Decision Support Systems Using Reference Point Optimization

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Abstract

This paper presents a review of various approaches to decision support, distinguishes a methodological approach based on reference point optimization and reviews advances in this field done in Poland under the contracted study agreement "Theory, Software and Testing Examples for Decision Support Systems" with the International Institute for Applied Systems Analysis.

1 Introduction

The concept of a decision support system – though widely used and developed both in research and in practical applications through more than last ten years — is not yet quite precisely defined. On the other hand, it is possible to give a broad definition of this concept by enumerating possible classes of decision support systems, describing the concept of a decision making process that is fundamental to all decision support systems, defining what a decision support system should and what it should not do, discussing possible approaches to and types of decision support. After attempting such a broad definition, we review in this paper in more detail a specific class of decision support systems — those that use the principle of reference point optimization for generating and evaluating decision alternatives, mostly with help of a computerized analytical model describing the essential features of a decision situation. Many of such systems have been developed during four years of a contracted study agreement between the Polish Academy of Sciences (including, as subcontractors, the Institute of Automatic Control of Warsaw University of Technology, the Institute of Systems Research of Polish Academy of Sciences, the Institute of Automatic Control of the Academy of Mining and Metallurgy of Krakow and the Institute of Informatics of the University of Warsaw) and the International Institute for Applied Systems Analysis, Laxenburg near Vienna, Austria. These developments and implementations are also reviewed in the paper.

A. Lewandowski et al. (eds.), *Aspiration Based Decision Support Systems*

2 Concepts and definitions of decision support systems

There are many proposed definition of a decision support systems in the current literature — see, e.g., Keen and Scott-Morton (1978), Sage (1981), Parker and Al-Utabi (1986), Gray (1986), Jarke (1986) and others. However, most of them do not take into account the fact that three main classes of decision support systems have been practically developed in applications and research. These are (see Lewandowski and Wierzbicki, 1987, also next paper):

A) *Simple tools for managerial decision support* (that might be used as building blocks of more sophisticated decision support systems) such as modern data bases, electronic spreadsheet systems, etc. as well as more complex but pragmatically designed systems composed of such tools;

B) *Decision support systems based on logical models and logical inference* whose main function are to help in recognizing a logical pattern in a decision situation; these systems typically involve the use of logical programming languages, expert systems style programming, knowledge bases, other tools of artificial intelligence;

C) *Decision support systems based on analytical models, multiobjective optimization and choice*, whose main functions concentrate on the process of choice among various decision alternatives either specified a priori or generated with help of the system. Such systems typically include a computerized model of a decision situation formulated in analytical terms and elements of multiobjective optimization and evaluation of alternatives.

All these three classes can be further subdivided according to various methodological principles. For example, the systems of the class C can be subdivided in various ways: systems that serve a strategic evaluation of novel decision situations versus systems that support repetitive, tactical decisions; systems that handle a number of discrete alternatives versus those that support the generation and choice among alternatives from a set of continuum power; between the latter, systems that use static linear, dynamic linear, static nonlinear or dynamic nonlinear analytical models that describe a given decision situation; systems in which the methodology of multiobjective alternative evaluation follows a definite (typically, culturally determined) framework of rationality versus systems that try to accommodate intercultural perceptions of rationality, see next paper; etc.

However, there are certain features that are common to all decision support systems. Observe that the systems of classes B and C contain explicitly models of the decision situation, although of different types. The same can be said, in fact, about the systems of the class A: when preparing a simple decision support tool, such as a date base or a spreadsheet, to support a definite decision process, one must assume, even if implicitly, a kind of a model of the decision situation. Thus, we can state that all decision support systems contain such models.