A hidden Markov model framework for occupancy modeling.

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Abstract: Occupancy – the proportion of area occupied by a species – is a key notion for addressing important questions in ecology, biogeography and conservation biology. Occupancy models allow estimating and inferring about species occurrence while accounting for false absences (or imperfect species detection). We show that most occupancy models can be formulated as hidden Markov models (HMM) in which the state process captures the Markovian dynamic of the actual but latent states while the observation process consists of observations that are made from these underlying states. The HMM framework provides a powerful alternative to the Bayesian state-space implementation of occupancy models. In particular, we show how occupancy models can be implemented in program E-SURGE, which was initially developed to analyse capture-recapture data in the HMM framework. Replacing individuals by sites provides the user with access to several appealing features of E-SURGE like, e.g., i) user-friendly model specification through a SAS/R-like syntax without having to write custom code, ii) decomposition of the observation and state processes in several steps to provide flexible parameterisation, iii) up-to-date diagnostics of model identifiability and iv) advanced numerical algorithms to produce fast and reliable results (including site random effects). Examples are provided, and gathered in a wiki platform http://occupancyinesurge.wikidot.com/.