Physics > Biological Physics

Routing Physarum with electrical flow/current

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Plasmodium stage of Physarum polycephalum behaves as a distributed dynamical pattern formation mechanism who's foraging and migration is influenced by local stimuli from a wide range of attractants and repellents. Complex protoplasmic tube network structures are formed as a result, which serve as efficient `circuits' by which nutrients are distributed to all parts of the organism. We investigate whether this `bottom-up' circuit routing method may be harnessed in a controllable manner as a possible alternative to conventional template-based circuit design. We interfaced the plasmodium of Physarum polycephalum to the planar surface of the spatially represented computing device, (Mills' Extended Analog Computer, or EAC), implemented as a sheet of analog computing material whose behaviour is input and read by a regular 5x5 array of electrodes. We presented a pattern of current distribution to the array and found that we were able to select the directional migration of the plasmodium growth front by exploiting plasmodium electro-taxis towards current sinks. We utilised this directional guidance phenomenon to route the plasmodium across its habitat and were able to guide the migration around obstacles represented by repellent current sources. We replicated these findings in a collective particle model of Physarum polycephalum which suggests further methods to orient, route, confine and release the plasmodium using spatial patterns of current sources and sinks. These findings demonstrate proof of concept in the low-level dynamical routing for biologically implemented circuit design.

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