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Inferring species interactions from multivariate presence-absence time-series data - should one explicitly account for the observation process?

In community ecology research, determining and assessing the mechanisms that drive the communities to exhibit patterns in observed species communities has become increasingly interesting topic in addition to just describing the patterns in species communities. Driven by the need for robust analytical methods, Joint Species Distribution Modelling (JSDM) concept has been developed rapidly throughout the last decade. Although existing JSDM frameworks are already well capable, for example, to quantify species abiotic interaction and species-to-species associations, separating truly biotic interactions from joint response to unaccounted abiotic factors has been challenging. Nevertheless, biotic interactions may often be of the prime interest and they could potentially be more reliably inferred from time-series data, where the data on species communities is repeatedly collected from the same units, using first-order multivariate autoregressive (MAR(1)) models. Within this framework, the AR matrix determines how the values of the process at previous time point affect the next time point, and thus its values can be interpreted as species causal interactions. The MAR-models considered so far in the literature have provided only a limited treatment of observational noise in the statistical model. We aim to address this issue by combining a Gaussian-noise MAR(1) model for continuous state-space latent process dynamics to model the observation process with a suitable probability distribution for the data.
We compare the proposed method to a direct MAR(1) model that uses the observed data at previous time point instead of values of a latent process to define the distribution in the next time point. We compare the two alternative models in terms of their predictive performance and potential ecological interpretation perspectives using both simulated data and a real time-series data on waterbirds presence-absences in a set of ponds.