

CEMRACS project: Horizontal Gene Transfer and Evolutionary Rescue

Modeling, analysis and numerics of horizontal transfer of plasmids in bacterial populations.

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Summary:

Horizontal Gene Transfer (HGT) enables exchange of genetic material between individuals among the same population without filiation. This modus operandi is known to play a key role in the evolution of resistance against antibiotics at the population level. The aim of the project is to investigate this fundamental question in the light of recent results at the interface stochastic processes/partial differential equations. The expected outcomes are quantitative results to decipher evolutionary dynamics subject to HGT and especially possible evolutionary rescue of populations that could be driven to extinction under unilateral HGT.

The cornerstone of the project will be the comparative numerical investigation of the individual-based stochastic process introduced in [1,2] with the integro-differential model obtained in the limit of large population size in the same articles. In particular, the probability of evolutionary rescue (population renewal from a pool of few individuals possibly far from the common type) will be carefully estimated from simulations of the stochastic process. It will be compared with a heuristics derived from the analysis of the integro-differential model based on the approximation of small phenotypical variance of its solutions, after [3,4].

The project will be completed by the reconstruction of lineages that led to evolutionary rescue when it happened, based on stochastic simulations.

References:

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- [3] O Diekmann, PE Jabin, S Mischler, B Perthame. The dynamics of adaptation: an illuminating example and a Hamilton–Jacobi approach, Theoretical Population Biology (2005)
- [4] A Lorz, S Mirrahimi, B Perthame. Dirac mass dynamics in multidimensional nonlocal parabolic equations, Communications in Partial Differential Equations (2011)

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