Inference for Size Demography from Point Pattern Data using Integral Projection Models

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Abstract: Population dynamics with regard to evolution of traits has typically been studied using matrix projection models (MPMs). Recently, to work with continuous traits, integral projection models (IPMs) have been proposed. IPMs are handled first with a fitting stage, then with a projection stage. Fitting these models has so far been done only with individual-level transition data. These data are used to estimate the demographic functions that comprise the *kernel* of the IPM specification. Then, the estimated kernel is iterated from an initial trait distribution to project steady state population behavior under this kernel. When trait distributions are observed over time, such an approach fails to align projected distributions with these observed temporal benchmarks.

The contribution here, focusing on size distributions, is to address this issue. We claim the above approach introduces an inherent mismatch in scales. The redistribution kernel in the IPM describes population level redistribution and the kernel should be interpreted at that scale. Fitting at the individual level produces parameter estimates which are at the wrong scale and do not allow this interpretation. Our approach views the observed size distribution at a given time as a point pattern over a bounded interval. We build a three-stage hierarchical model to infer about the dynamic intensities used to explain the observed point patterns. This model is driven by a *latent* deterministic IPM and we introduce uncertainty by having the operating IPM vary around this deterministic specification. Further uncertainty arises in the realization of the point pattern given the operating IPM. Fitted within a Bayesian framework, such modeling enables full inference about all features of the model. Such dynamic modeling, *optimized* by fitting data observed over time, is better suited to projection.