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Explainable artificial intelligence enhances the ecological interpretability of black-box species distribution models

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[...]ography and [...]ariables and species occurrence data and make predictions of how their distributions vary in space and time. During the past two decades, the field has increasingly made use of machine learning approaches for constructing and validating SDMs. Model accuracy has steadily increased as a result, but the interpretability of the fitted models, for example the relative importance of predictor variables or their causal effects on focal species, has not always kept pace. Here we draw attention to an emerging subdiscipline of artificial intelligence, explainable AI (xAI), as a toolbox for better interpreting SDMs. xAI aims at deciphering the behavior of complex statistical or machine learning models (e.g. neural networks, random forests, boosted regression trees), and can produce more transparent and understandable SDM predictions. We describe the rationale behind xAI and provide a list of tools that can be used to help ecological modelers better understand complex model behavior at different scales. As an example, we perform a reproducible SDM analysis in R on the African elephant and showcase some xAI tools such as local interpretable model-agnostic explanation (LIME) to help interpret local-scale behavior of the model. We conclude with what we see as the benefits and caveats of these techniques and advocate for their use to improve the interpretability of machine learning SDMs.

Keywords: ecological modeling, explainable artificial intelligence, habitat suitability modeling, interpretable machine learning, species distribution model, xAI

Explaining and predicting where and why species occur in space and time is central to ecology, biogeography and conservation biology (Pecl et al. 2017, Araújo et al. 2019). Species distribution models (SDMs) are currently the most widely used approach for