords: (PDE models, biological networks, cell movement, cell interactions)

[1] G. Bretti and R. Natalini. (2018). Numerical approximation of nonhomogeneous boundary conditions on networks for a hyperbolic system of chemotaxis modeling the physarum dynamics, Journal of Computational Methods in Sciences and Engineering 18, 85–115.
[2] E. Braun, G. Bretti and R. Natalini. (preprint 2019). Modeling of the behavior of cell populations in a microfluidic chip..
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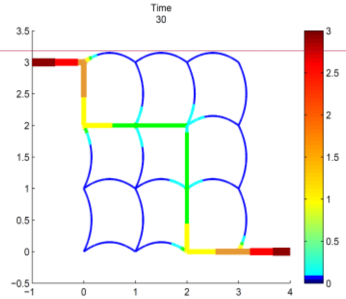

Figure 1. Slime mold is able to find the shortest path in a labyrinth network.

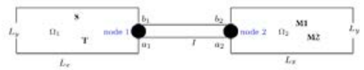

Figure 2. Network schematizing laboratory experiment on microfluidic chips on different cells populations.

Formattato: Nessuna sottolineatura