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Sequential Search and Selection Problem Under Uncertainty

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ABSTRACT

This paper formulates and discusses a series of sequential decision problems of the following common structure: A decision alternative of multiple attributes—that is, a job, an employee, or an investment alternative—is to be selected within a certain fixed length of time. An unknown number of alternatives are presented sequentially, either deterministically or in a random manner. The decision maker can rank all the alternatives from best to worst without ties, and the decision to accept or reject an alternative is based solely on the relative ranks of those alternatives evaluated so far. The nonparametric sequential decision problem is first studied for a model involving a discrete time period and then generalized in terms of continuous time. Also considered is a variant of this problem involving a Bayesian estimation of (1) the uncertain probability of having an alternative at a given stage in the discrete-time model and (2) the arrival rate of alternatives in the continuous-time model. The optimal selection strategy that maximizes the probability of selecting the absolute best alternative is illustrated with the job search problem and the single-machine job assignment problem.

Subject Areas: Decision Analysis: Sequential decision making; Dynamic Programming: Stochastic model applications; and Probabilistic Models: Optimal stopping rule.

INTRODUCTION

In many managerial decision situations, such as selling an asset in the open market, hiring an employee for a job, or purchasing some product on the market, decision alternatives are usually presented sequentially over time. Following an evaluation of an alternative, the decision maker (DM) may either (a) choose one of the available alternatives and terminate the search process or (b) reject it in favor of a continued and uncertain search process. The decision is usually made based on the "value" of the alternative under consideration and the possibility of finding a better alternative at a later stage of the search process.

To illustrate this class of sequential decision problems and to motivate this study, consider two examples from entirely different domains. The first example (Perry & Wigderson, 1986) concerns a PhD candidate looking for a job in a