PHYSICAL MATHEMATICS SEMINAR

Flow, phenotypes, and (multi-)functionality in biological transportation networks

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ABSTRACT:

Highly optimized complex transport networks serve crucial functions in many man-made and natural systems such as power grids and plant or animal vasculature. We show how the growth of the underlying tissue, coupled to the dynamical equations for network development, can drive the system to a highly optimized state. The incorporation of spatially collective fluctuating sources yields a minimal model of realistic reticulation in distribution networks, which we compare to real leaf networks. The entire phenotypic space of networks can be analyzed using the methods of Pareto efficiency, uncovering those networks which provide an optimal trade-off between construction cost, resilience, and efficiency. Finally, we consider a model of multi-functional networks, which need to be able to effectively deliver flow (e.g., blood or nutrients) to multiple sites at the same time and ask what the limits of such multi-functional behavior are. By phrasing this question in the language of constraint satisfaction problems, we uncover a link between flow networks and mechanical, balls-and-springs networks, suggesting that it is network topology alone that controls multi-functionality.

TUESDAY, SEPTEMBER 26, 2017
2:30 PM
Building 2, Room 142

Reception following in Building 2, Room 290
(Math Dept. Common Room)

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