Book of Abstracts

78th EWG-MCDA meeting and 5th EWG-BOR meeting

Catania, September 26th-28th

"Behavioural Issues in Multicriteria Decision Aiding"

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A **Special Issue** themed around the meeting will be published in the Journal of Multicriteria Decision Analysis ed Edited by Salvatore Corrente, Alberto Franco, Salvatore Greco and Raimo Hämäläinen.

This special issue solicits a discussion on behavioural aspects of decision-aiding procedures, encouraging contributions related to the behavioural issues of multicriteria decision support and their consideration in multicriteria decision-aiding methods. The submission deadline is 28 February 2025.

More details can be found here: Call for Papers.

MultiCriteria Decision Aid and complex decision problems

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Abstract

The MultiCriteria (MC) methods are quite easily used in problem situations that are considered complex because multiple actors and/or organizations, with different points of view and objectives, are involved. When a situation is ill or not structured, or a mess, MC methods can be combined with methods of problem shaping and structuring, and of uncertainties and difficulties limitation, in order to reduce complexity**.** Sometimes, MC models and methods can directly aid perception of a decision problem complexity and problem formulation, and can be used to reduce complexity and uncertainty and to orient knowledge acquisition and use. The MultiCriteria Decision Aid (MCDA) methodology uses formal methods (i.e., methods that reduce ambiguity, which is typical of human communication) and a constructivist approach in considering concepts, models, procedures and results as suitable tools (Roy 1987) to develop opinions and visions, knowledge pieces and working hypotheses, as well as to establish a dialogue between analyst and client (or analyst and actors of a decision process and stakeholders), based on these elements. From such a perspective, an MCDA intervention not only generates hard outcomes, such as models, method applications and/or decision support systems, but also "soft" outcomes (Montibeller 2005), which determine the decision aiding quality and the achievement of its ultimate aim (Norese 2020 and 2023).

Some activities of an MCDA approach are mainly oriented towards the involved organisations, to facilitate communication, to activate organisational learning processes at different levels and in different contexts, to detect and, sometimes, dissolve disagreements or micro conflicts, to destabilise certain convictions and to generate self-sufficiency in the repeated decisions for the client and its organisation. These activities are associated with an appropriate use of interactive procedures of modelling and method application and of simple logical tools that facilitate the visualisation and understandability of the model components, used data and MC method results. These activities allow an MCDA intervention to be completed and its quality improved, because they contribute to generate not only possible solutions but also detailed arguments, justifications, maps and logical reasoning for the decision making process.

A simple analysis framework will be presented to distinguish between different situations of MCDA intervention, with their main characteristics, and to describe internal or external factors that influence an MCDA approach and its results. Some synthetic case descriptions, in relation to different problem situations, should allow us to reflect on the interaction between theory and practice, in relation to the problem, the decision context and the process, and on the attitude of an analyst who aims to learn from his/her experience (and also from mistakes), to reduce and control uncertainty and time-wasting, and to aid decision making and action.

Keywords: Complex decision problems, Factors that influence the MCDA approach, Cases References

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A Multiple Criteria Approach for a Sustainable Urban Logistics Policies Ranking Problem

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Abstract

Urban policymakers have sustainability targets for 2030, and in European countries, there is a growing body of guidelines for defining Sustainable Urban Mobility Plans (SUMPs). Many cities also define specific plans regarding Sustainable Urban Logistics Plans (SULPs). It is challenging to collect accurate data to deal with urban logistics issues, and it is expensive to quantify policy effects to make choices in the context of conflicting interests among urban stakeholders. This paper aims to provide local policymakers with a Multiple Criteria Decision Analysis (MCDA) approach for assessing the classification of city logistics strategies from a sustainability perspective. This study characterizes and compares alternative city logistics scenarios as alternatives intended as the result of a mix of policy measures to organize Urban Freight Transport (UFT). In this research, an extension of the Deck Card Method (DCM) is used to build an entire model with interactions between selected criteria pairs. It was applied to a medium-sized city in Northern Italy to rank different scenarios for future planning activities. The DCM allows the policymaker to intuitively model preference among various alternatives and levels on suitable criteria scales.

Keywords

City logistics, Urban sustainability, Multiple criteria decision Analysis, Decision Support, Deck of Cards Method

Exploring the boundaries of Behavioural OR

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Abstract

The renewed attention to examining behavioural factors that could enhance or hinder OR-supported processes and outcomes is represented by work within what is now labelled as Behavioural OR (BOR). Despite buoyant BOR-related activity observed to date, BOR has been criticised for the looseness of its definition and the breadth of its remit. Against this background, we present a framework to help organise and guide the conduct of laboratory and field BOR studies, as well as set some domain boundaries for BOR. During our presentation, we will refer to the selected BOR studies to highlight the elements of the framework. We will end our presentation by discussing the implications of the behavioural perspective for advancing the OR discipline.

Multi-Objective Workflow Scheduling Algorithms in Cloud Computing

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Abstract

This study introduces a novel method for optimizing workflow scheduling in cloud computing environments, an NP-hard problem. Traditional heuristic rules for task prioritization, though effective, often require expert knowledge and extensive trial-and-error to tailor them for specific scenarios. To automate this process, we propose a multi-objective approach using evolutionary computation and simulation to derive new rules. Our contribution includes three algorithms: two address task scheduling and virtual machine allocation separately, while a third coevolves priority rules for both decisions simultaneously. Computational tests show this integrated approach significantly outperforms existing heuristics, improving the hypervolume ratio by 72.91% for makespan and cost optimization. Validation on new instances confirmed the evolved rules' efficiency, with a 90.26% improvement in hypervolume performance, demonstrating the robustness of our method.

Keywords

Multi-objective optimization, Hyper-heuristic, Genetic programming, Cooperative coevolution, Cloud computing, Machine learning

The optimal manipulation of a pairwise comparisons matrix equating the weights of two alternatives

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Abstract

In the paper we try to answer the question how difficult it is for a dishonest expert to provide manipulated data in a given case of decision-making process. We consider manipulation of a ranking obtained by the Geometric Mean Method applied to a pairwise comparisons matrix. More specifically, we propose an algorithm for finding an optimal way to equate the positions of two selected alternatives in a ranking. For this purpose we consider an additive version of pairwise comparisons matrices and use the orthogal projection on a selected linear space.

We also define a new index which measures how difficult such manipulation is in a given case.

Keywords

Pairwise comparisons, data manipulation, rank reversal, orthogonal projection

Construction of alternatives for stochastic choice models reflections from choice experiments on diabetic markets

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Abstract

According to design theories, alternatives result from a construct; it can be from an analyst or decision makers and stakeholders. The generation of alternatives for the development of an economic model on medical markets was initiated with academic researchers, since medical and economic investigators also advised medical policies, especially at the time of the study on policy options to address shortages of critical drugs and to provide recommendations on controversial drugs in the TZD class.

Global pharmaceutical pricing models have been so far driven by big life science companies in interaction with governments; the most common models discussed at a global level come from neo classical economic theory with adjustments of market prices, use of differentiated pricing to take into account adjustment of prices with GNPs differences or reference pricing to adjust access to consumers (e.g. in EU countries);other proposals include peak load pricing such as in Telecommunications. However, changes in international relation policies require now additional alternatives and objectives in a multi-stakeholders 'world for global health policies, the engagement of powerful non-state players and the role of social medias into politics. In EWG-MCDA meeting at West Attica (Athens 2024), it was proposed to use a C-K design framework to expand policy alternatives, using expansion of the concept space, especially for a cost sharing research agenda; after the recent communications at Euro and ADA conferences in July 2024, this paper proposes some advances for the general framework involving the South and North Hemispheres, and addressing common issues on major diseases such as diabetes.

Using MCDA to Communicate Commander's Intent in Air Combat

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Abstract

We report the development and testing of a new MCDA approach to guarantee that the air commander's intent remains intact as it is passed through the chain of command. In practice, the commander's intent does not follow any predefined format or structure. The commander has multiple objectives, and s/he orchestrates a wide range of capabilities to achieve them. Therefore, the wording of the intent is typically rather broad and does not even attempt to provide an exact guidance on how the chain of command from the commander's headquarters to pilots of fighter aircraft should execute it. As a result, interpretations of the intent are made at different levels of the command chain. Therefore, it is critical that these interpretations are maintained undistorted. In the defensive counter air operation studied, 2401 possible courses of action (COAs) were identified for operators at lower levels of the command chain to choose from. Two former air commanders helped to define the commander's intent by means of three criteria; survival of own planes, kill of enemy planes, and expenditure of missiles. In the MCDA model, the COAs are first scored under these criteria with linear value functions. Then, the commanders weight the criteria, and these weights are transmitted down to the chain. The operators at all levels of the chain use the criteria and weights in their respective decision making. The COAs obtained with MCDA are compared against the COAs provided by the current military practice in two simulated air combat scenarios. Two air force flag officers gave their weights for the criteria and then evaluated the simulation results. They found that the COAs generated by the MCDA model reflected the original intents better than the ones selected when the intents were passed through the command chain in a traditional way. We also analyzed the sensitivity of the results by an interval weight approach and found moderate sensitivity. Moreover, the commanders did the weightings using five procedures: Rank ordering, Direct, SWING, SMART and AHP. In their feedback, they preferred the direct and SWING procedures. The pairwise AHP procedure was not considered to be practically applicable. Our conclusion from this study is that the MCDA approach is useful in real-life military operations since the commander's intent is kept undistorted through the chain of command. The approach helps to clarify the ideas of the commander and offers a way to support the decision making of the operators at the different levels of the command chain.

Keywords

Military decision making, Communication, Decision making in a chain of command, User acceptance of weighting methods

C40 Reinventing Cities: Integrating Assessment, Planning, and Design for the Urban Regeneration of Bologna's Prati-Ravone District

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Abstract

The urban ecosystem is highly dependent on external inputs of matter and energy as well as internal balance led by social interactions and community synergies. All of this highlights how, firstly, potentially vulnerable the system is and, secondly, how complex it is, thus how needy is to enlarge our point of view to archive a holistic urban development process. The growing awareness of the inevitability of climate change leads to strategies and policies aimed at strengthening the adaptive capacity and transformability of human settlements to the progressive changes of climatic and environmental conditions. Recognizing the imponderability of some factors and the existence of often non-linear relationships among the components of a complex system as a spatial system may be, it is easy to understand why in this paper the idea is to bring the evaluation tool of Multicriteria Analysis ANP to spatial planning.

The pilot case was the Prati di Caprara-Ravone neighbourhood of Bologna, an area about 3 km from the city's historic centre, marked by 20th-century industrial and military development. The urban challenge was to recover an area marked by many difficulties due to the lack of infrastructure and community, but which at the same time presented opportunities due to its strategic location and green areas. From the outset, the methodology used reflects the holistic approach that characterized the entire study, combining classical urban analysis techniques with tools such as spatial SWOT and GIS technology, with a multi-level participatory process, involving the population with Focus Groups and interactive walks, and experts in the field from social to transportation through questionnaires and interviews. Thanks to the analysis that followed the interviews, it was possible to map the area according to a perceptual and emotional point of view, which combined with Lynch's analysis of the main characteristics of the place, made it possible to integrate a valuable source of data to the diagnosis of the area. This allowed a set of specific goals, strategies and actions to be formulated following the stages of identifying characteristic fragilities and diagnosing the problem. Behavioural data are too often simplified or uncalculated, due to their difficult acquisition and parameterization. The research then continued with the management of the evaluation's network structure and yielded as output a clear ranking of priorities for interventions and their programming for construction.

This example of integrated multidisciplinary evaluation, which in fact includes political and bureaucratic considerations, environmental analysis, social and behavioural analysis, as well as technical and construction-related, not forgetting to economic impact and the evolution of the project over time and in its different alternatives, may be considered as a case study for a future systematic integration of this type of data management within administrations and large-scale projects. Integration to present implementation tools would allow more effective monitoring of the economic, environmental, social, technical, and cultural sustainability of regeneration works in our cities, improving their resilience and circularity.

Keywords

Urban regeneration, integrated assessment, perception analysis, participatory program

How can existing MCDA software support sustainability assessment?

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Abstract

Multi-criteria decision analysis (MCDA) methods have been widely used to assess and compare the sustainability of different products, systems, organizations and institutions. MCDA methods support decision making by integrating information on life cycle impacts, including environmental, economic and social issues, and value judgements (i.e. preferences) of stakeholders. Most of the literature on MCDA and sustainability assessment focuses on methodological advances and/or on case study applications. However, there is a lack of systematic analysis of how existing software can support the application of MCDA for sustainability assessment. This study aims to fill this gap by identifying and assessing free MCDA software using a set of criteria derived from a literature review. The criteria cover the entire MCDA process, from supporting problem formulation and preference elicitation to robustness analysis. The literature reviewed includes applications of MCDA software for sustainability assessment and dedicated literature exploring the capabilities of MCDA methods to deal with sustainability issues. A total of 20 MCDA software tools were assessed using 26 criteria. In this contribution the main findings of this work will be presented, highlighting the key areas that require further attention from developers of MCDA software for sustainability assessment. These include support for problem structuring, stakeholder integration and uncertainty analysis.

Keywords

Sustainability assessment, MCDA software, decision support system

Voters' behavior to sort alternatives, elicitation of preferences and how to aggregate them

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Abstract

Preference-approval structures deal with preferences over alternatives through a weak order, and also selecting a subset of acceptable alternatives under a compelling consistency condition: acceptable alternatives are preferred to the others. In this contribution, we extend these structures to a more general situation, where voters can sort the alternatives in three disjoint classes instead of two (for instance, acceptable, neutral and unacceptable). These ternary preferences increase the expressivity of voters in comparison with approvals, weak orders, and preference-approvals.

We assume that, from a behavioral point of view, voters first sort the alternatives in the mentioned three classes and, secondly, they rank order the alternatives satisfying the following conditions: acceptable alternatives are preferred to the others, neutral alternatives are indifferent among them, and they are preferred to unacceptable alternatives.

In this scenario of ternary preferences, we propose a parameterized family of voting systems related to the Borda count where, for each individual, positive scores are assigned to the alternatives in the first class, a null score is assigned to each alternative in the second class, and negative scores are assigned to the alternatives in the third class.

Keywords

voting systems, Borda count, approval voting, preference-approvals

Navigating Human Behavior Complexities in Complex Business Environments: The Role of AI and MCDA

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Abstract

The prosperity of rural areas within the European Union (EU) is widely acknowledged, yet these regions grapple with challenges in an increasingly urbanized world. Despite diverse socio-economic performances, natural characteristics, and cultural heritage, many rural areas face intrinsic fragility in social, economic, and environmental aspects, leading to common challenges and missed opportunities.

To assist rural entrepreneurs, diverse models such as simulation and Multi-Criteria Decision Analysis (MCDA) can be employed. However, the representation of systems through simulation and the variability in MCDA methods can produce differing results, compounded by varying opinions within organizations on how to weight various criteria. This inherent complexity necessitates advanced analytical tools.

AI methods can provide substantial assistance in this context. By employing an ensemble of simulation models, different perspectives of a rural business can be studied. These models generate various scenarios that are ranked and classified using different MCDA methods, each with varied parameter sets. The diverse outcomes from these simulations present a complex dataset that can be challenging to interpret and optimize manually.

AI excels in making sense of the extensive data produced by these different models. It can analyze the various aspects of human behavior and their representation through mathematical models, providing a coherent interpretation of the results. This capability makes AI particularly suitable for navigating and optimizing the plethora of outcomes generated by simulation and MCDA methods, ultimately supporting rural development by identifying the most promising strategies for rural entrepreneurs.

By leveraging AI, rural areas can better address their socio-economic and environmental challenges, turning potential fragility into opportunities for growth and sustainability.

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Keywords

Simulation, MultiCriteria Decision Aid, Artificial Intelligence, Rural Entrepreneurship

Modeling Criteria and Project Interactions in Portfolio Decision Analysis with the Choquet Integral

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Abstract

We introduce a comprehensive framework for addressing multicriteria portfolio decision analysis challenges, particularly in situations where between-projects independence or within-project independence may not be assumed. The Choquet integral preference model, a widely adopted non-additive integral in multicriteria decision analysis, is employed to consider potential interactions between projects and between criteria. In this context, to streamline the preference model and maintain problem manageability, we opt for the 2-additive Choquet integral, which assigns values only to individual entities and pairs of entities. An illustrative example demonstrates the application of our approach to a multicriteria portfolio decision analysis problem.

Keywords

Decision Analysis, Multi-Objective Decision Making, Decision Support Systems

In search for consensus among peers

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Abstract

Many projects are the joint work of a team of peers. It could be a team of programmers at a software company or researchers at a university writing a joint paper. Often, the reward comes at the very end and can be in various forms: money, shares, stock options, etc. The question then arises as to how to distribute such a prize. The distribution should be adequate to the commitment and the effort put in and, conversely, be immune to the biased judgment of individual team managers. In this paper, we propose a novel method for calculating the ranking to find a consensus among peers in a team based on pairwise comparisons. We will also present research on the robustness of this method to manipulation and strategic behavior of those involved in the evaluation process.

Keywords

Consensus reaching, team of peers, pairwise comparisons, group decision making.

How do you generate the set of decision alternatives?

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Abstract

The generation of alternatives for decision problems is a critical activity that is regularly underestimated and underdeveloped in the decision analysis literature. The construction of a precise set of alternatives from which clients must choose and apply to solve the decision problem can itself form problems and affect the decision-making process, so the focus on generating alternatives is quite important. An ill-formed and limited set of alternatives have a significant impact on the quality of the final decision. The set of alternatives may be provided by the client as an input, but in most cases, this is not the case. Clients have a vague idea of what they have to decide: it is part of the decision-aiding process to construct a precise set of alternatives upon which we can apply a formal decision problem.

Within this context, this talk aims to catalyze the debate on the generation of alternatives through different lenses. The contribution of this talk is twofold. Formally, we present a framework in which we formalize the generation or design of alternatives and how they are generated by separating attributes. The reader can check the similarities of this idea with the concepts of ''expansive partitions'' in formal design theory. Practically, we discuss how existing OR methods generate alternatives, using as experiment a client with a house retrofitting decision and five OR Analysts. We then compare how such practices could improve within our new theoretical framework.

Keywords

Alternatives, Generation, Design, Decision analysis

How the ELECTRE methods can facilitate experiments in research ambits: the case of the potential impact of Italian quarries on water resources

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Abstract

Quarrying has a great importance for economic development and, at the same time, can have several adverse environmental impacts, and specifically may have a significant influence on water resources. In Italy there are about 4,000 quarries for which knowledge about their potential impact on water resources is limited. To this end, an experiment was developed at the Department of Ecological and Biological Sciences of the University of Tuscia by combining methods of Geographic Information Systems and Multi-Criteria Decision Aid. This study can be interpreted as the first national assessment of the sustainability of quarrying activities with reference to water resources (Paoletti et al, 2024).

The adopted procedure started from an analysis of the available databases, to identify the main potentially impactful criteria. Then ELECTRE Tri was used for categorizing the Italian quarries into five categories with increasing potential impact on water resources and ELECTRE III was then used to rank the riskiest quarries.

The experiment was carried out by varying the weights of the various criteria, by means of different methodological approaches; distinguishing the impact of each quarry separately for surface water and groundwater and then analyzing the overall impact on water resources; using the ranking of quarries falling into the two categories of highest impact to read the reliability of the results.

An ex-post analysis of the experiment and its methodological conclusions underlines both the strong points and some weaknesses of the procedure, to facilitate the next steps of this study and also to generalize these elements, which could improve similar research processes and the potentiality of the ELECTRE methods in these ambits.

Keywords

Quarry, water resources, ELECTRE methods, decision aid in research ambits

Reference

Paoletti M., Piscopo V., Sbarbati C., Scarelli A. (2024) Categorization of the Potential Impact of Italian Quarries on Water Resources through a Multi-Criteria Decision Aiding-Based Model. *Sustainability*, 16, 2804. https://doi.org/ 10.3390/su16072804

Dynamic Attribute Prioritization in Multiple Attribute Decision Making: Bridging the Gap between Shortlisting and Final Decision-Making

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Abstract

Multiple Attribute Decision Making (MADM) processes often involve numerous criteria that must be carefully evaluated to reach a decision. However, traditional MADM methods may not effectively account for changes in the relative importance of these criteria over time or as decision-making progresses. This paper proposes a dynamic approach to attribute prioritization in MADM, aiming to bridge the gap between the initial shortlisting phase and the final decision-making stage. By incorporating mechanisms for adapting attribute weights based on contextual changes or evolving preferences, our method enhances the flexibility and responsiveness of MADM models. We illustrate the effectiveness of our approach through case studies and simulations, demonstrating its ability to improve decision outcomes and adapt to dynamic decision environments. Our findings suggest that dynamic attribute prioritization offers a promising avenue for enhancing the robustness and practical utility of MADM techniques in complex decision-making scenarios.

Keywords

Multiple Attribute Decision Making, Dynamic Attribute Prioritization, Decision Making

Deep aggregation of incomplete rankings in Multiple Citeria Group Decision Making

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Abstract

In real-world decision-making problems often more than one Decision Maker is responsible for the process while most methods are suitable for a problem with just one decision maker. We aim to, instead of creating new methods supporting group decision-making, create a generic framework within which any method producing a ranking can be used in a group context. It is achieved via incomplete ranking aggregation. A suitable MCDA algorithm is used separately for each decision-maker. Then obtained rankings are aggregated into a compromise one. Since this problem has high complexity it is impossible to find an optimal solution in a reasonable time. In our approach, different heuristics and neural networks are used to introduce a tradeoff between computation time and the quality of the result.

Keywords

Incomplete rankings, group decision making, neural networks

Combining behavioural decision science and multi-criteria decision aids for climate services: A need for research

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Abstract

The World Meteorological Organization defines climate services as "…the provision and use of climate data, information and knowledge to assist decision-making". However, efforts to develop these services can be challenged by misalignments between what is produced by climate information providers and the decision needs of recipients. As a consequence, there has been growing recognition of the importance of the behavioral and social sciences in developing these services, in terms of better understanding 1) what decisions they need to support; 2) how climate information is currently interpreted, understood and utilized; and 3) how this information can be visualized and presented to improve comprehension and usefulness. Likewise, the last five years have seen an increase in MCDA approaches being applied in flood and drought management, to prioritize climate adaptation options and maximize risk-reduction. We reflect on the need to bring these streams of work together in order to develop climate and weather decision support tools that 1) consider cognitive and motivational biases in the elicitation of criteria and weightings; 2) apply robust MCDA approaches to enable the prioritization of alternative response options; and 3) present this information in a way that is interpreted as intended and used to support decision making.

Keywords

MCDA for climate services, behavioral decision research.

Decision Theory, Design Theory and Innovative Policy Design for Conflict Transformation and Management

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Abstract

Complex policy issues, decision aiding, and the intricate landscape of conflict transformation and management demand meticulous attention. In this context, our study delineates a structured three-step approach. We first focus upon Conflict Transformation and Management, improving Problem Structuring Methods, cognitive maps, and value trees to address conflict situations and complex decision-making tasks. We prioritize the transformation of subjective insights from Cognitive Maps into structured Value Trees. We then move from decision theory to design theory, where we aim to further enhance PSMs by introducing innovative and out-of-the-box alternatives, with a particular focus on Concept-Knowledge (C-K) theory to create a meaningful connection between PSMs and C-K theory. Finally we discuss how these findings relate to policy design, linking our research to Conflict Transformation and Management within the sphere of public policy.

Keywords

Sustainability assessment, MCDA software, decision support system

Process Tracing and Attention in Multi-Attribute Choice

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Abstract

Decision making among options that consist of many attributes is commonplace in various everyday contexts and understanding how these decisions are made is highly valuable for researchers and practitioners. Understanding the latent computational decision process behind the integration of values and attributes also allows better understanding of how decision making can be supported.

Here I discuss how a novel method called "scroll tracking" can be used to study the decision process in a multi-attribute context. Scroll tracking uses a mobile web application where the decision maker scrolls between options and the app tracks their response dynamics in pixel-time coordinate space. I then use scroll tracking data obtained from an experimental consumer choice study (N=115) to explore predictions made by attentional evidence accumulation models, a class of computational models employed in decision science.

The scroll tracking method is based on the notion that preference formation in binary choice is a dynamic process operating in an interactive processing pipeline in which representations of both options can be active at the same time. As the decision maker's motor output is a necessary component of the decision process, the trajectory of that output inevitably reveals information of the latent value comparison and attribute integration process. The novelty of scroll tracking lies in combining spatial and temporal information of the motor output within one decision process into a single value that can be tested in its predictive ability. Different degrees of contemplation and conflict between the decision options are detectable in the spatio-temporal scroll tracking data.

I demonstrate that the process tracing information obtained with the app can successfully predict different attention-choice relationships that are derived from previous literature. Furthermore, it can be used to predict subjective valuations, computational parameters, and psychometric responses. I also compare evidence accumulation models, equipped with the scroll tracking measurements, in their predictive ability. All the models benefit from the rich variety of data that scroll tracking provides. To further evidence the potential of scroll tracking, I discuss another experiment where it has been used to study risky choice.

The findings reported here are evidence of the potential of novel process tracing tools that can be used to covertly study latent decision processes in a naturalistic environment.

Keywords

Multi-attribute choice, process tracing, attention, evidence accumulation

A nonparametric approach to capture compromise effect

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Abstract

Compromise effect refers to the phenomenon where an option's attractiveness enhances when it becomes an intermediate rather than an extreme option in a choice set. I introduce a nonparametric approach to capture the compromise effect from standard observational {menu, choice} data. Instead of relying on utility/value functions to relate choices with preferences, the proposed model is constructed directly based on random preferences, represented as a distribution over the linear orderings of choice options. Consequently, in contrast to existing models of compromise effects, it circumvents complex specification assumptions. I demonstrate the model's performance using semi-synthetic data and compare it to benchmark methods. Moreover, I discuss the identification issues and estimation challenges, and propose approximation strategies.

Keywords

compromise effect, random utility, random preferences, bounded rationality

Replacing standard confusion matrix with overestimates and underestimates for ordinal classification problems

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Abstract

In multiclass classification problems, the standard confusion matrix is typically replaced by a series of confusion matrices, each corresponding to a specific class (or decision variable in MCDM literature). The ordinal classification problems differ from multiclass classification, but they share the same performance metrics as used in multiclass classification. We argue that ordinal classification has unique characteristics that set it apart from other classification. In ordinal classification, the concepts of false positive and false negatives are replaced by overestimates and underestimates. We suggest using different mathematical operators to measure the extent of overestimates and underestimates. The proposed metrics, designed for ordinal classifiers, not only introduce a new evaluation framework but also represent a significant advancement in the performance assessment of ordinal classification algorithms.

Keywords

EWG BOR-MCDA, machine learning, ordinal classification, performance measurement

A Data-Driven Approach to Digital Requirements Prioritization in Automotive Service Operations: Addressing Subjectivity and Improving Decision-Making

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Abstract

Among the most established manufacturing sectors, the automotive industry is facing the challenge of incorporating digital technologies into the traditional creation, production, and operation processes of vehicles. Specifically, we focus on digital products for servicing operations within the company's value chain. These products include websites, car configurators, stock locators, online sales platforms, mobile apps, and CRM, among others. Digital products are primarily software-based and can be improved through new functionalities and requirements that address user needs, expand business opportunities, enhance product performance, and improve user experience. These requirements are continuously identified and implemented in a quarterly cycle. However, managing multiple digital products simultaneously often involves a large number of new requirements. Due to limited resources and workforce, prioritizing which requirements to develop is crucial. Practitioners rely on various methodologies for prioritizing digital requirements, such as MoSCoW, Planning Poker, Cost of Delay, RICE, Kano. These methods are largely subjective, depending on the knowledge and experience of decision-makers. In this context, prioritization is framed as a classification task performed by DM that, based on their knowledge and expertise, map new requirements onto a 9-class ordinal scale.

This work focuses on the class estimation process, aiming to overcome the subjectivity issue of by proposing a data-driven approach. After defining the set of consensual and relevant criteria with the decision-makers, a set of aggregation operators are tested to determine which perform better in resembling the knowledge and decision taken by DM. For interpretability purposes, distance-based aggregator (like TOPSIS) and WA operators (like WA, OWA, WOWA) are used. Some methods effectively replicate most of the original class assignments. Additionally, in cases of significant discrepancies, the proposed approach revealed potential biases in the original classifications, likely caused by the "Hi.P.P.O." (Highest Paid Person's Opinion) effect.

Keywords

Requirements Prioritization, Data Aggregation, OWA, WOWA, Knowledge Extraction

Developing a knowledge base for the Sustainability Assessment of urban projects: the GLOSSA project

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Abstract

The SDG11 and the 2030 Agenda provide a fundamental starting point for monitoring and implementing sustainable development at the urban scale.

It is therefore necessary to be able to initiate decision-making processes that go beyond conventional statistics, including data generated, collected and archived by governments and those provided by external data sources. The indicator concept and its measurability become diriment in terms of urban spatial knowledge and consequently policy and operational decision making.

In this context, the present research proposes a "GLOcal Knowledge System for Sustainable Evaluation of Urban Projects" (GLOSSA), an Italian research Project of Relevant Interest (PRIN). Here, global indicators are localized and adapted at both national and local levels to support the measurement of progress toward sustainable development. Indeed, in line with the 2030 Agenda, the measurement and localization of indicators is recognized as a means to overcome economic, social and environmental challenges through coordination among state, regional and local levels.

In particular, the research aims to: i) build a framework of official SDG11 indicators at the global, European and Italian national levels; ii) identify innovative and operational indicators related to SDG11 proposed in the scientific literature, in the Sustainable Development Strategies produced at the Italian level and in the Sustainability Assessment Tools; iii) provide a set of relevant and useful indicators both for monitoring urban areas and for project construction and evaluation.

Keywords

SDG11, Sustainable Development, Indicators, Knowledge system

Addressing Behavioral Issues in Multicriteria Decision Aiding for Fine Wine Pricing: A Machine Learning Approach

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Abstract

Addressing behavioral issues in Multicriteria Decision Aiding (MCDA) for wine pricing requires a nuanced approach that recognizes the subjective and often emotional nature of decision making in this context. A comprehensive set of criteria ensures that all relevant aspects of fine wine pricing are covered, including quality, rarity, brand reputation, market demand, production costs and expert ratings. However, the integration of such a diverse set of criteria, which includes both objective measures (e.g., production costs, expert ratings) and subjective factors (e.g., brand reputation, consumer preferences), poses a significant challenge for effective analytical tools.

In this study, we propose a novel graph-based method using big wine network data, enriched and strengthened by the multimodality of such big data. Our approach exploits the diverse types of data available in the wine industry to build a more robust and comprehensive model for pricing decisions. We illustrate that subjective criteria significantly influence wine pricing through a graphical network that is influenced by the historical legacy of the wine producer. Our results show that categorized wine prices (such as superfine wine, fine wine and table wine) are determined more by collective emotional (subjective) effects than by objective criteria.

We also show that sophisticated models, particularly dynamic graph models based on multimodality, perform better in classifying behavioral pricing issues across all types of wine. These models capture the complex interactions between different factors, allowing for a more accurate and nuanced understanding of wine pricing. Our results suggest that by incorporating both objective and subjective data into a unified analytical framework, we can better address the challenges posed by the behavioral aspects of MCDA in the wine industry. This approach not only improves the accuracy of pricing strategies, but also provides valuable insights into the underlying factors that drive consumer preferences and market dynamics in the fine wine sector.

Keywords

Big data, Graph model, Machine learning, Multicriteria decision, Pricing

The SOCRATES software for policy impact assessment

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Abstract

Social Multi-Criteria Evaluation (SMCE) has been explicitly designed for comparing policy options and is a part of the latest version of the European Commission Better Regulation Toolbox (TOOL #62). From an operational point of view, the support of a software tool makes all required structuring steps transparent and computations very quick. The JRC SOCRATES (SOcial multi-CRiteria AssessmenT of European policieS), software helps structuring the SMCE methodological framework and, once both the multi-criteria and the equity matrices have been built, performs all required mathematical steps that are necessary to compare options using a multitude of assessment criteria and social actors` preferences. SOCRATES also checks the robustness of resulting rankings by performing a sensitivity analysis of all relevant inputs such as weights attached to dimensions or criteria.

https://knowledge4policy.ec.europa.eu/modelling/topic/social-multi-criteria-evaluation-policy-options_en/socrates_en

Keywords

Kemeny Median Ranking, Local and Global Sensitivity Analyses, Equity Analysis

Does starting below or above the Pareto Front in interactive MCDM result in different anchoring behavior? Results from a behavioral experiment

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Abstract

In interactive MCDM (IMCDM) reference-point methods, such as interactive goal programming (IGP), the human's search begins with a goal that they should adjust, ideally until they find their most preferred solution (MPS). This process resembles anchoring from classical psychology, where an initial number influences the human's estimate of a correct answer to a general knowledge question. In classical psychology, the error of anchoring is that the human misses the correct answer. In IMCDM, the costly mistake is missing the MPS. In previous behavioral experiments, we have shown that anchoring is present in interactive goal programming (IGP) and prevents them from finding their MPS.

When the PF is initially unknown to the DM, another critical factor is whether starting above or below the PF influences anchoring. However, little is known about this relationship with differing ideas between IMCDM and psychology researchers. According to the IMCDM literature, starting below the PF (when all criteria must be maximized) would decrease anchoring effects because it makes humans feel as if they are constantly gaining improvements in solutions by adjusting their goals. However, according to the psychology literature, starting below the PF could cause the participant to view the current set of solutions as inferior and accept the first better solution they see.

In this experiment, we gave the participants a starting goal and manipulated whether they started above or below a convex, maximizing PF. The participant's task was to pretend they were realtors and find an apartment that suited their clients' preferences, which they had received before using IGP. Using a sample of 167 participants, we found evidence of anchoring in IGP for both types of goals. Specifically, anchoring caused them to miss their client's MPS. We saw a limited effect when we compared anchoring between participants who started above the PF to those who started below it. Participants who started above the PF had stronger anchoring scores. We also show that where the participant starts influences where they set the rest of their goals. In other words, if a participant starts below the PF, they place the rest of their goals below it. These findings suggest that in IMCDM if the participant does not set their goals close enough and past the current approximation of the PF, they might get stuck and never find the true PF. This implication emphasizes the importance of behavioral research in IMCDM.

Keywords

Goal programming, anchoring, interactive methods, behavioral operations research, human-algorithm interaction

An enhanced simulation-based approach for multicriteria evaluation problems of SME's performance

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Abstract

The sigma-mu efficiency methodology, derived from Stochastic Multi-Attribute Acceptability analysis (SMAA), addresses uncertainty in decision alternatives' performance by constructing Pareto-Koopmans efficiency frontiers. These frontiers evaluate alternatives based on expected performance μ and variability σ, across diverse criteria weights.

In this paper, we assess alternatives' performance by synthesizing the distribution of composite indicator values, incorporating additional parameters beyond μ and σ, namely, skewness and kurtosis. These parameters offer valuable insights into the shape characteristics of the probability distribution of composite indicators, i.e. tailedness and symmetry.

Therefore, in this study, we propose revisiting the SMAA model by adopting the versatile Dirichlet distribution to the weights of the criteria. The Dirichlet distribution, thanks to its flexibility in representing shapes, incorporating prior knowledge, and supporting the simplex, is deemed suitable for modeling weights' uncertainty without expert elicitation and capturing skewness and kurtosis based on some shape parameters.

The proposed approach is employed to evaluate the performance of a sample of European Small and Middle-Sized Enterprises (SMEs) from 2018-2022 using financial, R&D and growth, and ESG criteria, creating a comprehensive composite indicator aligned with the sustainable goals of Agenda 2030.

Keywords

Sigma-Mu efficiency, composite indicator, Dirichlet distribution, SMEs.

A collaborative dashboard-building approach combining business intelligence and socio-technical multicriteria decision analysis: a tool to assist decision-makers in health settings

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Abstract

Remote patient monitoring (RPM) holds promise for accessible and equitable care delivery, regardless of location. Effective RPM program management relies on leveraging clinical, operational, and financial data for decision-making, yet navigating vast and sparse datasets poses challenges. Moreover, there is still a need for enhanced value assessment methods and tools to inform adopters about RPM implementation value and address current challenges related to patient resistance, health professionals' skepticism, and expensive setup and maintenance. In this context, health decision-makers require dashboard-based tools to help monitor and evaluate RPM programs across multiple dimensions, considering the diversity of perspectives of various stakeholders and end users.

Following a collaborative value modelling paradigm, our study proposes a novel collaborative approach in designing and building a multidimensional management dashboard (MMD) to aid decision-making in RPM program monitoring and evaluation. This approach leverages business intelligence, multicriteria decision analysis and participatory methods for (a) involving MMD end-users in selecting performance indicators aligned with RPM value, (b) building with relevant stakeholders a flexible multicriteria value model for customized analysis and a classification model for identifying RPM areas requiring corrective actions, and (c) engaging end-users in discussing how to integrate indicators and model information within adequate visualization formats for a user-friendly MMD. The implementation of this approach utilized the web-Delphi process, new workshop formats, and novel voting tools. Preliminary results from a case study on heart failure RPM in a Portuguese public health unit demonstrate the approach application in a real-world setting.

Keywords

Dashboard development, Collaborative modelling, Business intelligence, Multicriteria decision analysis, Participatory approaches

Evaluation of agro-sylvicultural systems, using the ELECTRE TRI-nC and ELECTRE III methods, including stakeholder behaviour

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Abstract

INRAE, the French National Research Institute for Agriculture, Food and the Environment, aims to promote agro-ecological projects to reduce the impacts of intensive agriculture on the environment, and to ensure the sustainability of agricultural systems, and the wellbeing of the population through food quality. The TETRAE AC^{2}TION project to which we are contributing, near Bordeaux, aims to evaluate the performance of agro-sylvicultural systems at level of field plots. The objectives are (i) to identify agroforestry systems in the study area, (ii) to take into account the stakeholders' behaviour, and (iii) to model the environmental performance using a panel of criteria.

Seven qualitative and quantitative agri-environmental and behavioural criteria were selected, based on the literature and discussions with experts. A large amount of information was collected through about thirty interviews with agroforestry farmers. These data and discussions allowed us to validate the relevance of the criteria formulated and to refine them. The selected criteria are Motivations, Workload, Woody vegetation management, Knowledge and external support, Cultural practices, Functional biodiversity, Landscape amenities.

The ELECTRE Tri-nC model was used to assign agroforestry systems into four performance categories, and ELECTRE III to rank them within each category. The results of these two double modelling runs demonstrated the relevance of the methodology and criteria used.

This study highlights the need to better understand stakeholder behaviour. It is useful to provide local stakeholders with decision support for their management system change, especially those in intensive processes. This is also very interesting at the local level to reconcile the urban population with agricultural practices.

Keywords

Agroforestry; Field crops; Stakeholders' motivations; Analysis for decision support; ELECTRE methods; TETRAE program

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Participatory modelling and multicriteria decision aiding for marine ecosystem management

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Abstract

The beluga whale population of the Saguenay Fjord in Québec, Canada is emblematic of the territory and an essential part of its historical, cultural and environmental heritage. Unfortunately, anthropogenic activities have had considerable impact on this population, whose numbers have dwindled over the years due to pollution, collisions and other human induced disturbances. As a result, conflicts of use have arisen between human activities and environmental protection. Although numerous measures already exist in this area to regulate tourist observation of marine mammals and commercial shipping, one activity remains difficult to regulate: pleasure boating. It is suspected of causing disturbance to the local beluga population, particularly during the calving period when tourism is at its peak. A dialogue is therefore needed between local stakeholders to devise an organization of activities that will promote cohabitation with these species, while maintaining the economic and tourism activities that sustain the area.

In this talk, we present our participatory process involving various stakeholders in the conversation on the measures to be envisaged to promote human/beluga cohabitation. The research question we address is the following: "What co-management scenarios can be proposed to regulate recreational activities in the beluga's critical habitat, in order to meet the challenges of human/marine mammal cohabitation? We present the scenarios co-constructed during the workshops as well as the criteria developed for a multicriteria evaluation of these scenarios. We also elaborate on the problem structuring phase of the project, the stakeholders identification and the challenges of conducting such a process.

Hierarchical DRSA-approach for the multiple channel retailing

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Abstract

The COVID-19 pandemic clearly showed that retailers require strategic guidance rather than ad hoc market response when transitioning from physical to multiple-channel sales. Integrating digital customer touchpoints in existing physical sales channels is an optimization problem requiring careful managerial planning and strategic thinking. Suboptimal solutions in terms of inadequate or improper specific multiple channel strategy implementation make retailers miss out on vital inter-channel synergies. Customer value is derived from an optimized combination of sales channels, their use, as well as their mutual interactions. So far, research efforts have been directed to quantify and objectify the existing two-dimensional multiple-channel strategic categorization. We introduced a model using the dominance-based rough set approach (DRSA) framework to derive a set of "if-then" decision rules. These rules served as a prescriptive managerial guideline for resource allocation on channel dimension attributes most important for implementing the planned multiple channel strategy and KPI prioritization in a specific strategic context. The derived multiple channel strategic roadmap proved to be a unique multiple criteria prioritization tool with strong managerial implications. The tool itself, however, is not without its limitations. Although the business scope of the roadmap is expanded through multiple channel dimensions later on, these qualitatively evaluated dimensions are intertwined with other quantitative KPIs. An improved version of the model is needed, one which separates qualitatively and quantitatively evaluated channel attributes. In this sense, qualitative inputs should all be analyzed simultaneously within a single, multiple dimension framework. By introducing advanced hierarchical ordering, we will be able to objectively extract all informational value from the observed channel attributes, allocating each retailer to a specific multiple channel strategy. By concluding the diagnostic phase, we will transition to the model's predictive (planning) aspect, where the modified DRSA method will be used to determine optimal levels of all analyzed quantitative KPIs, respective to the specific multiple channel strategy. This way, retailers will have a quantified pathway to each multiple channel strategy. This will allow for much more precise strategic planning and performance monitoring. There are several upsides to the proposed modifications of the previous model. Firstly, the practicality of the model is maximized through a clear cut between the diagnostic and predictive phases. Secondly, model prediction accuracy is improved through iterative segregation of qualitative and quantitative indicators. Thirdly, the derived output in the form of quantitative-based if-then rules can be easily combined into existing and widely spread strategic tools, such as the Balanced Scorecard.

Keywords

Multiple Criteria Decision Aiding, Dominance-based Rough Set Approach, Multiple channel strategy, Brick-and-click retail, Omni-channel strategy

Explainable Interactive Evolutionary Multiobjective Optimization with Dominance-based Rough Set Pairwise Comparisons

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Abstract

We present an Interactive Evolutionary Multiobjective Optimization (IEMO) method guided by decision rules derived from the Decision Maker's (DM's) preferences using the Dominance-based Rough Set Approach to Pairwise Comparison Table analysis (DRSA-PCT). This method involves an iterative process where preference elicitation alternates with optimization phases. During the preference elicitation phase, the DM is shown a sample of solutions from the current population and is asked to compare pairwise some of them. This preference information is structured using DRSA-PCT to prepare the ground for the induction of "if ..., then ..." decision rules representing the DM's preferences. These rules guide the next optimization phase to generate a new population of solutions converging towards the most interesting part of the Pareto front. This iterative process continues until the best compromise solution is found. We discuss the computational performance of the proposed method and how decision rules help explain the impact of the provided preference information on convergence to the best compromise solution. We also characterize the behavioral aspects of the proposed procedure. Notably, the ease of collecting preference information from the DM through pairwise comparisons and the clarity of the decision rules explaining the DM's preferences are key methodological highlights.