Piecewise Deterministic Markov Processes and Bacterial Growth

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Abstract

We investigate the modeling of bacterial growth through the construction of a multi-type branching process. Specifically, we consider the evolution of a cell population using a piecewise deterministic Markov branching tree. In this model, each cell divides into two offspring at a division rate that depends on its size x, while its size grows exponentially over time with an individual-specific growth rate.

Building on the model introduced by Doumic, Hoffmann, Krell, and Robert (2015), we extend the framework to distinguish between two bacterial types: those with a young pole and those with an old pole. We demonstrate that the proposed branching process is rigorously defined and satisfies a many-to-one formula. Furthermore, we establish that the mean empirical measure of this process converges to a growth-fragmentation equation, where size, growth rate, and type serve as state variables.

I will conclude by discussing ongoing work, in collaboration with Benoîte de Saporta, Bertrand Cloez, and Tristan Roget, focusing on the estimation of division rates in the two-type setting.

References

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