A Latent-State Model with Feedback for Time Series of Animal Feeding Behaviour

Abstract: We describe a family of models developed for time series of animal feeding behaviour. The models incorporate both an unobserved state, which can be interpreted as the motivational state of the animal, and a mechanism for feedback to this state from the observed behaviour.

Although they are not hidden Markov models (HMMs), the proposed models have some similar features, such as unobserved (latent) states, and the assumption that the distribution of the observation at a given time depends only on the current state of the latent process. Unlike the case of HMMs, the state transition probabilities are allowed to depend on covariates and, specifically, on previous behaviour, thereby allowing one to incorporate feedback from behaviour to motivation.

We discuss methods for evaluating and maximizing the likelihood of an observed series of behaviours, and thereby estimating parameters, and for inferring the most likely sequence of underlying states.

We apply these methods in an analysis of the feeding behaviour of the caterpillar *Helicoverpa armigera*, and thereby demonstrate the potential of this family of models as a tool in the investigation of behaviour.