Department of Statistics

Master's Thesis Defense

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Estimation of Density Dependence, Process Noise and Observation Error: A Comparison of Modified Maximum Likelihood, Restricted Maximum Likelihood and ML from Replicated Sampling

ABSTRACT

In this work, the properties of the joint parameter estimates of density dependence, process noise and observation error for the Gompertz time series state space model of Dennis et al. (2004) are investigated. Simulated data and real population counts from the North American Breeding Bird Survey (BBS) are used to exemplify, study and compare three statistical methods of parameter estimation, which are: maximum likelihood (ML) and restricted maximum likelihood (REML) for univariate time series and the maximum likelihood estimates for replicated time series data. Although a formal analytical proof is not given, the simulations strongly suggest that all types of estimates are consistent and seem to have good asymptotic efficiency properties, although convergence is slow. The replicated sampling maximum likelihood (RSML) estimates seem to be the best parameter estimation method for this simple stochastic model. In fact, it is shown that population monitoring programs can largely benefit from replicating the sampling procedure at each time step. If no replicated samples are available, it is preferable to compute the estimates obtained from first differencing, the REML estimates.

Contrary to what is suggested by the simplicity of this model, likelihood-based parameter estimation is not straightforward. The likelihood surface for finite samples is multi-modal, and simulations show that the mode that corresponds to the "true" simulated scenario may not be the one with the highest likelihood score. An approach to circumvent this problem using modifications to the Nelder-Mead (NM) algorithm is described and used here.

Major Professor: Brian Dennis