Available online at www.sciencedirect.com
ScienceDirect
European Journal of Operational Research 175 (2006) 135–154
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
www.elsevier.com/locate/ejor

Decision Support

Interactive meta-goal programming

Rafael Caballero [a,*], Francisco Ruiz [a], M. Victoria Rodríguez Uría [b], Carlos Romero [c]

[a] *Departamento de Economía Aplicada (Matemáticas), Facultad de Ciencias Económicas y Empresariales, Universidad de Málaga, Campus El Ejido s/n, 29071 Málaga, Spain*
[b] *Departamento de Economía Cuantitativa, Facultad de Ciencias Economicas y Empresanàles, Universidad de Oviedo, Campus del Cristo, 33006 Oviedo, Spain*
[c] *Departamento de Economía y Gestion Forestal, ETS Ingeniero de Montes Universidad Politecnica de Madrid, Avda, Complutense s/n 28040 Madrid, Spain*

Received 8 June 2004; accepted 26 April 2005
Available online 16 August 2005

Abstract

The concept of meta-goal programming is developed and linked to an interactive framework. An algorithm is proposed, in which the decision maker can establish target values on several achievement functions and use an interactive procedure to update these values. This substantially alleviates the problems associated with assigning to each attribute a target value, in order to build the goals, as well as the selection of a suitable achievement function. The functioning of the proposed interactive approach is illustrated with the help of an example taken from the farm management literature.

Keywords: Goal programming; Meta-goal programming; Interactive; Satisficing

1. Introduction

Goal Programming (GP) (Charnes and Cooper, 1961) represents a widely used approach in the Operational Research field. Recent surveys (e.g. Schniederjans, 1995; Jones and Tamiz, 2002) and special issues of specialized journals (e.g. Aouni and Kettani, 2001) have revealed its growing popularity in terms of successful applications to real-world problems and theoretical developments. Several authors argue that the main

* Corresponding author. Tel.: +34 952 131168; fax: +34 952 132061.
E-mail address: rafael.caballero@uma.es (R. Caballero).

0377-2217/$ - see front matter
doi:10.1016/j.ejor.2005.04.040

reason why GP has been so successful is the Simonian satisficing philosophy underlying the approach (see Lee, 1972, or Ignizio, 1976).

Although GP has many good properties, the approach is not exempt from difficulties. Perhaps the most important one is its underlying axiom, namely that the decision-maker (DM) is able to assign to each attribute a "satisficing" target value. This is a strong empirical requirement (González-Pachón and Romero, 2004). Another potential shortcoming is that there is no theoretical foundation for the choice of the form of the achievement function for the GP model, that is, the function of the unwanted deviation variables to be minimized in one way or another. Jones and Tamiz (2002) present a survey of GP applications to real problems, which illustrates that a large majority of the problems were solved using the lexicographic GP-variant. The next most popular approaches were the weighted and minmax GP-variants. Obviously, each GP-variant fits a different DM preference structure, and it is not easy to accept that the most common preference structure is the rigid lexicographic order. This leads us to suppose that, in many cases, it is the analyst's rather than the DM's personal preferences that influence the choice of the variant. Needless to say, both the allocation of target values to attributes and the choice of the GP-variant used have a critical impact on the final solution.

The mechanistic selection of the achievement function was recently addressed by introducing the concept of meta-goal that leads to a GP extension coined as Meta-GP (Rodríguez-Uría et al., 2002). This approach uses sensitivity analysis to derive a meta-achievement function, reflecting the DM's actual preferences for a particular decision-making problem. In this paper, we take a further step in this direction by formulating the Meta-GP approach within an interactive framework. Thus, "satisficing" targets are allocated to each attribute and the meta-achievement function is selected in accordance with the DM's actual preferences.

Interactive methods are the most widely used family of algorithms within the frame of Multiobjective Programming. Such methods were pioneered by Geoffrion et al. (1972), Benayoun et al. (1971), and Zionts and Wallenius (1976). Textbooks and surveys Steuer (1986), Shin and Ravindran (1991) and Miettinen (2002) give an idea of both the number of different interactive algorithms that have been developed, and the number of real cases to which they have been applied. The reason of their success lies in their capability to progressively adapt their performance to the decision maker's preferences. In some sense, it can be said that both the decision maker and the algorithm "learn" about the problem during the process. Traditionally, interactive methods have been classified according to two main criteria: the information required from the decision maker, and the inner resolution strategy. Following the first criterion, the methods are usually classified into four main groups (although more subgroups are considered in some studies):

- *Weighting methods*: The decision maker is asked to give, at each iteration, local weights for the criteria, e.g. the GDF method by Geoffrion et al. (1972).
- *Tradeoff methods*: The decision maker is asked to give at each iteration local tradeoffs among objectives (e.g. SPOT, by Sakawa, 1982), or to evaluate different tradeoffs (e.g. ISWT, by Chankong and Haimes, 1978), or to answer whether he/she prefers a tradeoff or not (e.g. Zionts and Wallenius, 1976).
- *Solution generating methods*: At each iteration, the decision maker has to choose one among a number of (efficient) solutions (e.g. Steuer and Choo, 1983).
- *Aspiration level or reference level methods*: At each iteration, the decision maker is asked to give reference levels for the objectives (e.g. Benayoun et al., 1971; Wierzbicki, 1981; Korhonen and Laakso, 1986a,b; Korhonen and Wallenius, 1988; Nakayama and Sawaragi, 1984).
- If the information given takes the form of target values for goals related to the objectives of the problem, then the method can be considered an Interactive Goal Programming approach. This is the group where the method proposed in this paper should be placed.