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Bayesian multilevel modeling of visual search trajectories: a simulation study and a hybrid foraging application

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Poster

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Abstract

Hybrid foraging refers to a visual search task where observers look for multiple instances of several target types. Examining different target types provides insights into the diverse strategies employed during search, such as selecting targets consecutively (runs), alternating between target types (switches), and adjusting the length of runs to meet task demands. Traditionally, search strategies have been analyzed using the proportions of runs and switches; however, these measures are influenced by experimental conditions, including sample size and task characteristics. To address these limitations, Clarke et al. (2022) proposed a Bayesian multilevel model that conceptualizes foraging as generative sampling without replacement, offering a more robust framework for understanding foraging strategies. This model introduces two parameters to evaluate target selection biases: one capturing target preference and another accounting for the spatial arrangement of targets. The spatial parameter incorporates both the Euclidean distance between targets and the angular differences in target search trajectories.

In this study, we examined the accuracy of Bayesian estimators for the spatial location parameters of the multilevel model through a simulation-based approach. The manipulated conditions included the spatial distribution of targets and the characteristics of simulated search trajectories. Model parameters were estimated using an MCMC algorithm implemented in the Stan programming language. Our analysis focused on the RMSE between true and estimated location parameters, as well as the sensitivity of Bayesian model evaluation statistics in identifying misspecified models. Additionally, we applied the multilevel model to real-world data from 30 young adults who completed the FORAGEKID task (Gil-Gómez de Liaño & Wolfe, 2022). This application aimed to evaluate the model's performance under real conditions and to demonstrate the insights provided by Bayesian estimates.

Keywords

Bayesian, Multilevel, Visual search, Simulation,

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