A Flexible Java Representation for Uncertainty in Online Operations-Research Models

Joel A. Shapiro • Warren B. Powell • David Bernstein
Department of Operations Research and Financial Engineering, Princeton University, Princeton, NJ 08544, USA
Department of Operations Research and Financial Engineering, Princeton University, Princeton, NJ 08544, USA
Department of Computer Science, James Madison University, Harrisonburg, VA 22807, USA
shapirojoel@hotmail.com • powell@princeton.edu • bernstdh@jmu.edu

Online OR models have been the subject of increased attention in recent years with the rapid expansion of the Internet. Although much has been written about the implementation, as well as the formal analysis of online models, little has been said about how to handle uncertainty in an online setting. In particular, the dynamic nature of uncertainty that is so characteristic of online models, where estimates and distributions evolve in parallel with the state of the model, has been largely ignored. In this paper, we present a new representation for uncertainty in online models. This representation is object-oriented and, as such, provides several important software-engineering advantages over traditional representations for uncertainty. Moreover, by using the event listener paradigm it provides an explicit mechanism for handling dynamic uncertainty in an elegant and extensible manner. A series of computational experiments demonstrates that there is no significant overhead to our representation when compared to traditional representations on a realistic application and, in some cases, our representation can be noticeably faster.
(*Software; Philosophy of Modeling; Simulation; Programming: Stochastic*)

1. Introduction

The explosive growth of the Internet, and computer power in general, has produced a surge in the implementation of *online models* in operations research. An online operations-research model can be loosely defined as any model used for ongoing, real- or near-real-time computer-based decision support. Online models are solved by *online algorithms*. The use of online algorithms dates back to the early days of computer operating systems, when online job-scheduling algorithms were first constructed to schedule the CPU dynamically to execute an uncertain stream of programs (also called "jobs"). These early algorithms were not user-accessible and instead ran "under the hood" as background jobs. A user could only see the results of the algorithm implicitly through the relative swiftness with which his job executed. In contrast, more recent applications of online algorithms support explicit user access to results, often for the purposes of planning or forecasting some external system.

Examples of online models abound. For instance, Perros and Elsayed (1996) analyze a variety of call admission control models for telecommunications providers that are used for online assignment of communications bandwidth to data streams (e.g., real-time video conferencing, voice traffic and multicast broadcasting like a recent Rolling Stones concert). The financial industry has long been an advocate of online models, for instance for portfolio risk management systems as in Linsmeier and Pearson (1996).

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