Computational resources for simulating under a spatial coalescent model across heterogeneous landscapes and testing hypotheses about the geography of genetic variation: QUETZAL-EGGS, -CRUMBS, -NEST and DECRYPT

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Abstract

Spatially explicit coalescent models in which the underlying demographic parameters are informed by the environment (either past, present, or temporally and spatially changing environments) provide a framework for hypothesis testing that incorporates geographic information about genetically sampled individuals. This general approach - Integrated Distributional, Demographic and Coalescent (iDDC) modelling - can be used to explain how heterogeneous, dynamic landscapes shape the history and genetic patterns of a species. However, iDDC approaches involve long and complex tasks that often require custom-fit simulators, some coding expertise, and extensive computing resources. Here we introduce several resources that offer improved speed and generality, as well as expand the feasible parameter space for conducting iDDC analyses compared to other software applications. Specifically, QUETZAL-EGGS are C++ iDDC simulators; QUETZAL-CRUMBS is a complementary set of Python tools for simulating on specific landscapes and conducting Approximate Bayesian Computation (ABC) analyses (e.g., prior sampling, geospatial operations, ENM/SDM, visualization); DECRYPT is a framework for automated, biology-informed robustness analysis of the multispecies coalescent model. All these tools and their dependencies for local use or remote computations are made readily available in a Docker container package called QUETZAL-NEST.

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