Decision Support

Approaches to Multistage One-Shot Decision Making

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PII: S0377-2217(13)01022-9
DOI: http://dx.doi.org/10.1016/j.ejor.2013.12.038
Reference: EOR 12064

To appear in: *European Journal of Operational Research*

Please cite this article as: Guo, P., Li, Y., Approaches to Multistage One-Shot Decision Making, *European Journal of Operational Research* (2013), doi: http://dx.doi.org/10.1016/j.ejor.2013.12.038

Approaches to Multistage One-Shot Decision Making

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Abstract. In this research, multistage one-shot decision making under uncertainty is studied. In such a decision problem, a decision maker has one and only one chance to make a decision at each stage with possibilistic information. Based on the one-shot decision theory, approaches to multistage one-shot decision making are proposed. In the proposed approach, a decision maker chooses one state amongst all the states according to his/her attitude about satisfaction and possibility at each stage. The payoff at each stage is associated with the focus points at the succeeding stages. Based on the selected states (focus points), the sequence of optimal decisions is determined by dynamic programming. The proposed method is a fundamental alternative for multistage decision making under uncertainty because it is scenario-based instead of lottery-based as in the other existing methods. The one-shot optimal stopping problem is analyzed where a decision maker has only one chance to determine stopping or continuing at each stage. The theoretical results have been obtained.

Keywords: possibility distribution, decision making, one-shot decision theory, scenario-based decision theory, focus point, multistage decision making, dynamic programming, optimal stopping problem

1. Introduction

Decision theories under uncertainty are theories of choice under uncertainty, where the objects of choice are probability distributions for expected utility theory, subjective expected utility theory and their varieties, or prospects framed in terms of gains and losses for prospect theory (Kahneman, Tversky, 1979), or possibility distributions regarded as possibilistic lotteries (Dubois et al., 2001). However, all of these theories are lottery-based theories which generally follow the Bernoullian framework of the weighted average.

One-shot (one-time) decision is typical for situations where a decision maker has one and only one chance to make a decision with partially known information. Let us begin with a real example of one-shot decision problems. The Great Sichuan Earthquake occurred at 14:28:01 CST on May 12, 2008. Official figures stated that 69,197 people were confirmed dead. Amongst many problems caused by the earthquake, Tangjiashan Lake particularly drew the attention of the world because it was seriously threatening the lives of 1,300,000 people, the Lanchengyu Oil Pipeline and the Chengbao Railway (one of the arterial railways in China). To prevent damage to the dam, the water in the lake needed to be drained away as soon as possible by building a sluice channel. There were only two alternatives for building a sluice channel: using explosives or digging by excavators. It was a one-shot decision to decide which method should be utilized in the face of the uncertainties from rain, aftershock, dam stability, land slip and time. Other examples of one-shot decision problems include the individual real estate investment (Guo, 2010b), the medical treatment choice of a person with a life-threatening illness, mergers and acquisitions (M&A) and other decision-analysis projects in enterprises (Clemen, Kwit, 2001). One-shot decision problems are commonly encountered in business, economics, and social systems.

Guo (2011) initially proposed the one-shot decision theory for dealing with one-shot decision problems. The one-shot decision theory provides the scenario-based choice instead of the lottery-based choices as in other decision theories under uncertainty. It is enlightened by the common phenomenon that when asking a person why he/she makes such a one-shot decision with little information, he/she will most often reply one scenario, which is crucial to him/her and the basis for achieving his/her conclusion. Let us refer to an example. An article in *Mainichi Japan* (June 16, 2012) reported that “Japan's government on Saturday approved bringing the country's first nuclear reactors back online since last year's earthquake and tsunami led to a shutdown of reactors nationwide.” Whether to restart nuclear reactors in western Japan was a typical one-shot decision problem. As mentioned in the same article, the main reason for such a decision was “demand is expected to peak in mid July or early August, so they need to begin work immediately to get the reactors up and running in time to avoid shortages.” In addition, *Japan Real Time* (May 18, 2012) said that