82ème journees ADMC

82nd meeting MCDA

Actes / Proceedings

Odense

September 24-26, 2015

EWG-MCDA
EURO Working Group
on Multicriteria Decision Aiding

Syddansk Universitet
UNIVERSITY OF SOUTHERN DENMARK

82ème Journées du Groupe de Travail Européen «Aide Multicritère à la Décision»
82nd Meeting of the European Working Group «Multiple Criteria Decision Aiding»
University of Southern Denmark, Odense, DENMARK
24-26 Septembre 2015 - *24th – 26th September 2015*

Day 1: 24 September 2015

Venue: University of Southern Denmark, Campusvej 55, 5230 Odense M.
Frequent busses (no 41 & 42) between train station and Campus site.
Registration: Campus hall (Campustorvet) up the stairs from the main entrance
Meeting: Auditorium 0100 by the main entrance

12:00 – 12:45	**Enregistrement / Registration of participants**
12:45 – 13:00	**Mot de bienvenue / Welcome address**
13:00-14:30	**Session 1, Chair:** Aida Valls
	Arayeh Afsordegan, Luis Del Vasto-Terrientes, Aida Valls, Núria Agell, Mónica Sánchez: A Hierarchical Assessment to Find the Most Sustainable Wind Farm Sites
	Jafar Rezaei, Chrysoula Vana, Lori Tavasszy: A green supplier segmentation using supplier potential matrix, ELECTRE TRI-C and carbon impact assessment
	Marco Cinelli,Stuart R.Coles, Mallikarjuna N.Nadagouda,Jerzy Błaszczyński, **Roman Słowiński, Rajender S. Varma, Kerry Kirwan:** Multiple Criteria Decision Aiding Moves Sustainable Nanotechnology Forward

Discussion papers
Marcus Brandenburg: Simulation and optimization to configure eco-efficient supply chains under consideration of performance and risk aspects
Fouad BEN ABDELAZIZ, Volker KUPPELWIESER and Olfa Meddeb, Unstable interactions in customers' decision making

14:30 – 14:45	**Coffee break**
14:45 – 16:15	**Session 2, Chair:** Roman Słowiński
	Alessandro Hill, Silvia Schwarze: Multi-objective design of ring tree networks under single-node-failures
	Ewa Konarzewska-Gubala, Mostefa Ider: Stochastic Goal Programming for Energy Mix Portfolio Selection (case of Poland)
	A.R. Pizarro, M. Münster and H.Ravn: Waste management with multiple objectives - a Danish case

Discussion papers
S. Rozakis: Multi-objective project selection for technology transfer in the academia

16:15 – 16:30	**Coffee break**

16:30 – 17:30	**Session 3, Chair:** Fouad BEN ABDELAZIZ
	Vasile Postolica: ISAC'S CONES.
	Erik Skov Madsen: Vocational Education and Vocational Skills - urgent need in European Production
17:30	**End of day 1**
20:00-22:30	**Official dinner in Restaurant Den Grimme Ælling (The Ugly Duckling),** Hans Jensens Stræde 1, 5000 Odense C

Day 2: 25 September 2015

Venue: Odense Adelige Jomfrukloster, Albani Torv 6, 5000 Odense C. This venue is an old convent in walking distance from the hotels in the city – see map.
Remember umbrellas or outdoor clothes as we walk 5 minutes for lunch restaurant.

09:00-10:15	**Session 4, Chair:** Aida Valls
	Skulimowski, Andrzej M.J: Applications of Anticipatory Networks to Planning Sustainable Decisions
	Stanislav E. Shmelev: Multidimensional Assessment of Sustainability at the Macro Scale
Discussion papers	
Tobias Rebs, Marcus Brandenburg: Inter-Organizational Quantitative Modeling for Sustainable Supply Chain Management	
10:15-10:30	**Coffee break**
10:30-12:15	**Session 5, Chair:** Milosz Kadzinski
	Eduardo Fernandez, Jorge Navarro: An extension of ELECTRE TRI-B using enhanced boundaries
	Milosz Kadzinski, Tomasz Mieszkowski, Michal Tomczyk, Sebastien Bigaret: Construct your own ELECTRE method
	Ghaderi, Mohammad Ruiz Vegas, Francisco Agell, Núria: Modeling Heterogeneity in Group Decision-making
Discussion papers	
Miriam Martínez-García Aida Valls Antonio Moreno: Making decisions with ELECTRE from semantic data	
12:15-14:00	**Lunch break,** restaurant Den Grimme Ælling (The Ugly Duckling), Hans Jensens Stræde 1, 5000 Odense C. This is a 5 minute walk from the meeting venue.
14:00 - 14:30	**EWG MCDA events**
14:30-	**Session 6, Chair:** Figueira, J.R.,

15:30	**Patrick MEYER, Alexandru-Liviu OLTEANU**: Generalized multi-criteria majority-rule sorting for handling imprecise or missing evaluations
	Andrea Arcidiacono, Marta Bottero, Chiara D'Alpaos, Alessandra Oppio: Assessing the impact of urban quality on real estate market: a proposal for a MCDA framework

Discussion papers
Roman Slowinski, Milosz Kadzinski, Salvatore Greco: Collective Classification Decisions under Uncertainty and Rule Preference Model

15:30-15:45	**Coffee break**
15:45-17:15	**Session 7, Chair:** Luis Dias
	Tolga GENC, Mehmet KABAK: Designing a Hybrid Energy Model with MCDM Methods
	Luis Dias, Carolina Passeira, João Malça, Fausto Freire: Integrating Life-Cycle Assessment and Multi-Criteria Decision Analysis to compare bio-diesel alternative chains

Discussion papers
Brabant, Q. and Couceiro, M. and Figueira, J.R., An empirical study of k-maxitive Sugeno integral in multiriteria decision aid

17:15-17:30	**Conclusion**

Day 3: 26 September 2015	
09:00-17:30	**Group social activity**

Please contact the local organizing staff if there are any needs or questions:

Mathilde Møldrup	Maria H. Petersen	Marie Mose	Lene Holbæk
+45 30226504	Student help	+ 45 65503406	+ 45 65503271

Session 1

A Hierarchical Assessment to Find the Most Sustainable Wind Farm Sites

Arayeh Afsordegan, Luis Del Vasto-Terrientes, Aida Valls, Núria Agell, Mónica Sánchez
Aida Valls <aida.valls@urv.cat>

Wind Energy is a crucial field in the quest for renewable energy given its increasingly positive impact on sustainability. Apart from being a major source of renewable energy, wind farms are quick and easy to build, they produce no emissions and make low resource demands. This combination of virtues makes Wind Energy one of the most promising tools to confront global warming. At present, studies are not only focusing on improving wind turbines but also on the impact of wind farm siting (Lee *et al.*, 2009). The assessment and selection of the best site in a given area must take into account several sustainability issues, involving technical, economic, environmental and social criteria. This paper considers the problem of finding suitable sites for wind farms in a region of Catalonia. Given public concerns about the impact of wind farms, the alternatives considered were based on combining information from participatory processes, interviews and a review of the projects in the regions of Urgell and La Conca de Barberà in Catalonia made by Gamboa *et al.* (2007).

A multi-criteria decision-making approach is used to select the most suitable site for the wind farms. Specifically, the hierarchical ELECTRE-III-H method proposed in Del Vasto *et al.* (2015) is used because the decision-maker is interested in analysing not only overall suitability but also the preference relations between different sites in relation to several sub-parts of the problem. ELECTRE-III-H is able to construct a partial pre-order at different levels of a hierarchy of criteria. In this direction, we have defined a hierarchy with two different levels of criteria. At the elementary level (the lowest), 9 indicators are taken into account. The intermediate level consists of 4 criteria: technical, economic, environmental and social. Finally, the goal level seeks the most sustainable solution.

A robustness analysis compares different scenarios with strict, normal and optimistic preference, indifference and veto thresholds. Results show that the best site found at the intermediate nodes is different for technical, economic, environmental and social criteria. Therefore, the best overall solutions change depending on the preference and veto thresholds fixed at each of these intermediate criteria so that the decision-maker can build the model that best represents the overall influence of each of these dimensions.

Acknowledgements

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A green supplier segmentation using supplier potential matrix, ELECTRE TRI-C and carbon impact assessment

Jafar Rezaei
(*Corresponding author*)
Assistant Professor
Transport and Logistics Group, Faculty of Technology, Policy and Management
Delft University of Technology, 2628 BX Delft, the Netherlands
Phone: +31 15 27 81716
Fax: +31 15 27 82719
j.rezaei@tudelft.nl

Chrysoula Vana
Researcher
Faculty of Technology, Policy and Management
Delft University of Technology, 2600 GA Delft, the Netherlands
Phone: +31628529217
Fax: +31 15 27 82719
c.vana@student.tudelft.nl

Lori Tavasszy
Professor
Transport and Logistics Group, Faculty of Technology, Policy and Management
Delft University of Technology, 2628 BX Delft, the Netherlands
Phone: +31 15 27 86343
Fax: +31 15 27 82719
l.a.tavasszy@tudelft.nl

Abstract – In the past decade, there has been an increasing interest in green supply chain management, integrating environmental thinking into supply chain management. Assessing a supplier's potential for improvement is very important when an organization wants to achieve certain environmental targets concerning their supply base, taking into account the limited resources available. In this paper, incorporating environmental evaluation criteria into a comprehensive supplier segmentation approach called 'supplier potential matrix' (SPM), a green supplier segmentation is proposed to segment the suppliers. Two overarching dimensions – supplier's capabilities and supplier's willingness - are used to evaluate the supplier's green potential. The two dimensions are measured by multiple criteria. We used ELECTRE TRI-C to solve the resulted multi-criteria decision-making problem. In order to make a more meaningful distinction, a simple method is also proposed to assess the suppliers with respect to the carbon footprint of the raw materials they supply. The results of this assessment are combined with the ones of the SPM, resulting in a more useful segmentation. The proposed model is applied to a sample containing the suppliers of a large international chemical company.

Multiple Criteria Decision Aiding Moves Sustainable Nanotechnology Forward

Marco Cinelli[1,*], Stuart R. Coles[1], Mallikarjuna N. Nadagouda[2], Jerzy Błaszczyński[3], Roman Słowiński[3,4], Rajender S. Varma[5], Kerry Kirwan[1]

[1] WMG, International Manufacturing Centre, University of Warwick, Coventry, UK

[2] ORD, NRMRL, WSWRD, WQMB, U.S. Environmental Protection Agency, Cincinnati, Ohio, 45268, United States

[3] Institute of Computing Science, Poznań University of Technology, Poland

[4] Systems Research Institute, Polish Academy of Sciences, 01-447 Warsaw, Poland

[5] Sustainable Technology Division, National Risk Management Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio, 45268, United States

[*] (M. C.): e-mail: m.cinelli@warwick.ac.uk;

Abstract

The responsible development of nanotechnology depends on the capacity of assessing its implications on sustainability as well as providing decision makers with support when they are faced with complex decision-making problems. This research shows how the Multiple Criteria Decision Aiding (MCDA) framework and tools were used to foster the development of sustainable nanotechnology. This work builds upon a green-chemistry based classification model, exemplified for silver nanoparticles, and developed through the use of Dominance-based Rough Set Approach (DRSA-based model) (Cinelli et al. 2015). The robustness of the ensuing model was assessed via the use of another MCDA method, Stochastic Multiple Criteria Acceptability Analysis (ELECTRE-based model). In order to achieve such objective four research phases have been devised.

References

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Simulation and optimization to configure eco-efficient supply chains under consideration of performance and risk aspects

Marcus Brandenburg
Institution University of Kassel, Department of Supply Chain Management
Kleine Rosenstr. 3, Kassel, Germany
e-mail : brandenb@uni-kassel.de

Abstract

Formal models that support multi-criteria decision making represent a strongly growing area in sustainable supply chain management research. However, uncertainties and risks in formal models for green supply chain (SC) design are seldom considered. The paper at hand suggests a hybrid simulation and optimization approach to configure an eco-efficient SC for a new product under consideration of economic and environmental risks. Discrete-event simulation (DES) is applied to assess the financial, operational and environmental performance of different SC configuration options. The analytic hierarchy process (AHP) is employed to solve the resulting multi-criteria decision problem of choosing exactly one option. The Value-at-Risk (VaR) concept is adapted to reflect economic and environmental risks. The approach is illustrated at a case example of a fast moving consumer goods manufacturer.

The submitted paper suggests new approaches from the conceptual and modeling perspective. The adoption of the VaR concept to assess operational and environmental risks in SC configuration represents a novelty. Furthermore, the suggested SC configuration model combines DES and AHP and thus is a hybrid one which complements a majority of models for (green) SC design and configuration that either employ simulation tools or optimization techniques. In the considered case study, financial and environmental performance improvements as well as the mitigation of related risks are identied as conflictive objectives. The risk assessment of the SC options helps ensuring that a minimum (financial, operational or environmental) performance is achieved by a configured SC for a new product.

Keywords: Supply chain management, Sustainability, Carbon emissions, Discrete-event simulation, Analytic hierarchy process, Fast moving consumer goods

Session 2

Multi-objective design of ring tree networks under single-node-failures

Alessandro Hill1 and Silvia Schwarze2
1Institute of Maritime Logistics, Hamburg University of Technology, Hamburg, Germany
alessandro.hill@tuhh.de
2Institute of Information Systems, Department of Business Administration, University of
Hamburg, Hamburg, Germany, silvia.schwarze@uni-hamburg.de

Abstract:
In this work we study concepts to increase the reliability for customers in ring tree networks in the case of single-node failures. The considered networks are solutions for the NP-hard capacitated ring tree problem [2, 3, 4], a model that combines cycle structures with tree structures under capacity constraints. There are two groups of customers. Customers of type two need to be connected to a central node by rings. Type one customers can either be integrated into these rings or used to extend the rings by tree structures. Steiner nodes can be used whenever beneficial for the overall edge cost minimization.

Since customer nodes situated on sub-trees are still vulnerable regarding their connectivity to the rings or the depot we introduce criteria that measure reliability of the network in the case of a node failure. On the one hand we consider the minimization of the number of disconnected customers in case of an outage. On the other hand we aim at minimizing the number of connected components in such a case. These objectives are related to known concepts in network design, namely, sub-tree customer capacities and tree-degree-constraints. They both conflict with the cost-oriented goal. Therefore, we study the corresponding bi-objective models to derive Pareto optimal solutions.

Using an exact algorithm based on a mathematical formulation we compute the Pareto fronts for a set of instances using an iterative strategy. In this work we extend ideas developed in [1] for edge failure scenarios to node failures.

References
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Stochastic Goal Programming for Energy Mix Portfolio Selection (case of Poland)

E. Konarzewska-Gubala, M. Ider
Wroclaw University of Economics
Komandorska 118/120
Wroclaw, Poland
e-mail : ewa.konarzewska-gubala@ue.wroc.pl

Abstract

The purpose of this paper is to apply an extension of the mean-variance portfolio (MVP) concept, using the stochastic goal programming model to determine the optimal energy mix portfolio for electricity generation for Poland, in order to meet the 2020 renewable targets fixed by European Union. Three scenarios for the evolution of energy prices and demand for electrical power will be considered. Alternative portfolios consisting of power generated from coal, wind, solar biomass, and import will be considered.

We will show, that despite the high cost per kilowatt of electrical power generated from renewables like wind, solar etc., incorporating these types of energies in the future energy mix portfolio of Poland, will permit to not only achive 2020 targets in terms of gas emission, but as well reduce costs, and better mitigate risk.

Given the high reliance of Poland on coal fired power plants, and the benefits that can be brought by renewables, it is extremely useful to investigate the impact of incorporating larger shares of these types of energies in the polish energy mix on cost, risk, and reduction of gas emission.

Waste management with multiple objectives - a Danish case

A.R. Pizarro*, M. Münster* and H.Ravn**
*Systems Analysis Department, Management Engineering, Technical University of Denmark, Produktionstorvet 426, DK-2800 Kgs. Lyngby, Denmark
**RAM-løse edb, Æblevangen 55, DK-2765 Smørum, Denmark

hans.ravn@aeblevangen.dk

Abstract:

In the Danish and EU context there is increased attention to waste management. In this perspective the ongoing Topwaste project has the objectives of improving use of waste for energy or material recycling, integrating economic, environmental and resource scarcity considerations.

The framework around management of waste and use of waste for energy is changing. The waste sector faces increased privatization, a growing international market, rising waste amounts and ambitious goals for increased material recycling. Meanwhile, the energy sector faces increased demand for renewable energy, including organic waste, as well as increased demand for flexibility in the energy system due to increased exploitation of wind and other fluctuating energy sources.

Optimization of the waste management and energy system requires complex, and sometimes conflicting, decision-making, with a consideration and integration of economic, environmental and social impacts. There is not a long tradition in the Danish central administration of integrated planning in waste and energy sectors, and multi-criteria decision analysis is a promising tool for mutual communication and clarification between decision-makers in both sectors.

The paper presents a decision support tool which targets the energy and waste sectors. Joint handling of the district heating and waste systems is undertaken at a national level in a new linear programming tool called OptiWaste. The model optimizes both investments and operation taking spatial distribution and fluctuating demands and productions into account. The model facilitates multi-objective optimization of economy, emissions and material recycling and makes it possible to identify appropriate joint development paths of the energy and waste sectors subject to different scenarios related to e.g. the expected level of biomass consumption or wind energy exploitation in the surrounding energy systems.

The model determines the Pareto frontier, which may be visualized for decision makers' evaluation. Additionally a subrange of the Pareto frontier may be identified by specifying an ideal point in the criteria space and finding the point with minimum distance to it. For any Pareto optimal point the underlying physical solution is analysed, in terms of energy and waste treatment plants established in each specific area, fuels consumed in the different plants, extension of various treatment options applied, etc.

Multi-objective project selection for technology transfer in the academia

S. Rozakis
Agricultural University of Athens, Iera Odos 75, 11855 Athens, Greece
email: s.rozakis@aua.gr

Abstract:

Technology transfer in universities has received a great deal of attention these days and beginning from the US numerous offices have been created to promote commercial use of research conducted by academics. The main role of tech transfer offices is to develop stemming from basic research into commercially viable products or services to the benefit of spin-off or existing companies. Universities often venture in technology transfer without much experience and lacking entrepreneurial culture. This is the case in agricultural sciences in Greece where there is a long tradition on extension services focusing on farmers, however research outcome concerning food industry usually remains latent. In this context an ad hoc tech transfer office supported by an ongoing project has undertaken an extensive campaign scanning all laboratories in the Agricultural University of Athens for invention disclosures. It is extremely important for the viability of this initiative to make the right decision selecting sustainable projects and the selection process to compare with good practices from elsewhere at the same time adapted to specific conditions of the case study.
Proposals received comprise 40 innovative business ideas elaborated by faculty and research staff, and they may be classified in several types, such as new products in agriculture or in industry, innovative processes, novel test and/or certification methods, applications/software, services etc. Funding is provided for a small number of selected proposals to implement fully fledged business plans for appropriate action (spin-off, licensing, etc.) and contacts with potential investors. The selection will be based on various criteria grouped into three categories: Technical maturity and degree of innovation, business sustainability and capacity of the project team to be involved. These aspects consist of several sub-criteria respecting the principles of coherence in multi-criteria analysis.
The selection of a subset of alternatives using multiple criteria belongs to the ranking or sorting problematique. The decision situation becomes more complex if in addition to the multiple evaluation criteria the decision-maker has to comply with specific limitations e.g. segmentation or policy constraints that characterize the final selection. This is the case as the Tech transfer managers wish to select proposals in such a way that all University Departments and all different types of ideas are represented. Moreover, the University administration strategy may wish some kind of diversification, to target to a minimum number of spin-offs, a number of licences, providing services etc. These constraints distort the independence of the alternatives, a usual, underlying concept in most MADM methods. In the presence of segmentation constraints the decision problem becomes combinatorial and the actual options for the decision maker are the combinations of the alternatives that comply with the segmentation constraints.
Several applications are reported in the literature concerning resource allocations problems in IT, the academia and the industry. One way to deal with is to use a two phase approach: first obtain a multi-criteria evaluation of the alternatives using an MADM method that evaluates the individual alternatives and then use this information in the objective

function of an IP model that incorporates the constraints.

In the current work we apply an extension of the PROMETHEE V method, named PROME-THEE V2 that fully exploits the advantages of the PROMETHEE family methods and offers more flexibility to the decision maker. We use information provided by PROMETHEE I in the form of leaving (φ^+) and entering (φ^-) flows to formulate a bi-objective IP problem. In order to help the decision maker choose his/her most preferred solution a decision aid process is also developed. PROMETHEE V2 is particularly appropriate for group decision making as it can effectively and transparently incorporate the preferences of all the stakeholders in the final decision.

Session 3

ISAC'S CONES

Vasile POSTOLICĂ
Romanian Academy of Scientists,
„Vasile Alecsandri" University of Bacău, Faculty of Sciences,
Department of Mathematics, Informatics and Educational Sciences România,
E-mail: vpostolica@ambra.ro

Abstract:

 This is a very short research work representing an homage to the regretted Professor George Isac, Department of Mathematics and Computer Science, Royal Military College of Canada, P.O. 17000, Kingston, Ontario, Canada, K7K 7B4. Professor Isac introduced the notion of "nuclear cone" in 1981, published in 1983 and called later as "supernormal cone" since it appears stronger than the usual concept of "normal cone". For the first time, we named these convex cones as "Isac's Cones" in 2009 , after the acceptance on professor Isac's part. This study is devoted to Isac's cones, including significant examples, comments and several pertinent references, with the remark that this notion has its real place in Hausdorff locally convex spaces not in the normed linear spaces, having strong implications and applications in the efficiency and optimization. Isac's cones represent the largest class of convex cones in separated locally convex spaces ensuring the existence and important properties for the efficient points under completeness instead of compactness.

Keywords: Isac's (nuclear or supernormal) cone, topology, locally convex space.

Vocational Education and Vocational Skills-urgent need in European Production

Erik Skov Madsen
Department of Technology and Innovation
Campusvej 55, Odense M
Denmark
e-mail : esm@iti.sdu.dk

Abstract:

This paper and presentation is based on case studies in China, Mexico and Denmark. The paper identifies challenges posed to production companies by a lack of vocational skills and vocational education. The study is focusing very on different types of production systems i.e. on manual, complex and automated production. The paper highlights how both China and Denmark have focused on theoretical rather than vocational education for more than a decade.

  Based on a combination of a literature review and field studies of cases, including studies of mass production and unmanned and automated production, a framework of skills related to process tasks is developed. The paper and the presentation conclude that much more focus is needed on the development of vocational education and vocational skills in Denmark, the U.K, and in the U.S. and in China for employees to be able to handle future automated and advanced production systems.

Session 4

APPLICATIONS OF ANTICIPATORY NETWORKS TO PLANNING SUSTAINABLE DECISIONS

Andrzej M.J. Skulimowski[1,2]

[1]AGH University of Science and Technology, Chair of Automatic Control and Biomedical Engineering, Decision Science Laboratory, Kraków, Poland; [2]International Centre for Decision Sciences and Forecasting, Progress & Business Foundation, Kraków, Poland, Email: ams@agh.edu.pl

Abstract:

This paper will present some recent extensions of the Anticipatory Networks (AN) decision model in the context of their applicability in multicriteria sustainable planning. Specifically, we will show how to apply the anticipatory decision-making principle to construct and filter scenarios that correspond to the sustainable future.

AN are a new tool in multicriteria decision making that is strongly combined with researching the future. It formalises multi-stage multicriteria planning and multicriteria backcasting. AN generalise earlier anticipatory models of decision impact in multicriteria problem solving [2] and constitute an alternative decision model to utility or value function estimations and diverse heuristics. In this model a multicriteria decision problem is modelled as a starting node in an anticipatory network, while the other nodes model the consequences of the decisions to be made or other multicriteria problems that depend on other problems or their consequences in a network. The decision choice is made based on a constructive analysis of causal relations that link the outcomes of the initial MCDM problem with their future consequences. Furthermore, it is assumed that future decision makers take into account the anticipated outcomes of some future decision problem linked by the causal relations with the problem being just solved. This fits exactly the common understanding of sustainable decisions, which main virtue is to allow "future generations" (of decision makers) benefitting from the decision framework passed by their predecessors. In the above causal network of decision problems this is formalised by the relations of anticipatory feedback. The latter allow to confine the sets of admissible nondominated decisions at starting nodes of anticipation taking into account the dependence of constraints and preferences in future decision problems on the outcomes of the decision just made. Since only some decisions may lead to desired consequences, this allows the decision makers to construct and apply an additional preference structure to the originally existing at the initial problem. Thus an AN is a multigraph which consists of both types, causal and anticipatory relations. Usually, it is supplemented by forecasts and exploratory scenarios regarding the future decision model parameters, a preference structure over the set of anticipatory feedbacks, an information exchange relations between decision makers which are not connected by a causal relations and so on. All they form a complex information model.

A real-life anticipatory network model G can be built if the following information about the future is available:
- Exploratory scenarios or forecasts concerning the parameters of future decision problems represented by the decision sets U, criteria F, the preference models θ of the future decision makers, and the type of their anticipated behavior (rational/partly rational/irrational),
- The parameters of the causal dependence relations r linking the nodes in the network,

- The anticipatory feedback relations pointing out which future outcomes are relevant when making decisions at specified nodes, and specifying the anticipatory feedback conditions.

Algorithms filtering the plausible exploratory scenarios taking into account the preference information contained in an anticipatory network G may be applied if we know that:

- All future agents whose decisions are modelled in the network are rational, i.e. they make their decisions complying with their preference structures,
- An agent can assess to which extent the outcomes of causally dependent future decision problems are desired. This relation is described by multifunctions linking present-time decisions with future constraints and preference structures,
- The above assessments are transformed into decision rules for the current decision problem. It should also be assumed that the latter affects the outcomes of future problems in a way known to the agent,
- There exists a relevance hierarchy H1 in the network G; usually the more distant in time an agent is (modelled by a node in G), the less relevant the choice of his/her solution.
- There exists a family of relevance hierarchies H2 of anticipatory feedbacks in the network G; usually the more distant in time an agent is, the less relevant the choice of his/her solution.

H1 and H2 allow the decision maker at the initial problem to derive a partial order that defines the sequence of operations in a decision selection algorithm. The decision making process in an AN is equivalent to filtering the set of all causal chains in the network that are determined by sequences of admissible decisions made along a causal path. This procedure is valid for the networks of cooperative agents as well as for hybrid networks [1] that include antagonistic games with Nash equilibria.

As an application example we will present the AN model built to align the innovative investment projects to a regional sustainable development strategy based on smart specializations. A related example refers to the strategy planning for a regional Creativity Support Centre, where the recommendations to the R&D policy makers are derived with an AN model. The above models benefit from data gathered with foresight and forecasting tools such as a group model building application and an online multiround Delphi (cf. www.ict.foresight.pl).

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Multidimensional Sustainability Benchmarking for Megacities

Stanislav E. Shmelev
Director, Environment Europe Ltd, Oxford, UK
E-mail: stanislav.shmelev@gmail.com

Abstract.

Urban sustainability assessment is required for the purposes of establishing strategic directions for 'greening' our cities to reduce the environmental impact of their performance, improve employment and economic viability and enhance the quality of life. This paper considers large world cities: London, New York, Hong Kong, Los Angeles, Sao Paolo, Rio de Janeiro, Paris, Berlin, Singapore, Shanghai, Sydney and Tokyo. The progress towards urban sustainability is defined as a multidimensional improvement. To assess urban sustainability performance, the paper applied Principal Component Analysis and Multi-Criteria Decision Aid tools to compare the cities on the range of dimensions: economic (Gross Regional Product, GRP), social (unemployment, Gini index) and environmental (carbon dioxide emissions, emissions of particulate matter, PM10), etc. The multi-criteria methods chosen for this assessment are ELECTRE III, NAIADE and APIS. The results have shown that Singapore dominates the sustainability rankings in most multi-criteria applications, showing particular strength in economic and environmental dimensions and a slightly less strong performance in the social dimension according to the APIS results. The paper explores the reasons why Singapore achieved such success, namely innovative sustainability strategy and new governance structures. Shanghai and Rio de Janeiro have been identified as cities with the lowest level of sustainability achievement and therefore the highest potential for the development of green economy.

Keywords: megacities, multi-criteria analysis, sustainability, Gini index, unemployment, CO2, emissions, waste, recycling, PM10, ELECTRE, NAIADE, APIS, policy

INTER-ORGANIZATIONAL QUANTITATIVE MODELING FOR SUSTAINABLE SUPPLY CHAIN MANAGEMENT

Tobias Rebs
Technische Universität Berlin, Department of Operations Management
Berlin, Germany
e-mail : tobias.rebs@tu-berlin.de

Marcus Brandenburg
Institution University of Kassel, Department of Supply Chain Management
Kleine Rosenstr. 3, Kassel, Germany
e-mail : brandenb@uni-kassel.de

Abstract

The consideration of environmental and social aspects has become essential for the management of supply chains where decision-making is particularly supported by formal models. This paper employs content and cluster analysis to review inter-organizational quantitative models for sustainable supply chain management (SSCM). In pursuit of greater insight into model purposes in conjunction with triggers for SSCM and sustainable risk management, this review confirms the preponderance of deterministic approaches focusing on the interplay of economic and environmental aspects while social indicators are broadly omitted. It is detected that stochastic approaches to model all factors of the triple bottom line are missing so far. Moreover, stakeholder pressures and incentives as well as sustainability-related risks measures are underrepresented, which calls for further research in this respect.

In a second step we intend to compare the findings on formal SSCM models to the results of a respective analysis of empirical and conceptual papers on SSCM. This approach illustrates to which extent formal SSCM models complement empirical / real-life applications of SSCM constructs and it points towards research gaps that need to be filled by formal SSCM models in order to exploit their full potential in the practical application context.

Keywords: decision support, formal modeling, literature review, sustainability, supply chain management, triple bottom line

Session 5

AN EXTENSION OF ELECTRE TRI-B USING ENHANCED BOUNDARIES

Eduardo Fernandez   Jorge Navarro

Universidad Autónoma de Sinaloa,
Ciudad Universitaria, Facultad De Ingenieria blvd. Las Americas s/n
Culiacan, Mexico
e-mail: eddyf171051@gmail.com

Abstract

Multi-criteria sorting is a particular case of classification problems, which has received increasing interest in recent years. In the framework of outranking approaches, the most widely used method is ELECTRE TRI, recently renamed as ELECTRE TRI-B. In this method, a boundary action (reference or limiting profile) is introduced to establish the boundary between adjacent categories. As an alternative method, Almeida-Dias et al. (2010) proposed ELECTRE TRI-C, where each category is defined through a single characteristic reference action. One can question if a single reference action (or limiting profile) is sufficient for an acceptable characterization of its related category (or boundary between adjacent categories). If the action to be assigned were incomparable with most actions in the reference set, an outranking-based sorting method would suggest ill-defined (vague) assignments. If each category is defined by a set of several reference actions, it enriches the definition of categories and allows narrower ranges of categories to which an action can be assigned. This idea inspired ELECTRE TRI-nC as a generalization of ELECTRE TRI-C. The present proposal rests on a similar idea applied to the boundaries between categories.

Let $\{C_1, \dots C_M\}$ ($M \geq 2$) be a set of ordered categories. C_M is assumed to be the most preferred one. The boundary between C_k and C_{k+1} is here characterized by a set of limiting profiles $B_k = \{r_{k,j}\}$ such that:

For $k=1, \dots M-1$

    a) $r_{k,j}$ belongs to C_{k+1};

    b) if $r_{k,j}$ is preferred to x, then x belongs to C_k;

    c) the elements in B_k are dominated by those in $B_{k'}$ ($k'>k$).

For the assignment of an action x, the degree of credibility of outranking and a threshold level λ are used in order to define λ-outranking relations and λ-strict preference relations between x and the boundaries B_k. We are interested in two exclusive situations: i) x λ-outranks B_k and ii) B_k is λ-preferred to x. Exploring the set of categories in increasing and decreasing order, Conditions i) and ii) allow sorting x by using pseudo-conjunctive ('pessimistic') and pseudo-disjunctive ('optimistic') logics as in ELECTRE TRI-B. The pseudo-conjunctive assignment is always equal to or lower than the pseudo-disjunctive one.

The new method holds similar properties to ELECTRE TRI-B: Uniqueness, independence, conformity (if x is λ-preferred to B_{k-1} and B_k is λ-preferred to x, then x is assigned to C_k), monotonicity, homogeneity, and stability on merging and splitting operations.

In some computer experiments the new proposal clearly outperforms ELECTRE TRI-B.

Construct your own ELECTRE method

Miłosz Kadziński, Tomasz Mieszkowski, Michał Tomczyk, Sebastien Bigaret
Poznań University of Technology, Poland
Email: Milosz.Kadzinski@cs.put.poznan.pl

Abstract:

All ELECTRE methods are based on the same rule: they first construct an outranking relation for all ordered pairs of compared objects, and then exploit this relation to deliver recommendation in function of the specific problem to solve. Several approaches have been designed for the three main types of multiple criteria problems: choice (e.g., ELECTRE I, Iv, and Is), ranking (e.g., ELECTRE II, III, and IV) and sorting (ELECTRE TRI-B, TRI-C, and TRI-rC). In fact, these methods are sequences of the elementary well-defined steps which contribute to some particular implementation of the construction and exploitation phases. When it comes to formalizing the general concepts of concordance and discordance, none of these approaches tolerates the freedom in their interpretation. As a result, each ELECTRE method is distinguished not only by its unique exploitation procedure, but also by the way it constructs an outranking relation. While these two phases are independent, paradoxically, a new approach can be obtained each time when coupling together the existing construction and exploitation procedures that have not been yet considered within a common methodological framework. Such developments are still considered valuable, because they are mainly application-driven, thus, allowing to deal with a specific multiple criteria problem at hand.

The contribution of this paper is of both methodological and software nature. It consists in postulating flexibility in constructing ELECTRE methods so that they are well suited for dealing with the specific real-world decision problems, and implementing this paradigm in practice. For this reason, we have designed a wide spectrum of elementary ELECTRE-based components that are able to interoperate, and make them available via the diviz platform. The proposed methodological bricks are useful for designing advanced approaches, supporting the analysts in both problem structuring and preference elicitation process.

At the stage of construction of an outranking relation, we consider a variety of procedures for carrying out the concordance and (non-)discordance tests, computing the credibility of an outranking relation, and checking the validity of a crisp relation. These are derived, e.g., from Electre Is, Tri-B, III, IV, and MR-Sort. We also account for the concepts which are not linked to any specific approach, such as modeling interactions between criteria, the effects of reinforced preference and counter veto, using pre-veto (discordance) thresholds, or numerous procedures for aggregating concordance and discordance degrees into a valued or crisp outranking relation. We ensure universality of the implemented modules so that they admit comparison of alternatives either with each other or with class profiles (boundary or characteristic ones). In this way, we provide means for constructing an outranking relation that may be subsequently exploited to derive choice, ranking, or sorting recommendation.

At the stage of exploitation of an outranking relation, we consider the following approaches: algorithms for finding the graph kernel as in the ELECTRE I methods, distillation and ranking procedures of ELECTRE III/IV, Net Flow Score rules for exploiting valued and crisp outranking relation, and class assignment rules of ELECTRE Tri-B, ELECTRE Tri-C, and ELECTRE Tri-rC. Taking advantage of such components, the user may "construct her/his own ELECTRE" in a few minutes without any mathematical or programming skills. This construction process boils down to combining the modules in one of several hundred ways that are possible with our proposal and discussed in the paper.

Disaggregation Approach for Understanding Diversity in Collective Preferences

Mohammad Ghaderi, Núria Agell
ESADE Business School, Universitat Ramon Llull
Av. Pedralbes, 60-62, 08034Barcelona, Spain
mohammad.ghaderi@esade.edu, nuria.agell@esade.edu

Francisco J. Ruiz
UPC-BarcelonaTech
Av. Víctor Balaguer, s/n, 08800Vilanova i la Geltrú, Spain
francisco.javier.ruiz@upc.edu

ABSTRACT

Understanding the heterogeneity in public preferences is a crucial issue in many strategic decisions. We propose a methodological framework to decompose preferences of a group, to represent their preference models by set of value functions, and to represent the heterogeneity level among preferences. Unlike classical aggregation method which pools information across respondents to the population mean, in our methodology the individual preferences are shrunk towards the most representative preference model for the entire group. The shrinkage is performed using Mahalanobis distance. Individual level preferences distant from the population preferences are penalized. Penalties are greater in the directions where less variation in preferences exists across individuals. The mathematical programming associated to the proposed model is convex under certain situations. Using this property, an efficient heuristic for solving the model is proposed. An illustrative example is presented to demonstrate model applicability.

Keywords: Preference Learning, Heterogeneity, Multiple Criteria Decision Aiding

Making decisions with ELECTRE from semantic data

Miriam Martínez-García, Aida Valls, Antonio Moreno
Departament d'Enginyeria Informàtica i Matemàtiques, Universitat Rovira i Virgili
Av Paisos Catalans, 26. 43007 Tarragona, Catalonia (Spain)
Email: miriam.martinez@urv.cat

Abstract:

Ranking a set of alternatives is a well-studied problem in MCDA. In our work we focus on the outranking method ELECTRE-III, which is able to construct a partial preorder from a pairwise comparison of a set of possible alternatives by means of pseudo-criteria.

Up to now outranking methods have considered mainly numerical and ordinal scales in the set of criteria. In our work we study the use of criteria built upon *semantic* variables, including additional domain knowledge by means of an ontology. The semantic variables are categorical multi-valued variables whose values are terms (i.e. tags) that can be interpreted at a conceptual level. The ontology is a knowledge representation structure that enables an exploration of semantic relationships between the terms found in the semantic variable [Gibert *et al.,* 2014].

The first goal is the redefinition of the procedure for constructing an outranking relation in ELECTRE-III from semantic multi-valued variables. These variables take on value a list of tags (i.e. terms) on each alternative. The concepts of the ontology correspond to these tags in order to be able to compare them semantically. Next, the ontology will also be used to store the user's preferences. Different models of representation of the preferences will be studied, such as the ones presented in [Valls *et al*., 2013].

In some application fields, semantic information takes an important role in the decision process. This is the case of recommender systems in Tourism [Borràs *et al.,* 2014]. When a tourist has to decide her destination, textual characteristics (i.e. tags) of the different places are key elements to be taken into account (e.g. types of activities to do, main landmarks, etc.). The study of this kind of techniques is crucial in the development of a new generation of semantic recommender systems.

This is a collaborative work between the ITAKA research group of University Rovira i Virgili and the Scientific and Technological Research Park in Tourism and Leisure (PCTTO) in Catalonia, Spain, in the frame of the Spanish research project SHADE (TIN- 2012-34369).

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Session 6

Generalized multi-criteria majority-rule sorting for handling imprecise or missing evaluations

Patrick MEYER, Alexandru-Liviu OLTEANU
Ecole navale
CC 600, F29240 Brest Cedex 9, France
e-mail :alexandru.olteanu@ecole-navale.fr

Abstract:

We propose an extension of a multi-criteria majority-rule sorting model that allows the handling of problems where the decision alternatives contain imprecise or even missing evaluations. Due to the imprecise nature of the evaluations we offer the possibility of assigning an alternative to one or more neighboring categories, both as input for inferring the model parameters as well as the output of the classification. Our contribution also contains an algorithmic approach for extracting the parameters of this model during an elicitation process, which is validated across a wide range of generated datasets.

Assessing the impact of urban quality on real estate market: a proposal for a MCDA evaluation framework

Oppio, M. Bottero, C. D'Alpaos, A. Arcidiacono
Politecnico di Torino, Dipartimento di Scienze, Progetto e Politiche del Territorio (DIST)
Viale Mattioli 39 - 10125 TORINO (ITALY)
e-mail marta.bottero@polito.it

Abstract:

Purpose

The purpose of this paper is to assess the impact of urban design quality and sustainable urban spaces on the market value of residential properties. Despite the advancement of research during the past two decades and empirical evidence about the relationship among real estate market and quality of open spaces and urban sustainability, there is still a lack of studies on urban quality assessment. Hedonic analysis (Rosen, 1974; Freeman, 1979) has been broadly developed by the use of poor attributes about qualitative features of location. This paper brings forward a multidimensional methodology for assessing the quality of open spaces, with the aim of supporting hedonic prices studies.

Methodology/approach

The contribution of this research is the proposal of a multimensional and multimethodological framework for assigning a score to the quality of open spaces. In particular, the Multi-Attribute Value Theory (Keeney and Raiffa, 1976) has been used for addressing the problem under investigation. The study combines Geographic Information Systems, Multi-Attribute Value Theory and Hedonic Price method in order to estimate the value of better urban design. Urban spaces, including green areas, walkable areas, streets and squares are evaluated with respect to the following attributes: a) accessibility; b) liveability; c) vitality and d) identity. The methodology has been applied on different neighbourhoods in the city of Milan, Italy.

Findings

The key findings show that private developers pay string attention to higher design quality of open space, as it has been demonstrated by comparing the scores assigned to new neighbourhoods mainly developed by private companies with ones with poor urban quality. The multi-methodological framework provides a robust basis for running different kind of analysis and for supporting policy and investment decisions both in the private and in the public sector.

Practical implications

This paper provides public sector, investors, developers with a tool able to put in evidence insights about those aspects of urban sustainability that are highly valued by real estate market. Given the decreasing role of the public sector in the provision of public spaces, demonstrating the value of better urban design by the assessment of its costs and benefits could provide private developers with robust elements for decisions.

The study bridges a significant gap in the literature concerning hedonic analysis of the added value of urban design on real estate market. The proposed multi-methodological approach constitutes a promising field of analysis for quantifying quality impacts of urban sustainability on properties value.

Keywords

Urban Quality, Real estate market, Multi-Attribute Value Theory, Sustainable development, Urban design

Collective Classification Decisions under Uncertainty and Rule Preference Model

Roman Słowiński[1,2], Miłosz Kadziński[1], Salvatore Greco[3,4]
[1]Poznań University of Technology, Poland;
[2]Systems Research Institute of the Polish Academy of Sciences;
[3]University of Catania, Italy;
[4]University of Portsmouth, UK

Abstract: Classification of acts described by outcomes that may be gained with some probabilities is a challenging problem mainly because an aggregation of the outcomes which leads to recommended classifications needs to respect preferences of a single or multiple decision makers (MDs). Moreover, the method used to assist the DMs has to satisfy their expectations concerning the type of recommendations. It should also rely on realistically available preference information, and handle a possible inconsistency of this information. Finally, it should use a preference model that aggregates the outcomes in an intelligible way, without the need of compensation between the different outcomes. To respond satisfactorily to the above requirements, we propose a methodology that relies on preference information in the form of classification examples provided by DMs on a subset of reference acts. As this information may be inconsistent with respect to stochastic dominance relation, it is structured using Dominance-based Rough Set Approach, and the resulting lower approximations of the quality class unions are used as an input for constructing a preference model in terms of "*if…, then…*" decision rules. Decision rules constitute an intelligible aggregation model that is non-compensatory and able to represent interactions between the outcomes. We induce all minimal-cover sets of rules, each one being compatible with non-ambiguous classification examples and satisfying some additional requirements imposed by the DMs, like assignment-based preference relations, and class cardinalities. Applying such compatible instances of the preference model on a set of all acts, we draw conclusions about the certainty of recommendation assured by different minimal-cover sets of rules. Then, we solve an optimization problem to get a univocal (precise) classification for all acts, taking into account the robustness concern. We also present a set of indicators and outcomes for judging the spaces of consensus and disagreement between the DMs.

Session 7

Designing a Hybrid Energy Model with MCDM Methods

Tolga GENÇ[1], Mehmet KABAK[2]

[1]School of Business, Aalto University, FI-00076, Helsinki, Finland
[2] Department of Industrial Engineering, Gazi University, 06570, Maltepe, Ankara, Turkey
Email: tolga95@yahoo.com

Abstract:
Climate change, pollution and energy supply are among the greatest problems of our time. Addressing them requires major changes in our energy infrastructure. Thus energy resources have been split in to three categories: fossil fuels, renewable energy resources (RES) and nuclear resources, we need a hybrid model of energy sources to supply our requirements. In order to bring an MCDM approach to hybrid model of energy infrastructures, we will design a fuzzy procedure for the weights of the criteria in the beginning.

It is getting to be clear that for energy supply, future will be mainly RES. But one may think rightly that RES (hydropower, solar energy, wind energy, modern bio-energy and geothermal energy) are lack of ability to supply power continuously. For that reason it is necessary to have hybrid model of RES and fossil fuels for the future needs. We will mainly develop a hybrid model for these requirements but at the initial stage, we will present a fuzzy MCDM approach for the weights.

RES can provide sustainable energy services, based on the use of routinely available, indigenous resources. But if the requirements are timely needed, the supply model should be a hybrid model of RES and fossil fuels. We chose wind energy to focus on it among RES and selected criteria to develop a sustainable model for future energy supply. In this proceeding, we will present a fuzzy technique for the method. We selected some criteria and apply a wide frame of questionnaire for wind energy to obtain sustainable and balanced energy supply.

Outcomes of the results in this study can provide guidance to energy planners in identifying the key factors and weights for the future energy requirements.

Integrating Life-Cycle Assessment and Multi-Criteria Decision Analysis to compare biodiesel alternative chains

Luis Dias, Carolina Passeira, João Malça, Fausto Freire
INESC Coimbra and Faculty of Economics, University of Coimbra
Av Dias da Silva 165, Coimbra, Portugal
e-mail : lmcdias@fe.uc.pt

Abstract:

The transport sector is highly dependent on fossil fuels with significant environmental impacts. This motivates environmental assessment studies of alternative fuel options, including biofuels based on agricultural crops, in particular biodiesel. The assessment of biofuel alternatives for transportation can be facilitated by Multi-Criteria Decision Analysis (MCDA) methods.

In this work we compare four Rapeseed Methyl Ester biodiesel production chains, corresponding to four different feedstock origins. The environmental impact of each chain is assessed in the context of a Life-Cycle Assessment (LCA) encompassing cultivation, transportation to Portugal, extraction and transesterification. We apply two different MCDA additive aggregation methodologies to aggregate various impact categories resulting from the Life Cycle Impact Assessment (LCIA) phase of the LCA.

The chosen MCDA methodologies, Stochastic Multi-Attribute Analysis and Variable Interdependent Parameter Analysis, are two complementary approaches to address one of the main difficulties of MCDA: setting the relative weights of the evaluation criteria. Indeed, weighting the various impacts in the LCIA phase is a controversial issue in LCA research and studies. The LCIA-MCDA approach proposed in this work does not require choosing a specific weighting vector, seeking to assess which conclusions are robust given some freedom allowed in the choice of weights. To study further the robustness of the conclusions, the effects of removing one criterion are analysed, one at a time.

An empirical study of k-maxitive Sugeno integral in multiriteria decision aid

Quentin Brabant and Miguel Couceiro
LORIA (CNRS, Inira Nancy Grand Est - Université de Lorraine)
Équipe Orpailleur Bâtiment B, campus scientifique
BP 239, F-54506 Vandoeuvre-lès-Nancy, France
fquentin.brabant, miguel.couceirog@inria.fr

José Rui Figueira
CEG-IST (Instituto Superior Técnico, Universidade de Lisboa)
Rua Rovisco Pais, Nº1, 1049-001 Lisboa, Portugal
figueira@tecnico.ulisboa.pt

Abstract: In this article, we are interested in the application of the Sugeno integral as a preference aggregation model for multicriteria decision aid. We study a parametrized notion of Sugeno integrals, namely, k-maxitive Sugeno integrals. These are simplified versions of Sugeno integrals that only take into account interaction of at most k parameters, thus giving rise to a preference aggregation model of lower computational complexity. Our preliminary results on real data seem to indicate that k-maxitive Sugeno integrals can provide good approximations when comparing non-parametrized and k-maxitive integrals on the same data sets, by simulated annealing. Our data consists of evaluations of hotels on several criteria as well as on global suitability. We show that the accuracy of k-maxitive Sugeno integrals for low values of k is close to the accuracy of non-parametrized Sugeno integrals, when trying to predict the global evaluation. Not surprisingly, when the problem is restricted to data subsets satisfying the Pareto condition, we observe an increase of the accuracy, especially when the value of k is high. Nevertheless, this discrepancy (between high and low values of k) becomes negligible when the latter Pareto assumption (seldomly verified in human evaluation) is not verified. We discuss these and other results, in particular, we indicate possible approaches to decide the most suitable value of k for a given problem.