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Predictability of evolution in complex fitness landscapes[1]

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Evolutionary adaptations arise from an intricate interplay of deterministic selective forces and random reproductive or mutational events, and the relative roles of these two types of influences is the subject of a long-standing controversy. In general, the predictability of adaptive trajectories is governed by the genetic constraints imposed by the structure of the underlying fitness landscape as well as by the supply rate and effect size of beneficial mutations. On the level of single mutational steps, evolutionary predictability depends primarily on the distribution of fitness effects, with heavy-tailed distributions giving rise to highly predictable behavior [1]. The genetic constraints imposed by the fitness landscape can be quantified through the statistical properties of accessible mutational pathways along which fitness increases monotonically. I will report on recent progress in the understanding of evolutionary accessibility in model landscapes and compare the predictions of the models to empirical data [2,3]. Finally, I will describe extensive Wright-Fisher-type simulations of asexual adaptation on an empirical fitness landscape [4]. By quantifying predictability through the entropies of the distributions of evolutionary trajectories and endpoints we show that, contrary to common wisdom, the predictability of evolution depends non-monotonically on population size.

[1] M.F. Schenk, I.G. Szendro, J. Krug and J.A.G.M. de Visser, PLoS Genetics 8, e1002783 (2012).
[2] J. Franke, A. Klözer, J.A.G.M. de Visser and J. Krug, PLoS Computational Biology 7, e1002134 (2011).
[3] J. Franke and J. Krug, Journal of Statistical Physics 148, 705 (2012).
[4] I.G. Szendro, J. Franke, J.A.G.M. de Visser and J. Krug (under review).

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