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Stochastic individual-based models with power law mutation rate on a general finite trait space

Abstract: We consider a stochastic individual-based model for the evolution of a haploid, asexually reproducing population, whose space of possible traits is given by the vertices of a (possibly directed) finite graph. The dynamics is driven by births, deaths, competition, and mutations along the edges of the graph. We are interested in the large population limit under a mutation rate given by a negative power of the carrying capacity K of the system. This results in several mutant traits being present at the same time and competing for invading the resident population.
We describe the time evolution of the orders of magnitude of each sub-population on the $\log K$ time scale, as K tends to infinity. Using techniques developed in [Champagnat, Méléard, Tran, 2019], we show that these are piecewise affine continuous functions, whose slopes are given by an algorithm describing the changes in the fitness landscape due to the succession of new resident or emergent types. We will illustrate the theorem by a series of examples describing surprising phenomena arising from the geometry of the graph and/or the rate of mutations.

This is a work in collaboration with Anna Kraut (Bonn University) and Charline Smadi (INRAE Grenoble).