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A goodness-of-fit metric for integrated-step-selection analyses

Understanding the drivers and consequences of animal movement is the primary goal of movement ecologists. As animals move through space, they experience changing environmental conditions, acquire necessary resources, and avoid risk – how they respond should ultimately affect their fitness but depends both on the habitat and the animals' movement capacity. Integrated-step-selection analysis (iSSA) is a recently developed statistical approach for simultaneously estimating both the habitat selection process and the selection-free movement process. iSSA has been used, for example, to examine how animals change their habitat selection and movement behavior in response to predation risk, roads, human recreation, management actions, and protected areas.

While iSSA has become popular for making inference about animal habitat use and movement, there is no consensus on how to evaluate a model's goodness-of-fit. iSSAs use conditional logistic regression as a fitting "trick" to approximate the parameters of the underlying model. The resulting model predictions are not themselves interpretable, since different parameters in the model may pertain to either the habitat selection kernel or the selection-free movement kernel. A goodness-of-fit metric for such a model – for example, a likelihood-based pseudo-R^2 – is thus not easily interpreted. Here, we propose a pseudo-R^2 based not on the likelihood of the conditional logistic regression model, but rather based on a selection-adjusted movement kernel – the normalized product of the habitat selection and selection-free movement kernels – parameterized by the fitted iSSA. We used simulations to demonstrate the performance of our metric, and we compared it to the naïve pseudo-R^2 calculated using the likelihood under the conditional logistic regression model.