

Estimation methods for nonlinear state-space models in ecology

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Keywords: AD Model Builder; Template Model Builder; theta logistic population model; BUGS

Abstract: The use of nonlinear state-space models for analyzing ecological systems is increasing. A wide range of estimation methods for such models are available to ecologists, however it is not always clear, which is the appropriate method to choose. To this end, three approaches to estimation in the theta logistic model for population dynamics were benchmarked by Wang (2007) and additional three approaches by Pedersen (2011). Similarly, we examine and compare the estimation performance of the three methods described in Pedersen (2011) with that of a novel tool called TMB. The first approach is to employ hidden Markov models (HMMs), which is a largely overlooked technique for problems of this type. The second and third method (the open source tools “AD Model Builder” [ADMB] and “Template Model Builder” [TMB]) use random effects via automatic differentiation the Laplace approximation. The fourth alternative is to use the popular Bayesian framework of BUGS. In simulation based estimation of the theta logistic population model all approaches give similar parameter estimates. However, ADMB is orders of magnitudes faster than BUGS and HMM, and the novel TMB framework is an order of magnitude faster than ADMB and with simpler source code due to automatic sparseness detection of the Hessian matrix.

References

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