118

A Tweedie Markov process and its application in fisheries stock assessment

In fisheries and ecological research data frequently occur (e.g., fisheries survey indices) that are distributed continuously along the positive real axis but with a finite point mass at zero. Hurdle models such as the delta-gamma model are popular in dealing with such zero-inflated continuous data. However, some research indicates that the Tweedie distribution is more robust than hurdle models to variable sampling conditions. The Tweedie distribution is versatile and includes a wide spectrum of important statistical distributions such as the normal, Poisson, compound Poisson-gamma, gamma, and Inverse Gaussian distributions. There is also the Tweedie Convergence Theorem which says that a wide range of data types converge to the Tweedie distribution. All these good properties make the Tweedie distribution promising in fisheries and ecological modeling. However, the Tweedie dispersion relationship is not general enough to cover some important dispersion types such as quadratic dispersion, and so far there is no Tweedie AR(1) model (autoregressive model of order 1), which limit the application of the Tweedie distribution. The latter is particularly important for spatiotemporal modeling. In this research we solve these issues by extending the Tweedie distribution to accommodate more dispersion relationships, and we propose a Tweedie Markov process with the AR(1) autocorrelation structure. We further study the inference performance of this new approach with extensive simulation studies, and apply it to analyzing survey data of juvenile Atlantic cod (Gadus morhua) off Newfoundland and Labrador with a comparison to the popular Gaussian model to demonstrate the Tweedie advantages.