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Markov-switching step-selection functions for state-dependent habitat selection

A central interest in ecology lies on animals' habitat and resource use. Combining movement and environmental data, step-selection functions (SSFs) form a popular framework for studying fine-scale habitat selection of animals, while also considering movement capacities when defining available habitat. However, animals usually switch between different behavioural modes, such as resting, foraging, and migration, which influence their preferences, selection, and movement patterns. Consequently, ignoring behavioural states in habitat selection analyses might lead to biased results and possibly erroneous conclusions. Since behavioural states are usually unobserved, it has recently been suggested to incorporate behavioural information inferred from hidden Markov models (HMMs) into habitat selection analyses. A naive approach is to first classify the data into different states using HMMs, interpreting the states as proxies for underlying behavioural modes, and then apply separate SSFs to each of these HMM states. However, this two-step approach ignores uncertainties in the state classification and might confound movement and selection patterns. In this talk, we propose the use of Markov-switching step-selection functions (MS-SSFs) which integrate both modelling approaches into a single model and allow to simultaneously estimate both - the underlying state dynamics and the corresponding movement and selection coefficients. We use a simulation study to showcase different scenarios in which MS-SSFs can be applied, and to compare the MS-SSF to the two-step approach. Furthermore, we illustrate the proposed method using real animal movement data from red deer (Cervus elaphus).