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EDITORIAL

OPTIMIZATION AND INTELLIGENT DECISIONS

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Abstract. Extension of optimization to decision-making systems is challenging topic of research. This paper surveys the special journal issue on the subject "Optimization and intelligent decisions." Papers on intelligent decision theory as well as on decision in economic systems are presented and discussed. Information technologies for web-based intelligent systems environment, which offers generic, modular, flexible and scalable system solutions for information retrieval, extraction, fusion, knowledge discovery and intelligent decision support, might be a subject of future research extending optimization in decision-making.

Keywords: decision-making, optimization, intelligent decision-support systems, economic systems.

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1. Introduction

Information technology applications that support decision-making processes and problem-solving activities have proliferated and evolved over the past few decades. In the 1970s, these applications were simple and based on spreadsheet software. During the 1980s, decision-support systems incorporated optimization models, which originated in the operations research and management science communities. From 1990s these systems were further enhanced with components from artificial intelligence and statistics. Intelligent decision-support using advanced decision and optimization technologies are becoming increasingly important in business management. Data warehouses and data mining can be used to store and analyze

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product, inventory, and sales information. Simulation and optimization, which can be found in advanced planning and scheduling systems, can be employed for, e.g., inventory, production, procurement, and distribution planning. Optimization techniques pierced through many chapters of business management, because their utilization "facilitates the choice and the implementation of more effective solutions which, typically, may involve complex interactions among people, materials and money problems" (www.euro-online.org). The latter challenge stimulates a study of existing techniques as well as development of new concepts for optimization. Current issue aims at a more exhaustive study of optimization and optimal decision-making towards knowledge-based technologies. The topics in the issue cover the trends and gain a common attitude towards but not only:

- global optimization;
- multi-criteria evaluation;
- multi-criteria verbal analysis;
- fuzzy multicriteria decision-making;
- genetic algorithm;
- optimization in data mining;
- knowledge modelling;
- knowledge-based decision support;
- knowledge-based architecture;
- decision support system;
- software development;
- applications in industry and business;
- risk management;
- operational variable job scheduling;
- formation of economic bubbles.

2. Intelligent decision support systems

Intelligent decision-making must be accompanied with important abilities such as generalization of empirical data, deductive inference using basic knowledge and an optimal choice from a set of alternatives. In the paper of Arslan G. and Aydin O. (2009), software for Fuzzy Multiple Criteria-Decision Making (FMCDM) problems has been developed and tested on real problems. Multicriteria decision-making (MCDM) problems arise in situations where a (group of) decision-maker(s) faces a problem of choosing the best alternative among several possible alternatives (Opricovic and Tzeng 2004). The main steps of MCDM can be stated as; establishing system evaluation criteria that relate system capabilities to goals, developing alternative systems for attaining the goals, evaluating alternatives in terms of the selected criteria, applying a normative multicriteria analysis method and accepting one alternative as "optimal". In general, the decision-makers (DMs) have to consider both quantitative and qualitative assessments of the criteria in evaluating the considered alternatives. Classical MCDM problems usually present judgments as crisp numerical values and they need to

evaluate the performance of alternatives versus each criterion. On the other hand, information about the alternatives is often imprecise or the DMs can only give approximate, incomplete or not well-defined, information. Another point that has to be taken into account is that some criteria may be subjective. To deal with these problems, fuzzy set theory has been frequently applied to MCDM problems, which may help resolve some difficulties frequently encountered in decision-making. It mainly aims to reduce the effects of imprecision like human judgment and preferences while searching for the optimal decision (Slowinski 1998). On the other hand, the application of FMCDM methods may yield some problems. Even for relatively small problems, the necessary computations are quite time-consuming and may lead to errors. Hence it is important to have appropriate software for applications of such methods. For this reason software is developed to enable the application of 2 special FMCDM methods. The main focus of this study is the development of software to be used in the implementation of two FMCDM methods and its application to 2 real problems. The problems considered also show how the software may help DMs to infer some interesting observations. It will be of great importance in real life applications and in consideration of alternative scenarios. The proposed software is a starting point for overcoming some of these difficulties for the introduced methods. The software can be improved in some respects, such as being more user-friendly and having graphs for sensitivity analysis. In addition to enabling the complex calculations needed, the software also presents steps of these algorithms in details.

Civil engineering is a field, where decision-making problems are complex (Brauers *et al.* 2008, Brauers and Zavadskas 2009) and their solution relies on multiple criteria (Ginevičius *et al.* 2008; Zavadskas *et al.* 2008). Therefore, a multi-criteria decision analysis approach (MCDA) can be applied for obtaining the problem's solution here (Brauers and Zavadskas 2009). Preparation of building repair activities in multi-family dwelling houses poses an important problem (Dytczak, Ginda 2009). Unfortunately, due to complex influence of the surrounding environment, the influence of a considerable number of components and diverse point of views has to be included during the analysis of repair needs. Potential influences result from a bunch of sources. The sources are of economic, technological, social and environmental nature. To support a decision-maker effectively, information pertaining to the importance of particular influences is required. Such information can be obtained using special means of multi-criteria decision analysis (MCDA) methodology (Brauers and Zavadskas 2009). The decisions made are usually based on an economical criterion only, and the influence of other issues is taken into account only intuitively. In reality, the conflicting nature of issues pertaining to interests of diverse stakeholders makes decision-making even harder. Additionally, some of the issues can be of intangible nature. Therefore, identification of appropriate repair activities' sequence requires application of a special methodology. A rather popular method, namely DEcision-MAking Trial and Evaluation Laboratory (DEMATEL) (Fontela and Gabus 1974) is applied in the paper for the classification of the criteria. Its extension using the zero unitarisation method (ZUM) allows to combine the influence of different points of view (called for short just merits) seamlessly. The proposed approach allows to identify the role of criteria governing assessment of policy alternatives to make more justified, multi-criteria policy choices.

Some authors believe that in developing project management methods the investigation of both project success and critical success factors should be made. One of the major aspects is project or contract management (Brauers and Zavadskas 2009). Contractors of international construction projects are often faced with complicated situations working in the conditions of uncertainty in construction. Project developers need various models of managing large and complex projects. One of the potential risk factors (Peldshus 2008) is associated with the requirements of contract conditions. Contractual relationships are mainly based on confrontational situations (Zaghloul and Hartman 2003; Keršulienė 2007; Mitkus and Trinkūnienė 2008; Turskis 2008) that reflect the level of trust (or mistrust) in the contract documents. Project management embraces the development of contract to be signed by employer and one or more contractors. Economic success of both parties largely depends on the contract developed, which also determines the behaviour of managers seeking to increase profit and protect themselves from losses (Branconi and Lock 2004). A simple quantitative method for evaluating the requirements defined in specifications of the contract is presented in (Ustinovichius *et al.* 2009). The suggested method for evaluating contract effectiveness may be widely applied at one of the stages of project management.

Many decision-making problems may be formulat as global optimization problems. Most numerically promising methods for solving multivariate unconstrained Lipschitz optimization problems of dimension greater than 2 use rectangular or simplicial branch-and-bound techniques with computationally cheap, but rather crude lower bounds. The branch-and-bound algorithm with simplicial partitions for global optimization, proposed in paper (Paulavichius and Zilinskas 2009), uses a combination of 2 types of Lipschitz bounds. One is an improved Lipschitz bound with the first norm. The other is a combination of simple bounds with different norms. The efficiency of the proposed global optimization algorithm is evaluated experimentally and compared with the results of other well-known algorithms. The proposed algorithm often outperforms the comparable branch-and-bound algorithms.

Business management often deals with job scheduling tasks being an important counterpart in logistics and supply chain management. The Operational Variable Job Scheduling problem is a more general version of the Fixed Job Scheduling problem, involving a time window for each job larger than its processing time (Kovalyov *et al.* 2007). The objective is to find the optimal subset of the jobs that can be processed. An interesting application area lies in Optimal Berth Allocation, which involves the assignment of vessels arriving at the port to appropriate berths within their time windows, while maximizing the total profit from the served vessels. Eligibility constraints are also taken into consideration. An integer programming model for the problem has been developed in (Eliiyi *et al.* 2009). Since the problem is NP-hard, a constraint-graph-based construction algorithm for generating near-optimal solutions has been developed. The computational results also reveal that proposed Randomized Constraint-Graph-Based Algorithm (RCGA), which exploits special structural characteristics of the problem, outperforms genetic algorithm as a construction algorithm in both solution time and quality. As the computational experiment reveals, the RCGA algorithm can be used in finding near-optimal solutions to the berth allocation problem. The performance of the algorithm does not deteriorate as the number of berths or ships increase. Since it takes very little time, the algorithm can be run daily or even more frequently. It can

also serve many other application areas of the problem, such as the assignment of gates to incoming aircrafts in an airport. For different application areas, some extra considerations may also prove useful, such as shifts or availability constraints for the machines.

We live in dynamic environment, where everything is in flux, and decision-maker has to make intelligent decisions based on uncertain and incomplete information. In conditions of objective existence of risk and connected with it financial and other losses there is a need for the certain mechanism which would allow to take risk into account while making decisions (Geoff 1999). The substantiation of necessity of the enterprise risk level integral estimation is provided in the paper (Vlasenko and Kozlov 2009). A calculation method for determining the probability curve of enterprise financial losses level have worked out. Examples of risk curve use are given. Methodology of plotting the curve of possible loss probability, or at least determination of regions and indices for acceptable, critical and catastrophic risk, is seen as quite an efficient tool of management decision-making by an organization.

Development of the distance learning courses is closely related with wide spectrum of intelligent decision technologies. The quality of the distance learning courses is largely influenced by competently prepared educational resources and an effective study support system. One of the possible ways to improve distance learning infrastructure and increase its effectiveness is to extend the architecture of present e-learning systems by the components for adaptable and sustainable learning. The research performed in (Dzemydienė, Tankelevičienė 2009) is devoted to developing the service-oriented distance learning environment adaptable to the user's needs. The proposed adaptable communication environment of distance learning is constructed by integration of new components of communication scenarios generation, adaptable for student's goals, multilayered domain ontology of learning subject and forming intelligent agents' framework possible. The paper presents the knowledge-based component architecture of the distance learning system, which enables better adaptation of learning resources to students, and analyses the possibilities of integrating ontology into the e-learning system. A conceptual approach is proposed for extending the existing distance learning system architecture by intelligent and deeper knowledge layers.

3. Decisions in economic systems

Study of phenomena of economic bubbles is the challenging in a light of current global crisis, because they tend to cause misallocation of resources into non-optimal uses, and, thus, they are generally considered to have a negative impact on the economy. An economic bubble is the commonly used term for an economic cycle that is characterized by a rapid expansion followed by a contraction, often times in a dramatic fashion. While some bubbles happen naturally as a part of the economic cycle, some also occur as a result of investor exuberance and serve as correctives. These typically happen in securities, stock markets, real estate and various other business sectors because of certain changes in the way key players conduct business. Bubbles that happen in equities markets and economies tend to cause resources to be transferred to areas of fast growth. At the end of the cycle of a bubble, the resources are then moved again, causing prices to suddenly deflate. Therefore the main problem is the causes of economic bubbles and the specific characteristics allowing to define the bubble.

The exact cause of economic bubbles has been discussed by many economists. In the paper of Girdzijauskas *et al.* (2009) model based on logistic function is developed for prediction of bubbles, which enables us to take prevention measures against bubbles creation. The article analyzes the types of economic bubbles, the reasons of their creation and to identify the main characteristics or symptoms indicating the bubble in the earlier stage of its appearance. For identification of the main features, allowing to forecast and prevent creation of bubble, the logistic growth models might be used. The method of the logistic investment management allows for a new treatment of the investment assessment and description of the reasons for the possible unsuccessful investment realization. The application of logistic growth models for economic bubbles analysis needs to be explored further seeking to develop effective tool for the prediction of economic bubbles, monitoring of stock and other markets.

The methods of systematic economic analysis and modelling are intensively applied not only in urban and industrial sectors but also in the research of agricultural development. Agrarian ecosystems are created due to human activity, which always has a purpose, i.e. to produce products, to protect nature, etc. Agrarian systems as well as natural systems are fed by the sun; however, in order to ensure high productivity of these systems the removal of nutrients together with production has to be compensated and the system has to be supplemented with large amounts of energy and materials. Sustainable development of farms requires the development of farming systems that contribute to the increase of farmer's income, reaching socially acceptable levels, the reduction of soil erosion and the improvement of physical and biological soil fertility (Ten Berge *et al.* 2000; Kropff *et al.* 2001). Optimal functioning of an agrarian ecosystem as a complex biological-social-technical system can be ensured only by systematic solution of the analyzed problems. As agrarian ecosystems combine biological and physical components, the social and agricultural production aspects have to be analyzed in them. As agrarian ecosystems combine biological and physical components, the social and agricultural production aspects have to be analyzed in them. Systematic approach requires a complex and comprehensive investigation of the analyzed object. The agrarian ecosystem as the one consisting of the components that interact among themselves and with external environment is analyzed in (Kurlavicius 2009). Decision Support System proposed, which estimates the efficiency of possible decisions and reduces uncertainty in management by means of analytical calculation or modelling methods, can help to evaluate and select the best possible agrarian decisions for farmers.

Knowledge management is the business activity intended to solve critical enterprise adaptability and competitiveness issues in the rapidly changing environment. The main goal of the knowledge management in enterprises is to create an organizational context for effective creation, storage, dissemination and use of enterprise knowledge, which are essential for securing enterprise competitiveness against the changing business environment and for setting the environment towards a desirable direction (Maier 2004). The problem of adjustment of business requirements and IT capabilities is known under the name of "Business and IT alignment" (Henderson, Venkatraman 1990). The process-oriented Knowledge-based Enterprise Model (KBEM) is presented in (Gudas 2009) by modifying Porter's Value Chain Model (VCM). The presented approach to the knowledge-based enterprise which is based on information technologies is grounded on the knowledge-based IS engineering paradigm. The

concept of the Enterprise Knowledge Space is defined, which delineates the boundaries and granularity of enterprise knowledge layers and components. The framework of the Enterprise Knowledge Space is based on the analysis of enterprise domains and aspects of the enterprise knowledge generalized by the following concepts: the Enterprise Knowledge Component and the modified VCM including knowledge management layer. The Enterprise Knowledge Space supports analysis and integration of knowledge about different domains and aspects of Enterprise management activities and is aimed to develop the enterprise knowledge modelling method and a knowledge management tool.

4. Discussion and conclusions

The issue is focused on the extension of optimization techniques to structure, organization, and manipulation of information for automated and human decision-making. Simulation and optimization, which can be found in advanced planning and scheduling systems, can be employed for, e.g., inventory, production, procurement, and distribution planning, are surveyed too. Real-world applications and in software solutions, which assist in solving decision problems, complement to theoretical frameworks, described in papers. Information technologies for web-based intelligent systems environment, which offers generic, modular, flexible and scalable system solutions for information retrieval, extraction, fusion, knowledge discovery and intelligent decision support, might be a subject of future research extending optimization in decision-making.

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