Newsletter of the European Working Group
"Multicriteria Aid for Decisions"

Bulletin du Groupe de Travail Européen
"Aide Multicritère à la Décision"

Groupe de Travail Européen "Aide Multicritère à la Décision"
Série 3, nº17, printemps 2008.

European Working Group "Multiple Criteria Decision Aiding"
Series 3, nº 17, Spring 2008.

## Opinion Makers Section

# Cynefin: repeatability, science and values

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## 1. Introduction

Several years back David Snowden visited Manchester Business School and gave a seminar on knowledge management. At this he described his conceptual framework, *Cynefin*, which, among other things, offers a categorisation of decision contexts (Snowden 2002). At first I thought this said little if anything more than many other ways of categorising decisions, such as the strategy pyramid stemming from Simon (1960) and beyond Simon back to the prehistory of military theory: *viz*. strategic, tactical and operational (see Figure 3 below). However, a colleague, Carmen Niculae, had more insight and working with her and others, I have since come to realise its power in articulating discussions of decision making and decision support.

In this little note, I want to explore the ideas underlying Cynefin and their import for thinking about values and how these enter into decision making in different contexts. There is nothing dramatic in anything I shall say. Many of you – most? all? – will have reached similar conclusions, but I have enjoyed thinking through these ideas and perhaps David Snowden will take this as a small apology for my initial dismissal of his ideas.

## 2. Cynefin

So what is Cynefin? It comes from the Welsh for 'habitat', or at least that is its narrow translation. But Snowden (2002) indicates that it also contains connotations of acquaintance and familiarity, going on to quote Kyffin Williams, a Welsh artist: "(Cynefin) describes that relationship – the place of your birth and of your upbringing, the environment in which you live and to which you are naturally acclimatised." The embodiment of such ideas as familiarity makes Cynefin clearly relevant to knowledge management. Nonaka's concept of *Ba* serves a similar purpose: a place for interactions around knowledge creation, management and use (Nonaka 1991; 1999; Nonaka and Toyama 2003). Snowden distinguishes Cynefin from Ba on the grounds that the Welsh word contains associations with community and shared history, but the fineness of this distinction need not concern us too much (for further discussion, see Nordberg 2006 and the references therein). What will concern us is how Cynefin relates to decision making and support; how it suggests the forms that decision analysis might take in different contexts; and how it relates to our self knowledge of our values – and values, it must be remembered, should be the driving force of our decision making (Keeney 1992).

Snowden's Cynefin model roughly divides decision contexts into four spaces: see

Figure 1. In the *known space*, or the Realm of Scientific Knowledge, The relationships between cause and effect are well understood. All systems and behaviours can be fully modelled. The consequences of any course of action can be predicted with near certainty. In such contexts, decision making tends to take the form of recognising patterns and responding to them with well rehearsed actions. Klein (1993) discusses such situations as recognition primed decision making; Snowden describes decision making in these cases as CATEGORISE AND RESPOND.

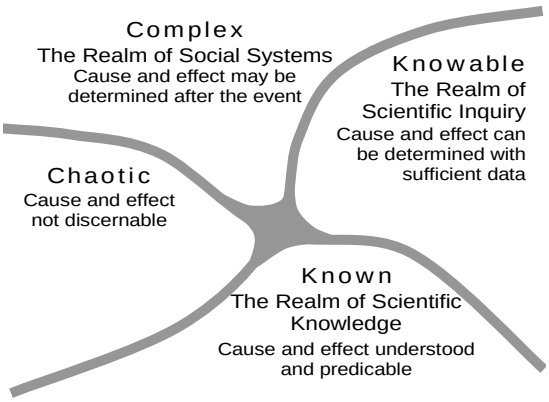


**Figure 1: Cynefin**

In the *knowable space*, the Realm of Scientific Inquiry, cause and effect relationships are generally understood, but for any specific decision there is a need to gather and analyse further data before the consequences of any course of action can be predicted with any certainty. Decision analysis and support will include the fitting and use of models to forecast the potential outcomes of actions with appropriate levels of uncertainty. This is the realm in which the standard methods of decision analysis as found in, say, Clemen and Reilly (1996) apply. Snowden characterises decision making in this space as SENSE AND RESPOND.

In the *complex space*, often called the Realm of Social Systems though such complexity can arise in environmental, biological and other contexts, decision making situations involve many interacting causes and effects. Knowledge is at best qualitative: there are simply too many potential interactions to disentangle particular causes and effects. There are no precise quantitative models to predict system behaviours such as in the known and knowable spaces. Decision analysis is still possible, but its style will be broader, with less emphasis on details. Decision support will be more focused on exploring judgement and issues, and on developing broad strategies that are flexible enough to accommodate changes as the situation evolves. Analysis may begin and, perhaps, end with much more informal qualitative models, sometimes known under the general heading of soft modelling, soft OR or problem structuring methods (Franco *et al.* 2006; 2007; Mingers and Rosenhead 2004; Pidd 2004; Rosenhead and Mingers 2001). If quantitative models are used, then they are simple, perhaps linear multi-attribute value models (Belton and Stewart 2002). Snowden suggests that in these circumstances decision making will be more of the form: PROBE, SENSE, AND RESPOND.

Finally, in the chaotic space, situations involve events and behaviours beyond our current experience and there are no obvious candidates for cause and effect. Decision making cannot be based upon analysis because there are no concepts of how separate entities and predict their interactions. Decision makers will need to take probing actions and see what happens, until they can make some sort of sense of the situation, gradually drawing the context back into one of the other spaces. Snowden suggests that such decision making can be characterised as ACT, SENSE AND RESPOND. More prosaically, we might say 'trial and error' or even 'poke it and see what happens!'

The boundaries between the four spaces should not be taken as hard; nor, for that matter should the distinctions between strategic, tactical and operational in the strategy pyramid. The interpretation is much softer with recognition that there are no clear cut boundaries and, say, some contexts in the knowable space may well have a minority of characteristics more appropriate to the complex space.

Snowden uses the ideas of Cynefin to discuss other issues such as organisational culture and leadership, and, of course, knowledge management (Snowden 2002; Snowden and Boone 2007). There is distinction within knowledge management between *explicit knowledge* – i.e., knowledge with can be encoded – and *tacit knowledge* – the skills, expertise, values and so that we cannot articulate, at least currently, other than by showing them in our behaviours (Polyani 1962). Nonaka's (1991; 1999) socialisation, externalisation, combination and internalisation (SECI) cycle suggests how these different forms of knowledge are shared across communities: see **Error! Reference source not found.**. Within Cynefin one would expect tacit knowledge to dominate in the complex and chaotic spaces, while explicit knowledge dominates in the known and knowable spaces. This in turn suggests that knowledge management relies more on socialisation in the complex and chaotic spaces whereas one uses combination in the known and knowable spaces. Indeed, the use of the term scientific knowledge in the known space suggests the archetypal example of explicit knowledge: a scientific model or theory.

## 3. Cynefin and Decision Making

What does Cynefin bring to discussions of decision making? Quite a lot, it seems to me. While I do not claim that any of the following could not be – indeed, has not been – discussed without the framework that Cynefin brings, it does seem to facilitate those discussions well. To give three examples:

- The strategy pyramid with its trichotomy of decision contexts has always seemed to me to miss one layer of decision making at its base: namely, recognition primed or instinctive decision making (French *et al.* 2008). Much decision making within organisations relates to the conduct of its work. To achieve its ends it – or its members – must *do* something and that doing inevitably involves decision making. Many such decisions are taken in a recognition primed fashion, often unconsciously, i.e. their context is the known space of Cynefin.
- Decision making in the complex and chaotic spaces on the left hand side of Cynefin will be based more on judgement, tacit knowledge and exploration. Thus the primary activity in deliberation will be the socialisation and sharing of tacit knowledge. Whereas in the known or knowable spaces, decision making will be based more on explicit knowledge and the use of decision models and data will be much more common. This suggests that decision support systems will be data- or model-based if they are applicable in the known or knowable spaces, whereas in the complex or chaotic spaces effective decision support will need to focus their efforts much more on collaboration: see Figure 4 (Niculae *et al.* 2004).

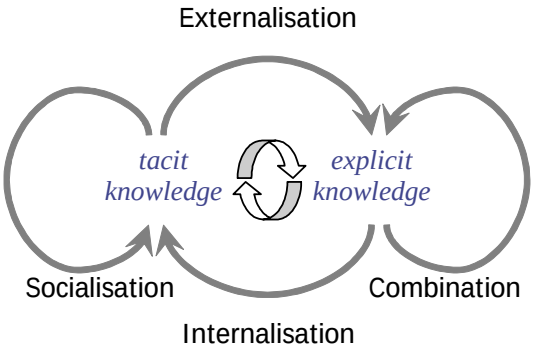


**Figure 2:Nonaka's SECI cycle**

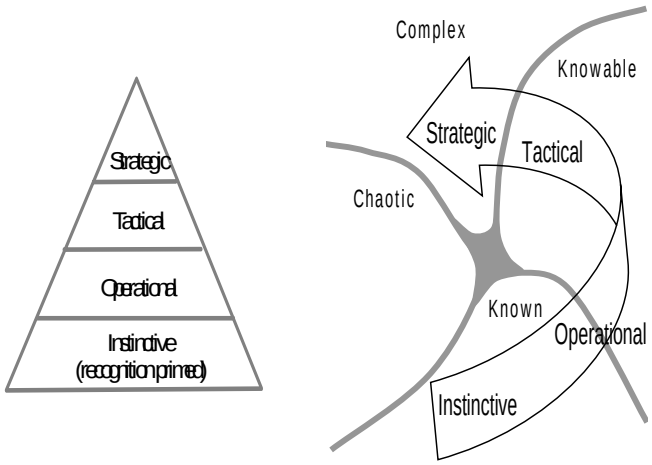


**Figure 3: Relationship between the perspective offered by the strategy pyramid and Cynefin**

- Carmen Niculae and I have explored the use of Cynefin in describing the handling of emergencies (French and Niculae 2005). We found that we could articulate the dynamics of an emergency intuitively using Cynefin and, in particular illustrate situations in which the authorities thought that they were handing an event in the known or knowable domains, whereas associated socio-political-economic issues were pulling the emergency into the complex domain. This dislocation between the authorities' perception of the situation and reality can and has led to the mishandling of emergencies.

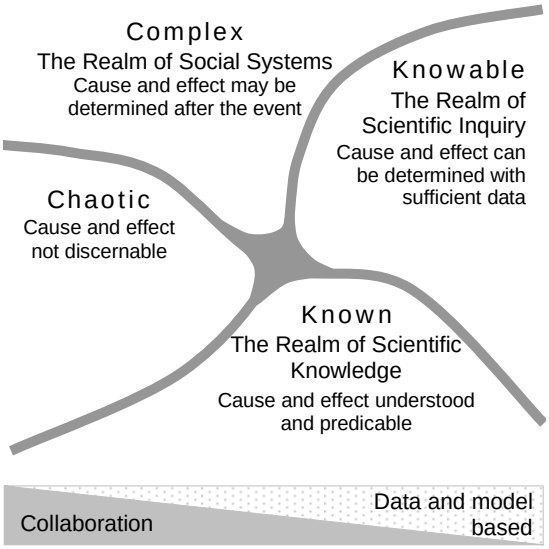


**Figure 4: The functional emphases of decision support systems in the different spaces**

## 4. Repeatability and Science

Note that contexts which fall into the known and knowable spaces are necessarily repeatable or commonly occurring in some sense; otherwise we would not have developed sufficient understanding to infer and test scientific theories and hence build predictive models. Contexts in the complex and certainly in the chaotic spaces tend to be novel. Repeatability lies at the heart of the *Scientific Method*: scientific knowledge is that which is based upon observations in repeatable circumstances. One can only verify scientific theories if they can be tested again and again in identical circumstances and shown to explain and predict behaviours of systems: i.e. as Cynefin suggests, cause and effect can be understood and predicted. Given this, it is not surprising that as statistical methodologies developed during the late 19th and first half of the 20th century that *frequentist* statistics dominated: i.e. approaches based upon conceptions of probability which have repeatability at their heart. Moreover, the primary goal of such statistical methods was to formalise the processes of estimation of parameters and confirmation or refutation of hypotheses. Bayesian statistics, based upon the formalisation of judgement and the ability to extend learning towards the analysis of unique, unrepeatable circumstances, grew up in the second half of the 20th century (Barnett 1999; French and Rios Insua 2000; French and Smith 1997).

A consideration of Cynefin suggests that statistical analyses focused on estimation and confirmation should be confined to situations in the known or knowable spaces. In the complex space there is likely to be and in the chaotic space certain to be 'insufficient repeatability'

to conduct such analyses. In the later spaces, one is likely to lean more to using exploratory data analysis (Tukey 1977), modern data mining (Klosgen and Zytkow 2002; Korb and Nicholson 2004) and perhaps Bayesian methods which can combine judgement and limited data to learn and explore trends and patterns without needing to go the whole hog of full estimation and confirmation. So I am continually concerned by the prevalence of statistical hypothesis testing in articles in *Management Science*, *Academy of Management Journal* and other social science journals: do the authors and editors really not understand the complexity of the spaces that they are studying? Of course, I am not saying that *all* such analyses are inappropriate. Far from it: however I would be surprised if *all* were appropriate.

## 5. Repeatability and Values

Repeatability does not just lie at the heart of Science: it has helped us think through and form many of our values – but far from all. It has always concerned me that some decision analysts have sought to measure preferences, whereas I have always sought to help decision makers think through, evolve and articulate their preferences. I have always seen value and utility elicitation as a constructive, reflective process not simply measurement. Cynefin has given me new insights into this distinction.

In the case of the known and knowable spaces, familiarity with similar circumstances means that decision makers will have explored and thought through their values: their judgements will be well rehearsed. They will know what they want to achieve in any particular decision simply because they 'have been there before'. Thus they have preferences that can be measured. Such is not the case in the complex or chaotic spaces. Novel issues require decision makers to reflect upon what they want to achieve (see also Slovic 1995). The methods of value focused thinking and the exploration, evolution and elicitation of values, weights and utilities (French *et al.* 2008; Keeney 1992; Keeney and Raiffa 1976) will lie at the heart of decision analyses in the complex space. As decision analysts we will need to work with our clients to help them deliberate on what their values are or – perhaps it would be better to say – to help them contextualise their fundamental values to the circumstances that they face.

If our background relates to work on decision making in the known or knowable spaces, perhaps because we have tended to work in artificial intelligence, expert systems, recognition primed decision making and some of the more operational areas of OR, it is perhaps not surprising then that we think of preferences as predetermined, waiting to be measured. But the more we work in the complex and chaotic spaces the more we find that preferences are not predetermined and so we see the process before us as one of helping the decision makers form them. What Cynefin does is provide a rough and ready indicator of the sorts of approach we should take in supporting decisions and whether we might expect the decision makers *a priori* to be clear on their preferences.

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# MCDA Research Groups

## CoDE (Computer & Decision Engineering)

http://code.ulb.ac.be

The Computer & Decision Engineering (CoDE) department has officially started the 1st May 2006. It results from the association of three laboratories of the Engineering Faculty of the Université Libre de Bruxelles: IRIDIA, I&R and SMG. The aim of this department is to join the expertise of the three laboratories to realize innovative research and particularly in the area of "business intelligence".

CoDE is currently composed of 9 Professors, 8 senior researchers, 31 PhD students and 6 scientific and industrial collaborators.

IRIDIA is the Artificial Intelligence research laboratory of the Université Libre de Bruxelles. It is deeply involved in theoretical and applied research in computational intelligence. The major domains of competence are: swarm intelligence, metaheuristics to solve combinatorial and continuous space optimization problems, the foundational study of biological networks and business applications. The research program in swarm intelligence is centered on the design of algorithms or distributed problem-solving mechanisms using the collective behavior of social insect colonies as main source of inspiration. In particular, members of IRIDIA have proposed innovative algorithms to solve different types of optimization problems and to control swarms of robots. The metaheuristic unit is internationally known for the ant colony optimization metaheuristic and is a leading team in various stochastic local search methodologies such as iterated local search and evolutionary computation. Members of the unit are also interested in multi-objective optimization with a focus on two main aspects:

1) The development of stochastic local search algorithms for multi-objective combinatorial optimization problems such as those based on the Pareto local search and the two-phase framework.

2) The sound evaluation and comparison of the results of multi-objective optimizers through outperformance relations, attainment functions, statistical tests and graphical means; another related issue here is the analysis of multi-objective optimizers through experimental design techniques.

Another point of research is related to biological networks. The main interest is the study of neural networks, immune networks, and chemical reaction systems and in the identification of what are their common features and mechanisms. Members of the unit are also interested in exploiting the results of these studies for the conception of adaptive distributed engineering artifacts. Finally, IRIDIA develops practical business intelligence applications such as data mining and object oriented solutions for companies and administrations.

The laboratory of computer science and networks (I&R) is taking part in numerous research projects, be it for the university or as part of national or international projects. These cover many fields of computer science, from spatio-temporal data modelling to semantic web, from software engineering to wireless network routing, from bioinformatics to data visualization. In the field of modeling, the department conceived, with the collaboration of the database laboratory of the École Polytechnique Fédérale de Lausanne, the MADS model for the representation of spatio-temporal data. Spatio-temporal databases make a historically significant and innovative field of study, as important scientific advances are necessary to develop the new generation of car navigation support and GPS-type geolocalised services. The LOBSTER project studies the benefits in this discipline of semantic web, a set of methods that provide a formal representation of the knowledge and the creation of intelligent agents capable of logical reasoning. Semantic Web is also the subject of several bioinformatics projects, such as INMOBIO which uses them to improve our comprehension of metabolic chains, primary means of

investigation for the discovery of new medications. On the other hand, the BIOMAZE project has developed the state of the art concerning the visualization of those extremely complex metabolic chains. Finally in the study of software engineering, the new VARIBRU project aims at developing solutions to support the creation of an unique software that will easily adapt to different users, contexts or environments. These techniques shall be applied during the entire life cycle of the software, from the very beginning of its development till the very moment of its use.

The "Service de Mathématiques de la Gestion" (SMG) is the operational research laboratory of the Engineering Faculty. Research activities of the SMG are mainly devoted to Decision Engineering, with a particular emphasis on Multicriteria Decision Aid.

Historically, members of the unit have been at the origin of the PROMETHEE & GAIA methods. New research themes are conducted in this direction. From a methodological point of view, an extension of PROMETHEE to sorting problems, called FlowSort, is currently under study. Additionally, new software developments are considered in a "first spin off" project that has started in September 2007.

Members of the SMG are stimulating the application of general multicriteria tools to various application fields. One may cite for instance the development and analysis of multicriteria auctions (combinatorial multicriteria auctions, lexicographic auctions) or the integration of multicriteria methods to geographical information systems. Another major research interest covers multicriteria relational clustering. The aim here is to develop new algorithms that allow the detection of group structures and relations between these groups in a multicriteria context. Finally, the topic of performance evaluation of telecommunication systems is addressed by means of queueing theory and matrix analytic methods.

From a practical point of view, researchers of the SMG are regularly involved in industrial projects. For instance, they have successfully collaborated with Elia (which is the company in charge of electricity transmission in Belgium) to elaborate a model for the replacement of low and high voltage equipments. Another project has been conducted with the federal police to evaluate the crime gravity in Belgium.

The common goal of IRIDIA, I&R and SMG is to develop new research synergies in cross disciplinary fields.

# Forum

## (Robustness Analysis)

### Bayesian Robustness

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The interest for the Bayesian approach is growing, not only among mathematical statisticians but also among scientists and practitioners from different fields. One of the reason for the interest resides in the possibility of performing inferences or making forecasts not only based on data from statistical experiments but also on expert's knowledge. The formal combination of the two sources of information is via Bayes Theorem. I am not going to illustrate the Bayesian approach thoroughly; I refer the interested reader to the many books on specialised or general aspects of Bayesian statistics. I just mention the books by Bernardo and Smith (1994), Robert (2001) and Congdon (2006) as representative of different approaches. Application of Bayesian methods has been favoured by the burgeoning development of simulation techniques, mostly Markov chain Monte Carlo (MCMC) ones, which has made possible sampling from posterior distributions even when their mathematical expressions are not known in closed form. A recent review on simulation techniques in Bayesian statistics is provided by Gamerman and Lopes (2006).

Despite of the growing interest for Bayesian methods and, actually, emphasised by it, statisticians and scientists should make a wise use of them and be wary of the critical aspects of the approach. Here I just want to mention a relevant one: robustness. The typical Bayesian approach combines prior distributions, models and loss functions to estimate parameters, test hypotheses and forecast future observations. Given a model described by a random variable X, with density $f(x \mid \theta)$, the expert provides information which is translated into a prior distribution $\pi(\theta)$, on the parameter $\theta$, which, combined with a sample $\mathbf{X}=(X_1, \ldots, X_n)$ from X, leads to a posterior distribution $\pi(\theta \mid \mathbf{X})$. Inferences and forecasts are based on the posterior distribution; in particular the parameter $\theta$ is estimated by specifying a loss function $L(\theta, a)$ and choosing the value of a minimising the expected posterior loss. Critics of the Bayesian approach are pointing out the arbitrariness of the choice of the prior distribution on the parameter and their concern can be extended to loss functions as well, whereas the choice of a model is a critical aspect shared by all statistical approaches. I will not discuss much about model selection and sensitivity to the choice of the model, preferring to concentrate on the two typical aspects of the Bayesian approach: prior and

loss function (the former in particular). I just mention that dependence on a parametric model can be weakened by considering a Bayesian nonparametric approach, i.e. when the model does not belong to a (parametric) class but it is chosen by a probability measure on the space of all possible models. More details can be found in Ghosh and Ramamoorthi (2003).

Prior to the choice of a distribution on the parameter $\theta$, elicitation of expert's opinion has to be performed. Different methods have been proposed, ranging from direct specification of prior distributions to lotteries and qualitative judgements, transformed into quantitative values by, e.g., controversial methods like the Analytic Hierarchy Process. Currently Dey and Ruggeri (2008) are developing a method to assess prior distributions based upon opinions on quantiles of the distribution of X, deemed as more natural than the specification of quantiles on the distribution of the parameter, especially in problems where generalised extreme value models are considered. Either directly or indirectly, expert's opinions lead to specification of some features of the prior distribution, like moments (in general, mean and variance) or quantiles. Based upon these features, the statistician chooses a suitable functional form for the prior distribution and its hyperparameters to better fit the expert's assessed values. Graphical tools, like the ones presented in Dey and Liu (2007), are helpful in showing the expert the shape of the prior corresponding to his/her assessment and induce him/her to refine it.

The choice of the prior used to be driven by mathematical considerations, like the need to get posterior distributions of known functional forms; conjugate priors are such a typical example since prior and posterior distributions have the same form (e.g. Gamma distributions when the model is either exponential or Poisson). Nowadays, powerful computers and, above all, MCMC techniques allow for almost any prior choice.

It is clear (even to supporters of the Bayesian approach) the high grade of arbitrariness affecting both elicitation and prior choice. Multiple experts' judgements are sometimes conflicting and they can hardly be combined into a unique prior. Even in the case of a unique expert, he/she might provide more quantiles than needed to determine the hyperparameters of a prior with selected functional form: some quantiles are used to find the hyperparameters and the others are used to check consistency of the assessed quantiles and the prior. At the end, a prior is chosen to fit the quantiles as well as possible. In general, identification of a unique prior corresponding exactly to expert's opinions is impossible: for a real valued parameter, the expert should be able to assign probability to any Borel set! Therefore, any prior distribution chosen by the statistician does not reflect exactly the expert's opinion. The critical implication of such arbitrariness is the influence of inaccurately specified priors on the quantities of interest, like posterior set probabilities and means. For this reason, Bayesian methods are not accepted as standard practice by many regulatory agencies in charge of, e.g., stating the efficacy of some drugs and treatments. See an interesting discussion on the topic in the *Journal of the National Cancer Institute*, Vol. 98, No. 21, November 1, 2006.

Bayesian robustness has been developed mainly to cope with this arbitrariness. The key idea behind it is the need to base inferences only on the actual assessment by the experts, specifying a class of priors compatible with their opinions and studying the influence of changes in the prior on the values of the quantity of interest. Good is among the first raising the issue of robustness, and his thoughts are discussed in Berger (1990). Robustness is considered in one of the very first Bayesian book, by Box and Tiao (1973) but it is meant about the choice of robust priors which are less affected by outliers; the choice of a t-distribution instead of a Gaussian one is the typical example. This approach is rather close in spirit, but not in mathematical tools, to the classical one which was very well described in the pioneer book by Huber (1981). I will mention later some tools, developed in the classical robustness, which have been widely used by Bayesians as well. The first relevant contributions, in the direction I am going to illustrate, are due to Kadane and Chuang (1978) and Berger (1984, 1985). The first paper illustrates stability of decision problems, specified by the triple $(\pi, l, L)$ with prior $\pi$, likelihood l and loss L, under convergence of priors and losses to $\pi$ and L, respectively. Philosophical aspects are illustrated in the paper by Berger (1984), whereas the first extensive discussion of the robust Bayesian approach in a textbook is due to Berger (1985). It is evident, even from the very first works on Bayesian robustness, as the interest rests mostly on prior distributions, rather than on model and loss function. The reasons for such selection are both practical (computations with classes of priors are easier than the ones with classes of models and losses) and, above all, deeper, to the very nature of the Bayesian approach, as mentioned earlier.

Berger (1990) traces back to Good's work the first interest for Bayesian robustness and discusses desiderata about classes of priors; his paper has been the reference paper for most of the people who started working in this field. The first half of the 90's saw a plethora of publications in Bayesian robustness and I was deeply involved in the two International Workshops on Bayesian Robustness, held in Italy in 1992 and 1995, whose selected papers were published in *Journal of Statistical Planning and Inference* (vol. 40, 2 & 3, 1994) and Berger et al. (1996). These proceedings and, even more, the paper by Berger (1994) discussed by the leading experts in Bayesian robustness, describe the state-of-the-art of early 90's. After the development of many methods, researchers moved to other areas of interest, especially the very innovative MCMC methods which would have changed dramatically the impact of Bayesian methods in statistics and in science. The book edited by Rios Insua and Ruggeri (2000) is not only the picture of what was developed in the Golden Age of Bayesian robustness but it is still the reference book in the field. In the last decade, Bayesian robustness has been recognised as important by many Bayesians and performed in a discrete number of

papers. Still some work is done in the field and the forthcoming special issue of *International Journal of Approximating Reasoning*, for which I acted as Guest Editor, is very representative of the current research: applications, loss robustness and algorithms. The interested reader can find a useful guided tour through Bayesian robustness in Berger, Rios Insua and Ruggeri (2000), and a very updated (up to the year 2000) bibliography in Rios Insua and Ruggeri (2000).

After this brief history of Bayesian robustness, I illustrate its most relevant aspects, especially the mathematical ones. I will not discuss the foundational aspects of Bayesian robustness, but I just mention the papers by Berger (1984) and Rios Insua and Criado (2000). Links with imprecise probabilities can be found in Walley (1991).

An expert provides information on the prior distribution, e.g. moments, quantiles, unimodality, etc. and it is translated into a class $\Gamma$ of priors sharing these features. Examples of classes are

$$\Gamma_S = \{\pi: \text{symmetric around } 0\}$$
$$\Gamma_{SU} = \{\pi: \text{symmetric and unimodal with mode at } 0\}$$
$$\Gamma_Q = \{\pi: \text{sharing some specified quantiles}\}$$
$$\Gamma_M = \{\pi: \text{with given mean and variance}\}$$

The above mentioned paper by Berger (1990) describes some features which are expected when a class of priors is specified:

- Easy elicitation and interpretation (e.g. moments, quantiles, symmetry, unimodality)
- Compatible with prior knowledge (e.g. quantile class)
- Simple computations
- Without unreasonable priors (e.g. unimodal quantile class, ruling out discrete distributions)

Once a class $\Gamma$ is defined, then Bayesian robustness deals with its influence on the quantity of interest $E^* h(\theta)$, i.e. the posterior expectation of a function h of the parameter $\theta$. The posterior mean is a typical quantity of interest since it is (see, e.g., Berger, 1995) the Bayesian optimal estimator of $\theta$ when a squared loss function $L(\theta , a)$ is considered and minimisation of posterior expected loss is chosen as the optimality criterion.

The *range*

$$\delta = \sup_\Gamma E^* h(\theta) - \inf_\Gamma E^* h(\theta)$$

is the mostly used robustness measure. When $\delta$ is *small* (according to the statistician's and expert's judgements), then any prior in $\Gamma$ can be chosen since all of them lead to similar results. When $\delta$ is *large*, then further information is needed to get a smaller class $\Gamma^*$ (as an example, further quantiles could be added). Smaller and smaller classes can be considered until either a *small* range is obtained or a *large* range cannot be further reduced. In the latter case, a prior distribution in $\Gamma$ can be considered and the corresponding value of $E^* h(\theta)$ reported along with the range. The choice of such prior can be driven by mathematical convenience if there is one leading to tractable computations. My favourite choice, not shared by all Bayesian statisticians, is a prior which satisfies some optimality criterion, like $\Gamma$-minimax posterior expected loss and $\Gamma$-minimax posterior regret, considered in, e.g., Betrò and Ruggeri (1992) and Rios Insua, Ruggeri and Vidakovic (1995), respectively.

Other classes of priors have been proposed in literature; they can be classified in different ways but here I would like to emphasise the distinction between those in which all priors share some features (like the one described before) and the neighbourhood classes. Many classes in the former group can modelled as generalised moments constrained classes, studied first by Betrò, Meczarski and Ruggeri (1994). The latter classes are not necessarily neighbourhood of a baseline prior distribution in a topological sense; sometimes they are just perturbations of such prior. These classes arise when a given distribution is considered a good candidate to reflect the prior knowledge and the effects of departures from it are studied in terms of changes in the quantity of interest. A typical example, proposed by Huber in the classical framework, is given by the $\varepsilon$-contaminations

$$\Gamma_\varepsilon = \{\pi: \pi = (1 - \varepsilon)\, \pi_0 + \varepsilon\, q, \, q \text{ in } \Omega\},$$

where $\pi_0$ is the baseline prior and $\Omega$ a class of priors, e.g. all possible, all symmetric or all symmetric and unimodal ones. Other neighbourhood classes are based on bounds on density functions or distribution functions. A general way to introduce topological neighbourhoods of a baseline prior is illustrated in Fortini and Ruggeri (1994) who use the concentration function.

Computation of ranges in classes of priors is considered a typical example of global sensitivity analysis, since it is a measure related to a whole class. As discussed in Berger, Rios Insua and Ruggeri (2000), two other approaches play a relevant role: informal and local sensitivity. The former approach is used in many Bayesian papers when few, different priors are entertained and the inferences upon them are compared. The latter approach measures the effect of infinitesimal changes in the baseline prior, using Frechet and Gateaux derivatives as in the papers by Ruggeri and Wasserman (1993 and 1995, respectively). This approach resembles the one based on influence functions developed in classical robustness. I will not discuss these approaches any further.

Computations of ranges is a difficult task, since it involves, in principle, functional optimisation. Most of the work in the early 90's was devoted to the search of algorithms to compute robustness measures, mostly the range. The goal was, in general, the transformation of the functional optimisation problem into a more manageable, nonlinear one. The key result behind such transformation is the equivalence, in general,

$$\sup_{\Gamma} E^{*} h(\theta) = \sup_{\Delta} E^{*} h(\theta)$$

where $\Delta$ is the set of the extremal measures in $\Gamma$, i.e. those measures such that any measure in $\Gamma$ can be expressed as their mixture. As an example, Sivaganesan and Berger (1989) prove that the supremum in the $\varepsilon$-contamination class with $\Omega$ = {all probability measures} is achieved for a Dirac measure at some value $\omega$ of the parameter, so that the optimisation problem has to be solved just searching for the optimal $\omega$.

Since $E^{*} h(\theta)$ is the ratio of two linear quantities in $\pi$, i.e. $\int h(\theta)\, l(\theta)\, \pi(\theta)\, d\theta$ and $\int l(\theta)\, \pi(\theta)\, d\theta$, with $l(\theta)$ being the likelihood function, optimisation is not a trivial task. For such reasons, Lavine (1991) proposed a linearisation technique which could make computations easier. Other approaches, proposed by O'Neill (2008) and Betrò and co-authors (see the most recent work by Betrò, 2008, for references to past works), are based, respectively, on importance sampling and linear semi-infinite programming applied to generalised moments constraints classes. The lack of multi-purpose, interactive, widely available software able to compute ranges for a large variety of classes is one of the reasons for the limited application of the plethora of methods developed in the last 15-20 years. Robustness analysis is deemed important by Bayesian statisticians but it is only sometimes performed in actual analyses, apart from some informal sensitivity check. The development of such user-friendly software is one of the major challenges ahead.

I have briefly described what is called robustness with respect to the prior, avoiding other important aspects, like loss and likelihood robustness. The former deals with classes of loss functions and the consequent range of Bayesian optimal estimators or with the search of non-dominated actions under classes of priors and/or losses, whereas the latter deals with perturbations of the likelihood. I refer to the review papers by Martin and Arias (2000) and Shyamalkumar (2000), respectively.

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# Consultancy Companies

## BANA Consulting

(www.bana-consulting.pt)

BANA Consulting (www.bana-consulting.pt) is a Portuguese based consulting company operating in the decision analysis field. Starting in 2006, BANA is proud to be one of the few organizations in Portugal providing public and private organizations with MCDA know-how and tools needed to improve organizations' decision making processes. It aims to help decision makers or decision groups in the difficult task of decision making when facing problems which deal with different objectives or points of view like balancing costs, benefits or risk.

The company was built upon the long range consulting and studying work of Prof. Carlos Bana e Costa during the last 20 years not only helping to further develop decision aiding theory but also providing organizations all over the world with the practical expertise they need in numerous consulting projects.

BANA develops consulting projects, provides training services and is able to build decision support tools suited to each clients needs.

Unlike the traditional expert 'black box' approach to decision support, BANA provides its clients with an interactive process-consultation approach designed to transfer its know-how to the client along the development of a socio-technical process of decision-aiding. This improves organizational management skills, resulting in gains of efficiency in resource allocation and efficacy is achieving core objectives.

Some services provided by BANA are:

- Development of strategic plans
- Allocation of resources
- Comparison of alternative locations for development of major infrastructures
- Participative evaluation of social, economic and environmental impacts of major infrastructures
- Resolution of horizontal and vertical conflict in when implementing public policy
- Analysis of cost, benefit and risk associated with projects and programs
- Evaluation of employee performance
- Evaluation of supplier performance
- Evaluation of bids in public calls for tenders
- Development of risk models and scenario analysis

To achieve its goals BANA makes use of several state of the art methodologies namely MACBETH. This pairwise

comparison methodology has been implemented in the M-MACBETH software package commercialized by Bana Consulting (download available at www.M-MACBETH.com ).

Measuring Attractiveness through a Category Based Evaluation Technique is the goal of the MACBETH approach. It permits the evaluation of options against multiple criteria. The key distinction between MACBETH and other methods is that it needs only qualitative judgements about the difference of attractiveness between two elements at a time, in order to generate numerical scores for the options in each criterion and to weight the criteria. The seven MACBETH semantic categories are: no, very weak, weak, moderate, strong, very strong, and extreme difference of attractiveness. As the judgements expressed by the evaluator are entered in the M-MACBETH software, their consistency is automatically verified and suggestions are offered to resolve inconsistencies if they arise. The MACBETH decision aid process then evolves into the construction of a quantitative evaluation model. Using the functionalities offered by the software, a value scale for each criterion and weights for the criteria are constructed from the evaluator's semantic judgements. The value scores of the options are subsequently aggregated additively to calculate the overall value scores that reflect their attractiveness taking all the criteria into consideration. Extensive analysis of the sensitivity and robustness of the model's results will then provide a deeper understanding of the problem, contributing to attain a requisite evaluation model: a sound basis to prioritise and select options in individual or group decision-making contexts.

Some of BANA's most recent projects include:

- Construction of models for bid evaluation in public calls for tenders as it was the case of the acquisition of armed vehicles by the Portuguese Ministry of Defence.
- Public call for tenders for the introduction of the Digital Terrestrial Television (DTT) in Portugal which is being carried out by the Portuguese regulatory authority for electronic and postal communications.
- Construction of a multiple criteria decision model to help the Secretary of Social Development and Human Rights (SEDSDH) of the Government of the Brazilian State of Pernambuco to elaborate its medium term strategic plan.
- Construction of a multiple criteria decision model for the selection of a concept for the new Lisbon's airport reference plan.
- Development of reusable bid evaluation models for the Portuguese Electric Transmission Company (this application is described in an article recently published in Decision Analysis, march 2008, vol. 5, issue 1, pp. 22-42).Development of reusable bid evaluation models for the Portuguese Electric Transmission Company REN (Bana e Costa, C.A., Lourenço, J.C., Chagas, M.P., Bana e Costa, J.C. (2008), "Development of reusable bid evaluation models for the Portuguese Electric Transmission Company", *Decision Analysis*, 5, 1 (22-42).)

# Software

## The Rubis Decision-Deck software resources

Raymond Bisdorff, http://charles-sanders-peirce.uni.lu/bisdorff/

Rubis is a new best choice decision method in the tradition of the Electre IS method that is available in the Decision-Deck software package. A brief description of it is given hereafter followed by a short illustrative application.

### A Decision-Deck software resource

#### The Decision-Deck (D2) project

The D2 project [2] provides an open source software, composed of various modular components, pertaining to the field of Multiple Criteria Decision Analysis (MCDA). It gives a user the possibility to add, modify or simply use existing plugged-in functionalities (plugins). These constituents can either be complete MCDA methods or elements common to a large range of procedures. The typical end-user of the Decision-Deck platform is an MCDA researcher, an MCDA consultant or a teacher in an academical institution.

The D2 project, started in early 2006, is at present actively supported by the MathRO laboratory of the Faculty of Engineering of Mons and the SMG of the Free University of Brussels (Belgium),the Lamsade laboratory of the University Paris-Dauphine and Karmic Software Research (France), the ILIAS laboratory of the University of Luxembourg, and the INESC (Coimbra, Portugal).

#### The D2 platform architecture

The Decision-Deck software is written in the Java programming language and is therefore platform independent. Its latest version can be downloaded from the collaborative software development management system Sourceforge [3]. Two kinds of implementation designs are available: on the one hand a rich Java client which implements locally the MCDA methods (D2), and on the other hand, a distributed web service and AJAX

based architecture, serving the MCDA methods from a distributed web server (D3). The Rubis choice method is actually implemented as such a web service on the *ernst-schroeder.uni.lu* RIA-server at the University of Luxembourg [1].

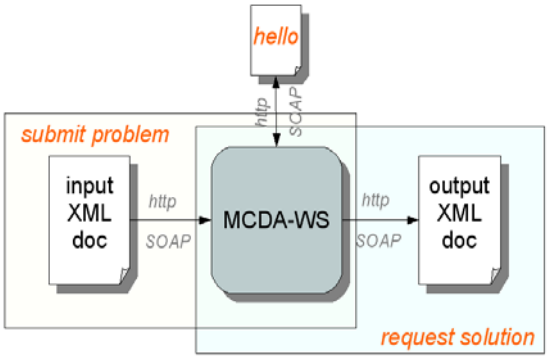


*Figure 5: The Decision-Deck asynchronous MCDA web service layout*

**Examples of D2-plugins**

The following MCDA methods are implemented in the current release of the D2 platform: - *sorting* of alternatives into ordered classes based on an outranking relation (IRIS), - *best choice* method based on an additive aggregation model accepting imprecise information on the scaling coefficients (VIP), - *ranking* of alternatives with a set of value functions (UTA-GMS/GRIP), and - *choosing a single best* alternative based on a bipolar-valued outranking relation (Rubis).

**The principles of the Rubis MCDA method**

The Rubis best choice method (Bisdorff, Meyer, Roubens 2007) [4] is a progressive multicriteria decision aid method in the tradition of the outranking methods. It is focused on the problem of selecting a single best alternative on the basis of the performances of all alternatives on a given consistent family of criteria. The Rubis solution consists mainly in a best choice recommendation (BCR) verifying the following principles:

1. Each non-recommended alternative is eliminated for well motivated reasons.

2. The number of alternatives retained in a BCR is as small as possible.

3. At each step of the progressive decision aiding a stable refinement of the previous BCR is delivered.

4. A BCR does not correspond simultaneously to a best as well as a worst choice recommendation.

5. The BCR is as credible as possible with respect to the preferential knowledge available in the current step of the decision aiding process.

Following recent formal results (Bisdorff, Pirlot, Roubens 2006) [5], it can be shown that such a BCR is given by the maximal credible and strict outranking kernels of the chordless odd circuits augmented bipolar-valued outranking digraph one may construct from a given performance tableau (see [4]).

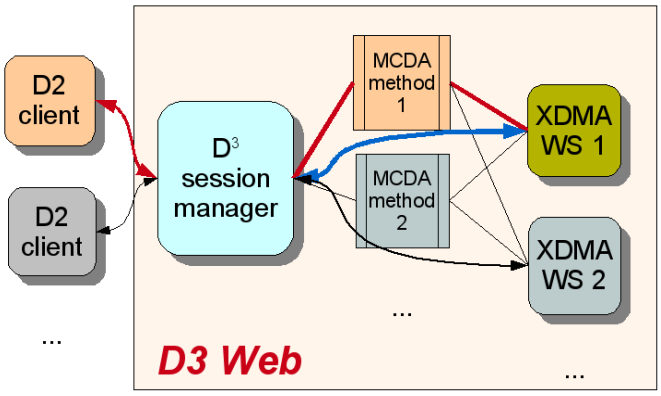


*Figure 6: The D3 Web application*

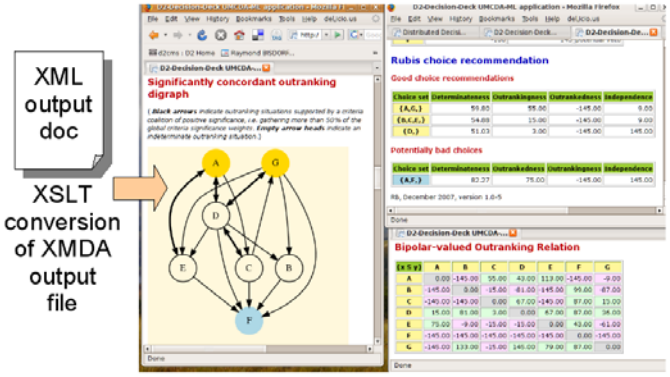


*Figure 7: Browsing the Rubis solver's XML encoded response*

**The Python Rubis Solver**

A Rubis best choice decision solver is actually implemented in the Python programming language via the digraphs Python module which can be downloaded from the following URL: http://ernst-chroeder.uni.lu/Digraph [6]. In order to distribute the solver in an operating system and programming language independent way, the Python Rubis solver offers also an asynchronous web service (WS) installed on the *ernst-schroeder.uni.lu* server at the University of Luxembourg [1].

### The Rubis MCDA-web service

Accessing the Rubis solver may thus be done via an MCDA-WS which follows the general recommendations of the Decision-Deck project (see Figure 1). Three standard SOAP RPC literal ports over HTTP are indeed published:

1. A *hello* port for testing the connection with the Rubis service provider.

2. A *submitProblem* port for submitting an XML encoded problem description.

3. A *requestSolution* port for requesting the XML encoded solution of the Rubis best choice decision method.

| # | Identifyer | Name | Comment |
|---|---|---|---|
| 1 | ant | Antequerra | An afternoon excursion to Antequerra and surroundings. |
| 2 | ard | Ardales | An afternoon excursion to Ardeles and El Chorro. |
| 3 | be | beach | Sun, fun and more |
| 4 | crd | Cordoba | A whole day visit by car to Cordoba. |
| 5 | dn | fa niente | Doing nothing |
| 6 | lw | long walk | A whole excursion with a picnic on the road. |
| 7 | mal | Malaga | A whole day visit by car to Malaga. |
| 8 | sev | Sevilla | A whole day visit by car to Sevilla. |
| 9 | sw | short walk | Less than a half day occupation. |

*Figure 8: Potential decision actions*

Detailed description of the architecture and technical instructions for accessing the Rubis web service from local clients in any programming language may be found on the RIA-server *ernst-chroeder.uni.lu* of the University of Luxembourg [1]. At the same address may be found detailed and technical information concerning the XML encoding of Rubis specific performance tableaus to be submitted to the Rubis solver with the corresponding XML encoding of the Rubis Solver's response file.

| # | Identifyer | Name | Comment |
|---|---|---|---|
| 1 | dis | Distance | Minutes by car to attend the place of the activity. |
| 2 | phy | Physical investment | Contribution to physical health care. |
| 3 | rel | Relaxation | Anti-stress support. |
| 4 | rest | restauration | Quality of the expected restauration facilities. |
| 5 | sun | Sun, fun, and ... more ! | No comment. |
| 6 | tour | Touristic interest | How many stars in the Michelin ? |

*Figure 10: The consistent family of criteria*

### Browsing the D3 Web Server offering the Rubis-WS

Following the previous design, the Rubis-WS requires a specific D3-Web session manager in order to asynchrounously submit a decision problem and subsequently request the corresponding solution in a coordinated and persistent way. Such a Decision-Deck D3 Web Application is at present installed at the following address: http://ernst-schroeder.uni.lu/d3/ (user:demo password: D3_demo).

The D3-Web application allows on-line submitting of XML encoded Rubis problem descriptions and visualization of the Rubis solver's response in a standad browser session (recent browser versions like IE 6+, Firefox 1.5+ etc are required due to the heavy use of javascripting).

| criterion | ant | ard | be | crd | dn | lw | mal | sev | sw |
|---|---|---|---|---|---|---|---|---|---|
| dis | -120.00 | -100.00 | -30.00 | -360.00 | 0.00 | -90.00 | -240.00 | -240.00 | 0.00 |
| phy | 3.00 | 7.00 | 0.00 | 5.00 | 0.00 | 10.00 | 5.00 | 5.00 | 5.00 |
| rel | 1.00 | -999.00 | 8.00 | 3.00 | 10.00 | 5.00 | 3.00 | 3.00 | 6.00 |
| rest | 8.00 | 10.00 | 4.00 | 8.00 | 10.00 | 1.00 | 8.00 | 10.00 | 1.00 |
| sun | 0.00 | 3.00 | 10.00 | 3.00 | 1.00 | 3.00 | 8.00 | 5.00 | 5.00 |
| tour | 5.00 | 7.00 | 3.00 | 10.00 | 0.00 | 8.00 | 10.00 | 10.00 | 5.00 |

*Figure 9: The performance tableau*

### Using a D2 rich Java client

The D3-Web Application may also be accessed with the help of a classic D2 rich Java client when using the D2-Rubis plugin [3]. With this resource it is possible for an analyst or decision aid consultant to describe a set of alternatives and a family of criteria. External evaluators may then remotely assess the performances of the alternatives on each criterion. Eventually the decision-maker can tune the criteria family by choosing adequate significance weights and discrimination thresholds. The final problem description is then automatically transformed in an XML encoded problem description and submitted to a distant Rubis web service. A subsequent request for viewing the Rubis solver's outcome results is operated in a standard browser session (See Figure 3).

| (x S y) | ant | ard | be | crd | dn | lw | mal | sev | sw |
|---|---|---|---|---|---|---|---|---|---|
| ant | 0.00 | -50.00 | 0.00 | -33.33 | 0.00 | -50.00 | -33.33 | -66.67 | -33.33 |
| ard | 83.33 | 0.00 | 16.67 | 50.00 | 50.00 | 50.00 | 16.67 | 16.67 | 16.67 |
| be | 0.00 | -16.67 | 0.00 | 0.00 | 16.67 | 33.33 | 0.00 | 0.00 | 16.67 |
| crd | -100.00 | -100.00 | -100.00 | 0.00 | -100.00 | -100.00 | 33.33 | 0.00 | -100.00 |
| dn | 33.33 | -16.67 | 33.33 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| lw | 66.67 | 50.00 | -33.33 | 33.33 | 0.00 | 0.00 | 0.00 | 0.00 | 33.33 |
| mal | 66.67 | -100.00 | -100.00 | 100.00 | -100.00 | -100.00 | 0.00 | 66.67 | -100.00 |
| sev | 66.67 | -100.00 | -100.00 | 100.00 | -100.00 | -100.00 | 66.67 | 0.00 | -100.00 |
| sw | 66.67 | -16.67 | 0.00 | 33.33 | 33.33 | 33.33 | 0.00 | 33.33 | 0.00 |

*Figure 11: Bipolar outranking relation valued in the interval [-100;100]*

## Small Illustrative Example

### The problem

A family, staying during their holidays in Ronda (Andalucia), is planning the next day's activity. The alternatives shown in Figure 4 are considered as potential actions. The family members agree to measure their preferences with respect to a set of six criteria such as the time to attend the place (*Distance* to be mimized), the required *physical investment*, the expected quality of the *restauration*, *touristic interest*, *relaxation*, *sun*, *fun*, and more ... (see Figure 5).

The common evaluation of the performances of the nine alternatives on all the criteria results in the performance tableau shown in Figure 6. On the qualitative criteria all performances are marked on a same ordinal scale going from 0 (lowest) to 10 (highest). On the quantitative *Distance* criterion (to be minimized) the required travel time to go to and return from the activity is marked in negative minutes.

In order to model only effective preferences, an indifference threshold of 1 point and a preference threshold of 2 points is put on the qualitative performance measures. On the distance criterion, an indifference threshold of 20 min, and a preference threshold of 45 min. is considered. Furthermore, a difference of more than two hours to attend the activity's place is considered to raise a veto. Finally, all citeria are juged equi-significant for the action to be chosen.

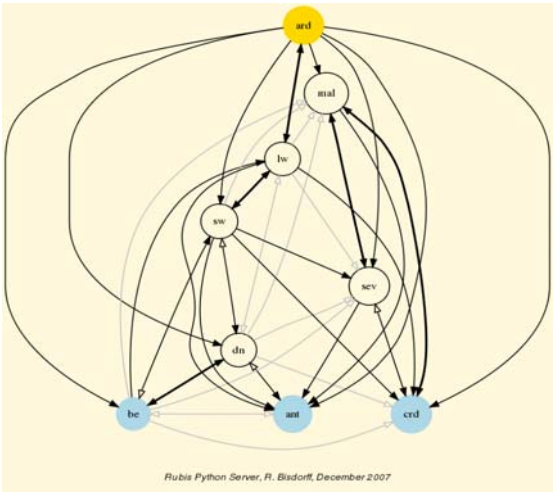


*Figure 12: The resulting outranking digraph and the Rubis BCR*

### The solution

The resulting outranking relation, bipolar-valued in the credibility domain [-100.00, +100.00], is shown in Figure 7. The 0.00 values indicate indeterminate outranking situations as one may observe when comparing the very contradicting alternatives *doing nothing* and *long walk* for instance. The -100.00 values, observed for the large cities excursions, and especially for the *Cordoba* trip, results from the vetos that are raised due to the excessive travel time needed to go there and return.

In the corresponding outranking digraph (see Figure 8), the Rubis Solver marks the afternoon excursion to *Ardales* and *El Chorro* as the Rubis best choice recommendation (see Figure 8, empty arrow heads and grey lines indicate indeterminate outranking situations), whereas the *beach* and *Antequerra* or *Cordoba* excursions appear being the worst choices. It is worthwhile noticing that three coherent groups of more or less indifferent alternatives clearly emerge: - *Ardeles*, *long* and *short walks*; - the large cities excursions with *Sevilla*, *Malaga* and *Cordoba*; and the relaxing - '*fa niente*', and *beach* alternatives. Our family members eventually appreciated very much the recommended *Ardales* excursion and all had a wonderful time the next day.

### References

[1] The Rubis resources at the university of Luxembourg: http://ernst-schroeder.uni.lu/

[2] The web site of the Decision-Deck project: http://www.decision-deck.org/

[3] The Decision-Deck sourceforge repository: http://decision-deck.sourceforge.net/

[4] R. Bisdorff, P. Meyer and M. Roubens, "Rubis: a bipolar-valued outranking method for the choice problem". 4OR, *A Quarterly Journal of Operations Research*, Springer-Verlag. (Online)] Electronic version: DOI: 10.1007/s10288-007-0045-5, pp 1 - 27, in press.

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## Persons and Facts

**2008 MCDM Awards**

International Society on Multiple Criteria Decision Making (MCDM) presented the 2008-awards at the 19th International Conference on MCDM in Auckland, New Zealand.

The **MCDM Gold Medal** is the highest honor that the Society bestows upon a scholar who, over a distinguished career, has devoted much of his talent, time, and energy to advancing the field of MCDM, and who has markedly contributed to the theory, methodology, and practice of MCDM. The Gold Medal was awarded to Professor **Theodor J. Stewart**, University of Cape Town, South Africa.

The **MCDM Edgeworth-Pareto Award** is the highest distinction that the Society bestows upon a researcher who, over his career, has established a record of creativity to the extent that the field of MCDM would not exist in its current form without the far-reaching contributions from this distinguished scholar. The award was given to **Professor Kalyanmoy Deb**, Indian Institute of Technology, Kanpur, India.

The **Georg Cantor Award** is the highest form of recognition that the Society bestows upon a researcher who, over a distinguished career, has personified the spirit of independent inquiry and whose many innovative ideas and achievements are decidedly reflected in the theory, methodology, and current practices of MCDM. The award was given to **Professor Valerie Belton**, University of Strathclyde, Glasgow, UK-

**MCDM Conference Chairmanship Award** was presented to Professor **Matthias Ehrgott**, The University of Auckland, New Zealand, for his most gracious hospitality, and for his outstanding leadership and resourcefulness in organizing, managing, and chairing the Nineteenth International Conference on Multiple Criteria Decision Making, Auckland, New Zealand.

**MCDM International Society: Elections**

Professor Kaisa Miettinen from Filand was elected President of the Society. Congratulions to Kaisa!

## About the 67th Meeting

**SNOW, FUN AND MCDA AT EWG-MCDA'67**

**IN ROVANIEMI, FINLAND**

The 67th meeting of the European Working Group - Multicriteria Decision Aiding was organized by the Finnish Operations Research Society (FORS) in Rovaniemi, Lapland (Finland) during April 3-5, 2008. The organization committee consisted of

- Risto Lahdelma (chair)
- Ahti Salo (vice-chair)
- Kaisa Miettinen (conference facilities)
- Pekka Salminen (scientific program)
- Riikka-Leena Leskelä (correspondence)
- Jussi Kangaspunta (secretary) and
- Antti Toppila (treasurer).

Because none of the organizers comes from Lapland, finding the right locations and services required some intense detective work. The science and conference centre Arktikum, which belongs to the University of Lapland was chosen as the conference site, and it proved to provide excellent facilities.

Arktikum: Jussi behind the registration desk and Antti giving advice.

57 participants had registered for a meeting, and after a few last-minute cancellations we still had over 50 participants representing 18 different countries. The theme of the meeting was "**Public and private interests in decision making**", but as usual, all aspects of MCDA were well covered. Out of the 35 submitted papers, we

managed to squeeze 21 for presentation during Thursday and Friday. The plenary presentation "**Experiences on MCDA methods in natural resources management**" was given by Professor Jyrki Kangas, who is the general director of Metsähallitus, the Finnish Forest Administration. Both full papers and abstracts were printed in the proceedings. For an electronic copy, please contact me.

The social program included a guided tour in the Arktikum exhibitions, a banquet on Friday evening, and snow and fun-filled excursion on Saturday. A total of 40 participants joined the excursion which included visiting Santa Claus on the arctic circle, ice fishing on lake Olkkajärvi, snow shoe walking, refreshments at a small cottage, sauna, making angels and Lordi-figures in the snow, and dining in the Vaattunki Wilds Centre. More information about the meeting can be found at http://www.operaatiotutkimus.fi/mcda67/.

Risto Lahdelma (risto.lahdelma at cs.utu.fi)

Some of the participants at the doorsteps of Vaattuki log mansion.

**Rovaniemi, Finland**, 3-5 April, 2008
**PROGRAMME**

Thème: **Les intérêts publics et privés dans MCDA**
*Theme:* ***Public and private interests in decision making***

La priorité donnée aux discussions pourra entraîner des modifications horaires.
*This schedule could be changed due to the priority given to discussions*.
**Jeudi le 3 avril / Thursday, April 3**

| | |
|---|---|
| 8:00 - 9:00 | Inscription / Registration |
| 9:00 - 9:30 | Session d'ouverture / Opening session: **R. Lahdelma, A. Salo** |

Session 1**:** K. Miettinen

| | |
|---|---|
| 9:30 - 10:00 | **J. Geldermann, J. Ludwig, J. Oberschmidt:** A modified PROMETHEE approach for product life cycle management |
| 10:00 - 10:30 | **J. Croston**: Forecasting for decision making |
| 10:30 - 11:00 | **M. Matos:** Harmonizing priority weights and indifference judgments in value function implementation |

*Papiers soumis à discussion/Papers submitted for discussion:*

**H. Trabelsi:** Etude théorique de la méthode multicritère d'aide à la décision pour le cas de la gestion des nappes souterraines

**K. Lakiotaki, N.F. Matsatsinis:** Learning customer profiles: methodology and implementation

| | |
|---|---|
| 11:00 - 11:20 | **Pause café/Coffee break** |

Session 2: B. Maréschal

| | |
|---|---|
| 11:20 - 12:00 | **Plenary**: **J. Kangas**: Experiences on MCDA methods in natural resources management |
| 12:00 - 12:30 | **P. Leskinen, T. Hujala, J. Tikkanen, A. Kangas, M. Kurttila:** Recently developed decision support systems and practical experiences related to participatory forestry decision making |
| 12:30 - 13:00 | **A. Menou, A. Benallou, R. Lahdelma, P. Salminen:** Decision support for centralizing cargo at a Moroccan airport |

hub using stochastic multicriteria acceptability analysis

*Papiers soumis à discussion/Papers submitted for discussion:*

**S.-O. Larsson**:Who needs decision support?

**M. De Vicente y Oliva, J. Manera Bassa, R. Guede Cid, M. Martín Del Peso**: Using MCDA to support compromise robust solutions in DEA with no a priori information about weights

13:00 - 14:00 **Déjeuner/Lunch**

Session 3: R. Slowinski

14:00 - 14:30 **G. Mavrotas**, **P. Xidonas, J. Psarras**: An integrated multiple criteria methodology for supporting common stock portfolio selection decisions

14:30 - 15:00 **A. Salo:** Robust Portfolio Modeling

15:00 - 15:30 **P. Korhonen, J. Ruutu**: On solving large-scale multiple criteria evaluation problems

15:30 - 16:00 **J. Almeida Dias, J. Figueira, B. Roy**: Electre Tri-C: A multiple criteria ordinal classification method based on central reference actions

*Papiers soumis à discussion/Papers submitted for discussion:*

**M. Doumpos, C. Zopounidis:** A multicriteria bank rating system

**N.F. Matsatsinis, P. Kontogiannis, P. Delias:** A web-based tele-working decision support system for e-banking services, based on a Multi-Criteria Analysis Method

16:00 - 16:30 **Pause café/Coffee break**

16:30 – 17:30 **Tour in Arktikum exhibitions**

**Vendredi le 4 avril/ Friday, April 4**

Session 4: A.Tsoukiàs

9 :30 – 10:00 **T. Riismaa, O. Vaarmann**: Optimizing the structure of multi-level processing system as a multi-objective optimization problem

10:00 - 10:30 **H. Hakonen**: Tool for multicriteria elevator planning

10:30 - 11:00 **R.P. Hämäläinen, E. Saarinen**: Systems intelligence in decision and negotiation support

*Papiers soumis à discussion/Papers submitted for discussion:*

**W. Brauers**: Multiple objective optimization in transportation systems : the case of seaport planning

11:00 - 11:30 **Pause café/Coffee break**

Session 5: M. Matos

11:30 -12:00 **G. Mavrotas, J. Figueira, K. Florios**: Solving bi-objective multidimensional knapsack problems exploiting the concept of core

12:00 - 12:30 **L.C. Dias, C. Lamboray**: Extensions of the prudence principle to exploit a valued outranking relation

12:30 - 13:00 **J. Pinho de Sousa, M. Andrade**: A multi-criteria framework for supporting the design and evaluation of demand responsive transport services

*Papiers soumis à discussion/Papers submitted for discussion:*

**V. Postolica**: Efficiency

**A. Skulimowski**: Applications of dynamic multicriteria rankings in technological forecasting

**J. Figueira, S. Greco, R. Slowinski**: Multiple criteria ranking using the most representative value function compatible with a reference preorder and intensities of preference

13:00 - 14:00 **Déjeuner/Lunch**

Session 6: L. Dias

14:00 - 14:30 **B. Roy**: Vie du groupe et prochaines réunions/Working group matters and next meetings

14:30 - 15:00 **C. Carlsson, R. Fullér, K.-M. Björk**: Problem solving with multiple interdependent criteria

15:00 - 15:30 **D. Loukas, I. Papadimitriou, G. Drosos, S. Anastasiadou**: Investigation of a categorical data distribution via the methods of multivariate data analysis – An application to a stochastic multicriteria group decision-making problem

*Papiers soumis à discussion/Papers submitted for discussion:*

**R. Lahdelma, P. Salminen**: Simulation techniques for Stochastic Multicriteria Acceptability Analysis

15:30 - 16:00 Pause café/Coffee break

Session 7: M. Köksalan

16:00 - 16:30 **K. Daniell, Ch. Mazri, A. Tsoukias**: Participatory decision processes and decision support

16:30 - 17:00 **I. Yeyseyeva, K. Miettinen:** Stochastic Multicriteria Acceptability Analysis for classification

17:00 – 17.30 **J.C. Leyva López**: A fuzzy extension of ELECTRE III method

*Papiers soumis à discussion/Papers submitted for discussion:*

**M. Benbouziane, A. Benamar**: The misalignment of exchange rates in the Maghreb countries: an analysis of nonlinearity and long memory process

**A. Benamar :** Le mésalignement du taux de change dans les pays du Maghreb: Une analyse de non linéarité et de mémoire longue

**G. Fernández Barberis, C. Escribano Ródenas:** How to select the best type of coffee shop? Applying a multicriteria decision aid model to solve the decision problem in the "Levante Español"

17:30 - 18:00 **Fermeture/Closing**

20:00 – 22 :30 **Banquet :** Restaurant Gaissa at Hotel Clarion Santa Claus

**Samedi le 5 avril / Saturday, April 5**

9:30 - 15:30 **Excursion:** Santa Claus' Village & Vaattunki Wilds Centre

Statistiques / Statistics

Nombre de contributions / Number of papers 35
Nombre de participants / Number of participants 56
Les personnes accompagnantes / Accompanying persons 8
Pays représentés / Countries represented 18

## Forthcoming Meetings

(This section is prepared by Carlos Henggeler Antunes)

### Forthcoming EWG Meettings/ 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 68th meeting of the European Working Group "Multiple Criteria Decision Aiding" will be held in October 2-3, 2008 in Chania (Crete), Greece. This meeting is organized by the Technical University of Crete. The main theme of this meeting is "Robustness in MCDA". Organizers: Professors Constantin Zopounidis (kostas@dpem.tuc.gr) and Michael Doumpos (mdoumpos@dpem.tuc.gr). Web site: www.dpem.tuc.gr/fel/mcda68.**

**The 69th meeting of the European Working Group "Multiple Criteria Decision Aiding" will be held in Brussels, Belgium. Possible dates: March 16-28, 2009 or April, 2-4, 2009. Organizer: Professor Yves de Smet: yves.de.smet@ulb.ac.be.**

### Other Meetings

CORS/Optimization Days 2008, Quebec City, Canada. May 12-14, 2008. http://www.cirrelt.ca/scrojopt2008/

20th MINI-EURO CONFERENCE : Continuous Optimization and Knowledge-Based Technologies, Neringa, Lithuania. May 20-23, 2008. http://www.mii.lt/EUROPT-2008/

APMOD 2008 - Applied mathematical programming and Modelling, Bratislava, Slovakia. May 28-30, 2008. http://www.apmod2008.org/

21st Meeting of the European Chapter on Combinatorial Optimization, Dubrovnik, Croatia. May 29-31, 2008- http://www.efzg.hr/eccoxxi

International Conference on Engineering Optimization, Rio de Janeiro, Brazil
June 1-5, 2008. http://www.engopt.org

2008 IEEE World Congress on Computational Intelligence (WCCI 2008), Hong Kong
June 1-6, 2008. http://www.wcci2008.org

2008 Manufacturing & Service Operations Management (MSOM) Conference, University of Maryland, College Park, USA. June 5-7, 2008. http://www.smith.umd.edu/dit/msom2008/index.html

INFORMS Marketing Science Conference, Vancouver, Canada. June 12-14, 2008. http://www.marketscience2008.sauder.ubc.ca

Matheuristics 2008, Bertinoro, Italy. June 16-18, 2008. http://astarte.csr.unibo.it/matheuristics2008/index.shtml

GDN2008 - Group Decision and Negotiation, Coimbra, Portugal. June 17- 20, 2008. http://gdn2008.fe.uc.pt/

Meeting of the EURO Working Group in Stochastic Modeling, Istanbul, Turkey. June 23-25, 2008. http://portal.ku.edu.tr/~STOCHMOD08/

IFIP TC8/WG8.3 Working Conference - International Conference on Collaborative. Decision Making (CDM'08), Toulouse, France. July 1-4, 2008. http://www.irit.fr/CDM08/

Genetic and Evolutionary Computation Conference (GECCO), Atlanta, USA. July 12-16, 2008. http://www.sigevo.org/gecco-2008/index.html

MPREF-08: Advances in Preference Handling, Chicago, USA. July 13-14, 2008. http://wikix.ilog.fr/wiki/bin/view/PreferenceWS/MdPref08

18th Triennial Conference of the International Federation of Operational Research Societies (IFORS), Sandton, South Africa. July 13-18, 2008. http://www.acitravel.co.za/event/index.php?eventID=3

Mini EURO conference on Computational Biology, Bioinformatics and Medicine,. Rome, Italy. July, 15-17, 2008.
http://eurocbbm.ku.edu.tr/RomeConference/homepage.htm

MIP 2008, Workshop on Mixed Integer Programming, Columbia University, New York, USA. August 4-7, 2008. http://coral.ie.lehigh.edu/mip-2008/index.html

7th International Conference on the Practice and Theory of Automated Timetabling (PATAT 2008), Montreal, Canada. August 19-22, 2008. http://w1.cirrelt.umontreal.ca/patat2008/

International Conference Operations Research 2008, Augsburg, Germany. September 3-5, 2008. http://www.or2008.de

Second IFIP International Conference on Artificial Intelligence in Theory and Practice, Milan, Italy. September 7-10, 2008. http://www.ifiptc12.org/ifipai2008

XIV Latin-Ibero American Congress on Operations Research (CLAIO 2008), Cartagena, Colombia. September 9-12, 2008. http://www.socio.org.co/CLAIO2008/

8th International Conference on Hybrid Intelligent Systems, Barcelona, Spain. September 10-12, 2008. http://his2008.lsi.upc.edu/posters.html

1st International Conference on Applied Operational Research (ICAOR'08), Yerevan, Armenia. September 15-17, 2008. http://www.tadbirstm.org.ir

Special session on MCDM within FLINS2008, Madrid, Spain. September, 21-24, 2008
http://www.mat.ucm.es/congresos/flins2008/

ANTS 2008 - Sixth International Conference on Ant Colony Optimization and Swarm Intelligence, Brussels, Belgium. September 22-24, 2008. http://iridia.ulb.ac.be/ants2008/

8th International Conference on Multiple Objective and Goal Programming, Portsmouth, United Kingdom. September 24-26, 2008. http://www.mopgp.com/mopgp08/mopgp08.htm

INFORMS Annual Meeting 2008, Washington DC, USA. October 12-15, 2008. http://meetings.informs.org/DC08/

3rd International Conference on Bioinspired Optimization Methods and their. Applications, Ljubljana, Slovenia. October 13-14, 2008. http://bioma.ijs.si/conference/2008/index.html

International Conference on Metaheuristics and Nature Inspired Computing (META'08), Hammamet, Tunisia. October 29-31, 2008. http://www2.lifl.fr/META08/

7th International Symposium on Operations Research and Its Applications, Lijiang, China October 31- November 3, 2008. http://www.aporc.org

VI ALIO/EURO Conference on Applied Combinatorial Optimization, Buenos Aires, Argentina. December 15-17, 2008 http://alioeuro2008.dc.uba.ar

INFORMS Computing Society Conference, Charleston SC, USA. January 11-13, 2009. http://ics09.meetings.informs.org/

INFORMS Practice Conference: Applying Science to the Art of Business, Phoenix AZ, USA. April 26-28, 2009. http://meetings.informs.org/Practice08/

CORS/INFORMS International Toronto 2009, Toronto, Canada- June 14-17, 2009

ISAHP2009 - International Symposium on the Analytic Hierarchy Process / Analytic Network Process, Istanbul, Turkey. June 30- July 3, 2009. http://www.isahp.org

23rd European Conference on Operational Research, Bonn, Germany. July 5-8, 2009

20th International Symposium on Mathematical Programming, Chicago, USA. August 23-28, 2009

INFORMS Annual Meeting 2009, San Diego California, USA. October 11-14, 2009

## Announcements

**DECISION DECK**

**Program of the previous meeting (LAMSADE)**

www.lamsade.dauphine.fr/d2workshop/?rub=programDetail

**Program of the next meeting (Univ. Coimbra)**

www.inescc.pt/d2-workshop/

## Call for Papers

**Web site for Call for Papers:**
www.inescc.fe.uc.pt/~ewgmcda/CallforPapers.html

## Books

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### Multi-Objective Decision Making

by
J. Zhang, D. Ruan, and F. Wu

This book proposes a set of models to describe fuzzy multi-objective decision making (MODM), fuzzy multi-criteria decision making (MCDM), fuzzy group decision making (GDM) and fuzzy multi-objective group decision-making problems, respectively. It also gives a set of related methods (including algorithms) to solve these problems. One distinguishing feature of this book is that it provides two decision support systems software for readers to apply these proposed methods. A set of real-world applications and some new directions in this area are then described to further instruct readers how to use these methods and software in their practice.

World Scientific. Series in Electric and Computer Engineering, Vol. 6. 2007

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### Evolutionary Algorithms for Solving Multi-Objective Problems

by
Carlos A. Coello Coello, Gary B. Lamont and David A. Van Veldhuizen

Second Edition, Springer. Genetic and Evolutionary Computation Series. 2007.

This textbook is the second edition of Evolutionary Algorithms for Solving Multi-Objective Problems, significantly augmented with contemporary knowledge and adapted for the classroom. All the various features of multi-objective evolutionary algorithms (MOEAs) are presented in an innovative and student-friendly fashion, incorporating state-of-the-art research results. The diversity of serial and parallel MOEA structures are given, evaluated and compared. The book provides detailed insight into the application of MOEA techniques to an array of practical problems. The assortment of test suites are discussed along with the variety of appropriate metrics and relevant statistical performance techniques.

## Articles Harvest

(This section is prepared by Juscelino ALMEIDA DIAS)

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Alexopoulos S., Y. Siskos, and N. Tsotsolas (2006). lanning a reader-oriented strategy for a publishing company: a case study. *Journal of Multi-Criteria Decision Analysis* 14 (1-3), 89-101.

Anestis G., E. Grigoroudis, E. Krassadaki, N.F. Matsatsinis, and Y. Siskos (2006). Skills Evaluator: a multicriteria decision support system for the evaluation of qualifications and skills in Information and Communication Technologies. *Journal of Multi-Criteria Decision Analysis* 14 (1-3), 21-34.

Aragonés-Beltrán P., J. Aznar, J. Ferrís-Oñate, and M. García-Melón (2008). Valuation of urban industrial land: An analytic network process approach. *European Journal of Operational Research* 185 (1), 322-339.

Arias-Nicolás J.P., C.J. Pérez, and J. Martín (2008). A logistic regression-based pairwise comparison method to aggregate preferences. *Group Decision and Negotiation* 17 (3), 237-247.

Arnott D. and G. Pervan (2008). Eight key issues for the decision support systems discipline. *Decision Support Systems* 44 (3), 657-672.

Bana e Costa C.A., J.C. Lourenço, M.P. Chagas, and J.C. Bana e Costa (2008). Development of Reusable Bid Evaluation Models for the Portuguese Electric Transmission Company. *Decision Analysis* 5 (1), 22-42.

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Burnaz S. and Y.I.Topcu (2006). A multiple-criteria decision-making approach for the evaluation of retail location. *Journal of Multi-Criteria Decision Analysis* 14 (1-3), 67-76.

Büyüközkan G., O. Feyzioğlu, and E. Nebol (2008). Selection of the strategic alliance partner in logistics value chain. *International Journal of Production Economics* 113 (1), 148-158.

C.-C. Huang, P.-Y. Chu, and Y.-H. Chiang (2008). A fuzzy AHP application in government-sponsored R&D project selection. *Omega* 36 (6), 1038-1052.

Capotorti A., G. Coletti, and B. Vantaggi (2008). Preferences Representable by a Lower Expectation: Some Characterizations. *Theory and Decision* 64 (2-3), 119-146.

Chan T. M., K. F. Man, S. Kwong, and K. S. Tang (2008). A jumping gene paradigm for evolutionary multiobjective optimization. *Evolutionary Computation, IEEE Transactions on* 12 (2), 143-159.

Chan Y., J.M. Mahan, J.W. Chrissis, D.A. Drake, and D. Wang (2008). Hierarchical maximal-coverage location–allocation: Case of generalized search-and-rescue. *Computers & Operations Research* 35 (6), 1886-1904.

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# Seminars

SÉMINAIRE «MODÉLISATION DES PRÉFÉRENCES
*ET AIDE MULTICRITÈRE À LA DÉCISION»*

**Responsables : Bernard ROY,**

**Daniel VANDERPOOTEN**

(le mardi, à 14.00, en salle P 510)

Prochaines réunions

18 mars 2008 Conférence de Meltem Öztürk (Maître de Conférences au centre de Recherche en Informatique de Lens à l'Université d'Artois : *Structures de préférences sur des intervalles*.

8 avril 2008 Conférence de Ronen Brafman (Professeur à la Ben Gurion University, Department of Computer Science, Israël) : *Different models of Preferences in Decision Theory and Artificial Intelligence*.

**Announcement:**

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

(http://www.inescc.pt/~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 Figueira (figueira@ist.utl.pt) and Luís Dias (ldias@inescc.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.inescc.pt/~ewgmcda

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.

**Groupe de Travail Européen "Aide Multicritère à la Décision" /**
**European Working Group "Multiple Criteria Decision Aiding"**

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This newsletter is published twice a year by the "E-WG on MCDA", in November/December and April/May , with financial support of the Association of European Operational Resea Societies and the logistics support of INESC-Coimbra and CEG-IST, Instituto Superior Técnico, Lisbon.
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