The space of genotypes is a network of networks: Implications for evolutionary and extinction dynamics

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The forcing that environmental variation exerts on populations causes continuous changes with only two possible evolutionary outcomes: adaptation or extinction. In this work we address this topic by studying the transient dynamics of populations on complex fitness landscapes.

There are three important features of realistic landscapes of relevance in the evolutionary process: fitness landscapes are rough but correlated, their fitness values depend on the current environment, and many genotypes do not yield viable phenotypes. We capture these properties by defining time-varying, holey, NK fitness landscapes.

We show that the structure of the space of genotypes so generated is that of a network of networks: in a sufficiently holey landscape, populations are temporarily stuck in local networks of genotypes. Sudden jumps to neighbouring networks through narrow adaptive pathways (connector links) are possible, though strong enough local trapping may also cause decays in population growth and eventual extinction.

In summary, a combination of analytical and numerical techniques to characterize complex networks and population dynamics on such networks permits to derive quantitative relationships between the topology of the space of genotypes and the fate of evolving populations.

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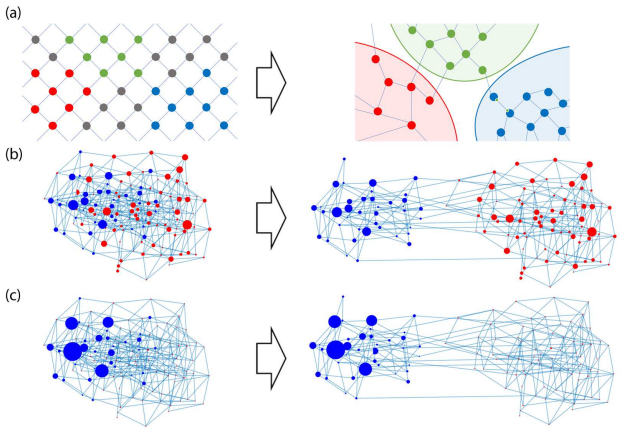

Fig. 1. Can the space of genotypes be viewed as a network of networks in competition for population?