**Characterizing the exploration of rugged fitness landscapes by subdivided populations**
**Internship and funded PhD**

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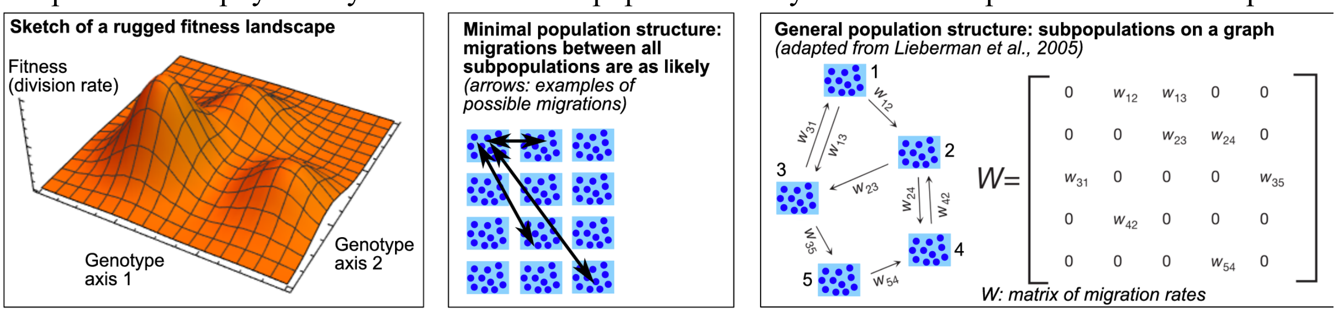
Populations of living organisms are pushed toward optimality by natural selection. However, they are also constrained by the available paths toward optimality, and by their environment. From a given state, populations may not be able to reach the absolute maximum of a fitness landscape, which represents fitness (reproduction rate) versus genotype (genetic type). Indeed, fitness landscapes are often rugged, like the energy landscapes of glassy physical systems [1].

Real microbial populations are subdivided between habitats, e.g. among different organs and among different hosts in the case of an infection. This can have major consequences on the way microbial populations evolve [2]. Structured populations, with their local competition, have smaller effective population sizes, which can allow the maintenance of larger genetic diversity, due to the increased importance of stochastic fluctuations. Indeed, population size is formally analogous to the inverse temperature in a physical system. Subdivided populations may thus better explore fitness landscapes.




We aim to characterize the ability of subdivided microbial populations to explore model and real rugged fitness landscapes, to quantify the predictability of their evolution, and to establish a universal description of complex subdivided populations on graphs. We also aim to study the impact of population subdivision on the evolution of antimicrobial resistance [3], a case which is crucial for public health, and to investigate the exploration of rugged fitness landscapes by expanding populations.

Several directions are possible. They all involve a combination of analytical calculations and numerical simulations based on statistical physics, with proportions depending on the background and tastes of the applicant. Possible directions include:
- Studying biased random walks on rugged fitness landscapes and models of populations on graphs.
- Developing applications to antimicrobial resistance evolution and expanding populations.

## Practical information:

The internship and PhD will take place at EPFL (École Polytechnique Fédérale de Lausanne) in Lausanne, Switzerland, in the new group of Anne-Florence Bitbol that will start on February 1st, 2020. The PhD position is fully funded with a competitive salary. PhD applicants will need to be admitted to an EPFL graduate school, either EDPY (Physics) or EDCB (Quantitative and Computational Biology).

**References:**
[1] I. G. Szendro, M. F. Schenk, et al. J Stat Mech, P01005 (2013)
[2] A. F. Bitbol and D. J. Schwab. PLoS Comput Biol, 10(8):e1003778 (2014)
[3] L. Marrec and A. F. Bitbol. J Theor Biol, 457:190 (2018)