Available online at www.sciencedirect.com
SCIENCE DIRECT®
Fuzzy Sets and Systems 146 (2004) 205–220
FUZZY sets and systems
www.elsevier.com/locate/fss

An interactive fuzzy satisficing method for multiobjective linear programming problems with random variable coefficients through a probability maximization model

Masatoshi Sakawa, Kosuke Kato*, Hideki Katagiri

Department of Artificial Complex Systems Engineering, Graduate School of Engineering, Hiroshima University, Kagamiyama 1-4-1, Higashi-Hiroshima 739-8527, Japan

Received 15 January 2002; received in revised form 2 April 2004; accepted 14 April 2004

Abstract

Two major approaches to deal with randomness or ambiguity involved in mathematical programming problems have been developed. They are stochastic programming approaches and fuzzy programming approaches. In this paper, we focus on multiobjective linear programming problems with random variable coefficients in objective functions and/or constraints. Using the probability maximization model to maximize the probability that each objective function becomes a certain value under chance constrained conditions, the stochastic programming problems are transformed into deterministic ones. As a fusion of stochastic approaches and fuzzy ones, after determining the fuzzy goals of the decision maker, an interactive fuzzy satisficing method to derive a satisficing solution for the decision maker by updating the reference membership levels is presented. An illustrative numerical example is provided to demonstrate the feasibility of the proposed method.

Keywords: Fuzzy mathematical programming; Multi criteria analysis; Linear programming; Stochastic programming; Interactive programming

1. Introduction

In actual decision making situations, we must often make a decision on the basis of vague information or uncertain data. For such decision making problems involving uncertainty, there exist two typical approaches: probability-theoretic approach and fuzzy-theoretic one.

* Corresponding author. Tel.: +81-824-24-7693; fax: +81-824-24-7694.
E-mail addresses: sakawa@msl.sys.hiroshima-u.ac.jp (M. Sakawa), kato@msl.sys.hiroshima-u.ac.jp (K. Kato).

0165-0114/$ - see front matter
doi:10.1016/j.fss.2004.04.003

Stochastic programming, as an optimization method based on the probability theory, have been developing in various ways [24,25], including two stage problem by Dantzig [4], chance constrained programming by Charnes and Cooper [2]. Especially, for multiobjective stochastic linear programming problems, Stancu-Minasian [24,25] considered the minimum risk approach, while Leclercq [10] and Teghem Jr. et al. [26] proposed interactive methods.

On the other hand, fuzzy mathematical programming representing the vagueness in decision making situations by fuzzy concepts have been studied by many researchers [8,14,15]. Fuzzy multiobjective linear programming, first proposed by Zimmermann [29], have been also developed by numerous researchers, and an increasing number of successful applications has been appearing [5,7,9,12,15, 21–23,27,30].

As a hybrid of the stochastic approach and the fuzzy one, Wang et al. considered mathematical programming problems with fuzzy random variables [28], Liu et al. [11] discussed chance constrained programming involving fuzzy parameters. In particular, Hulsurkar et al. [6] applied fuzzy programming to multiobjective stochastic linear programming problems. Unfortunately, however, in their method, since membership functions for the objective functions are supposed to be aggregated by a minimum operator or a product operator, optimal solutions which sufficiently reflect the decision maker's preference may not be obtained. To cope with the problem, Mohan et al. [13] proposed an interactive satisficing method, but the method requires a large amount of work which the decision maker must do in the interaction procedure and there was assumed that all of random variables are Gaussian. As preceding researches, we proposed interactive fuzzy satisficing methods for multiobjective linear/nonlinear programming problems with/without fuzzy parameters [15,18–21]. Furthermore, as their extensions, we showed the usefulness of the interactive fuzzy satisficing method based on an expectation optimization model for multiobjective linear programming problems involving random variable coefficients [16,17]. Since objective functions are evaluated by their expectations in the method, the aspiration of the decision maker for the degree of realization of objective function values cannot be taken into account.

Under these circumstances, in this paper, we focus on multiobjective linear programming problems with random variable coefficients in objective functions and/or constraints. Using the probability maximization model to maximize the probability that each objective function becomes a certain value under chance constrained conditions, the stochastic programming problems are transformed into deterministic ones. Assuming that the decision maker has a fuzzy goal for each of the objective functions, having determined the fuzzy goals of the decision maker, we present an interactive fuzzy satisficing method to derive a satisficing solution for the decision maker by updating the reference membership levels. An illustrative numerical example for multiobjective linear programming problems involving random variable coefficients demonstrates the feasibility of the proposed method.

2. Multiobjective linear programming problems with random variable coefficients

In this paper, we deal with multiobjective programming problems involving random variable coefficients in objective functions and the right-hand side of constraints. Such multiobjective linear