Developments in decision technologies

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Abstract: New methodological advances in decision making, as well as further developments in information technology, continue to foster progress in the field of decision technology. We report on recent progress in decision technology including new decision methods and measures, and system integration. Finally, we highlight some examples from the broad range of application of decision technology.

Keywords: attitudinal based expected value; embedded systems; fuzzy sets; genetic algorithm; interactive evolutionary computation; music composition; mobile communication; *p*-median; ordered weighted averaging operator.

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1 Introduction

Modern networked computer systems enable managers to use information in new ways and to make significantly more effective decisions (Turban et al., 2005). Today's revolutionary decision technologies allow these decisions to be made more rapidly than ever before. Decision technology is at the intersection of information technology and decision methodologies. Recently developed decision technologies can provide organisations with a strategic advantage in a competitive environment. The complexity of modern decision making has brought about the development of improved decision technologies, and much research is dedicated to the study of this important area.

The Symposium on Decision Technology and Intelligent Information Systems at InterSymp: International Conference on Systems Research, Informatics and Cybernetics provides an annual forum for such discussions (Engemann and Lasker, 2003). This

special focus symposium provides a venue for high quality discussion of recent advances in decision technologies. This volume is an outgrowth of research that investigates contemporary decision methodologies and models, combining traditional approaches with new technologies to provide innovative solutions to important and complex problems.

2 Decision methods and measures

Increasingly complex decision-making problems have lately led to more robust methodologies of decision making, which can account for imprecision and may overcome some of the shortfalls of more traditional analysis (Reeves and Rowe, 2003). For example, in many location models, strong crisp assumptions, like known demands and distances, may be unrealistic. With their approach to the problem, María José Canós, Carlos Ivorra and Vicente Liern present the fuzzy *p*-median problem as a vehicle to relax these assumptions in order to solve real-world problems. Their methodology allows a decision maker to improve an optimal covering of a location problem by considering partially feasible solutions in which some demand is left uncovered. They show that this fuzzy version can be used to analyse the global structure of a given instance of the crisp problem.

It is important to note that the objective of the public sector is often to maximise social benefits, but generally the objective of the private sector is to maximise profits. It follows that a private firm may prefer leaving a part of the demand uncovered if the firm finds that to be more profitable. Accordingly, Canós, Ivorra and Liern propose a fuzzy opportunity set in such a way that the decision maker could choose partially feasible solutions, which partially cover the demand. They develop techniques to study and improve decision-making in location problems like the *p*-median problem. It is a more realistic approach to the problem and allows the decision-maker to avoid bad solutions appearing as optimal. The algorithms that they have developed permit efficient solutions to be obtained for medium and large-sized instances of the model. Small variations in the parameters of the model lead to very different locations that the decision-maker would ignore if he or she just applied a crisp approach.

Real world complexities are also introduced by intangible factors, which typically arise in decision processes. Executives making decisions confront a plethora of uncertainties concerning technologies, competitors' actions, and market response. Classical financial investment evaluation methods require hard numbers, while much of the payoff may be indirect and qualitative. Traditional methodologies often ignore both the disposition of the decision maker and intangible benefits and costs. Intangible benefits might include keeping up with the latest technologies and maintaining an image with customers, while intangible costs might include hidden costs of coordination.

Kurt Engemann, Holmes Miller and Ronald Yager introduce a methodology, which provides support in such a complex decision environment. They introduce a new aggregation measure for continuous random variables, useful in cases of decision making under risk in which the decision maker wishes to incorporate his disposition. The decision maker may systematically align probabilistic elements with his own judgement. In evaluating alternatives one must consider intangible factors as well as the more quantifiable tangible factors. Engemann, Miller and Yager propose a method to incorporate intangibles into the attitudinal based expected value to support decision

making. By providing the ability to incorporate a decision maker's risk attitude, the methodology establishes a new dimension that is consistent with how people act in actual uncertain decision environments.

3 Interconnected systems

Decision technologies are rapidly being implemented into an extraordinary range of applications. Wim Smit and Wim Hendriksen foresee very exciting possibilities and opportunities to apply embedded systems, especially in the area of advanced and autonomous decision support systems. They report on the discipline of embedded systems (Smit, 2002) as it has developed over the last 30 years, as well as to the developments, which might be expected in the coming years. Embedded systems have been used as a major element in increasing the labour productivity in many businesses. Due to the various application fields of embedded systems, many scientific disciplines have adopted these systems in the different stages of idea generation, research, development, engineering, testing, manufacturing and maintenance.

Smit and Hendriksen focus on some critical items in the development process of embedded systems from idea generation towards their first installment in a product. They comment that the discipline of embedded systems might grow into a unifying science for the development of products and systems. It can be of tremendous value in systems which need a lot of external data from different sources, and which cannot be handled by humans. At the same time the discipline of embedded systems plays an important role in innovation, because by its nature, smart decisions and smart organisations are the results of such new smart tools.

4 Varied application areas

The possibilities for applying decision technology are broadened by a vivid imagination, as is evidenced by the utilisation of computers to assist in creating music. For several decades research involving music composition by computer has been evolving, with much progress being made in the area of interactive systems. Music composition is a creative activity, with the composer utilising an iterative feedback process involving listening and modifying.

Motoki Kamitani and Tadashi Ae propose an augmented interactive evolutionary music computation (IEC) technique. IEC is an optimisation technique used in an inductive process to find a preferable solution in the area of the user's subjective goal. In general, the subjectivity of the human is not easily modelled clearly (Kimura et al., 2002). In IEC, one does not need to formulate an evaluation function clearly, and therefore, it has been used for supporting human intellectual works such as industrial design and art activities (Tokui and Iba, 2000).

As another example of the far-reaching area of application of decision technology, we note what is occurring within the transportation business. Here, one observes a tendency towards the integration of the ongoing delivery process with in-house processes. The goal is to achieve dynamic vehicle planning as well as vehicle control. In order to achieve this, it will be necessary to improve on the often cost-intensive, time-consuming and error-prone mobile communications between dispatchers and drivers typical for

medium-sized transport operators. Elmar Erkens describes a communication system for vehicle-fleet control, which supports the working processes of the driver as well as the forwarding agent. He reports on successfully substituting the prevalent mobile vocal communication with a continuous data-based communication. Both parties are now able to obtain online access to all necessary and updated information needed for their individual sequence of operation at any time.

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