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Sequencing a Set of Alternatives Under Time Constraints

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We consider a problem of sequencing a set of alternatives (i.e. manufacturing methods, job applicants or target journals) available for selection to complete a project. Associated with each alternative are the probability of successful completion, the completion time, and the reward obtained upon successfully completing the alternative. The optimal sequencing strategy that maximizes the expected present value of total rewards, is derived based on a simple ordering parameter. We further consider an extension in which one of the alternatives will not be available for selection if not selected by a certain time, and another extension in which the selection process is allowed only for a limited period of time. We propose solution strategies to the selection and sequencing problem under time constraints.

Key words: project selection, sequencing/scheduling, stochastic programming

INTRODUCTION

Suppose that we are considering submitting a manuscript to a journal for possible publication. Since it is unethical to submit a manuscript to more than one journal simultaneously, we must decide to which journal the manuscript is sent first. Our ordering strategy may be based on several factors, such as the acceptance rate, turn-around time and prestige of each journal considered. Let p_i, $i = 1, 2, \ldots, n$, be our subjective probability that the manuscript will be accepted in journal i if submitted, and t_i be the turn-around time needed from submission to acceptance (or rejection). If the manuscript is accepted in journal i, we receive a quantifiable reward r_i. Otherwise, the manuscript is resubmitted to another journal until accepted. Knowing the coefficients p_i, t_i and r_i of each journal, we should arrange the order of journals so as to maximize the expected reward.

Consider another example in which several different alternative methods are available to complete an R&D project.[1] Associated with each alternative are the probability of successful completion, the completion time and the profit obtained upon completion. If an alternative fails when attempted, another alternative is selected. The selection process continues until one of the alternatives is completed successfully.

As an additional example, suppose that several manufacturing methods (prototypes) are available for selection in producing a new product. It takes time t_i to produce it by method i, $i = 1, 2, \ldots, n$. The quality measure X_i of the product produced by method i is assumed to be a random variable from a known distribution function F_i. The lower tolerance limit is given to be x^*; any product below x^* will be scrapped without any salvage value. Alternative methods (prototypes) are undertaken one at a time until we finally obtain a product that meets the lower tolerance limit. This example is equivalent to the manuscript submission problem with $p_i = 1 - F_i(x^*)$ and $r_i = E[X_i | X_i \geq x^*]$.

In the so-called secretary problem,[2,3] an employer interviews n applicants sequentially for a secretarial position and must decide immediately after each interview whether or not to hire the current interviewee. Consider a variation of the secretary problem in which the scalar-valued score of applicant i, $i = 1, 2, \ldots, n$, which is revealed upon completion of the interview, is assumed to be a random variable X_i from a continuous probability distribution F_i. The evaluation process is continued until the first applicant whose score is higher than the pre-determined aspiration level x^* is hired. This variation of the secretary problem is also

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