Opinion Makers Section

Modern MCDA software: requirements and opportunities

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Keywords : design, agile life cycle, rich web applications, cloud

1. Introduction

Complexity, credibility and change: here are three issues we face in modern decision-making problems. These issues are far to be independent, and the mix is rather explosive. Therefore, the supporting software for the decision process needs special features. Why is that so explosive? What are the new requirements? Are there new opportunities? Let's drill.

Software is a major productivity enhancer for organizations. But nowadays in software, **change** is the only constant. Still, software only changes because business requirements and technology evolves on a growing rate. Merges and acquisitions, law enforcements, stock market and electronic components price variations are both constraints and opportunities. So evolution is an entropic but also a developing factor. It's just a fact.

According to Murphy's laws, modern organizations and business processes' **complexity** would grow until it exceeds the capability of the decision maker who must manage it. Therefore, the latter needs trusted expert evaluators and consultants. In the space-time continuum, the **credibility** of the whole process is based on previous success (karma) and on the credibility of the components: people, process, data and software. The person's qualifications and track record are solid arguments in the application for her role, as a decision maker or evaluator. The way decision results are computed must be transparent, explicit, consensual and reproducible. Data has to be genuine, measurable, reliable, safe and certified. And software itself has to match these constraints. Ultimately, interactions with data, process, people and software providers must be secured by trusted third parties. Trusted third parties need also to be secured, the same way, recursively.

The structure of the global decision process appears to be characterized by fractal properties and Möbius-like functions that can be either decomposed or recomposed at different granularity levels. But at the global level nobody's seems to be in charge. This whole situation is a complex problem and if we are consistent with our earlier observations, we must conclude there is no hope to deal with it. Just like the Wikipedia project seems to be in the early days. But wait a minute. Wikipedia is a smart software that implements such a complex distributed editing decision process who brilliantly succeeded. So what contradicts our rationale? A bunch of must-have software requirements described below.

2. Modern MCDA software requirements

Rich user interaction. As Wikipedia deals with text based resources, MCDA software deals with typed, complex data like alternatives, criteria, performance evaluations, discrimination thresholds, organized either as individual data or as aggregates (i.e. collections, trees, matrix, graphs, and so on). Data and process complexity can be represented as object-oriented structures with sates and behavior. The interaction with people must be supported by rich graphic user interfaces, including inputs from, keyboard, mouse and touch screens. The productivity depends on ergonomics. Data input and change must be done with little effort from the user. The user interface should be flexible and customizable. Third party components and data must be accepted, as mash-ups of charts and maps (when integrating GIS and MCDA).

Distributed architecture. Just as Wikipedia is available from any connected computer or mobile terminal, modern MCDA software needs to follow the users, either experts or decision makers, in their business journey. This requires a distributed architecture, including collaborative, multiple platforms and asynchronous support, interconnected service delegation. And the best location and solution seams to be the *cloud*: generous, low cost and elastic, taking advantages of open data and open process initiatives.

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Agile application life-cycle development. As Wikipedia, modern MCDA software needs to deliver new ideas as fast (as wiki) as they appear, whether it is about data, structure, presentation, formulas, process or code. The technical requirements go far beyond text editing but this is definitely a must-have. The agile movement embraces change and reconciles reactivity and quality. It disrupts the classical application life-cycle management by emphasizing frequent releases of emergent value driven features, through user stories, implemented in incremental iterations. Server-side scripting technologies (python, javascript, ruby, etc.) allow process and formula customization without the shortcuts of the classical development cycle: edit-compile-stop the server-redeploy-restart and -test. Design-time and runtime can eventually be merged.

Full traceability. Ultimately, Wikipedia would never grow without the collaborative features that allow contributors to trace and discuss changes, even when they do not work in the same room at the same time, or even when they don't know each other. Modern MCDA software needs full traceability, including: historisation and versioning, logging and audit traces, time machine for data, structures and programs, to undo and redo changes, record and replay scenarios with different parameters. It also needs the ability to create, compare and merge development branches, in order to simulate and experiment different hypothesis, and assess change impacts. Traceability is fundamental in detecting changes and making effective the whole process.

3. Conclusion

Integrating all these features will definitely reconcile complexity, credibility, and change. The decision process' reproducibility may be guaranteed. When a previously trusted major witness appears to be eventually unreliable, the change impact and the rehabilitation of the accused data, structure, process or people may be fully restored within minutes. The fractal structure of the global decision process, harassed by undirected decisions, top-down and bottom-up decision flows and crossfires, waterfall propagations, ripple effects, and rebounds may become stable and trustworthy.

As a community we may eventually become the decision makers of our own destiny.

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The D4 MCDA Web Application Server, University of Luxembourg (user: demo D4_Demo). http://leopold-loewenheim.uni.lu/cawa/

MyDraft, a software foundation for open MCDA processes: http://www.karmicsoft.com

MCDA Research Groups

MCDA research at the University of Portsmouth[1]

The MCDA research at the University of Portsmouth is spread over two departments in two faculties: the Strategy and Business Systems in the Portsmouth Business School and the Logistics and Management Mathematics Group in the Faculty of Technology. Our research directions in MCDA are multiple:

AHP/ANP:

The Analytic Hierarchy Process (AHP) is historically a strong research area in Portsmouth. A review of the method has been recently published by the research group for practitioners (Ishizaka & Labib, 2010) and researchers (Ishizaka & Labib, 2011). Several research projects have been explored:

- The Analytic Hierarchy Process is a widely used multi-criteria decision making method. The literature has proposed several variants for the measurement scale, the derivation of priorities and the aggregation of the local priorities, which may lead to different final results. A first project has been to compare the different method to calculate priorities (Ishizaka & Lusti, 2006). Then, we have compared the different variants of AHP with the utility theory (Ishizaka et al. 2010). In this work, we demonstrate that the aggregation method of the local priorities and the measurement scale in AHP has a strong influence on the selection of the compromise alternative and therefore on the degree of concordance with the utility theory.

- In a recent work, we have developed a method including 'fairness' and veto possibility in the assignment of weights to the decision-makers in a group decision (Ishizaka & Labib, 2011). As most of the decisions are taken in groups, it is therefore important to provide the decision-makers with a transparent and fair methodology for group decisions in order to avoid biased decisions toward the most powerful or brilliant speaker.

- A new area has been to validate the Analytic Hierarchy Process using the methods of experimental economics (Ishizaka et al., 2011). Some attempts have been proposed in the past to validate the method against verifiable objective results (e.g. area of geometric figures). However, these techniques do not address real-life problems where alternatives are often more difficult to compare because of the subjectivity of the criteria. The goal in this research was to study the behaviour of human

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subjects in real decision problems under controlled laboratory conditions. Validations with experimental economics methods are currently used to evaluate other MCDA methods.

- A further development was to explore the differences between fuzzy logic and the Analytic Hierarchy Process in the context of supply chain management (SCM) (Labib, 2011). Unlike many similar studies, the two techniques have been performed on the same case study in order to improve our understanding of the differences in the proposed techniques. The paper provides an extensive analysis of comparing the two methods, and is considered a significant contribution to modelling the supplier selection problem in the supply chain management field.

- A new project is about the concept of reconfigurable manufacturing systems (RMS). The proposed generic model is considered an innovative idea that addresses the flexibility of holons and facilitates evaluation of reconfigurable manufacturing systems considering conventional economical and operational aspects as the main performance objectives. The underlined research is based on investigating new requirements such as functionality and capacity for process reconfigurability along with reconfiguration time/cost. By allowing interactions among all the Analytic Network Process (ANP) clusters and their relevant elements in terms of outer dependencies and inner dependencies, the critical factors affecting the system performance are explored and evaluated (Abdi & Labib, 2011).

Goal Programming:

The University of Portsmouth has a track record in the research of the theory and application of goal programming dating back to 1995. This research is continuing along several lines:

- A recent textbook (Jones and Tamiz, 2010) details the current state-of-the-art in goal programming. This textbook includes several chapters on good goal programming practice aimed at practitioners of the topic. It also contains chapters on current developments and applications in finance and healthcare aimed at academic researchers.

- A recent algorithm detailed in (Jones, 2011) gives a rigorous means of weight sensitivity analysis in goal and multiple objective programming. This algorithm allows for the addition of preference information in order to set the bounds of the sensitivity algorithm

- Recent projects in applying goal programming to the field of healthcare are detailed in (Oddoye *et al.*, 2008) and (Li *et al.*, 2009). These papers deal with multiple objective resources allocation problems in hospitals in the United Kingdom and China respectively. A combination of queuing theory or discrete event simulation to model patient flow and goal programming to meet the multiple conflicting goals of different hospital departments or stakeholders is used. These projects link

with theoretical work into multiple objective simulation modelling detailed in (Willis and Jones, 2008).

Outranking methods:

With the recent arrival of two French speaking senior lecturers, the MCDA research in Portsmouth has been expanded to the MCDA French School.

- The first research area has been to develop Web-based computer systems to provide an open and wide access to advanced ranking systems. ELECTRE III has been implemented for ranking British universities. It produces a customized ranking based on personal preferences, where information is uncertain and vague. This system is often used by prospective students (Giannoulis & Ishizaka, 2010). Other Web-based computer systems are currently under development.

- The second research area aims to introduce visualization techniques to complement prescriptive approaches. Most of the proposed decision aid methods provide the user only with a prescriptive approach (quantitative analysis) without any descriptive approach (qualitative analysis). It is therefore not possible to justify and recommend ways of improvements (Nemery et al., 2011).

Grants:
Our research group is currently involved in three large European projects using multicriteria techniques:

- FP7-SEC-2009-1, Sea Border Surveillance, Integration Project, € 9'841'613, 2010-2013
  The study will define the architecture for cost-effective European Sea Border Surveillance systems, integrating space, land, sea and air assets, including legacy systems, apply advanced technological solutions to increase performances of surveillance functions, develop and demonstrate significant improvements in detection, tracking, identification and automated behaviour analysis of all vessels, including vessel difficult to detect in open waters as close to coast. MCDA techniques are be used to determine the best surveillance technique.

- FP7-SST-2008-TREN 1, LOGistics & MANufacturing trends and sustainable transport (LOGMAM), Cooperation project, € 1'824'561, 2010-2011
  The study will to give an insight into new logistics and manufacturing trends, their impacts on economic and environmental sustainability and to provide scenario based recommendations for European freight transport policy considering both economic and environmental sustainability. A multi-criteria study is used to trade-off the relevant criteria for selecting the best practices.

- INTERREG IV-A-2007-2013, CHARM 3 (CHannel integrated Approach to marine Resource Management), Action 9.2, €369'479, 2009-2012
  The study will explore the practices, motivations and constraints of English Channel fishermen diversifying into complementary business activities. The Analytical Hierarchy Process (AHP) will be used to determine the

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relative importance that stakeholders attribute to five key constraints upon diversification: economic; social; administrative; lack of opportunities; and lack of information.

PhD students:

The MCDA research group in Portsmouth is also keen to foster new talents. Several PhD students have been enrolled:

- How MCDA methods can ensure that Corporate Social Responsibility (CRS) actions have a fair weight in decisions and not only a symbolic one. (J. Poplawska, ongoing)
- How Balance Score Card (BSC) can be prioritised with AHP? A case study in the Tourism industry in Malta is investigated. (A. Quintano, ongoing)
- How to take in account the view of several stakeholders in the fishery industry with AHP? (R. Morgan, ongoing)
- Informing container port policy in the presence of congestion (G. Whitley, ongoing)
- Goal programming to model fairness in co-operative games (N. Zaibidi, ongoing)
- Goal programming for portfolio selection with application to mutual funds (R. Azmi, 2010)
- Instance-based flexible parameter tuning for meta-heuristics using fuzzy-logic (J. Ries, 2009)
- Multiple objective models for bed allocation in a for-profit hospital. (Li, 2008)
- Investigation of multi-objective analysis techniques to simulation optimisation (K. Willis, 2008)

Visiting researchers

The MCDA research group in Portsmouth has recently hosted several visiting researchers:
Dr Ersilia Luguili (Politecnico di Torino), Mr Karim Lidouh (Université Libre de Bruxelles), Mr Armando Carlomusto (Università degli studi di Cassino), Dr Sergey Gritsyuk (Obninsk State Technical University), Dr Mila Bravo (University of Valencia), Dr Blanca Perez (University of Oviedo), Mr Tony Chen (Foshan University, China)

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Forum

ON ROBUST LINEAR PROGRAMMING WITH UNCERTAIN RIGHT-HAND SIDES: DUALITY, COMPLEXITY AND APPLICATIONS

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How to represent and handle uncertainty in optimization models has long been a major concern in Operations Research or Decision Analysis. The most widely used approaches, which mainly rely on probabilistic techniques, are Stochastic Programming methods and stochastic Dynamic Programming (see e.g. [5], [6], [12]). However such approaches suffer various types of limitations: they are most often computationally very demanding (the well-known 'curse of dimensionality' in stochastic Dynamic Programming appropriately illustrates this); they also often rely on unrealistic assumptions such as stochastic independence of various uncertain parameters; and last, but not least, in many contexts of application, the data specifying the probability distributions of the uncertain parameters - which are assumed to be at hand to run the solution algorithms - often fail to be available in practice.

As possible alternatives, *robust optimization* models and solution algorithms have started being actively investigated in the late 90's , stimulated by the steadily increasing needs of applications. Among the early contributions to this recent research field, we can mention Kouvelis & Yu [8], Ben Tal & Nemirovski [2][3] , Bertsimas & Sim [4]. In robust optimization approaches, no probability distribution is assumed for the uncertain parameters, these are only considered as taking all possible values in some given *uncertainty set* (also referred to as *scenario set*). We note that uncertainty sets most commonly considered are: (i) finite discrete sets; (ii) bounded polyhedra (this case is commonly referred to as 'polyhedral uncertainty'); (iii) ellipsoids ('ellipsoidal uncertainty'). When the robust optimization problem considered can be expressed as a linear program with uncertain coefficients in the objective function and/or in the constraint matrix, and/or in the right-hand side, then we have a so-called *robust linear program*.

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Various types of robust linear programming models and associated solution methods have been investigated so far, which (significantly) differ according to which parameters of the problems under consideration are subject to uncertainty. We mention in particular: (a) row-wise uncertainty and (b) column-wise uncertainty. In the former, uncertainty sets are specified for one or several rows of the constraint matrix, and there is one specific (separate) uncertainty set for each of the rows subject to uncertainty. In the latter, uncertainty sets are specified for one or several columns, and there is one specific (separate) uncertainty set for each of the columns subject to uncertainty. We note that uncertainty on the coefficients of the objective function can be viewed as a special case of (a), while uncertainty on the right-hand side (RHS uncertainty in brief) can be viewed as a special case of (b).

Models and solution algorithms for polyhedral row-wise uncertainty have been investigated in [4]. The case of ellipsoidal row-wise uncertainty has been thoroughly investigated in [2], [3]. In both cases, the resulting robust optimization models are polynomially solvable whenever the standard (deterministic) version of the problem is solvable in polynomial time. In particular, polynomial solvability of robust versions of discrete optimization problems such as shortest paths, network flows, etc. is obtained.

On the other hand, robust linear programs under column-wise uncertainty has been addressed in [13], and the special case of polyhedral right-hand side (RHS) uncertainty has been more recently investigated in [9], [10], [11].

The main focus of our discussion here will be on the latter class of robust linear programs with RHS uncertainty, which will be denoted R_LP_RHSU.

We will successively discuss : (1) duality issues and NP-Hardness results; (2) alternative duality relationships in robust linear programming; (3) typical applications illustrating the class R_LP_RHSU.

(1) We start by discussing an important *negative result* (first pointed out in [9]) stating that: "***strong duality does not hold*** *between a given robust linear program with RHS uncertainty and its dual, assuming, of course, that the same uncertainty set for the same uncertain parameters is considered for the primal and for the dual"*.,

More precisely, the optimum robust solution value for the primal differs in general from the optimal robust solution value for the dual. This result is important for various reasons, in particular it helps in understanding why taking the dual of an instance of a *polynomially solvable* class of robust linear programs can give rise to a class of *strongly NP-Hard* robust linear programs. We illustrate this situation below by means of the following example which refers to a classical OR problem, namely the Max-Flow problem in a capacitated network, the dual of which is a Min-Cut problem.

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Let $G = [X, U]$ be a given directed graph with $n = |X|$ nodes, $m = |U|$ arcs, capacities $c = (c_u)_{u \in U}$ on the arcs, s and t ($s \neq t$) two distinguished nodes in X. First suppose that c is fixed (deterministic) and given, then the maximum s-t flow problem can be formulated as the linear program:

$$(MF) \begin{cases} \text{Max } z \\ \text{s.t:} \\ A x - z b = 0 \quad (1) \\ 0 \leq x \leq c \quad\quad (2) \end{cases}$$

where A is the node-arc incidence matrix of the graph, and b the n-component vector with all components 0, except $b_s = +1$ and $b_t = -1$.

Denoting $\pi = (\pi_i)_{i=1,..n}$ and $\theta = (\theta_u)_{u=1,..m}$ the dual variables w.r.t. (1) and (2) respectively, the dual to this problem is a *minimum s-t cut problem* which can be stated as the linear program:

$$(MC) \begin{cases} \text{Min } c^T\theta \\ \text{s.t:} \\ (\pi, \theta) \in P \end{cases}$$

where P is the polyhedron in $\mathbf{R^{n+m}}$ defined as the set of all (π, θ) satisfying:

$$(3) \begin{cases} A^T\pi + \theta \geq 0 \\ \pi_s = 0, \quad \pi_t = 1 ; \\ \theta \geq 0, \; \pi \text{ without sign restriction} \end{cases}$$

Suppose now that the capacities are *uncertain*, and only known to belong to a given polyhedral uncertainty set $\mathscr{C} \subset \mathbf{R^n_+}$ defined as the set of $c = (c_u)_{u=1,...m}$ satisfying:

$$(4) \begin{cases} c_u = \overline{c_u} - \delta_u y_u \;, \forall u = 1,..m ; \\ 0 \leq y_u \leq 1 , \; \forall \, u = 1,..m ; \\ \Sigma_u y_u \leq \Gamma \end{cases}$$

where, $\forall \, u = 1,..m$, $\overline{c_u}$ is the *nominal capacity* of arc u; δ_u is the *worst-case reduction* of capacity of arc u (it is assumed that $0 \leq \delta_u \leq \overline{c_u}$); Γ is a given nonnegative constant chosen in the range $[1, m]$.

An uncertainty set as defined in (4) is seen to be in 1-1 correspondence with the solution set of a continuous knapsack problem; we therefore refer to this special case of polyhedral uncertainty as *knapsack-constrained uncertainty* (in brief, KCU). We note that KCU uncertainty corresponds to the model considered in the analysis of [4].

Now, the robust version of (MC), which consists in minimizing over P the worst-case value

Max $\{ c^T\theta \; / \; c \in \mathscr{C} \}$ can be stated as:

$$(5) \underset{(\pi, \theta) \in P}{\text{Min}} \left\{ \underset{c \in \mathscr{C}}{\text{Max}} \left\{ c^T\theta \right\} \right\}$$

This is recognized as a robust linear programming problem with uncertain objective function complying with Bertsimas & Sim's model of uncertainty, therefore (5) is *polynomially solvable* as shown in [4].

This is in big contrast with the complexity status of the robust version of (MF) which has been shown in [10] to be *strongly NP-Hard* (indeed, strong NP-Hardness still holds even when restricting to the special case where the only arcs having capacity subject to uncertainty are those originating in the source node s , refer to [10] for details). Major differences in mathematical structures are therefore exhibited between the class R_LP_RHSU and the class of problems with uncertainty on the cost coefficients: under the same uncertainty model (namely KCU), the latter is polynomially solvable, whereas the former is strongly NP-Hard.

As already mentioned, the above observation is consistent with the existence of *duality gaps* for the robust versions corresponding to primal-dual pairs of linear programs. To illustrate this on the primal-dual pair (MF)-(MC), let us introduce the notation $\gamma(S, c)$ to represent, for any capacity assignment c, the capacity of the cut separating the subsets of nodes S and $X \backslash S$, i.e:

$\gamma(S, c) = \Sigma_{u \in \omega+(S)} c_u$. ($\omega+(S)$ is the set of arcs originating from S and terminating in $X \backslash S$).

Then, solving the robust version of (MF) amounts to computing:

$$(6) \; z^*_{MF} = \underset{\substack{c \in \mathscr{C} \\ s \in S, t \notin S}}{\text{Min}} \left\{ \underset{S \subset X}{\text{Min}} \left\{ \gamma(S, c) \right\} \right\}$$

and solving the robust version of (MC) amounts to computing:

$$z^*_{MC} = \underset{\substack{S \subset X \\ s \in S, t \notin S}}{\text{Min}} \left\{ \underset{c \in \mathscr{C}}{\text{Max}} \left\{ \gamma(S, c) \right\} \right\}$$

Clearly, the values z^*_{MF} and z^*_{MC} defined above *do not coincide* in the general case.

(2) We next address further issues concerning duality in robust linear programming by mentioning another type of result concerning the relationships between a robust linear program and its dual, which, at first sight, might appear to be in contradiction with the fact outlined in section (1) above, namely, the presence of *duality gaps*. The result in [1] (see also [7]) can be appropriately illustrated on the optimal robust maximum flow problem: in this case it amounts to viewing relation (6) above as an equality between the left-hand side representing maximum flow value w.r.t. the *worst-*

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case capacity assignment;and the right-hand side representing minimum capacity of a cut under the *best possible* capacity assignment. Indeed this is only a special case of a general property valid for robust versions of arbitrary primal-dual pairs of linear programs, which is subsumed in [1] as 'Primal-worst equals dual-best'. However, this property (interesting per se) *cannot be considered as a strong duality relationship* in the context of robust linear programming. We can see at least two major reasons for this: (a) from a theoretical point-of-view, strong duality *would not be consistent* with the big differences in complexity status when switching from primal to dual which have been pointed out in our discussion above; (b) from the point-of view of applications, optimizing w.r.t. the *best case* (the best possible occurrence of uncertain parameters) certainly cannot correspond to fulfilling a robustness requirement, such an objective can even be viewed as *completely opposite to robustness* (an optimal solution specially taylored for the most favourable occurrence of uncertainty would in some sense deserve to be qualified as *'anti-robust'*).

(3) We finally conclude this discussion by briefly mentioning a few typical applications giving rise to instances of problems in the class R_LP_RHSU, in particular:
- *Robust PERT scheduling under uncertain task durations*;
- *Robust network optimization under uncertain customer requirements*;
- *Robust maximum flow and minimum cuts*;
- *Robust inventory management under uncertain customer requirements*;
- *Robust power system management problems*;

More detailed descriptions of each of these problems, including analysis of some polynomially solvable special cases, will be found in ref [11] . In any case, the above (by far non exhaustive) list is enough to illustrate the wide variety of applications encompassed within the class R_LP_RHSU of robust linear programs with right-hand side uncertainty.

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Consultancy Companies

Poliedra is a research centre at Politecnico di Milano, one of the most important Italian technology universities in engineering, architecture and design. Poliedra's main objective is to develop and use innovative methodologies and tools for decision-making processes in the fields of environment, transport and sustainable mobility. In the next pages, some exemplificative projects are presented.

The centre, supervised by Alberto Colorni and Eliot Laniado, two faculty members from Politecnico di Milano, has a staff of twenty researchers and it includes:

✓   a *Transport* lab
✓   an *Environment* lab
✓   a *Software development* lab

EXPERTISE

✓   decision-making methods and operational research

- o   multi-criteria analysis
- o   project and policy evaluation methods
- o   group decision support systems and negotiation procedures
- o   indicator definition and estimation
- o   optimization of systems and processes
- o   routing and scheduling algorithms

✓   mobility

- o   sustainable mobility planning
- o   travel demand management measures (e.g. road pricing, traffic control, park-and-ride)
- o   demand responsive transport systems (e.g. car-pooling, car-sharing, bike-sharing, dial-a-ride)
- o   design of mobility systems based on zero-emissions vehicles
- o   transport survey organization and data collection
- o   transport systems and demand modelling
- o   traffic estimation and prediction systems
- o   multi-modal traveller information systems

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- o intelligent transportation systems

✓ environment and public participation

- o strategic environmental assessment of plans and programmes and environmental impact assessment
- o environmental concerns integration in Structural Funds Programmes
- o environmental reporting
- o GIS and webGIS designing and implementation
- o capacity building and awareness raising projects
- o public participation in decision-making processes
- o sustainable development strategies and environmental sustainability tools (Local Agenda 21, EMAS, GPP, …)

Decision aid for mobility services: design of an innovative electric vehicles-sharing system for Milano

Green Move is an ongoing research project financed by Regione Lombardia that involves eight different departments and research centers of Politecnico di Milano. The project will go on until the beginning of 2013. The objective of the project is to design and implement a vehicle-sharing system in Milan, able to offer to users different categories of FEV (Full Emission Vehicles). The system aims to be open, standardized, interoperable, modular and multi-business in order to support the spread of the service both on the territory and among new vehicle fleets owners and users. The key characteristics of the service are the following:

- o *Multi-ownership*: the system will offer the opportunity for single users, private companies, associations, etc, to join the service not only using vehicles provided by the service itself but also sharing their personal electric car or fleet applying a peer2peer approach in the field of sustainable mobility;
- o *Key-less-mobility*: personal smartphones are the main tool to use shared vehicles;
- o *Intermodality*: the service is defined as a vehicle-sharing system offering to users a multi-modal fleets;
- o *Multi-business*: the standardized way to join the system gives the chance to design alternative services and flexible mobility solutions;
- o *Green mobility credits*: the opportunity to profile the user and to link his behavior to the effective consumption of energy makes possible to satisfy the personal will of low impact life style and to set up a credits system able to repay virtuous behavior.

Focusing on the five listed above innovative points, the design of the full scale service will be assisted by a multi-criteria analysis of a wide number of possible service alternatives. In order to be really innovative, to avoid critical and inefficient choices even in a preliminary phase and to modulate the service around effective experiences, the context analysis has been considering the survey of a wide number of best practices concerning traditional and innovative vehicle sharing systems. Using a set of possible performance indicators, the most significant best practices will be analyzed and ranked. Clustering the best practices into homogeneous groups, we identified the key performance characteristics of a "successful" vehicle sharing system. Furthermore, it was possible to identify specific interesting niches to be explored in the alternatives formulation.

The performance of each alternative will be evaluated with quantitative and qualitative models. The winning alternatives will be implemented in a trial in order to test the operating modes and the service efficiency. The trial will be carried out with electric vehicles and docking stations in a specific area of Milan. The performance of the service in term of accessibility and usability for the user will be measured with specific monitoring system.

A Multi Criteria Decision Analysis to evaluate transportation systems: the tramway case study in Como

The research concerns a case study for the analysis and evaluation of different alternatives of transportation systems.
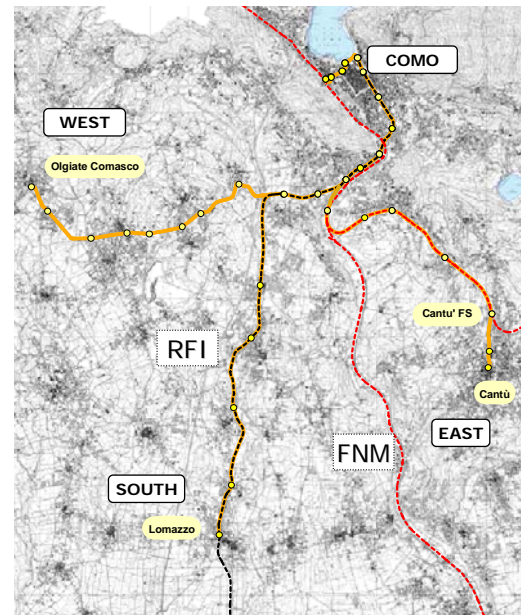
Tramway network extensions toward different suburban directions: Olgiate (West), Lomazzo (South), and Cantù (East)

The goal is to reorganize the urban and suburban mobility in Como (Italy) and to offer a more competitive level of service of public transportation systems (railroad, bus and tramway). The effects of such alternatives on mobility, environment, land use, economy, and the social and bureaucratic feasibility are evaluated using mathematical models as well experts' evaluations.

Business model Territory	Profit	No profit	Cooperative
City center	✗	✗✗✗ ✗	
Metropolitan area	✗✗✗		✗

Clusterization concerning Territory covered by the service and Business model adopted. In this example, the combination City Center – No profit and Metropolitan area - Profit are the candidates to constitute two alternatives.

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The transport system has been modeled with a multi-class and multi-modal Deterministic User Equilibrium assignment using the commercial software EMME\2. The modal choice model is a Multinomial Logit, that represents the local public transportation, the car, and the park&ride modes.

The alternatives are compared using a multi-attribute value theory (MAVT), which is appropriate because of the presence of conflicting objectives and conflicting actors, with different interests and decision powers. The MAUT allows ranking different alternatives by assigning to each one a global utility based on its scores as regards a selected set of criteria.

Algorithms applied to transport service: a real-time information system for public transportation in case of unexpected events, delays and service interruptions

An on-going project whose objective is to improve management, sustainability and eco-compatibility of urban mobility by using the citizen as user and producer of mobility information is described. The project

People waiting a bus during an underground disruption

aims to realize a service platform able to detect, aggregate and interpret urban mobility in real time from information from existing infrastructure on the territory and data from mobile devices. The project, which will be carried out by many partners, will set up trials of the system in several cities. The part designed for the city of Milano concerns the information and management of unexpected events, delays and service interruptions concerning public transportation. Using information about the status of urban mobility, citizens, commuters and tourists, the system could reschedule in real time their movements. The idea is that the effectiveness and competitiveness of public transportation can be improved through an integrated system based on real-time data management. **Participation in multi-criteria decisions: a software tool and a case study**

AMACI is a software prototype developed to deal with the decision phase in the context environmental assessment, which allows to involve both administrators and stakeholders with different opinions and interests. Identifying and involving the interested subjects (decision-makers, stakeholders, etc.) in every phase of the process, and supporting the communication with analyses and tools easy to understand and use have been considered key factors throughout the development of the software. AMACI enables to compare the alternatives on the basis of their impacts, in the framework of the Multi Attribute Value Theory and to manage the conflict due to the presence of a variety of criteria, decision-makers and stakeholders, supporting the

consequent negotiation. The main features of AMACI are the following:

- o it provides a framework for the description of a decision problem and structures the decision making process for each decision-maker with the integrated use of trees and matrices;
- o it makes use of the multiattribute decision analysis, including tools to define utility functions;
- o it computes the ranking of the alternatives;
- o it helps a group of decision-makers in dealing with uncertainty and in managing the possible conflict.

Among other projects, AMACI has been used to perform the Strategic Environmental Assessment of the local planning process of the Municipality of Trezzo sull'Adda (Italy). The main steps of the procedure were been:

- o identification of stakeholders (public, relevant authorities);
- o definition of alternatives; identification of the evaluation criteria;
- o elicitation of the decision-maker preferences;
- o estimation of the effects of the alternatives;
- o comparison between alternatives; sensitivity analysis.

The alternatives are evaluated on environmental, economic and social criteria, defined according to a tree structure. The utility functions and the criteria weights have been elicited from the town councilor for the environment.

In the Trezzo sull'Adda case of study, the methodology and the tools used helped to support effectively the Municipality to take the decision and to communicate it in a transparent and clear way to citizens especially concerning the weights used and to discuss the results on the basis of the sensitivity analysis.
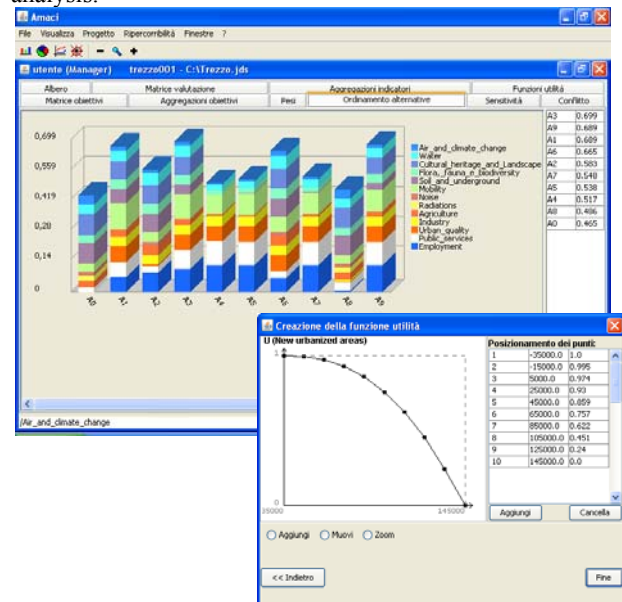
Utility function and ranking of the alternatives: the length of the bars is proportional to the global performance of the alternative.

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Software

An Overview of Existing Multi-Criteria Spatial Decision Support Systems

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1. Introduction

In a previous issue of the EWG-MCDA newsletter [1], Jacek Malczewski went over the subject of integrating multi-criteria methods in Geographical Information Systems (GIS). In that note he covered all of the advantages that arise from combining these two fields. GIS are often used to generate sets of alternatives for decision problems based on the spatial relationships of connectivity, contiguity, or proximity. These alternatives are then usually tested for suitability according to several constraints using overlay methods. There is however no spatial tool that can manage conflicting preferences regarding the different criteria used for evaluation. GIS also lack the ability to test parameter values or models for their robustness. Enhanced analytical capabilities and sensitivity tools are only a few of the benefits that we get by integrating MCDA to these geographic systems.

Unfortunately this integration also has its drawbacks and numerous difficulties have been slowing down research in this field. The first difficulty that comes to mind is also the one that has attracted most of the attention up till now and which is the technical aspect of the problem. With the several data formats for spatial data, the heterogeneous architectures of GIS, and the complex processes followed by MCDA methods, most studies have indeed forgotten the usability aspects and the semantic differences.

Regardless, several interesting works have been achieved and significant progress has been made towards completing a full MCDA-GIS solution. This communication is an overview of systems that successfully implement MCDA-GIS integration or of tools that are useful towards applying it.

2. Types of Integrated Software

The coupling of MCDA tools with GIS has been used in several hundreds of projects and studies over the last twenty years as evidenced by the survey that J. Malczewski realised in 2006 [2]. Among all of these cases, several ways to use the MCDA and GIS combination have started to appear and naturally, these have had an impact on the developments of such systems.

2.1. Loose coupling

Loose coupling is the first usage that has been made of GIS and MCDA-capable systems. It consists in using separate applications for each specific step in the decision process. These could lead to complex operations that needed to be entirely managed by the analyst. A common decision process could resemble the following steps:

- defining the alternatives using the GIS's data management functionalities (e.g. binary or overlay operations),
- evaluating the alternatives by entering their characteristics in an MCDA application,
- taking knowledge of the results and producing a map to display them using a GIS.

The direct advantage of this procedure was its low cost in software. However this came at a heavy price as the concrete separation between these steps made it hard to fully comprehend the spatial aspect of the problem. Spatial relationships between alternatives were therefore not considered at all during the MCDA evaluation step. Furthermore since the transfers of data were done by human interventions, the risk for errors was high. And in the cases where interfaces were developed to link different systems and transfer data automatically from one another, the works achieved could not be used with other systems because of technical differences.

2.2. Tight coupling

In the last ten to fifteen years, the need for automatic communications between systems has given birth to works that coupled MCDA tools and GIS under a single interface. To achieve such a result the methods of one field (usually MCDA) were implemented as a module, routine or script into the other system which is used as a base. Even though the sources of data were not always the same and the data transfers from one system to another were not entirely transparent to the user, this type of tight coupling has been an important step towards the integration of both fields. By making both tools known to the analysts and easier to use, these systems showed the importance of combining them. A few drawbacks were still present though. Flexibility and interactivity were the main concerns of these systems. Researchers began therefore to search for ways to break multi-criteria decision processes in order to give analysts the same freedom they experience with spatial analysis functions [3].

2.3. Fully integrated systems

When looking at the evolution of Information Technologies, we see that through the Internet, several applications and services have opened themselves to the masses. Sometimes simplified, they were made available as web services to all individuals and thereby formed a new generation of participatory systems. These are characterized by their accessibility but also by the way they interact. Web-services nowadays are standardised so that mash-ups (i.e. hybrid combinations of web applications) have been made possible. Their evolution into linked services is reaching a new stage in the type of experience they offer to the user [4]. The number of websites that use Google Maps as a base and add services on top (e.g. weather, navigation, traffic, parking…) has recently experienced very strong growth. Of course one could expect the same type of user experience from multi-criteria SDSS. This however would require a good formalisation of all data structures used in these kinds of problems. Standards have started being defined for geographical information, yet there is hardly anything similar available for multi-criteria techniques.

3. Available Solutions

For the last few years, several researchers have developed their own systems in order to solve the problems they were

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facing. However the systems that successfully merge MCDA methodologies and GIS are scarcely made available to all users. Either these developments are made in the framework of private projects, or they are simply not made public even though related articles are published. Among the available options, three of them stand out as systems that have often been used by analysts and geographers or as projects that show promise for the future: IDRISI GIS, ESRI's ArcScript extensions, and the DECERNS project.

3.1. IDRISI GIS
IDRISI GIS was the first commercial GIS to ever integrate routines for the SMART methodology and for the determination of the weights using Saaty's method. These routines were well documented [5] and the authors also proposed examples of usage on raster as well as vector data. Later extended, the current version of the software includes a complete MCDA module with support for the Ordered Weighted Average (OWA), MOLA heuristic, and Analytical Hierarchy Process (AHP).
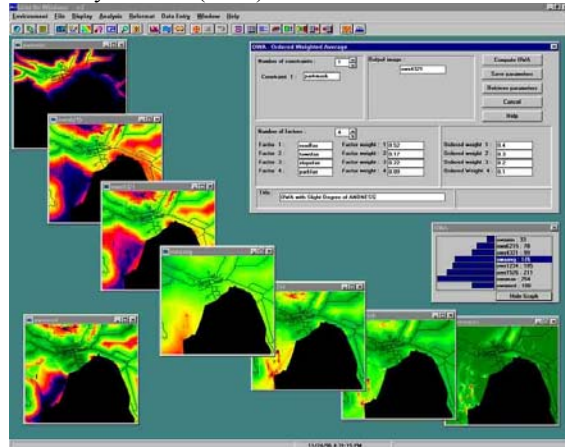
*Multicriteria module within IDRISI GIS [6]*

3.2. ESRI ArcGIS
ESRI's GIS software suite is now one of the best known alternatives on the market. Proposing systems for virtually every type of application requiring the management of geographic information, ESRI has put a great effort into making its systems very accessible. The ArcScripts section [7] of their website has now for a long time allowed developers to propose their own functions and additional packages to complete the existing systems. Among those scripts, one can find that several methods are available: AHP, OWA, SAW, TOPSIS… ArcScript is unfortunately not open anymore for new submissions, but ESRI has added several other services in replacement.

3.3. DECERNS SDSS
DECERNS SDSS is a project being developed at the IATE (Obninsk University, Russia) and integrating MCDA and GIS in a single web-based architecture [8]. Since they share the same database, this system allows the user to rapidly switch to any tool at any moment of the analysis. They can thereby engage in a more iterative process of testing the robustness of a model and changing the parameters before giving final recommendations. However, even though both tools have been developed together, they were kept separate as two independent subsystems that are able to interact. This system is therefore closer to a tight coupling rather than a complete integration.
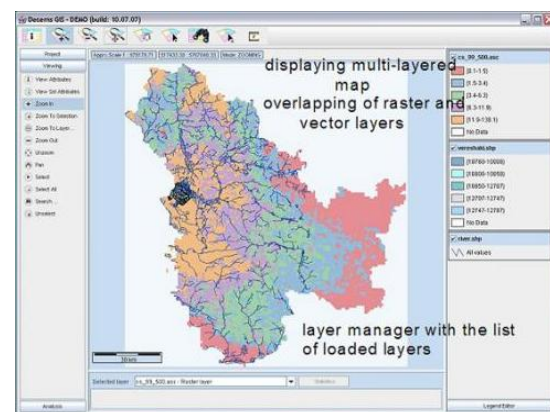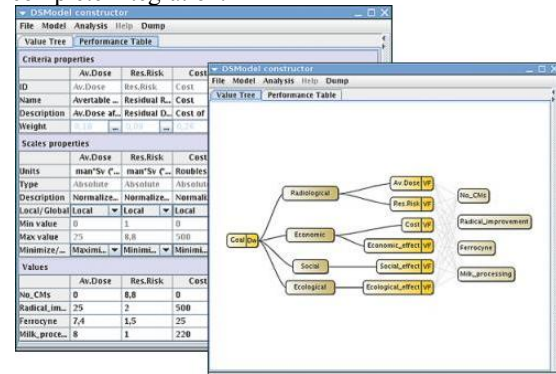
The two subsystems of DECERNS SDSS [8]

As of now, DECERNS integrates the following MCDA methods among others: MAVT, AHP, TOPSIS, PROMETHEE, MAUT, SMAA.

3.4. Other options
For problems that do not require too complex analytical functions, there is still the possibility of coupling separate software for the different steps of the analysis. Analytical software such as R, Mathworks Matlab, and Microsoft Excel have since long been included in spatial analyses with some of the major GIS. For that purpose, most of them are able to export their attribute data in Excel format.

4. Tools of Interest for Future Developments
If the aforementioned systems do not match all needs, there is still the possibility to develop new software entirely dedicated to specific problems. We can indeed find several tools and packages that help ease that process. The first ones include some interesting GIS that offer ways for the extension of their analytical capabilities. But there are also some programming libraries that offer the spatial or mathematical functions one might need.

4.1. Noteworthy GIS
The following are some GIS that offer the possibility to extend their functionalities and therefore could be of interest to integrate MCDA methods in them. Some studies have been realised with the objective of choosing the most appropriate GIS for different purposes [9]. The objective of this section is only to present a few suitable candidates and I encourage the interested reader to dig further into the abundant literature.

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- **ESRI** sells the commercial GIS with the most complete offer [10]. Their software ArcGIS and its variants are designed for every type of machine with desktop, server, but also mobile applications. These systems offer the possibility of developing additional functions in the form of scripts in order to automate some processes.
- On the other side, **GRASS** is the most complete GIS that the Open Source community has to offer [11]. One of its most interesting features is its support for a large panel of formats (including commercial ones). Its other point of interest is the possibility to extend it by developing modules or scripts for specific processes. Its only downside is that its user interface is so complex that new users might have trouble getting used to it.
- **qGIS** or **Quantum GIS** is one of the attempts to make GRASS more accessible through a simpler interface [12]. Some of its latest versions also allow it to import additional functions developed for GRASS.
- **SAGA GIS** is a GIS designed for scientific purposes and that offers a complete API for the development of additional modules [13].

4.2. Spatial APIs
Aside from complete systems, there are also developers and companies that propose APIs or programming libraries that implement spatial analysis functions. These functions can thereby be added to any existing application.

- On top of its systems, **ESRI** proposes complete APIs [10]. These are coded in almost all major programming languages and include APIs for application development (Java and .NET), web development (Javascript, Flex, and Silverlight), and mobile development (iOS, Windows Phone and Android).
- **GeoTools** [14] and **GeotoolKit** [15] are two interesting Java libraries that propose several spatial functionalities and that have been used in countless developments of geographical desktop applications.

4.3. Multicriteria development tools
For several years, the multi-criteria community has lacked an important set of tools for facilitating the development of multi-criteria applications. This has slowly started to change with the arrival of open source projects intended to plug the gap.

- **Decision Deck** is the most important group of initiatives acting to offer an open source platform for developing, designing, and sharing multi-criteria tools [16]. Several developments can be used as is, while others can help in developing more complex systems.

5. Conclusion
The integration of MCDA and Geographical Information Systems still has a long way to go. Up till now hampered by the lack of software solutions for MCDA methodologies, this trend should start to change with the appearance of recent initiatives in this domain. Some very convincing projects have recently given birth to tools that will help reduce the delay of MCDA-GIS compared to other technologies.

Yet at this early stage of the field, advanced projects such as the DECERNS SDSS raise the interesting and difficult question of whether a full integration really is necessary at this point. Indeed tight coupling of independent systems seems to be sufficient for the majority of studies. In the near future however, the need for fully integrated systems should be more apparent as linked services offer much more flexibility. However the lack of studies on conceptual and operational aspects of this field makes it very difficult to advance further. Therefore it still might take a long time before multi-criteria spatial decision support systems reach the maturity of other existing services. In particular, major advances still need to be realized in the field of cognitive sciences regarding the use of these tools.

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[10]   ESRI: http://www.esri.com

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[12]   Quantum GIS: http://qgis.org

[13]   SAGA GIS: http://www.saga-gis.uni-goettingen.de/html/index.php

[14]   GeoTools: http://www.saga-gis.uni-goettingen.de/html/index.php

[15]   GeotoolKit: http://www.geotoolkit.org

[16]   Decision Deck: http://www.decision-deck.org

About the 71th Meeting

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About the 73rd Meeting

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UMR CNRS 6240 LISA,
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The 73rd Meeting of the European Working Group "Multiple Criteria Decision Aiding" (MCDA'73) was held on April, from Thursday 14 to Saturday 16, at the University of Corsica - Pasquale Paoli, Corte (France). The organization of this meeting was coordinated by Pascal Oberti (University of Corsica, Laboratory UMR CNRS 6240 LISA). The main theme of MCDA'73 was "**Spatial approaches of the multicriteria evaluation**", including multicriteria evaluation research applied to concrete territories or / and using geographic information systems. Within the University of Corsica, this topic is in the structuring project "Dynamics of the territories and sustainable development" of the research laboratory UMR CNRS 6240 LISA which supported MCDA'73 with the Association of European Operational Research Societies (EURO). Committees of the meeting were the following.

Organizing Committee
Pascal Oberti,
University of Corsica
Dominique Grandjean,
University of Corsica
Anne Casabianca,
University of Corsica
Ange-Michel Poli,
University of Corsica

Scientific Committee
Maurice Baslé, University of Rennes 1
José Rui Figueira, Ecole des Mines de Nancy
Bernard Fustier, University of Corsica
Salvatore Greco, University of Catania
Marie-Antoinette Maupertuis, University of Corsica
Vincent Mousseau, Ecole Centrale Paris
Giuseppe Munda, Autonomous University of Barcelona
Pascal Oberti, University of Corsica
Christophe Paoli, University of Corsica
Bernard Roy, University of Paris-Dauphine
Roman Słowiński, Poznan University of Technology

MDCA'73 was attended by 47 participants from 13 countries: Austria, Belgium, Canada, France, Germany, Greece, Italy, Luxembourg, Mexico, Poland, Spain, Switzerland and The Netherlands. Overall, 43 proposals had been submitted, out of which 18 communications were presented, 15 papers were included for discussion and 7 posters presented by young MCDA researchers. A debate on "Spatial multicriteria evaluation approaches: what methodological issues and applications?" was

introduced by Vincent Mousseau, José Rui Figueira, Francis Macary and Luc Boerboom. Interesting discussions and broad participation have enriched the meeting. Social events (Corsican meals and songs, guided town tour, visit of the Museum of Corsica,) have also contributed to exchanges between group members.

Both full papers, abstracts and posters are on the Web site http://mcda.univ-corse.fr/ implemented by Christophe Paoli. From 4 to 6 of submitted papers will undergo a two-fold blind review to be selected for publication in a special issue of the International Journal of Multicriteria Decision Making (IJMCDM), a new journal published by Inderscience (http://www.inderscience.com/browse/index.php?journalID=350).

The MCDA'73 program is presented below.

PROGRAMME */ PROGRAM*

Jeudi 14 avril 2011 / *Thursday, April 14, 2011*
Campus Mariani, Amphithéâtre Landry / *Amphitheatre Landry*
9h00-11h00
Inscriptions / *Registration*

11h00-11h30
Session d'ouverture / *Opening session*
A. Aiello, Président de l'Université de Corse Pasquale Paoli
M.-A. Maupertuis, Directrice de l'UMR CNRS 6240 LISA
P. Oberti, organisateur de la 73e réunion du Groupe de travail européen AMCD

11h30-12h30
Session poster Jeunes Chercheurs / *Young Researchers Meeting*
Président / *Chairman :* **Ange-Michel Poli**
F. Tramoni : Outranking multicriteria approach applied to treatments and energy recovery of sewage sludge in Corsica
P. Haurant : Selection of photovoltaic plants in Corsica: a concrete case of study using ELECTRE IS
M. de L. Vazquez, J.-P. Waaub, A. Ilinca : Étude de cas d'un méga parc éolien : Test d'un modèle AMCD-SIG favorisant un processus de décision circulaire
G.-R. Retali, **P. Meyer, M. Le Goff-Pronost** : Implementation of remotely monitored medical dialysis units: dealing with multiple criteria and multiple decision makers
A.-L. Olteanu, **R. Bisdorff, P. Meyer** : Multi-criteria clustering for large scale problems

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T. Veneziano, **P. Meyer**, **R. Bisdorff** : Analyse inverse robuste en aide à la décision multicritère face à un décideur non expert

M. Ayadi, **A. Rebai**, **K. Jabeur** : Development of New Multi-Attribute Selection Procedures Based on Regret and Rejoicing

12h30-14h00
Déjeuner / *Lunch*

14h00-16h00
Session 1 : Débat / *Debate*
Approche spatiale de l'évaluation multicritère : quels enjeux méthodologiques et applications ? /
Spatial multicriteria evaluation approaches: what methodological issues and applications?
Président / *Chairman* : Pascal Oberti

14h00-14h20
V. Mousseau : Décisions à caractère spatial : nouvelles questions de recherche pour l'AMCD
14h20-14h40
J.R. Figueira: Problèmes multicritères pour la définition de zonages territoriaux: méthodes, algorithmes et applications

14h40-15h00
F. Macary, **J.A. Dias**, **A. Probst**, **V. Gobert**, **D. Uny** : Risques de pollution de l'eau dans un petit bassin versant agricole en Gascogne : évaluation de l'effet de pratiques environnementales par une modélisation multicritère spatialisée
15h00-15h20
L. Boerboom, **A. Ozgun Oskay** : A distributed open source web-application for spatial multi-criteria evaluation
15h20-16h00
Discussions
Papiers soumis à discussion / *papers submitted to disc ussion*
- *M. Bottero*, **E. Comino**, **S. Pomarico**, **M. Rosso** : Environmental analysis and territorial planning: a Multicriteria - Spatial Decision Support System for assessing the quality of a river basin
- **A. Boggia**, **S. Greco**, **G. Massei** : Implementation of dominance based rough set approach module in a geographic information system

16h00-16h30
Pause café / *Coffee break*
16h30-18h00
Session 2 : Complexité des décisions / *Complexity of decisions*
Président / *Chairman* : Roman Słowiński
16h30-17h00

A. Zabeo, **S. Giove**, **L. Pizzol**, **P. Agostini**, **A. Critto**, **A. Marcomini** : A spatial decision support system for Regional Risk Assessment of degraded land
17h00-17h30
M. Morin, *I. Abi-Zeid* : Planification et choix multicritère de routes dans le cadre de missions de recherche et sauvetage
17h30-18h00
T. Comes, **M. Hiete**, **F. Schultmann** : A Spatial Scenario-Based Multi-Criteria Decision Support System for Strategic Emergency Management
Papiers soumis à discussion / *papers submitted to disc ussion*
- *V. Ferretti*, **S. Pomarico** : The development of a Multicriteria-Spatial Decision Support System for siting a waste incinerator plant in the Province of Torino (Italy)
- *W.K.M. Brauers*, **R. Ginevicius** : Optimization of Well-Being for the Lithuanian Districts by the MOORA Method

19h30-21h15
Diner corse au restaurant / *Corsican dinner at restaurant*
21h30-23h00
Spectacle chants corses - Amphithéâtre Landry /
Show "Corsican songs" - Amphitheatre Landry

Vendredi 15 avril 2011 / *Friday, April 15, 2011*
Campus Mariani, Amphithéâtre Landry /
Amphitheatre Landry

9h00-10h30
Session 3 : « Connaissance imparfaite et visualisation de l'information » / Imperfect knowledge and visualization of information
Président /Chairman : Maria Franca Norese

9h00-9h30
S. Corrente, *S. Greco*, *R. Słowiński* : Robust Ordinal Regression in case of a Hierarchy of Criteria and Imprecise Evaluations
9h30-10h00
S. Ben Amor, **B. Mareschal** : Taking imperfection of information into account in the PROMETHEE methods
10h00-10h30
I.M. Lami, E. Masala, *S. Pensa* : **Multiple Criteria**

Decision Analysis and visualization of spatial data.

An application to a Corridor 24 section.

Papiers soumis à discussion / *papers submitted to discussion*
- **C. Ohresser**, **N. Gartiser**, *J. Renaud*, **A. Ghenaïm**, **E. Caillaud** : Conception portuaire et acceptabilité sociale : un exemple d'analyse multicritère

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- ***B. Schuh*, T. Hein, I. Baart, A. P. Blaschke, C. Habereder, G. Haidvogl, S. Hohensinner, S. Preiner, W. Reckendorfer, K. Reiter, G. Stanzer, G. Weigelhofer** : Optimised management of riverine landscapes based on a multi-criteria Decision Support System: merging societal requirements and ecological development in a changing world (Optima Lobau)

10h30-11h00
Pause café / *Coffee break*
11h00-12h30
Session 4 : Méthodes d'AMCD et applications / *MCDA Methods and applications*
Président /Chairman : Salvatore Greco
11h00-11h30
E. Fernandez, **E. Lopez, G. Mazcorro, J. Navarro** : Application of multi-criteria analysis and optimization to public project portfolio selection
11h30-12h00
M. F. Norese, **V. Carbone** : An application of ELECTRE Tri to support innovation
12h00-12h30
A. Valls, **X. Mercadé, M. Schuhmacher, A. Passuello** : Distributing sewage sludge on the most suitable agricultural soils
Papiers soumis à discussion / *papers submitted to discussion*
- ***F. Abastante, I.M. Lami*** : A combined use of House of Quality (HoQ) and Analytic Network Process (ANP) to evaluate an urban design competition

12h30-14h00
Déjeuner / *Lunch*

14h00-15h30
Session 5 : AMCD, projet et logiciels / *MCDA, project and software*
Président /Chairman : **Bernard Roy**
14h00-14h25
R. Słowiński : Vie du groupe et prochaines réunions / Working group matters and next meetings
14h25-14h30
M. F. Norese, **A. Cerchia, E. Liguigli, C. Novello, D. Rolando** : An integration of different skills and competences to help communities and local authorities in MCDA processes
14h30-15h00
A.-M. Poli : Evaluation of Management Effectiveness in Marine Protected Areas: practices and limits
15h00-15h30
P. Oberti, C. Paoli : A new support for participatory multicriteria decision aiding : Ev@l software
Papiers soumis à discussion / *papers submitted to discussion*
- ***T. Wanderer*** : GIS based Decision Support Tool for Offshore Wind Energy

- ***O. Sobrie*** : Implementation of the ELECTRE TRI multi-criteria method in an Open Source Geographical Information System
- ***S. Bigaret, P. Meyer*** : diviz : an innovative tool for a new work methodology in MCDA

15h30-16h00
Pause café / *Coffee break*
16h00-17h30
Session 6 : Modèles décisionnels et obtention de paramètres /
Decision models and parameters elicitation
Président /Chairman : José Figueira
16h00-16h30
T. Veneziano, **P. Meyer, R. Bisdorff** : Robust elicitation of criteria weights and thresholds in a multicriteria decision aid context
16h30-17h00
M. Kadziński, S. Greco, R. Słowiński : Extreme ranking analysis in robust ordinal regression
17h00-17h30
Ch. Hurson, Y. Siskos : A synergy of multicriteria techniques to assess additive value models
Papiers soumis à discussion / *papers submitted to discussion*
- ***J. Zheng*, V. Mousseau, M. Pirlot, S.A. Metchebon Takougang** : A simulation-based Robustness Study in Electre Tri Method
- **S. Greco, *J. Siebert*, R. Słowiński** : Modelling interactions on bipolar scales using robust ordinal regression: the UTA^{GSS} method
- ***M.A. de Vicente y Oliva, J. Manera Bassa*** : Multicriteria Clustering: analyzing outputs of internationalization
- ***W. Habenicht*** : ENUCUT − An Interactive Approach to Integer Linear Vector Optimization Problems
- ***V. Postolică*** : A Class of Optimal Splines mixed up in Multicriteria Evaluation and Related Topics

17h30-17h40
Clôture des travaux scientifiques / *Closing speech* : **Pascal Oberti**

Samedi 16 avril 2011 / *Saturday, April 16, 2011*
9h45
Rassemblement sur le Campus Mariani / *Gathering at the Campus Mariani*
10h00-11h45
Visites guidées du musée de la Corse et de la ville de Corte / *Guided tour of the Museum of Corsica, guided town tour*
12h00-13h15
Déjeuner au restaurant / *Lunch at restaurant*
13h30
Départ en bus pour rejoindre l'aéroport de Bastia-Poretta / *Free bus to reach the Bastia-Poretta airport*

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Series 3, nº23, Spring 2011.

Let us note that the 8th Decision Deck Workshop has been co-located with MCDA'73 (http://mcda.univ-corse.fr/).

Forthcoming Meetings

(This section is prepared by Carlos Henggeler Antunes)

Forthcoming EWG Meetings/
Prochaines réunions du Groupe

Note:

- It should be remarked again that this is a bilingual group; all the papers should be presented in both official languages of the group (i.e. French with English slides, and *vice-versa*).

- Ceci en un groupe bilingue ; tous les papiers doivent être présentés dans les deux langues officielles du groupe (i.e. en français avec les transparents en anglais et *vice-versa*).

The 74th of the European Working Group "Multiple Criteria Decision Aiding" will be held in Haute Ecole d'Ingénierie et de Gestion du Canton de Vaud – Yverdon-les-Bains – Suisse. October, 6-8 2011. Topic: Systèmes d'information géographique, territoire et environnement. Organizer: Dominique Bollinger.

Other Meetings

5th Global Conference on Power Control and Optimization (PCO'2011). June 1-3, 2011 LE Meridien Dubai, Dubai, UAE.
http://www.pcoglobal.com/

IFORS 2011 - International Federation of Operational Research Societies Conference, 10-15 July 2011, Melbourne, Australia; http://www.ifors2011.org

Optimization 2011, 24-27 July 2011, Lisbon (Caparica), Portugal; http://www.fct.unl.pt/optimization2011

MIC 2011 - 9th Metaheuristics International Conference, 25-28 July 2011, Udine, Italy; http://mic2011.diegm.uniud.it

MISTA 2011 - Multidisciplinary International Scheduling Conference: Theory and Applications, 9-12 August 2011, Arizona, USA; http://www.mistaconference.org/

DEA 2011, 25-27 August 2011, Thessaloniki, Greece; http://www.deazone.com/dea2011

OR 2011 - International Conference on Operations Research, 30 August-2 September 2011, Zurich, Switzerland; http://www.or2011.ch/

ESA 2011 - 19th European Symposium on Algorithms, 5-7 September 2011, Saarbruecken, Germany; http://esa-symposium.org/

14th Meeting of the EURO Working Group on Transportation and 26th Mini EURO Conference, September 6-9, Poznan, Poland; http://www.ewgt2011.put.poznan.pl/

OR 53, 6-8 September 2011, Nottingham, United Kingdom; http://www.theorsociety.com/OR53

AIRO 2011 - 42nd Annual Conference of the Italian Operational Research Society, 6-9 September 2011, Brescia, Italy; http://airo2011.eco.unibs.it

ORP3 2011 - Operation Research Peripatetic Postgraduate Programme, 13-17 September 2011, Cadiz, Spain; http://orp3.uca.es

ORSSA 2011 Conference, 18-21 September 2011, Zimbabwe; www.orssa.org.za

BALCOR 2011: 1st International Symposium and 10th Balkan Conference on Operational Research, 22-25 September 2011, Thessaloniki, Greece; http://balcor.uom.gr

The 11th International Symposium on Operations Research in Slovenia (SOR'11), 28-30 September 2011, Dolenjske Toplice, Slovenia; http://sor11.fis.unm.si

74th Meeting of the EWG on MCDA - MCDA'74, 6-8 October 2011, Yverdon, Switzerland. Organizer: HEIG-VD, Contact: Dominique Bollinger. Topic: "GIS, territorial and environmental management".

Operations Research Society of Eastern Africa 2011 Conference, 13-14 October 2011, Nairobi, Kenya; http://www.orsea.net/

ADT 2011 - 2nd International Conference on Algorithmic Decision Theory, 26-28 October 2011, Piscataway, New Jersey, USA; http://www.adt2011.org

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INFORMS Annual Meeting 2011, 13-16 November 2011, Charlotte, North Carolina, USA; http://meetings.informs.org/charlotte2011

OiE 2011 - 6th Scientific Conference Economy and Efficiency – contemporary solutions in logistics and production, 16-18 November 2011, Poznan, Poland; http://konferencja.logistyka-produkcja.pl/en

2011 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 6-9 December 2011, Singapore; http://www.IEEM.org

INFORMS Conference on Business Analytics & Operations Research, 15-17 April 2012, Huntington Beach, USA; http://meetings.informs.org/Analytics2012

75th Meeting of the EWG on MCDA - MCDA'75. April, 2012, Tarragona, Spain. Organizer: Universitat Rovira i Virgili. Contact: Aida Valls

INFORMS 2012 International Beijing, 24-27 June 2012, Beijing, China; http://www.orsc.org.cn/engindex.html

EURO 2012 - EURO XXV International Conference, 8-11 July 2012, Vilnius, Lithuania; http://www.euro-2012.lt

76th Meeting of the EWG on MCDA – MCDA'76. October, 2012, Portsmouth, Great Britain. Organizer: University of Portsmouth. Contact: A. Ishizaka.

Announcements and

Call for Papers

The vol.1. no.3 of InternationalJournal of Multicriteria Decision Making (IJMCDM) has been published. http://www.inderscience.com/browse/index.php?journalI D=350&year=2011&vol=1&issue=3

Special Issue on Evolutionary Multiobjective Optimization: Methodologies and Applications of the Journal of Multi-Criteria Decision Analysis (Wiley-Blackwell)
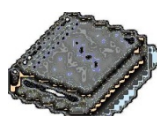
http://emoatmcdm.gforge.inria.fr/specialissue.php

Submission deadline: July 31, 2011

Guest editors: Dimo Brockhoff and Kalyanmoy Deb

Books

NEW FRONTIERS IN EVOLUTIONARY ALGORITHMS
Theory and Applications
by Hitoshi Iba & Nasimul Noman (University of Tokyo, Japan)

ISBN 978-1-84816-681-3

http://www.worldscibooks.com/compsci/p769.html

This book delivers theoretical and practical knowledge of Genetic Algorithms (GA) for the purpose of practical applications. It provides a methodology for a GA-based search strategy with the integration of several Artificial Life and Artificial Intelligence techniques, such as memetic concepts, swarm intelligence, and foraging strategies. The development of such tools contributes to better optimizing methodologies when addressing tasks from areas such as robotics, financial forecasting, and data mining in bioinformatics.
The emphasis of this book is on applicability to the real world. Tasks from application areas – optimization of the trading rule in foreign exchange (FX) and stock prices, economic load dispatch in power system, exit/door placement for evacuation planning, and gene regulatory network inference in bioinformatics – are studied, and the resultant empirical investigations demonstrate how successful the proposed approaches are when solving real-world tasks of great importance

MULTIPLE CRITERIA DECISION MAKING
From Early History to the 21st Century
by Murat Köksalan (Middle East Technical University, Turkey), Jyrki Wallenius (Aalto University, Finland) & Stanley Zionts (SUNY Buffalo, USA)

Groupe de Travail Européen "Aide Multicritère à la Décision"
Série 3, nº23, printemps 2011.

European Working Group "Multiple Criteria Decision Aiding"
Series 3, nº23, Spring 2011.

ISBN: 978-981-4335-58-4

http://www.worldscibooks.com/business/8042.html

Multiple Criteria Decision Making (MCDM) is all about making choices in the presence of multiple conflicting criteria. MCDM has become one of the most important and fastest growing subfields of Operations Research/Management Science. As modern MCDM started to emerge about 50 years ago, it is now a good time to take stock of developments. This book aims to present an informal, nontechnical history of MCDM, supplemented with many pictures. It covers the major developments in MCDM, from early history until now. It also covers fascinating discoveries by Nobel Laureates and other prominent scholars.

The book begins with the early history of MCDM, which covers the roots of MCDM through the 1960s. It proceeds to give a decade-by-decade account of major developments in the field starting from the 1970s until now. Written in a simple and accessible manner, this book will be of interest to students, academics, and professionals in the field of decision sciences.

Portfolio Decision Analysis

By: Salo, Ahti; Keisler, Jeffrey; Morton, Alec (Eds.)

ISBN 978-1-4419-9942-9

http://www.springer.com/business+%26+management/operations+research/book/978-1-4419-9942-9

Portfolio Decision Analysis: Improved Methods for Resource Allocation provides an extensive, up-to-date coverage of decision analytic methods which help firms and public organizations allocate resources to 'lumpy' investment opportunities while explicitly recognizing relevant financial and non-financial evaluation criteria and the presence of alternative investment opportunities. In particular, it discusses the evolution of these methods, presents new methodological advances and illustrates their use across several application domains.

The book offers a many-faceted treatment of portfolio decision analysis (PDA). Among other things, it (i) synthesizes the state-of-play in PDA, (ii) describes novel methodologies, (iii) fosters the deployment of these methodologies, and (iv) contributes to the strengthening of research on PDA. Portfolio problems are widely regarded as the single most important application context of decision analysis, and, with its extensive and unique coverage of these problems, this book is a much-needed addition to the literature. The book also presents innovative treatments of new methodological approaches and their uses in applications.

The intended audience consists of practitioners and researchers who wish to gain a good understanding of portfolio decision analysis and insights into how PDA methods can be leveraged in different application contexts. The book can also be employed in courses at the post-graduate level.

Articles Harvest

(This section is prepared by Juscelino ALMEIDA DIAS, judias@ist.utl.pt)

Rim Kalaï, Daniel Vanderpooten
The lexicographic α-robust knapsack problem
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Abdur Rais, Ana Viana
Operations Research in Healthcare: a survey
International Transactions in Operational Research
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An improved branch-and-bound clustering approach for data partitioning
International Transactions in Operational Research
Volume 18, Issue 2, pages 231–255, March 2011

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Multi-objective memetic algorithm: comparing artificial neural networks and pattern search filter method approaches
International Transactions in Operational Research
Volume 18, Issue 2, pages 183–203, March 2011

David K. Smith
A bibliography of applications of operational research in sub-Saharan Africa
International Transactions in Operational Research
Volume 18, Issue 2, pages 149–182, March 2011

Andrzej P. Wierzbicki ,Wojciech Burakowski
A conceptual framework for multiple-criteria routing in QoS IP networks
International Transactions in Operational Research
Volume 18, Issue 3, pages 377–399, May 2011

Faramak Zandi, Madjid Tavana A fuzzy group quality function deployment model for e-CRM framework assessment in agile manufacturing
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Pages 1-19 Volume 61, Issue 12011

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Some generalized aggregating operators with linguistic information and their application to multiple attribute group decision making
Pages 32-38,
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M. Shakhsi-Niaei, S.A. Torabi, S.H. Iranmanesh
A comprehensive framework for project selection problem under uncertainty and real-world constraints
Pages 226-237,
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Pages 376-384,
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An Integrated Artificial Neural Network Fuzzy C-Means-Normalization Algorithm for performance assessment of decision-making units: The cases of auto industry and power plant,*Pages 328-340*,
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Decision-making with distance measures and induced aggregation operators
Pages 66-76,
Computers & Industrial Engineering, Volume 60, Issue 1,2011

Chantal Baril, Soumaya Yacout, Bernard Clément
Design for Six Sigma through collaborative multiobjective optimization
Computers & Industrial Engineering,
Pages 43-55,Volume 60, Issue 1,2011

Banu Soylu
A multi-criteria sorting procedure with Tchebycheff utility function ,Computers & Operations Research
Volume 38, Issue 8, August 2011, Pages 1091-1102

Antoine Jouglet, David Savourey Dominance rules for the parallel machine total weighted tardiness scheduling problem with release dates
Pages 1259-1266,

Computers & Operations Research
Volume 38, Issue 9, 2011

Salvatore Greco, MiŁosz Kadziński, Roman SŁowiński
Selection of a representative value function in robust multiple criteria sorting
Pages 1620-1637,
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A preference ordered classification for a multi-objective max–min redundancy allocation problem
Pages 1855-1866
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Pages 460-468,
Decision Support Systems
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Fan Wang, Xiaofan Lai, Ning Shi
A multi-objective optimization for green supply chain network design
Pages 262-269,
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Jianping Li, Liwei Wei, Gang Li, Weixuan Xu An evolution strategy-based multiple kernels multi-criteria programming approach: The case of credit decision making, *Pages 292-298,*
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An interactive approach for multi-attribute auctions
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An incident information management framework based on data integration, data mining, and multi-criteria decision making,*Pages 316-327*,

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Pages 720-726
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IPSSIS: An integrated multicriteria decision support system for equity portfolio construction and selection
Pages 398-409
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E. Zio, R. Bazzo
A clustering procedure for reducing the number of representative solutions in the Pareto Front of multiobjective optimization problems
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A general approach for optimizing regular criteria in the job-shop scheduling problem
Pages 33-42
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An attribute weight based feedback model for multiple attributive group decision analysis problems with group consensus requirements in evidential reasoning context
Pages 179-189 ,
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Dominance rules in combinatorial optimization problems
Pages 433-444, European Journal of Operational Research
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Murat Mut, Margaret M. Wiecek
Generalized equitable preference in multiobjective programming
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Dylan Jones
A practical weight sensitivity algorithm for goal and multiple objective programming
Pages 238-245
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A weighted max–min model for fuzzy multi-objective supplier selection in a supply chain
*Pages 139-145*International Journal of Production Economics,Volume 131, Issue 1, 2011

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Pages 146-157, International Journal of Production Economics
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Neural network application for fuzzy multi-criteria decision making problems
Pages 490-504,International Journal of Production Economics,Volume 131, Issue 2, 2011

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Pages 52-57, International Journal of Production Economics ,Volume 132, Issue 1, 2011

Tadeusz Antczak
A new characterization of (weak) Pareto optimality for differentiable vector optimization problems with *G*-invex functions *Pages 59-68*
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M.J. Mahmoodabadi, A. Bagheri, S. Arabani Mostaghim, M. Bisheban Simulation of stability using Java application for Pareto design of controllers based on a new multi-objective particle swarm optimization
Pages 1584-1607, Mathematical and Computer Modelling
Volume 54, Issues 5-6, 2011

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An extension of the Electre I method for group decision-making under a fuzzy environment
Pages 373-386 Omega
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Theresa J. Barker, Zelda B. Zabinsky A multicriteria decision making model for reverse logistics using analytical hierarchy process
*Pages 558-573*Omega
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Yi Peng, Gang Kou, Guoxun Wang, Yong Shi FAMCDM: A fusion approach of MCDM methods to rank multiclass classification algorithms
Pages 677-689 Omega
Volume 39, Issue 6, 2011

Danielle C. Morais, Adiel Teixeira de Almeida
Group decision making on water resources based on analysis of individual rankings
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Strategic performance measurement in a healthcare organisation: A multiple criteria approach based on balanced scorecard
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MB-GNG: Addressing drawbacks in multi-objective optimization estimation of distribution algorithms
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Decision Support and Optimization in Shutdown and Turnaround Scheduling
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A multiple objective goal programming approach to the truckload routing problem
J Oper Res Soc 62 (8): 1524-1532

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Adding value to bank branch performance evaluation using cognitive maps and MCDA: a case study
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Influence of aggregation and measurement scale on ranking a compromise alternative in AHP
J Oper Res Soc 62 (4): 700-710

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Solving multi-objective multicast routing problems by evolutionary multi-objective simulated annealing algorithms with variable neighbourhoods
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Other Works

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PhD dissertations

SAUVANET Gaël

Université François Rabelais De Tours

Manuscript title Recherche de chemins multiobjectif pour la
conception et la réalisation d'une centrale de mobilité
destinée aux cicliste

Defense date
5th april 2011

Advisor : NÉRON Emmanuel Professeur des Universités,
Université François Rabelais Tours
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François Rabelais Tours

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Members invited:
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Tours

The work presented in this thesis aims at proposing methods
for computing bicycle paths across a metropolitan. Unlike the
problem of the classical shortest path, here the context is
multiobjective because several criteria such as distance, safety
and effort must be considered in the path computation. In a
multiobjective problem, there is no single solution, but a set
of compromise solutions. Then, the difficulty is to compute
paths under a time constraint of a few seconds, in order to
integrate the computation in the respond-time of a web page
for example.

Two approaches were discussed to solve this problem. The
first one is an *a posteriori* approach where all compromise
solutions are computed. A classical method of the literature is
presented here and improved by using preprocessing. The
proposed improvements are based on single objective shortest
path searches in order to compute lower and upper bounds on
the costs of paths from all nodes to the target node.

The second approach is an *a priori* method that takes user
preferences into account to focus on the computation of the
best compromise solution. The method allows to guide the
search by the selection of the most promising sub-paths first,
according to the user preferences.

Finally, we propose to model the road network as a line graph
to take into account new criteria such as travel time or the
linearity of the path and new constraints as prohibited
maneuvers. To take into account these new criteria and
constraints, it's necessary to define costs on the nodes, the
arcs and on arc sequences.

All this work was necessary to develop the service Géovélo,
which is a multiobjective route planner adapted to bicycle.
The service is available on a website and as mobile
applications.

Keywords: shortest path problem, graph, multiobjective
optimization.

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Groupe de Travail Européen "Aide Multicritère à la Décision"
Série 3, nº23, printemps 2011.

European Working Group "Multiple Criteria Decision Aiding"
Series 3, nº23, Spring 2011.

Announcement:

The "Useful links" section of the group's homepage

(www.cs.put.poznan.pl/ewgmcda)

is being enlarged. Contributions of URL links to societies, research groups and other links of interest are welcome.

A membership directory of the European Working Group on "Multiple Criteria Decision Aiding" is available at the same site. If you would like to be listed in this directory please send us your data (see examples already in the directory).

Contact: José Rui Figueira (figueira@ist.utl.pt)

Web site for the EURO Working Group "Multicriteria Aid for Decisions"

A World Wide Web site for the EURO Working Group on "Multicriteria Aid for Decisions" is already available at the URL:

http://www.cs.put.poznan.pl/ewgmcda/

Web site Editor: Milosz Kadzinski
(Milosz.Kadzinski@cs.put.poznan.pl)

This WWW site is aimed not just at making available the most relevant information contained in the Newsletter sections, but it also intends to become an online discussion forum, where other information and opinion articles could appear in order to create a more lively atmosphere within the group.