Chapter 4

A Study of Fully Fuzzy Linear Fractional Programming Problems by Signed Distance Ranking Technique

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ABSTRACT

The aim of this chapter is to study fully fuzzy linear fractional programming (FFLFP) problems where all coefficients of the decision variables and parameters are characterized by triangular fuzzy numbers. To deal with this, the authors have first to transform FFLFP problems to fuzzy linear programming (FLP) problems by using Charnes and Cooper method and then use signed distance ranking to convert fuzzy linear programming (FLP) problems to crisp linear programming (LP) problems. The proposed method is solved by using the simplex method to find the optimal solution of the problem. The authors have studied sensitivity analysis to determine changes in the optimal solution of the fully fuzzy linear fractional programming (FFLFP) problems resulting from changes in the parameters. To demonstrate the proposed method, one numerical example is solved.

INTRODUCTION

Mathematical optimization is the process of finding the conditions that give the maximum or the minimum value of a function. A number of methods have been developed for solving different types of optimization problems (Astolfi, 2006).

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The technique of Linear programming (LP) may be used for solving broad range of problems arising in business, government, industry, hospitals, libraries, etc. As a decision making (DM) tool, it has demonstrated its value in various fields such as production, finance, marketing, research and development and personnel management. The goal of LP is to determine the values of decision variables that maximize or minimize a linear objective function, where decision variables are subject to linear constraints. The Hungarian mathematician Bela Martos (1960, 1961) has first formulated a linear fractional programming (LFP) problem. In mathematical optimization, LFP is a generalization of LP. Whereas the objective function in a linear programming problem is a linear function, the objective function in a linear-fractional programming problem is a ratio of two linear functions. A linear programming problem can be regarded as a special case of a linear-fractional programming problem in which the denominator is a constant. The mathematical form of linear fractional programming problem is stated by Charnes and Cooper (1962) is given below:

\[
\text{Max or Min } Z(x) = \frac{cx + \alpha}{dx + \beta} = \frac{N^r}{D'}
\]

subject to the constraints:

\[
Ax = b, x \geq 0
\]

where \( x \in \mathbb{R}^n \) represents the vector of variables to be determined, \( c, d \in \mathbb{R}^n \) and \( b \in \mathbb{R}^m \) are vectors of (known) coefficients, \( A \in \mathbb{R}^{m \times n} \) is a (known) matrix of coefficients and \( \alpha, \beta \in \mathbb{R} \) are constants. The constraints have to restrict the feasible region to \( dx + \beta > 0 \), i.e., the region on which the \( D' \) is positive.

Zadeh (1965) introduced the notion of fuzzy sets to describe vagueness mathematically in its very abstractness and tried to solve such problems by giving a certain grade of membership to each member of a given set. Zadeh (1965) has defined a fuzzy set as a generalization of the characteristic function of a subset. A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse, a value representing its grade of membership in the fuzzy set. The membership grades are very often represented by real numbers in
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