Estimating temporal changes in parameters of stochastic population models

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Abstract: Density dependent population models, such as the logistic model, usually assumes a stationary environment when fitted to simple count data. This assumption can be unrealistic due to anthropogenic effect on the environment or natural catastrophes, and instead require model parameters to vary in time. For instance, a deteriorating habitat can be described by a gradually declining carrying capacity, while an oil spill might abruptly affect the growth rate of a species. Such models can be approximated by diffusion processes with parameters changing through time and illustrate how population fluctuations respond to changes in different parameters. The estimation should be easy to implement and the results capture earlier (abrupt) or ongoing changes. We will present how temporal changes in different parameters can be estimated using maximum likelihood estimation with parametric bootstrap and the Integrated Nested Laplace Approximation (INLA) method. We illustrate how the quality of data and sample size influence the inference of the parameters. We discuss the difference between a trend in density independent populations, which is a trend in population fluctuations, versus gradual change in carrying capacity of a density dependent population, which is a trend in a population parameter. This distinction will also be discussed in terms of prediction.

References

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