
On The Fine Line Between “Heuristic” and “Optimal” Sequential Question Strategies

Jonathan D. Nelson and Björn Meder
Max Planck Institute for Human Development

Matt Jones
University of Colorado Boulder

Author Note

Correspondence concerning this article should be addressed to Jonathan Nelson (jonathan.d.nelson@gmail.com phone +49 030-82406-658, fax +49 030-82406-394), or Björn Meder (meder@mpib-berlin.mpg.de +49 030-82406-239, fax +49 030-82406-394), Center for Adaptive Behavior and Cognition, Max Planck Institute for Human Development, Lentzeallee 94, 14195 Berlin, Germany. BM and JDN contributed equally to this research and share first authorship on this paper. This research was supported by Grants ME 3717/2-2 to BM and NE 1713/1-2 to JDN from the Deutsche Forschungsgemeinschaft (DFG) as part of the priority program “New Frameworks of Rationality” (SPP 1516), and Air Force Office of Scientific Research grant FA9550-14-1-0318 to MJ. We thank Luisa Bentivegna, Bryan Bergert, Henry Brighton, Anna Coenen, Vincenzo Crupi, Flavia Filimon, Gerd Gigerenzer, Gudny Gudmundsdottir, Wasilios Hariskos, Laura Martignon, Javier Movellan, Felix Rebitschek, Azzurra Ruggeri, Özgür Şimşek, Katya Tentori, Jan Woike, Charley Wu, and the ABC Research Group for helpful contributions to this research and manuscript.

Abstract

How should tests (or queries, questions, or experiments) be selected? Does it matter if only a single test is allowed, or if a sequential test strategy can be planned in advance? Do people's intuitive test selections follow statistical principles? For selecting a single test, several Optimal Experimental Design (OED) ideas have been proposed in statistics. The OED models are mathematically nontrivial. How is it that they predict human behavior well in many tasks? One possibility is that simple strategies correspond to OED models. We prove that simple heuristic strategies can identify the highest information value queries (as quantified by OED models) in several situations, thus providing a possible algorithmic-level theory of human behavior. But are the OED models in fact optimal for sequential search, as is frequently presumed? We consider the Person Game, a 20-questions scenario, as well as a two-category, binary feature scenario, that are popular in psychological research. In each task, we demonstrate via specific examples, and extended computational simulations, that neither the OED models nor the heuristic strategies in the literature are optimal for sequential search. We call for experimental research into how people approach the sequential planning of tests, and theoretical research on what sequential planning strategies are most successful.

Keywords: Sequential information search, optimal experimental design (OED) models, heuristics, optimality, split-half heuristic, maximum-entropy question heuristic, multi-step question strategies, probability gain, stepwise methods, greedy methods, impact