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EURO Working Group on Multicriteria Decision Aiding
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NEWSLETTER
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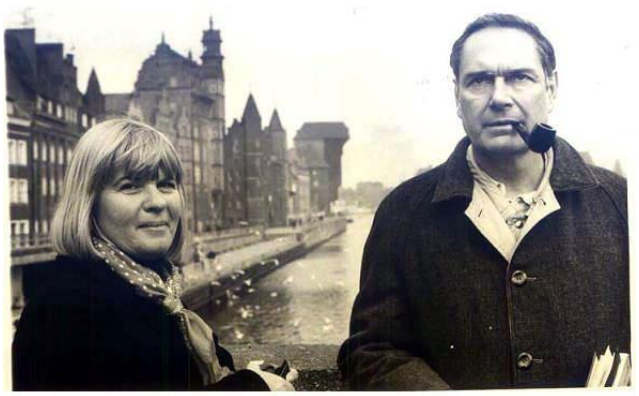
Persons and Facts

Les coordinateurs du Groupe de Travail d'EURO sur l'Aide Multicritère à la Décision ont le chagrin de vous faire part du décès de Françoise Roy, épouse de Bernard Roy, survenu le 30 novembre 2015. Françoise était proche des membres du groupe car elle accompagnait Bernard dans la plupart des réunions depuis la création du groupe par Bernard en 1975. Elle participait dans la vie du groupe comme un de ses membre. Une dame de grande culture, aimable et souriante, bienveillante aux jeunes adeptes du multicritère. Sa présence aux réunions du groupe contribuait à une ambiance unique dont jouissait ce groupe grâce à la personnalité du couple Roy.
Au nom des membres du groupe, nous présentons à Bernard Roy nos plus sincères condoléances et nous l'assurons de garder un bon souvenir de Françoise.

Roman Słowiński, José Figueira et Salvatore Greco

The coordinators of the EURO Working Group on Multiple Criteria Decision Aiding, are very sad to let you know that Françoise Roy, spouse of Bernard Roy, passed away on November 30, 2015. Françoise was close to members of the group as she was accompanying Bernard in most meetings since the group was created by Bernard in 1975. She participated in the life of the group as one of its members. A lady of great culture, friendly and smiling, sympathetic to young followers of the multicriteria methodology. Her presence at meetings of the group contributed to a unique atmosphere enjoyed by this group thanks to the personality of the Roy couple.
On behalf of the group, we present to Bernard Roy our sincere condolences and assure to keep a good memory of Françoise.

Roman Słowiński, José Figueira and Salvatore Greco



Françoise et Bernard Roy à Gdańsk en 1988



Françoise et Bernard Roy au Grand Trianon à Versailles en 2011



Françoise et Bernard Roy à Paris en 2014

Opinion Makers Section

Multi-criteria models integrated with Geographical Information Systems

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1. Introduction: integration between MCDA and GIS

Addressing decision problems may involve the simultaneous application of a multi-criteria analysis approach and a spatial analysis approach by means of Geographical Information Systems (GIS). Although multi-criteria analysis and the development of GIS tools represent two distinct areas of research, they can both benefit from their combined use, and for this reason handling their integration currently represents a research frontier (Chakhar and Martel, 2003; Malczewski, 2006).

The conventional MCDA approach assumes the spatial homogeneity of alternatives within the case study area, although it is often unrealistic (Massei et al., 2014). In fact, when the alternatives have also a spatial dimension, their classification, sorting or choice also depends on this spatial characterization (Malczewski, 1999). On the other hand, GIS are dedicated to the management of data, but they show significant limitations in the analyses that also involve value judgments (Malczewski, 1999; Eldrandaly et al., 2005). For this reason, a specific field of study has been established, concerning the development of spatial decision support systems, and in general for finding the most proper and functional forms of integration between MCDA models and GIS.

The MCDA-GIS integration can be classified according to a “three levels system”. The first and initial step is called indirect integration: the two instruments are separated but are connected through an intermediate system. The second level consists in the so-called *built-in* MCDA-GIS: the multi-criteria models are included as integrated components in the geographic system, while remaining independent both logically and functionally. In fact, while using the interface of the geographic software, the multi-criteria model uses a separate database. Only through complete integration (Malczewski, 2006) of the two systems, which includes the same interface and the same database, real application efficiency is reached. In this case, the MCDA model or models are activated within the GIS software as if they were one of its many functions.

Following, three models integrating MCDA-GIS are presented, here focused on environmental studies and evaluation of sustainable development, for supporting public decisions in this sensitive field. The three models presented in this context have been designed and fully developed by the research group named Environmental Laboratory, which is part of the Research Unit of Applied Economics, Department of Agricultural, Food and Environmental Sciences, University of Perugia. This research group has a plurennial experience in this field of research, and started to work on combination and integration between MCDA and GIS since from 1998. The applications proposed by the group, in relation to this type of instruments, are mainly focused on environmental evaluations, sustainable development, territorial planning and analysis.

2. The modular suite *r.mcda* in GRASS GIS

The modular suite *r.mcda* (Massei et al., 2014), based on five different multi-criteria decision analysis methodologies, is developed within GRASS GIS 6.4 svn (Grass Development Team, 2012a, 2012b). GRASS is an advanced and well-known open source GIS software (Frigeri et al., 2011), among the most used for geospatial data management, analysis and image processing, graphics/maps production, spatial modelling and visualization.

This suite is an example of flexible and complete integration between MCDA and GIS. Not only because more than one MCDA method is applied, but also because, being the methods incorporated as GRASS-GIS modules, they present a user-friendly interface.

The great advantage of the *r.mcda* suite is the open nature of GRASS GIS. This allows a real improvement of the tool, because all GRASS GIS users can potentially modify the existing modules or perfect the algorithm applied. It is not to underestimate that modules being developed in open source software encourage the development of new functionality within the community, thus increasing the flexibility and adaptability of the instrument.

Moreover, the suite is based on different algorithms developed in one modular package, and this allows adding new modules without the need to modify the original code. This enables the scientific evolution of MCDA to be followed up.

The five methods currently used in the modules are: ELECTRE I (Roy, 1991, 1997), Fuzzy set (Yager, 1977, 1988, 1993), REGIME (Hinloopen et al., 1983; Nijkamp and Hinloopen, 1990), Analytic Hierarchy Process (Saaty, 1977, 1990, 1992) and Dominance-based Rough Set Approach (DRSA) (Greco et al., 2001). This last module in particular represents the first implementation of the DRSA in a geographical context (Massei et al., 2014).

The name of each module is structured as follows: r.mcda.[algorithm]. Prefix r refers to raster data, mcda is the name of the suite, whereas the [algorithm] has to be substituted by the name of the MCDA method applied. For instance, the module corresponding to the ELECTRE I method is named *r.mcda.electre*, and so on. The modules use and process raster, and therefore the outputs are raster. The spatial nature of the data is always present in the multi-criteria process, because the basic unit of analysis is the single cell. This is not possible in the case of indirect integration.

Each criterion in all the modules is represented by a raster map (criterion map), which describes how the attribute is distributed in space. Each cell of the GRASS region stands for an alternative, and is described by means of the value assumed for the same cell the raster used as its criterion. The assignment of weights depends on the method applied. Figures 1, 2 and 3 report some examples, in this case for the *r.mcda.electre* module, of entry of inputs and relative outputs generated.

Currently, the suite has been used for various analysis of environmental nature, in order to support public decisions. For example, it has been used for the fire risk assessment in wooded areas in order to take appropriate preventive measures, or for choosing areas suitable for agricultural use of wastewater from agro-industrial activities (Massei et al., 2014).

The suite *r.mcda* is available from the GRASS addons repository at the following link: http://grasswiki.osgeo.org/wiki/GRASS_AddOns#mcda.

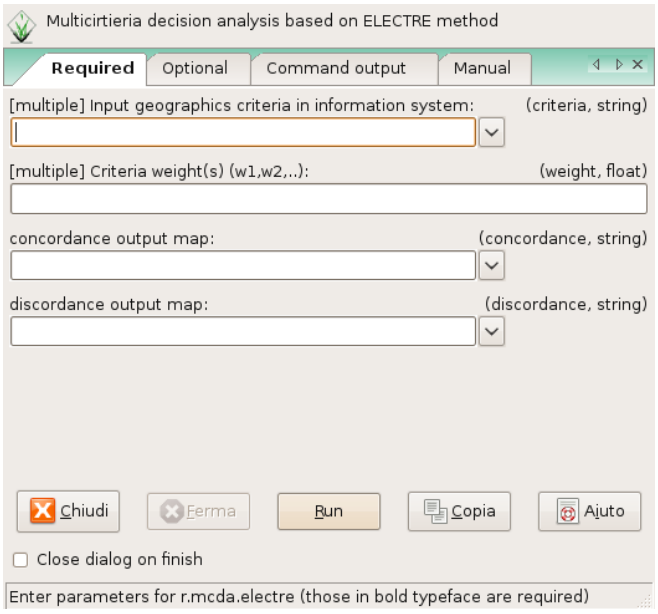


Figure 1 – Example for data entry in the r.mcda.electre module.

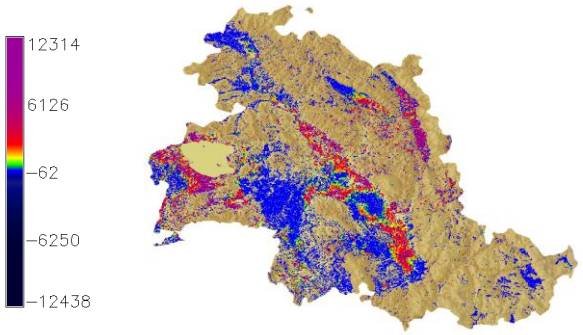


Figure 2 – Example of Concordance Index Map, *r.mcda.electre* module.

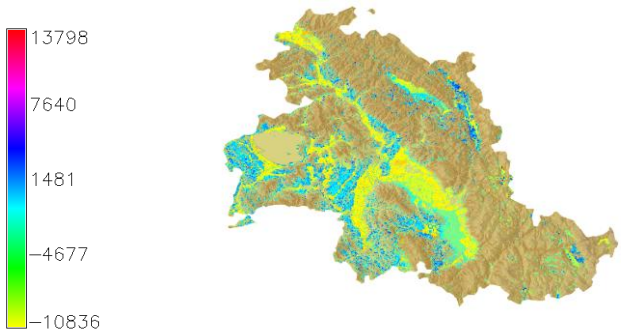


Figure 3 – Example of Discordance Index Map, *r.mcda.electre* module.

3. The plugin *VectorMCDA* in QGIS

VectorMCDA is a plugin developed within the open-source GIS software QuantumGIS (QGIS Development Team, 2013), and it implements some multicriteria decision aid algorithms. As the name suggests, the plugin is mainly based on vector data.

VectorMCDA works assuming that each geographical object, described with a record in the attribute table, is a single geo alternative. Each algorithm implemented in the plugin analyzes and elaborates the geographic attributes as criteria. Then, it returns as an output preference indices, adding in the attribute table one or more columns. Such an output is shown also as geographic maps in QGIS canvas and in a graphical html page.

The algorithms available in the current *VectorMCDA* version (1.0.1) are several. The module *GeoWeightedSum* implements the classical weighted sum algorithm (Triantaphyllou, 2000) and returns a map, showing the preferences granted to the various geo-alternatives; the module *GeoTOPSIS* implements the ideal point algorithm based on the TOPSIS method (Hwang and Yoon, 1981) and returns a map which shows the ranking of the alternatives; the module *GeoFuzzy* implements the Fuzzy method proposed by Yager (1977): it returns the fuzzy intersection and fuzzy union MCDA indices; the module *GeoPromethee* implements the Promethee method (Brans and Vincke, 1985) in a geographic context; the outputs are the negative and the positive fluxes for each alternative, while the net flux can be calculated using geoprocessing functions; the module *geoRSDB* implements the DOMLEM algorithm for Dominance- based Rough Set Approach (DRSA) (Greco et al., 2001); this module produces the classification of geo alternatives and a file reporting all the rules extracted and used for classifying. Thanks to this rules file, *geoRSDB* can be used both as MCDA method and as an instrument for back analysis. Furthermore, the plugin includes two modules which are not complete MCDA methods: *geoConcordance* and *geoXMCDA*. The former calculates the concordance and discordance index for each geo-alternative, as a base for assessment with ELECTRE models family (Roy, 1991, 1997); *geoXMCDA* is the first implementation in QGIS of xMCDA standard (http://www.decision-deck.org/xmcda/), for granting the MCDA data interoperability. The module is not yet mature and it is not usable for proper application; anyway it is under active development and testing phase.

For all the modules, the user may provide the weight values directly or using the AHP approach weighting procedure (Saaty, 1990), that is implemented in the plugin. All the MCDA methods provide, as results, both maps and graphs, and the values are stored in the attribute table, as an additional record.

Figures 4, 5 and 6 report some examples of outputs generated within *vectormcda*, for three of the five modules (*GeoWeightedSum*, *GeoFuzzy* and *GeoRSDB*).

The suite *VectorMCDA* is available at the following link: http://plugins.qgis.org/plugins/VectorMCDA/

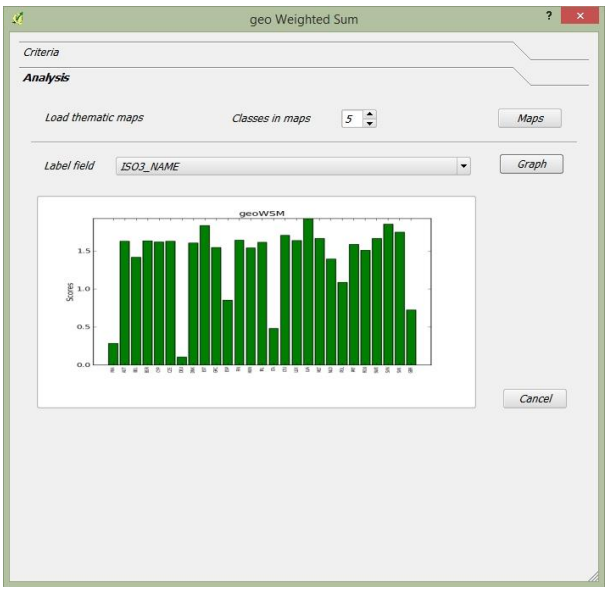


Figure 4 - Example of output for the *GeoWeightedSum* module

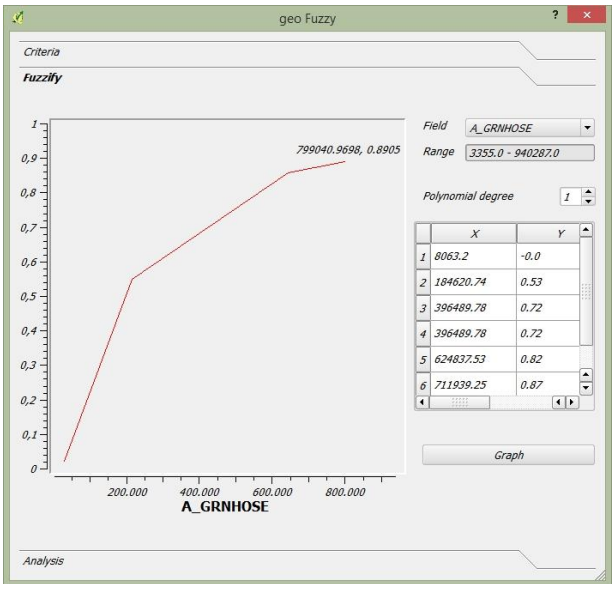


Figure 5 - Example of output for the *GeoFuzzy* module

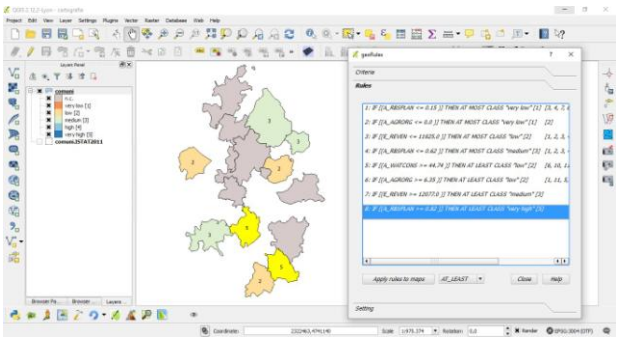


Figure 6- Example of output for the *GeoRSDB* module (classification and rules extraction).

4. The model *GeoUmbriaSUIT*

GeoUmbriaSUIT is a calculation procedure used in a geographic environment, aimed to evaluate sustainability at territorial level, using multiple criteria that cover environmental, economic and social aspects. Practically, it consists of a plugin working in the open-source GIS software QuantumGIS (QGIS Development Team, 2013).

The multi-criteria method used within *GeoUmbriaSUIT* is the algorithm TOPSIS (Technique for Order Preference by Similarity to Ideal Design) (Hwang and Yoon, 1981), which defines a ranking based on the distance from the worst point and the closeness to an ideal point, for each of the criteria used.

For the sustainability assessment procedure, *GeoUmbriaSUIT* uses a geographic vector file (e.g. a shapefile) where the graphic data represent the study area and the single evaluation units within it (the alternatives, e.g. the regions of a country, or the municipalities of a region), while the alphanumeric data (attribute table), describe the environmental, economic and social aspects related to the evaluation units by means of a set of indicators (criteria). The use of the algorithm available in the plugin allows to treat individually the indicators representing the three dimensions of sustainability, and to compute three different indices: environmental index, economic index and social index. The linear combination of the three indices gives an overall sustainability index for each geographic unit. The higher the value of this index, the better the performance of the unit in terms of sustainability.

Entry of weights can be done directly, if known, or with the use of a pairwise comparison table.

The results of the model are both alphanumeric, i.e. the values of the indices, and graphic. Graphic outputs consist of maps showing the multi-criteria analysis results for each territorial unit analysed (Figure 7), and two types of graphs, exemplified in Figures 8 and 9.

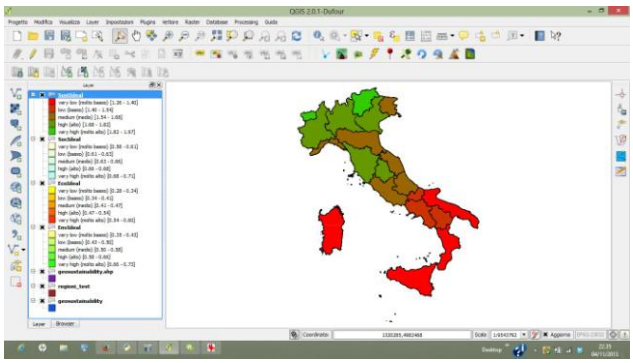


Figure 7- Output map example in *GeoUmbriaSUIT*

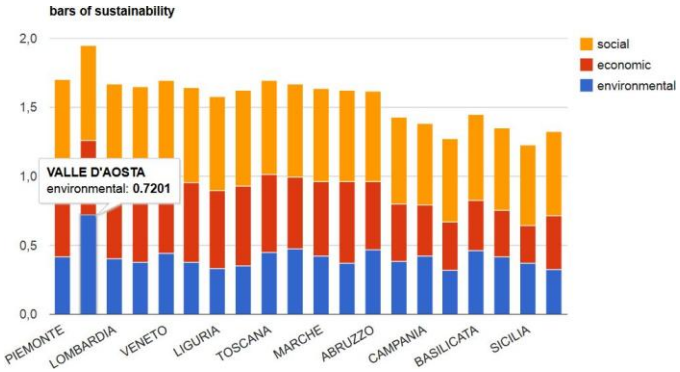


Figure 8 – Example of sustainability bars in *GeoUmbriaSUIT*

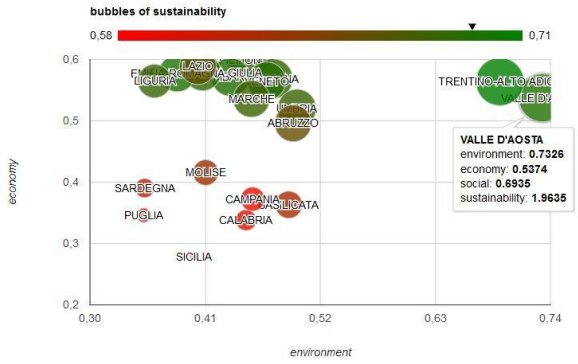


Figure 9 – Example of sustainability bubbles in *GeoUmbriaSUIT*

The first type of graph is a stacked histogram, in which the overall height is proportional to the sustainability value as the linear combination of the three indices (environmental, economic and social). The second type of graph is represented by bubbles, in which their position, dimension and color provide information about sustainability and its three dimensions. In particular, the *x*-axis is ordered according to the environmental index, the *y*-axis is ordered according to the economic index, the color (from red that means low, to green that means high) is ordered according to the social index, while the dimension of the bubble is proportional to the final sustainability value. Both graphs are interactive and allow for the index values to be displayed upon request by the user (using the mouse).

The presence of separate indices and graphic output make *GeoUmbriaSUIT* a readable and transparent tool, in comparison with many other existing models that address sustainability assessment. Generally classical models produce just an aggregate index of sustainability as final result of their calculations, which are often cryptic and difficult to interpret. This is a typical problem that occurs when using evaluation tools for complex concepts such as sustainability, with output represented in a single index. *GeoUmbriaSUIT*, on the contrary, is extremely transparent and readable, calculating three different indices for

economic, environmental and social aspects, and providing graphic output in addition to the alphanumeric one.
Finally, the plugin has the possibility to implement the DOMLEM algorithm, based on the Dominance Based Rough Sets Approach (DRSA) (Greco et al., 2001). In this case, the exemplary cases are the best alternatives found after the analysis. DRSA is not used to get ranking but to extract the decision rules that can explain the positions obtained by the alternatives in the ranking, based on the criteria used. Using it, transparency, traceability and back analysis capability are increased. Traceability means that from the score it is possible to go back to the rules and from the rules back to the input data.
GeoUmbriaSUIT is available at the following link:
http://plugins.qgis.org/plugins/geoUmbriaSUIT/

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MCDA Research Groups

An Approach to Sustainable Development Based Energy and Climate Policy

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Summary

Planning for India's energy future requires addressing multiple and simultaneous economic, social and environmental challenges. While there has been conceptual progress towards harnessing their synergies, there are limited methodologies available for operationalising a multiple objective framework for development and climate policy. We propose a 'multi-criteria decision analysis' (MCDA) approach to this problem, using illustrative examples from the buildings and cooking sectors. An MCDA approach enables policy processes that are analytically rigorous, participative and transparent, which are required to address India's complex energy challenges.

Introduction

India faces a challenging decade ahead in energy and climate policy-making. The problems are multiple: sputtering energy production capabilities; limited energy access; rising fuel imports; continued electricity governance and pricing challenges; and growing environmental contestation around land, water, and air. In addition, the December 2015 Paris Agreement provides a new and heightened context for India's energy and climate policies. Every country, including India, will have to regularly update its climate contributions and report on progress. Amongst other goals, India intends to reduce the emissions intensity of its GDP by 33 to 35% by 2030 from 2005 levels (UNFCCC 2015). These intended 'contributions' for India, and the requirement to progressively increase the level of ambition, will necessarily influence its domestic energy use, given that energy accounts for 77% of its greenhouse gas emissions (WRI 2014). To do so in a manner which enables India to address multiple and simultaneous challenges in the context of its sustainable development led approach suggests great complexity.

So far, India's approach to energy policy-making has been largely supply oriented and in silos, leading to a number of disconnects: between energy planning and social objectives, between domestic and foreign policy energy debates, and between energy and climate policy. Bridging these disconnects requires a shift in the decision-making process to explicitly consider the linkages across India's multiple sustainable development objectives. This principle is already enshrined in the National Action Plan on Climate Change's "co-benefits" approach. However, while conceptually promising, the approach has not yet been backed by a methodology to operationalize it.

In this article, we introduce "Multi-Criteria Decision Analysis" or MCDA, as a potentially useful way forward. MCDA presents a set of well-established approaches for a range of decision-making arenas, and can be deeply salient to Indian energy policy because it allows decision-making to account for complexities, while maintaining rigor and deliberation. In presenting an MCDA approach, we build on other efforts to operationalize multiple objective approaches to Indian energy decisions. These include an early framework for multi-criteria analysis (Dubash et al. 2013), energy dashboards (Sreenivas and Iyer 2015; SSEF 2015), and state and sectoral analyses (Jain et al. 2015; GGGI 2014).

The remainder of the article describes the essence of an MCDA approach and lays out its benefits, details and applications. The approach is applied illustratively to two case studies: access to modern cooking fuels and building energy efficiency. We present key insights from the two cases in the following sections.

Operationalizing a MCDA Approach

The synergies between sustainable development and climate considerations are of growing significance. While

some national studies track achievement ex post of these sustainable development objectives, the primary challenge is to move beyond an illustration of their potential to a methodology that allows an ex ante focus during policy making.

Four broad sustainable development objectives comprise the common set of social preferences that cut across decision making within an energy policy context. These are economic, social, environmental and institutional objectives which should ideally be served simultaneously. Within this context, we apply the MCDA approach illustratively to two sectors, cooking and buildings. The cooking sector is important because over 700 million people in India do not have access to modern cooking fuels and the adverse health effects of traditional, open-stove cooking result in an estimated one million premature deaths annually (Census 2011; Smith et al. 2014). Selecting effective policies to provide modern cooking fuels for rural households is therefore a development imperative.

Buildings, on the other hand, represent India's rapid urban transformation, and it is expected that two-thirds of the buildings stock to exist in 2030 is yet to be built (Kumar et al. 2010). Building energy efficiency policies offer benefits that go beyond energy savings, such as carbon mitigation, energy security, job creation, and increased socio-environmental outcomes. However, if unaddressed, the sector could lock India into a high-carbon growth path. We focus on evaluating energy efficiency policy options for new building envelopes in the residential sector, where most new construction is expected.

We analyze both sectors using an MCDA approach and discuss its advantages for decision making in the following section. The input data for the case studies, and part of the methodology in the buildings case, draws on NITI Aayog's Indian Energy Security Scenarios, a bottom-up energy accounting model.i The MCDA approach results are presented graphically in the "spider diagrams" in Figure 1 and 2. The larger the area of a spider, the better the policy alternative will be at fulfilling multiple objectives. These outcomes are illustrative, because they are preliminary and are not fully based on stakeholder consultations beyond expert input.

Figure 1: Illustrative MCDA results for the cooking sector study

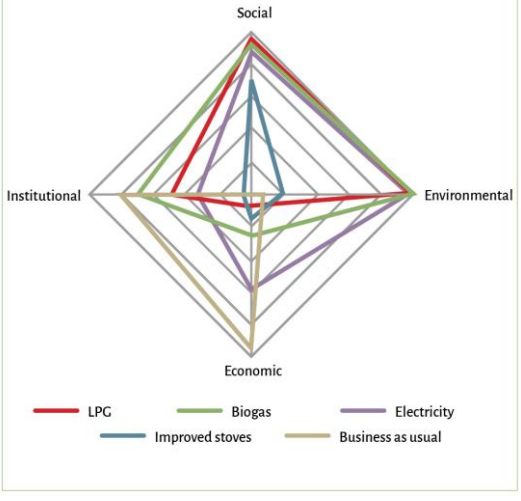
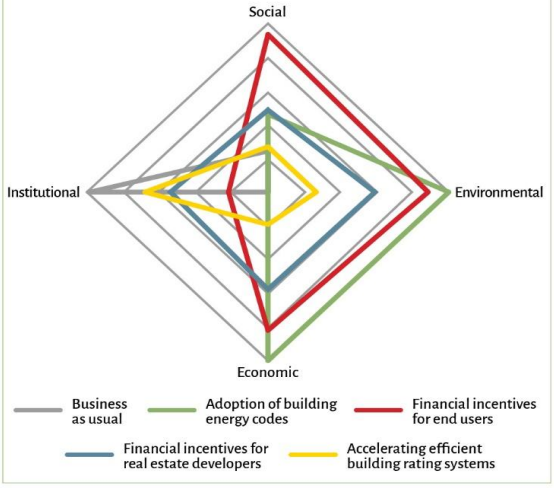


Figure 2: Illustrative MCDA results for the buildings sector study

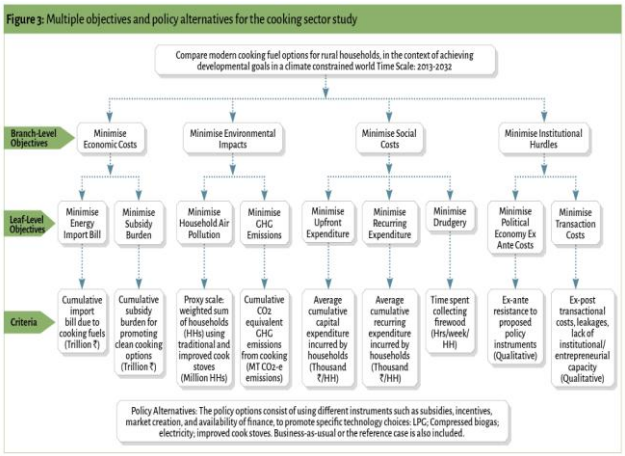


Insights for Policy

An MCDA approach provides important benefits: a structure for addressing multiple objectives simultaneously, a means to account for information that is not easy to quantify (such as distributional questions), and a rigorous consideration of choices involving synergies and tradeoffs when there are different stakeholder opinions on policy priorities. Examples from the two cases help demonstrate these benefits.

First, the approach requires policymakers to explicitly state the policy objectives to be achieved, and the weight given to each objective. For example, in the cooking case, the economic, social, environmental and institutional objectives are explicitly laid out at the start of decision making. Figure 3 shows the policy question with its explicit objectives and their translation to specific metrics or criteria against which different policy options can be evaluated. This approach encourages consideration of factors that are often ignored, such as household drudgery.

Figure 3: Multiple objectives and policy alternatives for the cooking sector study



Further, the approach requires identifying the relative weight given to each objective, such as minimizing household air pollution versus reducing greenhouse gas emissions. This attention enhances the transparency of process, and the effectiveness of the final decision.

Second, MCDA offers a range of tools for incorporating both quantitative and qualitative information with equal rigor. Importantly, the approach allows the use of qualitative information, for example, the consideration of implementation obstacles, which are often hard to analyze but nonetheless crucial to consider. In the buildings case, institutional questions are explicitly considered as a combination of ex ante implementation challenges, such as interests for or against a policy, and ex post elements such as the availability of required capacity or skills. As Figure 2 demonstrates, by including qualitative analysis on implementation, the results shift considerably - the building energy code policy that fares best on environmental, social and economic fronts, scores worst on ease of implementation. It thereby brings the attention of policymakers to the institutional trade-offs of this policy option.

Third, given the careful consideration of qualitative information and subjective weighting of objectives, MCDA approaches are necessarily underpinned by an early involvement of stakeholders. These include technical experts, policymakers, industry, end-users and civil society. For example, in the cooking case, to assess the relative importance of limiting drudgery versus other objectives, it is important to understand the preferences of the target cook stove users themselves. This broadening of the information base beyond expert analysis to include relevant stakeholders likely adds to the complexity of the process, but certainly enhances buy-in and enriches the analytical base.

Last, the process of deliberation and repeated iteration involving a wide range of stakeholders improves the sectoral knowledge base. The approach demands an identification of key issues, addition of information and refinement of argument and scores, all of which help plug data gaps to create a robust energy and sustainable development data spine. The buildings example is a case in point, as answering the policy problem requires researching data varying from the upfront investment needed for efficiency, to the local pollution reduced from lower diesel generator use.

Approaching a policy problem in this manner sheds light on the complementarities and tradeoffs between different objectives, which could either lead to clear winners or losers amongst the alternatives being considered. Or, it could facilitate further deliberation on the tradeoffs, and ways to improve the policy alternatives (by piecing together components that do well on many objectives, if possible) to further minimize tradeoffs and identify better policy options.

Key Steps of a MCDA Approach

Step 1: Define the problem. Identifies the policy question's scope and time horizon by bringing all stakeholders on board at the start.

Step 2: Identify policy objectives and specific metrics for assessment. Requires a clear understanding of national priorities thereby allowing for a greater range of alternatives to be considered.

Step 3: Identify policy alternatives to evaluate. Requires consideration of alternative policy approaches and an identification of the metrics for success.

Step 4: Analyze the alternatives. Identifies data gaps and provides a transparent basis for discussions.

Step 5: Elicit stakeholder preferences and normalize quantitative and qualitative information. Allows qualitative information to be equally integrated with quantitatively determined objectives.

Step 6: Aggregate through weights and compare consequences. Captures the interactive effects across policy objectives and the relative importance of the criteria.

Step 7: Uncertainty and sensitivity analysis. Tests the robustness of the inputs and the process by identifying any inordinate changes to the results from changing assumptions.

Step 8: Choose the preferred policy alternative. Implement the preferred alternative and evaluate results to feed back into the policymaking process.

Conclusion

Development policymaking, which incorporates energy and climate considerations, is a complex undertaking. It involves multiple objectives and various actors operating at different levels of governance. The MCDA approach proposed offers a useful way to work within this complexity, and facilitates a sustainable development approach to energy and climate policy making.

MCDA is particularly suitable in the climate context as it allows policymakers to place relative weights on economic and social development objectives, compared to climate objectives, consistent with India's co-benefits based approach to climate policy. Moreover, it allows transparent assessment of complementarities and tradeoffs across development and climate objectives. While this article is focused on mitigation, an MCDA approach can be used for a wide range of applications, including adaptation, as well as for other questions of social policy. In the immediate term, using the approach would strengthen coherence between India's domestic and international position on climate change which rests on the principle of not compromising development needs. Further, it can be employed to distinguish between additional climate actions that India could undertake with external aid which fall outside the scope of co-benefits. In the longer term, it can be used for opportune planning purposes that are

already in progress, such as India's National Energy Policy, or sectoral feasibility of India's climate commitments.
Ultimately this approach, underpinned by active deliberation, gives rise to decision processes that are participative, transparent and repeatable. Recognizing that MCDA approaches can be time and resource intensive, they are proposed as a starting point for more structured and inclusive policy making – to allow for India's energy and climate actions to be compatible with its broader social, economic and environmental goals.

ENDNOTES

I Our calculations use a draft version of IESS version 2, made available to us for this analysis. Version 2 of the IESS is now available at indiaenergy.gov.in.

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Software

ELECTRE TRI-rC: *diviz* software components for multiple criteria sorting with characteristic class profiles

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In this short paper, we present a method for multiple criteria sorting, called ELECTRE TRI-rC [1], along with its software implementation on the *diviz* platform. ELECTRE TRI-rC constructs an outranking relation to compare a set of alternatives $A=\{a_1,...,a_i,...,a_n\}$ with some characteristic class profiles $b_h$defined for all classesCl_h, h=1,...,p(with Cl_p being the best class). The method exploits this relation to derive for each alternative a class interval it should be assigned to. ELECTRE TRI-rC can be seen a revised version of ELECTRE TRI-C [2]. It uses, however, the assignment rules identifying the extreme classes for each alternative with univocal and easily interpretable rules.

The ELECTRE TRI-rC method

Preference information

The preference information supplied by the Decision Maker (DM) is composed of:

(1) Characteristic profile b_h for each class Cl_h, h=1,...,p; each profile b_h is formed from the most representative performance values for Cl_h on g_j, j=1,...,m (see Fig.1);

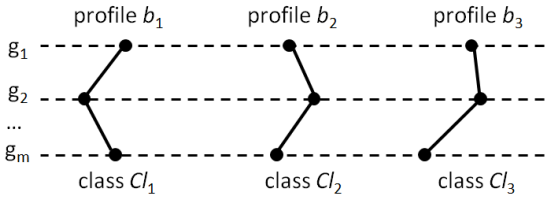


Fig.1. Characteristic class profiles.

(2) Weight w_j,indifference q_j, preference p_j, and veto v_j thresholds for each criterion g_j; the thresholds can be defined with affine functions;

(3) Cutting level λ which indicates the minimal value of an outranking credibility justifying the truth of an outranking relation.

The performance of each alternative $a \in A$ on criterion g_j is denoted by $g_j(a)$.

Verification of the truth of outranking relation

For each pair (a,b_h) composed of an alternative and a characteristic class profile, the method proceeds with verification of the truth of an outranking relation in the following steps:

(1) Compute the marginal concordance index $c_j(a,b_h)$ quantifying a degree to which criterion $g_j$agrees with the hypothesis about outranking aSb_h:

$$c_j(a,b_h)=\begin{cases} 1 \text{ if } g_j(a)-g_j(b_h)\geq -q_j, \\ 0 \text{ if } g_j(a)-g_j(b_h)\leq -p_j, \\ \dfrac{p_j-[g_j(b_h)-g_j(a)]}{p_j-q_j} \\ \quad \text{if } -q_j > g_j(a)-g_j(b_h) > -p_j. \end{cases}$$

(2) Determine the comprehensive concordance index $C(a,b_h)$ indicating the strength of the coalition of criteria which support the hypothesis about a being at least as good as b_h:

$$C(a,b_h)=\frac{\sum_{j=1}^{m} w_j c_j(a,b_h)}{\sum_{j=1}^{m} w_j}.$$

(3) Compute the marginal discordance index $d_j(a,b_h)$ quantifying a degree to which criterion $g_j$opposesto the hypothesis about outranking aSb_h:

$$d_j(a,b_h)=\begin{cases} 1 \text{ if } g_j(a)-g_j(b_h)\leq -v_j, \\ 0 \text{ if } g_j(a)-g_j(b_h)\geq -p_j, \\ \dfrac{[g_j(b_h)-g_j(a)]-p_j}{v_j-p_j} \\ \quad \text{if } -p_j > g_j(a)-g_j(b_h) > -v_j. \end{cases}$$

(4) Compute the credibility $\sigma(a,b_h)$ of an outranking relation by integrating the comprehensive concordance and non-discordance indices:

$$\sigma(a,b_h)=C(a,b_h)\prod_{i\in F}\frac{1-d_i(a,b_h)}{1-C(a,b_h)}$$

where $F=\{i: D_i(a,b_h)>C(a,b_h)\}$.

(5) Verify the truth of a crisp outranking relation S:

$$\sigma(a,b_h)\geq \lambda \Leftrightarrow aSb_h.$$

(6) Verify the truth of preference $\succ$, indifference ~, and incomparability R relations in the following way:

$$aSb_h \wedge not(b_hSa) \Rightarrow a \succ b_h,$$
$$aSb_h \wedge b_hSa \Rightarrow a \sim b_h,$$
$$not(aSb_h) \wedge not(b_hSa) \Rightarrow aRb_h.$$

Sorting recommendation

The assignment rules of ELECTRE TRI-rC indicate the worst $Cl_L(a)$and the best class $Cl_R(a)$ in which alternative a can be assigned.

To determine $Cl_L(a)$, compare a successively to b_h, for h = p-1,..., 0, seeking the first characteristic profile b_h such that:

$$a \succ b_h \wedge \sigma(a,b_{h+1}) > \sigma(b_h,a),$$

and select $Cl_L(a)=Cl_{h+1}$. These conditions can be interpreted as follows: since $a$is clearly better than b_{L-1} and there exist sufficiently strong arguments in support of a being at least as good as b_L, a cannot be assigned to a class worse than $Cl_L(a)$.

To determine $Cl_R(a)$, compare a successively to b_h, for h = 2,..., p, seeking the first characteristic profile b_h such that:

$$b_h \succ a \wedge \sigma(b_{h-1},a) > \sigma(a,b_h),$$

and select $Cl_R(a)=Cl_{h-1}$.

Thus, $a$is assigned to the class interval $Cl(a)=[Cl_L(a), Cl_R(a)]$. In case $Cl_L(a)=Cl_R(a)$, the recommended assignment $Cl(a)$ is precise. For a detailed justification of the assignment rules of ELECTRE TRI-rC, see [1].

ELECTRE TRI-rC software components on *diviz*

diviz is an open-source software which allows to design, execute, and share complex workflows implementing procedures of decision analysis [3]. The software infrastructure consists of a Java client for algorithmic workflow design and visual analysis of the outcomes, and distant servers for executing the workflows.

MCDA procedures as well as visualization or reporting tools are available in *diviz* via XMCDA web-services. They need to read inputs and write outputs formatted using the XMCDA standard. XMCDA represents MCDA concepts (e.g., alternative, class, outranking relation, or veto threshold) using general data structures referred to as MCDA types which are coded in XML with tags and attributes. In this way, the standard ties together all the web-services, making their interoperability possible.

Procedures for construction of an outranking relation and computation of the sorting recommendation have been implemented as a collection of individual modules (components). Each of them is responsible for deriving different type of results. In Fig. 2, we present a structure of the module computing the final assignments with ELECTRE TRI-rC. The implemented modules are more universal, i.e., they can be used for dealing with ranking, choice, or sorting with boundary class profiles, but we review their functionality as limited to the scope of the original ELECTRE TRI-rC method.

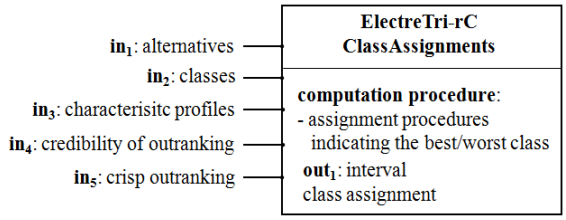


Fig. 2. Structure of the *diviz* module for computing interval class assignments with the ELECTRE TRI-rC rules

ElectreConcordance (PUT) requires the user to specify a set of alternatives (in1) and their performances (in4), characteristic class profiles (in2) and their performances (in5), a set of criteria along with their preference directions as well as indifference and preference thresholds (in3), and criteria weights (in6). The module delivers comprehensive concordance indices for all pairs composed of an alternative and a characteristic class profile.

ElectreDiscordance **(*PUT*)**requires exactly the same inputs as *ElectreConcordance* but criteria weights. Note that in the specification of criteria, one needs to include the veto thresholds. The module computes marginal discordance indices.

ElectreCredibility **(*PUT*)** requires the user to specify a set of alternatives (in1) and characteristic class profiles (in2) along with the results of concordance and discordance tests derived from *ElectreConcordance* and *ElectreDiscordance*. To compute credibility as defined with $\sigma(a,b_h)$, the module needs to be parameterized to use marginal discordance indices and a denominator (i.e., to consider only sufficiently great discordance as compared to $C(a,b_h)$).

cutRelationCrisp **(*PUT*)**needs to know a valued outranking relation), i.e., the credibility of an outranking (in3) between alternatives (in1) and characteristic class profiles (in2). By referring to the DM-provided parameter λ, the module transforms a valued outranking relation into a crisp one.

ElectreTri-rCClassAssignments **(*PUT*)**needs to be supplied with a valued (in3) and crisp (in4) outranking relation between alternatives (in1) and characteristic class profiles (in2) as well as a set of decision classes (in5). The output of the module provides a possibly imprecise assignment interval for each alternative computed w.r.t. the assignment rules of ELECTRE TRI-rC.

The detailed documentation of these modules is available at the *diviz* website [3].

The design of decision analysis workflows in *diviz* is performed via an intuitive graphical user interface. Each component is represented by a rectangular box which can be linked to data files or other computation modules. To construct a workflow, the user chooses the modules (s)he is interested in from the list of available elements. Using a ``drag-and-drop" function, (s)he adds them to the workspace along with the data files. Subsequently, the inputs and outputs of different components can be linked using connectors to define the structure of the workflow. Once the design is finished, it is possible to execute the workflow.

Illustrative example

To illustrate the proposed approach, we will refer to the problem of assessing environmental impact of cities. It has been originally considered by the Economist Intelligence Unit. A set of 15 European cities is rated across a range of specific areas, such as the intensity of CO_2 emission (g1), energy consumption (g2), water management (g3), and waste use (g4). All these criteria have the form of indicators aggregating several more detailed aspects which contribute to a score on a 0 to 10 scale. The performance table, as visible in *diviz*, is provided in Tab. 1.

	g1	g2	g3	g4
OSL	9.58	8.71	6.85	8.23
STH	8.99	7.61	7.14	7.99
CPH	8.35	8.69	8.88	8.05
BRU	8.32	6.19	9.05	7.26
PAR	7.81	4.66	8.55	6.72
ROM	7.57	6.40	6.88	5.95
MAD	7.51	5.52	8.59	5.85
IST	4.86	5.55	5.59	4.86
ATH	4.85	4.94	7.26	5.33
WAR	4.65	5.29	4.90	5.17
LIS	4.05	5.77	5.42	5.34
PRG	3.44	3.26	8.39	6.30
BEG	3.15	4.65	3.90	4.30
SOF	2.95	2.16	1.83	3.32

KIE	2.49	1.50	5.96	1.43

Tab. 1. Performance table

The aim is to assign these cities to three decision classes: Cl1-Cl3 (with Cl3 being the best one).

Preference information

Let us consider the following pieces of preference information:

· characteristic class profiles on all criteria for Cl1 = 4.4, for Cl2 = 5.9, and for Cl3 = 7.6;
· indifference thresholds for all criteria = 0.2;
· preference thresholds for all criteria = 0.5;
· veto thresholds for all criteria = 4.5;
· weights for g1 and g2 = 3 and for g3 and g4 = 2,
· cutting level λ=0.65.

Workflow

The version of *diviz* with ELECTRE TRI-rC modules can be downloaded from [3].

The structure of the *diviz* workflow with the input data and modules responsible for the ELECTRE TRI-rC computations is presented in Fig. 3. ***It can be downloaded from the newsletter section at theEWG-MCDA web-site*** [4]. You can import it into *diviz* using option Workflow - Import as new. The workflow contains also the input data files so that one can see how to suitably prepare the inputs for other problems at hand.

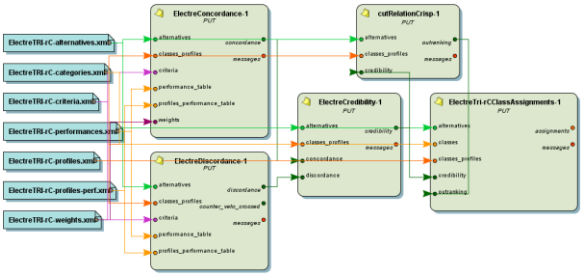


Fig. 3. Structure of the *diviz* workflow used in the illustrative study

Sorting recommendation

In Tab. 2, we present the class intervals suggested for the alternatives by ELECTRE TRI-rC. For 7 cities, the method indicates a precise assignment to Cl3, for 3 cities to Cl2, and for 4 cities to Cl1. Only for PRG the suggested assignment is imprecise.

	$Cl_L(a)$	$Cl_R(a)$
OSL	Cl3	Cl3
STH	Cl3	Cl3
CPH	Cl3	Cl3
BRU	Cl3	Cl3
PAR	Cl3	Cl3
ROM	Cl3	Cl3
MAD	Cl3	Cl3
IST	Cl2	Cl2
ATH	Cl2	Cl2
WAR	Cl1	Cl1
LIS	Cl2	Cl2
PRG	Cl1	Cl2
BEG	Cl1	Cl1
SOF	Cl1	Cl1
KIE	Cl1	Cl1

Tab. 2. The class intervals suggested by ELECTRE TRI-rC.

Obviously, one can also analyze the outputs of each individual component, i.e., the results of concordance and discordance tests, credibility degrees, truth of the outranking relation. Moreover, *diviz* enables to experiment with the parameterization of the method, while saving the results of the previous executions. For example, when changing λ to 0.75, the assignment for PAR becomes imprecise [Cl2,Cl3]. For any help regarding the use of ELECTRE TRI-rC modules on diviz, please contact the authors.

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[1] Kadziński, M., Tervonen, T., Figueira, J.R. (2015). Robust multi-criteria sorting with the outranking preference model and characteristic profiles. *Omega* 55, 126-140.

[2] Almeida Dias, J., Figueira, J.R., Roy, B. (2010). Electre Tri-C: a multiple criteria sorting method based on characteristic reference actions. *European Journal of Operational Research* 204(3), 565-580.

[3] The Web site of the *diviz* project: *http://www.diviz.org/*

[4] The newsletter section at the EWG-MCDA web-site:http://www.cs.put.poznan.pl/ewgmcda/index.php/newsletter

About the 83rd Meeting

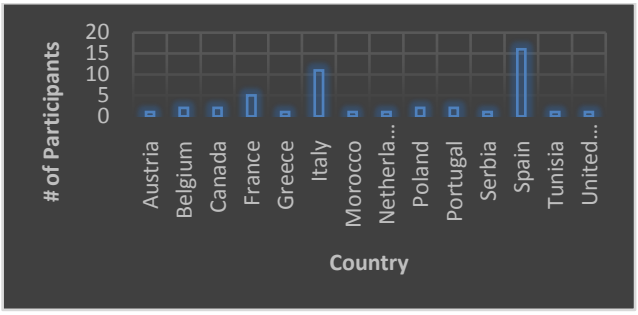
83rd EWG-MCDA Report
31st of March - 2nd of April, Barcelona, 2016

The 83rd European Working Group in Multicriteria Decision Aiding (EWG-MCDA) was hosted by ESADE Business School, Ramon Llull University in Barcelona, Spain between March 31st and April 2nd, 2016.

The theme of the meeting was "MCDA Applications to Business and Management" covering research issues in the area of multicriteria decision aiding, involving new theoretical research and applications to business and management. The papers were organised around different topics providing a representative sample of current work in MCDA from the global community. Thirteen articles were presented during six working sessions and 17 papers were posed for discussion.

Diverse range of topics presented at the conference

Participants attended an engaging panel session with Professors from different business schools in Spain. Each panel member shared his/her perception on trends in decision aiding systems for business and management. Panellists included Helena Ramalhinho from UPF, Miguel Angel Ariño from IESE, Francesc Miralles from La Salle, URL, Marc Le Menestrel from UPF, and Esteve Almirall from ESADE, URL. Thank you to all the panellists for a stimulating discussion.
We would like to thank Vincenç Torra, our guest speaker this year for his lecture titled: "Choquet integral: distributions and decisions". Dr. Torra is a professor of Information Technology from the University of Skövde's School of Informatics.
The level of interest in this year's conference was excellent. We received 34 submissions with many authors eager to present their research. There were 48 participants representing 30 universities and 14 countries. Among the participants were around 20 students.



Represented Countries

As per tradition, participants received a peek at the next venue and exciting activities planned for the 84th and 85th edition of the EWG-MCDA conference to be held in Vienna, Austria and Padova, Italy, respectively.

Day 1 of the conference concluded with seaside dining at the Ca La Nuri for the gala dinner. Participants had the opportunity to relax from the day's events and network with other members of the community while enjoying a traditional Spanish meal of paella.
Day 3 of the conference participants enjoyed a guided tour of some of Barcelona's tourist highlights including the Sagrada Familia, Parc Güell, and the old city centre. Thankfully, the weather cooperated with us.

We would like to express our sincere gratitude to all authors for making the conference possible through their contributions and participation. We sincerely thank the members of the organizing committee for their effort in the preparation of this event, and all the members of the Scientific Committee for their help in the reviewing process.

Conference Participants



We hope all participants had a successful and inspiring conference and a pleasant stay in Barcelona. We look forward to seeing you in Vienna.

Núria Agell, ESADE Business School
April 2016

PROGRAMME / PROGRAM

Thursday March 31st, 2016
Room 105 (First Floor)-Sant Cugat Campus
ESADE Business School, Barcelona

11.00– 12.00 Enregistrement / Registration of participants
Light Lunch
13.00 Welcome address / Mot de bienvenue
Jonathan Wareham
Faculty Dean of ESADE Business School
13.15 –15.15 Session 1 (Chair: Aïda Valls)

- Salvatore Corrente, Salvatore Greco, Benedetto Matarazzo, Roman Słowiński: Robust ordinal regression approach to decision under risk & uncertainty.
- Willem K. M. Brauers, Alvydas Baležentis, Tomas Baležentis: Is it possible to avoid the Spread by Sampling with the Assistance of Multi-Objective Optimization?

Discussion Papers / Articles soumis à discussion

- Mohamed Ayman Boujelben : A unicriterion analysis based on the PROMETHEE principles for multicriteria ordered clustering.
- Fouad Ben Abdelaziz, Volker G. Kuppelwieser: Towards the Identification of Important and Non-correlational Criteria –an Multiobjective Approach.
- Chiara D'Alpaos, Rubina Canesi: AHP Modeling to Assess Real Estate Investments Riskiness.
- Nikolaos Matsatsinis, Theodoros Papadimitriou, Alkaios Sakellaris: Towards a multi-criteria video games recommendation system.

15.15 –15.45 Coffee Break / Pause café
15.45 –17.30 Session 2 (Chair: Marta Bottero)

- Francis Macary: Using multiple criteria decision aid to improve best agricultural and environmental management practices in the area of big wine company near Bordeaux.
- F. F. Fagioli, L. Rocchi, L. Paolotti, A. Boggia: From the farm to the agri-food system: an

indicators framework for evaluating multi-functionality through the value chain.

Discussion Papers / Articles soumis à discussion

- Alessandra Oppio, Valentina Ferretti, Alberto Colorni Vitale: Defining combinations of alternative projects for urban regeneration using Decision Analysis.
- A. Boggia, F.F. Fagioli, L. Paolotti : MCDA and farm management: sustainable strategies for farms considering multi-purpose plans
- H. Yamnahakki A. Menou: Modeling safety airport management Problem with Multicriteria Decision Aiding and Multi-levels Method.
- Jenn Nguyen, Germán Sánchez, Cecilio Angulo: Comparing FHOWA to FOWA operators for Human Resources selection.

Move to ESADECREAPOLIS Auditorium

17.30 – 19.00 Panel Session / Table ronde (Chair: Núria Agell)

Trends in decision aiding systems for business and management

Participants:

Helena Ramalhinho (UPF); Miguel Angel Ariño (IESE); Francesc Miralles (La Salle, URL); Marc Le Menestrel (UPF); Esteve Almirall (ESADE, URL).

Move to Gala Dinner: Restaurant Ca la Nuri (Playa de Barcelona)

Friday April 1st, 2016
Room 105 (First Floor) - Sant Cugat Campus
ESADE Business School, Barcelona

9.00 –10.30 Session 3 (Chair: Milosz Kadzinski)

- Parisa Madhooshiarzanagh, Irène Abi-Zeid: A Preference Disaggregation Model for ELECTRE TRI-NC: Application and Validation.
- Salvatore Corrente, José Rui Figueira, Salvatore Greco, Roman Słowiński: Applying MCHP, ROR and the SMAA methodology to the ELECTRE III method with interaction between criteria.

Discussion Papers / Articles soumis à discussion

- Ferran Gionés, David Riu, Xari Rovira: Using Fuzzy-TOPSIS Method to Rank Investors' Decision Variables in Venture Proposals Evaluation.
- Miriam Martínez-García, Aida Valls, Antonio Moreno: New concordance and discordance indices in ELECTRE-III for semantic data.
- Jafar Rezaei, Linde van Wulfften Palthe: Port choice modelling using best worst method.
- Kannan Govindan, Ronja Ehling, Miłosz Kadziński: Evaluation of sustainable third-party reverse logistics provider using ELECTRE III.

10.30 –11.00 Coffee Break / Pause café

11.00 – 12.30 Session 4 (Chair: Sarah Ben Amor)

- Ferretti Valentina, Pluchinotta Irene, Tsoukiàs Alexis: How to innovatively design public policies?
- Marta Bottero, Alessandra Oppio: Strategic management and Multicriteria Decision Aiding: an application for the Alpine refuges in Lombardy Region (Italy).
- De Vicente y Oliva, María A., Manera Bassa, Jaime, Alvarado Riquelme, María, García Vegas, Ricardo: Social impact of social innovation: a multicriteria evaluation of social enterprises in Spain.

Discussion Papers/ Articles soumis à discussion

- Anna Risch, Vincent Clivillé, Lamia Berrah: Aspect multicritère de la performance énergétique des bâtiments.
- Mladen Stamenković: Stepwise benchmarking evaluation of European educational systems
- Antonino Scarelli, Maria Franca Norese, Aqeel Mustafa : New frontiers for MCDA: from hundreds of indicators to structured models and processes of decision aiding – part 2.

12.30 – 14.00 Lunch

14.00 – 14:30 Preparation of next meetings/ Vie du groupe

14.30 – 15.30 Session 5 (Chair: Salvatore Corrente)

Main Lecture - Vicenç Torra:
Choquet integral: distributions and decisions

15.30 – 16.00 Coffee Break / Pause café

16.00 – 18.00 Session 6 (Chair: Núria Agell)

- Teresa C. Rodrigues, Gilberto Montibeller, Mónica D. Oliveira, Carlos A. Bana e Costa: Extending Reasoning Maps for Modelling Multi-criteria Value Interactions.
- Souhir Ben Souissi, Marc Pirlot, Lahcen Elhiki, Mourad Abed: Towards a generic system based on MCDA to support decision in antibiotic prescription.
- Siamak Zahedi, Mohammad Ghaderi: Analyzing Households' Willingness to Pay for External Costs of Air Pollution and GHG Emissions: A Multiple Criteria Decision Aiding.
- Bastien Rizzon, Vincent Clivillé, Sylvie Galichet: Aide à la décision multicritère dans un système de management de l'énergie.

Discussion Papers/ Articles soumis à discussion

- E. Borgonovo, V. Cappelli, F. Maccheroni, M. Marinacci: Risk Analysis and Decision Theory: A Bridge.
- Arayeh Afsordegan, Núria Agell, Mar Vila, Mónica Sánchez: An Extension of the Optimization Water-Energy Model Using Qualitative Multiple Criteria Decision Making Tools.

– Fouad Ben Abdelaziz, Sarah Ben Amor: An Interactive Multicriteria Decision Aiding Approach for Mixed Evaluations.

18:00 Workshop Closure

Forthcoming meetings

• 84th Meeting of the EWG-MCDA (MCDA 84) - From Axioms to Applications: Bridging the gap between theory and practice in MCDA.
Vienna, Austria, September 22-24, 2016

University of Vienna, School of Business, Economics and Statistics, http://mcda2016.univie.ac.at/

The University of Vienna is very pleased to host the 84th Meeting of the EURO Working Group on Multiple Criteria Decision Aiding and extends a warm welcome to all the participants. The meeting will take place from September 22nd to 24th at the Faculty of Business, Economics and Statistics.

The overall topic of this meeting is "From Axioms to Applications: Bridging the gap between theory and practice in MCDA". In accordance with this topic, we invite you to contribute papers that discuss new theoretical and methodological developments and their possible applications, as well as papers on practical applications of new methods, or applications that can stimulate new theoretical development.

In addition to the established methods and application areas of multiple criteria decision aid, we also look for papers exploring the relationship of MCDA to related areas like group decisions or decisions under risk and uncertainty, and papers that deal with the application of MCDA in new and innovative areas. Following the tradition of the working group, we particularly encourage to submit and present not only papers resulting from completed research projects, but also papers describing ongoing research and work in progress.

The organizers can also be contacted at mcda2016@univie.ac.at (main organizer - Rudolf Vetschera).

Submission of abstracts: June 3, 2016
MCDA 84: September 22-24, 2016

• 12-14/5/2016
57th meeting of the EURO Working Group for Commodities and Financial Modelling, Coimbra, Portugal, www.uc.pt/go/ewgcfm2016

• 15-22/5/2016
Behavioural OR Summer School (BOR)
Aalto, Finland
http://bor.aalto.fi/summerschool.html

• 16-18/5/2016
ISCO 2016 - 4th International Symposium on Combinatorial Optimization
Salerno, Italy
http://www.isco2016.it

• 18-20/5/2016
13th ESICUP Meeting
Ibiza, Spain
https://paginas.fe.up.pt/~esicup/extern/esicup-13thMeeting/

• 22-26/5/2016
Urban Computing 2016 - International Symposium on Emerging Frontiers of Urban Computing and Smart Cities
Valencia, Spain
http://www.iaria.org/conferences2016/URBANCOMPUTING.html

• 23-25/5/2016
ICDSST 2016, The 2nd International Conference on Decision Support System Technology
Plymouth, UK
https://icdsst2016.wordpress.com/2015/04/01/icdsst-2016/

• 23-26/5/2016
14th International Conference on Data Envelopment Analysis - DEA 2016
Wuhan, China
http://www.deaconference.com/dea2016/home/index.html

• 23-27/5/2016
CORE@50 Conference: Bridging Gaps
Louvain-la-Neuve, Belgium
http://core50.be/index.php/coreat50/

• 26-28/5/2016
ECCO XXIX 2016 - 29th Conference of the European Chapter on Combinatorial Optimization
Budapest, Hungary
http://ecco2016.euro-online.org/

• 29/5-1/6/2016
LION'10 - Learning and Intelligent Optimization Conference
Ischia Island (Napoli), Italy
http://www.lion10.unina.it/index.php

• 30/5-1/6/2016
Canadian Operational Research Society Annual Conference (CORS2016)
Banff National Park, Canada
http://www.haskayne.ucalgary.ca/cors2016/

• 31/5-2/6/2016

Computational Management Science Conference CMS 2016
Salamanca (Spain)
http://www.cms2016.com

• 1-3/6/2016
IPCO XVIII - 18th Conference on Integer Programming and Combinatorial Optimization
Liège, Belgium
http://events.ulg.ac.be/ipco2016/

• 8-10/6/2016
10th International Workshop on Hybrid Metaheuristics - HM 2016
Plymouth, UK
http://www.dmi.unict.it/hm2016/

• 8-10/6/2016
12th International Conference on Applied mathematical programming and Modelling (APMOD 2016)
Brno, Czech Republic
http://www.apmod2016.org/

• 9-11/6/2016
HELORS 2016: 5th International Symposium and 27th National Conference on Operational Research
Athens, Greece
http://eeee2016.teipir.gr

• 9-10/6/2016
ICORD- EWG ORD Workshop
ITAM, Mexico City
http://ifors.org/icord2016/

12-15/6/2016
INFORMS International Conference
Hawaii, USA
http://meetings2.informs.org/wordpress/2016international/

• 13-14/6/2016
ICSIBO - International Conference on Swarm Intelligence Based Optimization
Mulhouse, France
http://www.mage.fst.uha.fr/icsibo2016/

• 15/6-17/5/2016
Smart Cities 2016
Málaga, Spain
http://smart-ct2016.lcc.uma.es

• 19-23/6/2016
EngOpt 2016, the 5th International Conference on Engineering Optimization
Iguassu Falls, Brazil
www.engopt.org

• 20-24/6/2016
2016 International Conference on Group Decision & Negotiation
Bellingham, WA, USA
http://wp.wwu.edu/gdn2016/

• 24/6/2016
Workshop on Recent Advances in Multi-objective Optimization
Lancaster, UK
http://moo.univie.ac.at

• 25/6-1/7/2016
XIV International Conference on Stochastic Programming
Búzios, Brazil
http://icsp2016.sciencesconf.org/

• 26/6-2/7/2016
EURO PhD School on Sustainable Supply Chains
Koblenz & Aachen, Germany
http://www.sustainablesc.rwth-aachen.de/eps-sustsc/

• 28-30/6/2016
MIM 2016 - 8th IFAC Conference on Manufacturing Modelling, Management, and Control
Troyes, France
http://mim2016.utt.fr/

• 28-30/6/2016
ICAOR 2016 - 8th International Conference on Applied Operational Research
Rotterdam, The Netherlands
http://www.orlabanalytics.ca/icaor.htm

• 1-2/7/2016
EUROPT 2016 - 14th EUROPT Workshop on Advances in Continuous Optimization
Warsaw, Poland
http://www.europt2016.ia.pw.edu.pl/

• 2-5/7/2016
Data Envelopment Analysis International Conference 2016 (DEAIC2016)
Nanjing, China
http://www.deafrontier.net/deaic2016/home.html

• 3-6/7/2016
EURO 2016 - 28th European Conference on Operational Research
Poznań, Poland
http://www.euro2016.poznan.pl/

• 9/7/2016
10th Multidisciplinary Workshop on Advances in Preference Handling (M-PREF)
New York, USA
http://www.mpref-2016.preflib.org

• 10-16/7/2016
ESCC 2016 - 3rd International Conference on "Energy, Sustainability and Climate Change
Marathon, Athens, Greece
http://saharidis.wix.com/escc

• 11-13/7/2016
StochMod16, the international meeting of the EURO Working Group on Stochastic Modelling
Louvain-la-Neuve, Belgium
http://stochmod.eu/Meetings/StochMod16/

• 12-14/7/2016
MIMAR - 9th IMA International Conference on Modelling in Industrial Maintenance and Reliability
London, UK
http://www.ima.org.uk/conferences/conferences_calendar/mimar9.html

• 18-29/7/2016
12th MCDA/M Summer School 2016
Recife, Brazil
http://cdsid.org.br/mc-summer-school2016/

• 20-24/7/2016
GECCO 2016 - Genetic and Evolutionary Computation Conference
Denver, Colorado, USA
http://www.sigevo.org/gecco-2016/

• 25-29/7/2016
2016 IEEE WCCI/CEC 2016
Vancouver, Canada
http://www.wcci2016.org/

• 6-11/8/2016
ICCOPT 2016 - The fifth International Conference on Continuous Optimization
Tokyo, Japan
http://www.iccopt2016.tokyo/

• 17-19/8/2016
Modeling and OPtimization: Theory and Applications (MOPTA)
Pennsylvania, USA
http://coral.ie.lehigh.edu/~mopta

• 17-19/8/2016
IWOCA 2016 - 27th International Workshop on Combinatorial Algorithms
Helsinki, Finland
http://iwoca2016.cs.helsinki.fi

• 26-29/8/2016
MOD 2016 - 2nd International Workshop on Machine learning, Optimization and big Data
Volterra, Tuscany, Italy
http://www.taosciences.it/mod/

• 30/8-2/9/2016
OR 2016
Hamburg, Germany
http://or2016.de/

• 1-3/9/2016
CO2016 - International Symposium on Combinatorial Optimisation 2016
Kent, Canterbury, UK
http://www.kent.ac.uk/kbs/co2016/index.html

• 4-7/9/2016
Matheuristics 2016 - 6th International Workshop on Model-based Metaheuristics
Brussels, Belgium
http://iridia.ulb.ac.be/matheuristics2016

• 6-9/9/2016
2016 AIRO Conference
Trieste, Italy
http://www.airo.org/conferences/airo2016/

• 6-8/9/2016
0R 58 - UK Operational Research Society Annual Conference
Portsmouth, U.K.
http://www.theorsociety.com/Pages/Conferences/OR58/OR58.aspx

• 22-24/9/ 2016
84th Meeting of EURO Working Group on MCDA
Vienna, Austria
Organizer: Rudolf Vetschera
http://mcda2016.univie.ac.at/

• 14-16/9/2016
EWGLA 2016 - 23rd meeting of the EURO Working Group on Locational Analysis
Malaga, Spain
http://ewgla2016.lcc.uma.es

• 17-18/9/2016
PPSN 2016 - 14th International Conference on Parallel Problem Solving from Nature
Edinburgh, Scotland, UK
http://ppsn2016.org/conference/

• 19-23/9/2016
DMO 2016 - International Conference on Decision Making and Optimization
Athens, Ohio, USA
https://www.ohio.edu/engineering/dmo-2016/

• 2-6/10/2016
XVIII CLAIO, the Latin-Iberoamerican Conference on Operations Research
Santiago, Chile
http://www.claio2016.cl/

• 5-7/10/2016
CENTERIS Workshop on Multicriteria Decision Making & Applications in Enterprise Information Systems
Porto, Portugal
http://centeris.eiswatch.org/

• 9-12/10/2016
IEEE International Conference on Systems, Man and Cybernetics
Budapest, Hungary
http://www.smc2016.org

• 27-28/10/2016
Workshop on "Optimization challenges in the evolution of energy networks to smart grids"
University of Coimbra, Portugal
http://www.uc.pt/en/org/inescc/org_scientific_events/optenergy2016

• 27-31/10/2016
META'2016 - International Conference on Metaheuristics and Nature Inspired Computing
Marrakech, Morocco
http://meta2016.sciencesconf.org/

• 7-8/11/2016
EURO Mini Conference DA2PL'2016 - From Multiple Criteria Decision Aid to Preference Learning
Paderborn, Germany
https://homepages.uni-paderborn.de/kiudee/

• 13-16/11/2016
INFORMS Annual Meeting
Nashville, USA
http://meetings2.informs.org/wordpress/nashville2016/

• 6-9/12/2016
2016 IEEE Symposium on Computational Intelligence in Multicriteria Decision-Making
Athens, Greece
http://ssci2016.cs.surrey.ac.uk/MCDM.htm

• 26-28/2/2017
INOC2017 - 8th International Network Optimization Conference
Lisbon, Portugal
http://inoc2017.fc.ul.pt/

• April 2017
85th Meeting of EURO Working Group on MCDA
Padova, Italy
Organizer: Chiara D'Alpaos

• 4-7/7/2017
12th Metaheuristics International Conference (MIC 2017)
Barcelona
http://mic2017.upf.edu/

• 10-14/7/2017
MCDM 2017
Ottawa, Canada

• 17-21/7/2017
28th IFIP TC7 Conference 2017 on System Modelling and Optimization
Middle East Technical University, Ankara, Turkey
http://iam.metu.edu.tr/ifip17

• 17-21/7/2017
IFORS 2017
Québec City, Canada
http://ifors2017.ca/

• 19-22/9/2017
11th International Conference on Parametric Optimization and Related Topics (ParaoptXI)
Charles University, Prague, Czech Republic
http://paraoptxi.fsv.cuni.cz

• September 2017
86th Meeting of EURO Working Group on MCDA
Paris, France (or Delft, The Netherlands)

Seminars

SEMINAIRE « MODELISATION DES PREFERENCES
ET AIDE MULTICRITERE A LA DECISION »
Responsables : Bernard ROY, Daniel VANDERPOOTEN
(le mardi à 14h00 – salles à préciser)

Prochaines reunions

12 avril 2016: Conférence de Alessio Ishizaka
University of Portsmouth
Multi-criteria sorting methods: AHPSort I and II.

17 mai 2016: Conférence de Karell Bertet
Laboratoire L3i, Université de La Rochelle
Structure de Treillis: panorama des aspects structurels et algorithmiques. Quelques usages en fouille de données et représentation des connaissances.

28 juin 2016: Conférence de Meltem Öztürk
LAMSADE – Université Paris Dauphine
Approche multicritère pour la réutilisation des friches

urbaines: étude de cas d'Alger

Web site for Annoucements and Call for Papers:
www.cs.put.poznan.pl/ewgmcda



Books

Non-Additive Measures: Theory and Applications

Editors: **Torra,** Vicenç, **Narukawa**, Yasuo, **Sugeno**, Michio(Eds.)

Springer, 2014

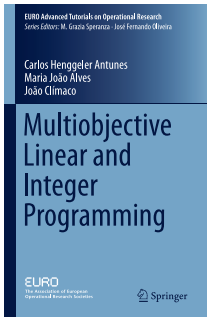
This book provides a comprehensive and timely report in the area of non-additive measures and integrals. It is based on a panel session on fuzzy measures, fuzzy integrals and aggregation operators held during the 9th International Conference on Modeling Decisions for Artificial Intelligence (MDAI 2012) in Girona, Spain, November 21-23, 2012. The book complements the MDAI 2012 proceedings book, published in Lecture Notes in Computer Science (LNCS) in 2012. The individual chapters, written by key researchers in the field, cover fundamental concepts and important definitions (e.g. the Sugeno integral, definition of entropy for non-additive measures) as well some important applications (e.g. to economics and game theory) of non-additive measures and integrals. The book addresses students, researchers and practitioners working at the forefront of their field.

http://www.springer.com/us/book/9783319031545

Multiple Criteria Decision Making: Applications in Management and Engineering

Editors: **Zopounidis**, Constantin, **Doumpos**, Michael (Eds.)

This book presents a broad range of innovative applications and case studies in all areas of management and engineering, including public administration, finance, marketing, engineering, transportation, and energy systems. It addresses issues related to problem structuring, preference modeling, and model construction, presenting a framework that provides clear decision-making support in practice. In addition, it includes hybrid and integrated techniques combining multiple criteria decision making (MCDM) with other analytical methods. The book reflects the growing impact of MCDM in the field of management science and operations research. Building on recent and established theoretical advances and presenting their applications in specific domains, it offers a comprehensive resource for researchers, graduate students and professionals alike.
http://www.springer.com/us/book/9783319392905



EURO Advanced Tutorials on Operational Research

Multiobjective Linear and Integer Programming

Carlos **Henggeler Antunes**,
Maria João **Alves**,
João **Clímaco**

About this Textbook

This book opens the door to multiobjective optimization for students in fields such as engineering, management, economics and applied mathematics. It offers a comprehensive introduction to multiobjective optimization, with a primary emphasis on multiobjective linear programming and multiobjective integer/mixed integer programming. A didactic book, it is mainly intended for undergraduate and graduate students, but can also be useful for researchers and practitioners. Further, it is accompanied by an interactive software package - developed by the authors for Windows platforms - which can be used for teaching and decision-making support purposes in multiobjective linear programming problems. Thus, besides the textbook’s coverage of the essential concepts, theory and methods, complemented with illustrative examples and exercises, the computational tool enables students to experiment and enhance their technical skills, as well as to capture the essential characteristics of real-world problems.

Table of contents (6 chapters)

- Introduction (Pages 1-8)
- Formulations and Definitions (Pages 9-26)
- Surrogate Scalar Functions and Scalarizing Techniques (Pages 27-56)
- Interactive Methods in Multiobjective Linear Programming (Pages 57-136)
- A Guided Tour of iMOLPe (Pages 137-159)
- Multiobjective Integer and Mixed-Integer Linear Programming (Pages 161-203)

Supplementary Material
(http://www.uc.pt/en/org/inescc/software)

iMOLPe - interactive Multi-Objective Linear Programming explorer

Interactive software package to deal with linear programming problems with multiple objective functions, which includes: - scalarizing processes for computing efficient solutions based on weighted-sums, reference points and constraints on objective function values; - distinct solution search strategies and visualization of results obtained with the TRIMAP method; - STEM, ICW and Pareto Race interactive methods.The version available for download is limited to 6 objective functions, 100 decision variables and 100 functional constraints.

MOMILP software

Interactive software package to deal with mixed-integer linear programming problems with multiple objective functions implementing the interactive reference point method using branch-and-bound, also including a generating algorithm for bi-objective problems and a set of tools that can be used at any phase of the decision support process.The version available for download is limited to 6 objective functions, 100 decision variables and 100 functional constraints.

http://link.springer.com/book/10.1007%2F978-3-319-28746-1



Articles Harvest

(This section is prepared by Salvatore CORRENTE, salvatore.corrente@unict.it)

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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 EUROWorking 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
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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.

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