

ADA 2024 Wednesday Scientific Program

This is the Wednesday Scientific Program of ADA 2024. Note that the program may still change slightly.

The presenter(s) are underlined, and the other authors are in plain text. View abstracts below or by clicking the presenter's name.

The discussants of the PhD Incubator presentations are indicated with parentheses. Blitz PhD incubator presentation are indicated with (Blitz).

The session IDs are formatted followingly: <Day>.<Session Number>.<Lecture Hall>.

For example, Wed.4.D refers to the 4th session of Wednesday and is arranged in lecture hall D.

The Poster Session Thu.3.X is arranged outside lecture hall B.

Time \ Day	Wednesday 10 July 2024		
	Lecture Hall B	Lecture Hall D	Lecture Hall E
08:30 - 09:00	Registration & Coffee		
09:00 - 10:00	Wed.1.B Opening Keynote (Lecture Hall B) Prof. Simon French: Decision Analysis: Theory Meets Practice		
10:00 - 10:15	Break		
	Parallel Sessions		
	Wed.2.B Behavioral Decision Making I Session Chair: Jack Soll <u>Raimo P. Hämäläinen</u> Tuomas Lahtinen, Kai Virtanen <u>Jyri Mustajoki</u> Juuso Liesiö, Miika Kajanus, Mika Marttunen <u>Daniel Feiler</u> Jordan Tong <u>Jack Soll</u> Jessica Reif, Rick Larrick	Wed.2.D Forecasting I Session Chair: Jay Simon <u>Mark Himmelstein</u> Sophie Ma Zhu, Nikolay Petrov, Ezra Karger, Amory Bennett, Philip E. Tetlock <u>Cem Peker</u> Yael Grushka-Cockayne, Victor Jose, Jack Soll, Jacob Rittich <u>Jason Merrick</u> Yael Grushka-Cockayne, Cade Massey <u>Jay Simon</u>	Wed.2.E Utility Theories Session Chair: Mikko Harju <u>Aurelien Baillon</u> Han Bleichrodt, Chen Li, Peter Wakker <u>Peng Xu</u> Tri Tran <u>Enrico Diecidue</u> <u>Mikko Harju</u> Juuso Liesiö, Kai Virtanen
10:15 - 11:45			
11:45 - 12:30	Lunch		
	Parallel Sessions		
	Wed.3.B Behavioral Decision Making II Session Chair: Gilberto Montibeller <u>Junyi Chai</u> <u>Alessandra Cillo</u> Manel Baucells <u>Johannes Müller-Trede</u> Gwendolin Sajons, Elena Shvartsman <u>Gilberto Montibeller</u> Florian Federspiel, Matthias Seifert	Wed.3.D Forecasting II Session Chair: Pavel Atanasov <u>Jyrki Savolainen</u> Maaz Bhatti <u>Ville Satopaa</u> Marat Salikhov <u>Asa Palley</u> Ville Satopaa, Yael Grushka- Cockayne, Charles Persinger <u>Pavel Atanasov</u> Regina Joseph	Wed.3.E Incomplete Information Session Chair: Eeva Viikkumaa <u>Juuso Liesiö</u> Peng Xu <u>Francesco De Pretis</u> Mantas Radzvilas, William Peden <u>Joaquín de la Barra</u> Ahti Salo, Mahdi Pourakbari- Kasmaei <u>Eeva Viikkumaa</u> Petri Rikkinen, Juuso Liesiö
12:30 - 14:00			
14:00 - 14:15	Break		
14:15 - 15:45	Parallel Sessions		
	Wed.4.B Eliciting and Modelling Probabilities Session Chair: David Gonzalez Jimenez <u>Manel Baucells</u> Lonnie Chrisman, Thomas Keelin <u>Canan Ulu</u> Alessandra Cillo, Emanuele Borgonovo, Alessandro Ortis, Sebastiano Battiato	Wed.4.D Value of Information Session Chair: Emanuele Borgonovo <u>Jeeva Somasundaram</u> Luc Wathieu <u>Andrea Hupman</u>	Wed.4.E Multicriteria Decision Analysis Session Chair: Evangelos Triantaphyllou <u>Evangelos Triantaphyllou</u> Juri Yanase <u>Juho Roponen</u>

Jens Witkowski
Rupert Freeman

Ali Abbas

Sebastian Schär
Jutta Geldermann

David Gonzalez Jimenez

Emanuele Borgonovo
Francesca Beccacece,
Margherita Cigola, Giovanni
Rabitti

Evangelos Triantaphyllou
Juri Yanase

15:45 - 16:00

Break

16:00 - 17:00

Wed.5.B
Kahneman Panel (Lecture Hall B)

Panel moderators:
Emanuele Borgonovo & Yael Grushka-Cockayne

Panelists:
Manel Baucells (in presence)
Don Kleinmuntz (in presence)
David Budescu (online from New York)
Robin Keller (online from California)
Peter Wakker (online from Rotterdam)

Oral Presentations

Wed.2.B: Behavioral Decision Making I

Session Chair: Jack Soll

Generating Policy Alternatives for Decision Making: A Process Model, Behavioural Issues, and an Experiment

Submission ID-036

Raimo P. Hämäläinen, Tuomas Lahtinen, Kai Virtanen

Systems Analysis Laboratory, Aalto University, Finland

The generation of alternative policies is essential in complex decision tasks with multiple interests and stakeholders. A diverse set of policies is typically desirable to cover the range of options and objectives. Decision modelling literature has often assumed that clearly defined decision alternatives are readily available. This is not a realistic assumption in practice. We present a structured process model for the generation of policy alternatives in settings that include non-quantifiable elements and where portfolio optimisation approaches are not applicable. Behavioural issues and path dependence as well as heuristics and biases which can occur during the process are discussed. The behavioural experiment compares policy alternatives obtained by using two different portfolio generation techniques. The results of the experiment demonstrate that path dependence can occur in policy generation. We report thinking patterns of subjects which relate to biases and heuristics.

An approach for modelling interdependent actions in portfolio decision analysis and its application in a regional climate roadmap

Submission ID-034

Jyri Mustajoki¹, Juuso Liesiö², Miika Kajanus³, Mika Marttunen¹

¹ *Finnish Environment Institute*

² *Aalto University*

³ *Savonia University of Applied Sciences*

We present a structured portfolio decision analysis approach to support the consideration of interdependencies between actions (i.e., interactions). This has been a challenge, for example, in environmental management problems, in which there can be tens of possible actions and consequently, hundreds of possible interactions between them to be modelled. The approach aims to reduce the cognitive load of stakeholders making the assessment of interactions by providing i) heuristics for selecting a shortlist of actions to which the modelling of interactions will be focused, ii) a holistic way to evaluate the interactions, and iii) a structured way for carrying out sensitivity analysis based on how intensively the interactions would be considered in the modelling. The approach was tested in a case of a climate roadmap of the North Savo region, Finland, for the year 2035. The approach helped to identify an efficient set of actions for preparing and adapting to climate change through better understanding of synergies and trade-offs between the actions.

Inverted Metrics: How Jensen's Inequality Neglect Can Cause Projects to Run Over Time and Over Budget

Submission ID-072

Daniel Feiler¹, Jordan Tong²

¹ *Tuck School of Business, Dartmouth College*

² *Wisconsin School of Business, University of Wisconsin--Madison*

We examine a judgmental bias that emerges when the metric in which past data are observed or experienced has an inversion-mismatch with the dimension in which the forecast is being made. For example, consider a case in which past data are in terms of "cases" per week that can be handled but the forecast is in terms of how many "weeks" it will take one to handle a certain number of cases. We show, in a series of experiments, that individuals exhibit a predictable behavioral bias in such decision tasks, as a consequence of Jensen's Inequality Neglect. In pre-registered Experiments 1 and 2 we demonstrate how the psychological bias can cause individuals to predictably underestimate how long it will take their organization to complete a given amount of work. In pre-registered Experiments 3, 4, and 5 we examine this phenomenon in a sample of managers, with real world stimuli, and with break-even forecasting, leading to budget overruns. We show how an intuitive misunderstanding of this mathematical principle is sufficient to generate the classic findings of the planning fallacy in predictable situations.

The Inclusion of Anchors When Seeking Advice: Causes and Consequences

Submission ID-096

Jessica Reif , Rick Larrick , [Jack Soll](#)

Fuqua School of Business, Duke University

Scholars have devoted considerable research attention to examining how people use advice from others. However, there is much less research exploring the preceding step of how people ask for advice. Sometimes advice seekers include their own thinking in their requests, providing anchors that make it difficult for advisors to access their own independent judgments. Across naturalistic and laboratory samples, we find that advice seekers include anchors when seeking quantitative advice 20-50% of the time. In five pre-registered studies, we investigate the causes and consequences of including anchors when seeking advice. We find that impression management motives increase the tendency to include anchors when seeking advice, while a goal of preserving advisors' independence reduces the tendency to include anchors. We also find that advice seekers who have put more thought into a decision task prior to seeking advice are more likely to include anchors in their requests. Finally, we find that advice seekers who include anchors when seeking advice benefit less from opinion combination strategies such as averaging because they introduce shared sources of error. In sum, this work highlights how the question one asks matters. We discuss implications for research on advice seeking and the wisdom of crowds.

Wed.2.D: Forecasting I

Session Chair: Jay Simon

The Forecasting Proficiency Test: A Practical Forecaster Evaluation Tool

Submission ID-028

[Mark Himmelstein](#)^{1, 7}, [Sophie Ma Zhu](#)^{2, 7}, [Nikolay Petrov](#)^{3, 7}, [Ezra Karger](#)^{4, 7}, [Amory Bennett](#)^{5, 7}, [Philip E. Tetlock](#)^{6, 7}

¹ *Georgia Institute of Technology*

² *University of British Columbia*

³ *University of Cambridge*

⁴ *Federal Reserve Bank of Chicago*

⁵ *Quorum Research*

⁶ *University of Pennsylvania*

⁷ *Forecasting Research Institute*

Some people are better at making predictions than others. From forecasting tournaments to surveys of professional forecasters, numerous studies conclude that judgmental forecasting is a measurable and reliable skill. Information about the skill distribution of a pool of forecasters can help information aggregators implement performance weights, or hiring managers select top applicants. But how can the best forecasters be identified in practice? We develop and validate a Forecasting Proficiency Test (FPT), a practical assessment of general forecasting skill that can be administered in one hour. Our research design compares two sources of information as potential diagnostic tools: forecasts about real events that can be adapted for arbitrary time horizons, and objective cognitive assessments established or hypothesized to be associated with forecasting ability. A key emerging insight from our work is that continuous quantile forecasts are more psychometrically reliable indicators of latent ability than probability forecasts, but that probability forecasting also involves unique skills distinct from continuous quantile forecasts. Our results provide both theoretical insight into the nature of forecasting skill, as well as a real world tool that can be used by decision makers looking to build forecasting teams or optimally aggregate groups of forecasters.

Using Prediction Interval Skewness to Improve Forecast Accuracy

Submission ID-024

[Yael Grushka-Cockayne](#)¹, [Victor Jose](#)², [Cem Peker](#)³, [Jack Soll](#)⁴, [Jacob Rittich](#)⁵

¹ *Darden School of Business, University of Virginia*

² *McDonough School of Business, Georgetown University*

³ *New York University Abu Dhabi*

⁴ *The Fuqua School of Business, Duke University*

⁵ *University of Göttingen*

Aggregating individual forecasts improves accuracy through the "wisdom of the crowd" effect. This paper examines how accuracy of the aggregate forecast can be further improved when prediction intervals are also elicited and available. We consider a simple theoretical model where forecasters observe an unbiased signal from a data-generating process. Each forecaster reports lower and upper estimates along with a most likely estimate for a continuous quantity. Such three-point estimates are commonly collected in practice, and provide information on the skewness of forecasts. Our theoretical analysis suggests that i) the simple average of most likely estimates overestimates small quantities, and underestimates large quantities, and ii) forecasters who have a right(left)-skew in their prediction intervals are more accurate in their most likely estimates for small(large) quantities. Evidence from experimental forecasting tasks supports these observations. Based on

these findings, we develop and test an aggregation method that uses the implied skewness in three-point estimates when combining forecasts. Using data from several forecasting tasks, we demonstrate that our method improves forecast accuracy for small and large quantities at the extremes.

Decision-making with Ordinal Ratings

Submission ID-126

[Jason Merrick](#)¹, Yael Grushka-Cockayne², Cade Massey³

¹ *Virginia Commonwealth University*

² *University of Virginia*

³ *University of Pennsylvania*

Experts often provide judgments on an ordinal scale, which are easy to generate and intuitive. Ordinal ratings, however, are not trivial to aggregate across multiple experts, as they provide neither the strict preference ordering of a ranking nor the intensity of preference of cardinal scores. In addition, ordinal rating judgments often map to a broad set of outcomes, which are not expressed through the ordinal, discrete set of choices elicited. In this way, ordinal rating also neglects to express the degree of uncertainty that may exist when rankings are interpreted as forecasts. We offer a framework for mapping ordinal ratings to continuous forecasts, allowing for the ratings to be aggregated and for representing the uncertainty that may exist in the submissions. Finally, our framework allows for rendering the aggregate distributional forecasts back to the original ordinal scale, providing again an intuitive set of judgements, to be used by the decision maker. We demonstrate our framework in the context of National Football League (NFL) scout assessments of players' performance. These assessments, treated as forecasts, are utilized by general managers when making player selection decisions in the annual college draft.

Sports Betting Markets as Forecasters: Exploring Real-Time Price Data from Four Major Sports

Submission ID-039

[Jay Simon](#)

American University

This work analyzes real-time moneyline data for MLB, NFL, NBA, and NHL games from multiple sportsbooks from opening until closing. The vast majority of prior work on sports betting markets is limited to opening and closing prices only. Generally, the closing prices reflect better forecasts than the opening prices. However, access to each complete sequence of prices allows for more detailed analysis of how these markets behave. Several possible inefficiencies are explored. While some are unique to a particular sport or have diminished over time, two appear to persist broadly. First, price changes tend to exhibit negative autocorrelation. Second, there are classes of games for which forecasts do not improve in the hours leading up to the game. Causes and implications of both types of inefficiencies are discussed.

Wed.2.E: Utility Theories

Session Chair: Mikko Harju

Source Theory: A Tractable and Positive Ambiguity Theory

Submission ID-048

[Aurelien Baillon](#)¹, Han Bleichrodt², Chen Li³, Peter Wakker³

¹ *Emlyon Business School, Lyon, France*

² *Department of Economics, University of Alicante, Spain*

³ *Erasmus School of Economics, Erasmus University Rotterdam, the Netherlands*

This paper introduces source theory, a new theory for decision under ambiguity. It shows how Savage's subjective probabilities, with source-dependent nonlinear weighting functions applied to them, can be used to model Ellsberg's ambiguity (unknown probabilities). It can do so in Savage's framework of state-contingent assets, and does not need complex two-stage gambles, multistage optimization principles, expected utility for risk (descriptively problematic), or any linear algebra. Still the mathematical analysis is simple, with intuitive preference axioms, tractable calculations and prescriptive implementability, empirically realistic fittings and predictions, and convenient graphical representations of ambiguity attitudes. We provide new ways to compare weighting functions, not between persons as is common, but within one person and between sources. So-called p-matchers turn out to capture uncertainty attitudes well, giving Arrow-Pratt-like transformations, however, "within" rather than "outside" functions. Within-person-between-sources comparisons are the main novelty of ambiguity over risk, first demonstrated by Ellsberg's paradox.

Decision Support Model for Incomplete Risk-Seeking Preferences

Submission ID-107

[Peng Xu](#)¹, Tri Tran²

¹ *University of Essex - Essex Business School*

² *University of Groningen*

Risk-seeking behavior has been extensively documented across various research fields such as decision sciences, economics and finance, psychology. In this research, we propose a decision support model based on reverse second-order stochastic dominance (RSD) to accommodate incomplete risk-seeking preferences. Specifically, we establish dominance conditions according to the RSD criterion in discrete state-space. We then develop a stochastic optimization model that enables to identify an optimal decision alternative whose dominance over a pre-specified benchmark is robust for all risk-seeking decision makers. Furthermore, we demonstrate that RSD-based

optimization model can be formulated as a mixed-integer linear programming problem to generate decision recommendations. The developed decision support model is well-suited to support data-driven decision analytics problems, including production and operations management, logistics and supply chain management, and healthcare management, particularly in the presence of incomplete preference information.

Why Do People Discount? The Role of Impatience and Future Uncertainty

Submission ID-073

Enrico Diecidue

INSEAD

Despite the intuition that risk preferences affect intertemporal choice because the future is uncertain, time discounting is commonly regarded as a reflection of impatience. Our experimental data show that approximately 43% of the observed time discounting can be explained by an aversion against future uncertainty rather than impatience, even when controlling for utility curvature. Future uncertainty receives disproportional weight because subjects engage in subproportional probability weighting, a behavioral regularity that does not feature in the standard risk framework of most intertemporal choice models. We find that many people do not demand compensation for waiting but rather for an uncertain future.

Spatial Decision Analysis with Location-Dependent Attribute Weights: Axiomatic Foundations and Incomplete Preference Information

Submission ID-051

Mikko Harju¹, Juuso Liesiö², Kai Virtanen^{1, 3}

¹ *Aalto University School of Science*

² *Aalto University School of Business*

³ *National Defence University*

Preferences between decision alternatives with geographically varying consequences can be represented by spatial value functions. Such a function first evaluates consequences locally and then aggregates these values across the spatial region under consideration. We present two ways to improve the use of spatial value functions. Firstly, existing spatial value functions evaluate consequences identically at each location. We ease this restriction by evaluating consequences with respect to multiple attributes and allowing the relative importance of these attributes to vary between locations. This multi-attribute model enables the representation of a wider range of preferences without a significant increase in complexity. Secondly, eliciting the spatial weighting that represents the relative importance of locations from a decision maker is challenging. We introduce an approach for generating a spatial weighting based on incomplete information on the decision maker's preferences captured by a limited number of preference statements. This approach is transparent for a decision maker since the resulting weighting can be easily visualized.

Wed.3.B: Behavioral Decision Making II

Session Chair: Gilberto Montibeller

Contextual Thinking in Behavioral Anomalies

Submission ID-014

Junyi Chai

Faculty of Business and Management, BNU-HKBU United International College, Beijing Normal University - Hong Kong Baptist University, Zhuhai, China

People's choices often depend on choice sets they face. In binary choices, people tend to choose the relatively "moderate" option (called the compromise effect) or to choose the dominant option after adding an "asymmetrically dominated" option (called the attraction effect). Such behavior anomalies are irrational seemingly, which invoke constructive models of preferences to explain them. In this paper, we develop a theoretical framework of context-dependent preferences, what we call contextual thinking, that contains two-fold thinking: inferiority aversion and attention. Through formulating the two-fold thinking, the effect of choice sets on choice behaviors can be captured by deliberating perceptions' distortions on dimensions' importance. Meanwhile, it remains the forms of dimensions' value functions unchanged. The unique feature of our theory is extending the bedrock of the classical range-based model by further incorporating the influences of relative position of options. We exploit the applause features like elasticity vanishing, proportional thinking, diminishing sensitivity, and loss aversion, which enhance the theory's capacity of explaining behavior anomalies. Our model particularly explains the attraction and compromise effects in a united way.

Predicting The Present Equivalent Of Cash Streams

Submission ID-058

Manel Baucells¹, Alessandra Cillo²

¹ *Darden School of Business, University of Virginia, U.S.*

² *LIUC Cattaneo University, Castellanza (VA), Italy*

We explore the implicit discount rates individuals use to discount not one, but multiple future payouts. Our focus is to incorporate both decreasing impatience and the often neglected magnitude effect. Employing a ceteris paribus design, the study investigates whether the magnitude effect is driven by the sum of cash flows, the highest cash flow, the first, last, or the lowest. The best predictive model suggests that the discount rate decreases with the sum of payoffs and the highest cash flow. We also observe decreasing impatience, using either a

beta-delta model or the Ebert-Prelec model. We do not find a strong support for a model with cash-flow specific discount rates. We also use different model specifications to design a retention bonus whose goal is to keep employees as highly motivated as possible during an extended period of time. All models that account for magnitude effect do a good out-of-sample job, whereas the models that only account for decreasing impatience do not. Thus, our research provides better predictions that can aid in designing the financial aspects of products.

„Silly“ mistakes and our willingness to rely on people and machines for decision support

Submission ID-104

Johannes Müller-Trede¹, Gwendolin Sajons², Elena Shvartsman³

¹ IESE Business School

² ESCP Business School

³ WHU Business School

We report a series of experiments that assess people's reliance on AI and other algorithmic decision support systems in a judgment and a reasoning task. Our results suggest that people willingly rely on AI/DSS when they expect that doing so should improve their performance on the task. In contrast with prior findings, we do not find evidence for a generalized aversion to using AI/DSS or evidence for people avoiding AI/DSS (more so than decision support coming from another person) after observing the AI/DSS make mistakes. Our findings indicate that people's reliance on AI and other algorithmic decision support systems may be both simpler in theory and more diverse in practice than suggested by previous research.

Behavioral Decision Analysis: Past, Present, and Future

Submission ID-155

Gilberto Montibeller¹, Florian Federspiel², Matthias Seifert³

¹ Loughborough Business School, Loughborough University, UK

² INCAE Business School, La Garita, Costa Rica

³ IE Business School, IE University, Madrid, Spain

Traditional research in the domain of Decision Analysis has focused on the design and application of logically consistent tools to support decision-makers during the process of structuring problem complexity, modeling uncertainty, generating predictions, eliciting preferences, and, ultimately, making better decisions. Two commonly held assumptions are that the decision maker's cognitive belief system is fully accessible and that this system can be understood and formalized by trained analysts. However, in past years, an active line of research has emerged studying instances in which such assumptions may not hold. We aim to unite this community under the common theme of Behavioral Decision Analysis. This presentation traces the historic evolution of this sub-field of Decision Analysis and lays out a foundation and taxonomy for Behavioral Decision Analysis, which can unify this work across various domains. The taxonomy we suggest categorizes research based on task focus (prediction or decision) and behavioral level (individual or group). Two theoretical lenses that lie at the interface between (1) normative and descriptive research, and (2) normative and prescriptive research are introduced. We then proceed to highlight representative works across the two lenses focused on individual and group-level decision-making.

Wed.3.D: Forecasting II

Session Chair: Pavel Atanasov

Enhancing Flood Prediction Through The Application Of Large Language Models - Case Studies In The UK, Scotland, And Japan

Submission ID-108

Maaz Bhatti^{1, 2}, Jyrki Savolainen^{3, 4}

¹ LUT School of Engineering Sciences

² Iceye

³ LUT Business School

⁴ CSC – IT Center for Science

Floods, intricate in causation and profound in local impact, necessitate early and intelligent responses. This paper introduces an advanced early flood warning system leveraging the capabilities of Llama 2 and Mistral large language models (LLMs). The system extracts insights from textual information, encompassing factors like property damage and human casualties. Using a case study approach, the paper explores flash floods in the UK and Scotland and floods in Japan, all of which occurred in 2023, by drawing data from social media platform X (formerly Twitter) and digital news stories. The integration of retrieval augmented generation augments LLM knowledge with supplementary text data from the sources.

The paper outlines a framework for data analysis, emphasizing context-aware reasoning capabilities of the LLMs along with data pre-processing and model validation accuracy for the intelligent early flood warning system. Preliminary findings suggest that LLM-based warning systems may serve as a foundation for enhanced flood predictions. Furthermore, it is suggested that human expert verification remains crucial due to the inherent uncertainty in the utilized data sources.

BIN Model of Forecaster-Specific Skill and Event-Specific Predictability

Submission ID-080

Ville Satopaa¹, Marat Salikhov²

¹ INSEAD

² New Economic School, School of Management SKOLKOVO

The BIN (Bias-Information-Noise) model decomposes differences in predictive performance between two groups of forecasters in terms of bias (systematic deviations from the base rate), information (use of relevant cues), and noise (use of irrelevant cues). In this work, we generalize the BIN model by allowing bias, information, and noise to depend on the characteristics of the target event (e.g., the topic, geographical region, etc.) and the forecaster (e.g., intelligence test scores, open-mindedness, gender, etc.). This allows us to understand what kind of forecasters' predictions tend to have low noise, low bias, or high information, and whether certain types of events can exacerbate the negative effects of bias, (lack of) information, or noise. Akin to item-response theory models used in psychometrics, our model controls for event difficulty and hence explains forecaster skill in terms of bias, information, and noise. In our application, we consider a large dataset of probabilistic predictions of geopolitical events. We find that there is considerable heterogeneity in terms of bias, information, and noise parameters both across experts and events; and that several forecaster- and event-specific covariates appear to have a strong and statistically significant link with the bias, information, and noise parameters.

Machine-Moderated Judgmental Forecasting to Improve Prediction Accuracy and Decision Making

Submission ID-063

Ville Satopaa ¹, [Asa Palley](#) ², Yael Grushka-Cockayne ³, Charles Persinger ⁴

¹ INSEAD

² Indiana University, Kelley School of Business

³ University of Virginia, Darden School of Business

⁴ Eli Lilly and Company

Obtaining accurate forecasts is critical to making good decisions in many managerial problems. Forecasts may be generated by a statistical model (machine) or through human judgment. Machines are well-suited to detect patterns and regularities in existing data while humans can apply their domain-specific knowledge and reasoning to the problem at hand. An integrated method that uses both sources might rely on a machine to make an initial forecast and then allow humans to update this forecast. Human judgments, however, may suffer from systematic behavioral patterns that reduce their accuracy. Based on a model of humans as imperfect Bayesian updaters, we propose a three-stage hybrid approach which adds a second machine to search for and reduce biases in the human adjustment. We illustrate our approach by applying it to more than 20 years of forecasts at a major pharmaceutical company and to judgments gathered from participants in two laboratory experiments.

Human Forest and Wisdom-of-Crowds Solutions to the Reference Class Problem

Submission ID-068

[Pavel Atanasov](#) ^{1, 2}, Regina Joseph ^{2, 3}

¹ IE University

² Pytho LLC

³ Sybilink

Decision scholars have promoted the benefits of base rates in judgmental forecasting for five decades. But picking a suitable reference class is an even older challenge, dating back to the 1800s. We propose a two-step wisdom-of-crowds solution to the reference class problem. First, elicitation uses the Human Forest process, whereas forecasters define 'predictively useful' reference classes and query a database. For example, a clinical trials forecaster may select a class consisting of all Phase II, large-molecule, COVID-19 trials. The resulting custom base rates (e.g., 20%) and forecaster adjustments (e.g., 20% to 25%) are scored for accuracy. Second, the Most Popular Selections (MPS) algorithm aggregates the class selections of many forecasters, selecting the most popular variables (e.g., Trial Phase) and values (e.g., Phase II). Stopping rules guard against overly narrow classes. We test MPS performance using data from two forecasting tournaments, featuring over 1700 reference-class selections across 60 probabilistic questions, focused on clinical trial progression. MPS-derived base rates outperform 75% of individual forecasters' base rates in terms of Brier scores ($p < .01$ vs. 50%). MPS-aggregation does not involve forecast averaging, so the wisdom-of-crowds effect is not driven by error cancellation but by collective selection of relevant features and algorithmic restraint.

Wed.3.E: Incomplete Information

Session Chair: Eeva Vilkkumaa

Optimization Models for Cumulative Prospect Theory under Incomplete Preference Information

Submission ID-049

[Juuso Liesiö](#) ¹, Peng Xu ²

¹ Aalto University School of Business

² Essex Business School, University of Essex

Prospect stochastic dominance conditions can be used to compare pairs of uncertain decision alternatives when the decision makers' choice behavior is characterized by cumulative prospect theory, but their preferences are not precisely specified. This paper extends the use of prospect stochastic dominance conditions to decision settings in which the use of pairwise comparisons is not possible due to the high or possibly infinite number of decision alternatives. In particular, we first establish equivalence results between these conditions and the existence of solutions to a specific system of linear inequalities. We then utilize these results to develop stochastic optimization models whose feasible solutions are guaranteed to dominate a specified benchmark distribution. These models can be used to identify if there exists a decision alternative within a set that is preferred to a given benchmark by all decision makers with an S-shaped value function and a pair of inverse S-shaped probability weighting functions. As such the models offer a flexible tool to conduct behavioral analyses in decision settings

such as portfolio selection, procurement optimization or inventory management. We demonstrate the application of these models using real data.

Exploring representational power and decision-making performance in imprecise Bayesian methods

Submission ID-141

[Francesco De Pretis](#)^{1, 2}, Mantas Radzvilas³, William Peden⁴

¹ *University of Modena and Reggio Emilia (Italy)*

² *Indiana University Bloomington (USA)*

³ *University of Konstanz (Germany)*

⁴ *Johannes Kepler University Linz (Austria)*

When faced with uncertain situations where relevant physical probabilities are unknown, determining how to make decisions becomes challenging. The Bayesian approach suggests creating a probability distribution by blending subjective intuition and objective constraints. However, imprecise Bayesians argue that this method falls short in capturing ambiguity and propose an alternative using credal sets to represent doxastic states. The degree of uncertainty regarding the physical probability of an event corresponds to the level of divergence in the credal set according to their view. This approach effectively represents and accounts for ambiguities by measuring the extent of the divergence.

While imprecise Bayesianism has primarily been hailed for its epistemological features, this abstract examines its properties in decision-making scenarios. To evaluate the effectiveness of standard Bayesianism versus imprecise Bayesianism, we develop a model and conduct tests using a binomial probability problem. Our findings reveal that the representational tools employed by imprecise Bayesianism can lead to underperformance in decision-making. This observation has been overlooked as previous research on imprecise Bayesianism has not utilized agent-based modeling to provide insights into its short-term performance. Therefore, we raise the question of how much value should be attributed to representational power versus decision-making performance in imprecise Bayesian methods.

Identifying Cost-Efficient Actions Portfolios to Improve the Reliability of Distribution Grids

Submission ID-078

[Joaquín de la Barra](#)¹, Ahti Salo¹, Mahdi Pourakbari-Kasmaei²

¹ *Department of Mathematics and Systems Analysis, Aalto University, Finland*

² *Department of Electrical Engineering and Automation, Aalto University, Finland*

In distribution grids, the cost-effectiveness of a given reinforcement action in mitigating the risks due to external hazards depends on what other actions are implemented. Thus, to maximize the effectiveness of selected actions, all alternative action portfolios have to be considered. For this problem, we develop a framework to help Distribution System Operators (DSOs) protect multiple grids by selecting reinforcement actions in response to several hazards, based on information provided by reliability indices and subject to investment constraints. The problem is structured as an influence diagram in which scenarios, defined as combinations of realizations for three types of hazards, are represented by a chance node. The proposed framework accommodates partial information about the scenario probabilities, the perceived importance of the grids, and the relevance of reliability indices. Building on this information, a mixed-integer linear programming problem is solved to identify all non-dominated portfolios at different levels of investment costs. The decision model is illustrated with a case study in which the DSO seeks to mitigate risks associated with three hazards in three distribution grids. The novelty of the proposed approach lies in combining reliability indices and scenario analysis with the use of partial information in Portfolio Decision Analysis.

Supporting the Development of a Robust, Market-Shaping Strategy with Scenario-Based Portfolio Decision Analysis: Case Study with Nordea

Submission ID-047

[Eeva Vilkkumaa](#)¹, Petri Rikkinen², Juuso Liesiö¹

¹ *Aalto University School of Business*

² *Aalto University School of Science*

Strategic decision-making is challenging due to multiple strategic objectives and long planning horizons that make it difficult to assess the future impacts of proposed strategic actions with respect to these objectives. Moreover, strategy work often requires a balance between preparing for alternative scenarios for the future (i.e., developing a robust strategy), and trying to steer the course of change towards a desirable direction (i.e., developing a market-shaping strategy). We present a model-based framework for supporting the development of a robust, market-shaping strategy. For the purposes of this framework, we develop a new portfolio decision analytic model and algorithms to help generate decision recommendations for selecting strategic actions, when (i) the actions' scenario- and objective-specific impacts, the baseline values for these impacts, as well as preferences between strategic objectives are incompletely specified, and (ii) information regarding scenario likelihoods is incomplete and may depend on the selected actions. This framework is applied in a high-impact case on supporting the strategy process at the payments unit of Nordea Bank Abp, the largest retail bank in the Nordic countries.

Wed.4.B: Eliciting and Modelling Probabilities

Session Chair: David Gonzalez Jimenez

The Metalog+: A Feasible and Universal Probability Distribution Family

Submission ID-086

[Manel Baucells](#)¹, Lonnie Chrisman², Thomas Keelin³

¹ *Darden School of Business, University of Virginia*

² *Lumina Decision Systems*

³ *Keelin Reeds Partners*

There has been a longstanding interest among statisticians and analysts for parametric probability distributions flexible enough to match arbitrarily shaped, non-normal data sets (e.g., the traditional Pearson family proposed in 1895, or the Johnson family introduced in 1949). The metalog family emerged in 2016 as a new alternative and has been widely adopted for use in practice for its simplicity and flexibility. The properties and limitations of the metalog, however, remain poorly understood; resulting in users not knowing what they are doing. The goal of this paper is to uncover a variety of properties and offer prescription on how to handle the metalog family. Properties include the maximal number of modes, how to diagnose feasibility, how to repair lack of feasibility, and ensure universality of convergence. In all cases, we consider both the theoretical aspects, as well as the numerical implementation. The result is the so called metalog+, a flexible parametric family with the potential of approximating any distribution.

Utilization of Advice from Human-in-the-loop Systems

Submission ID-038

Alessandra Cillo ², [Canan Ulu](#) ¹, Emanuele Borgonovo ³, Alessandro Ortis ⁴, Sebastiano Battiato ⁴

¹ *Georgetown University*

² *LIUC - Cattaneo University*

³ *Bocconi University*

⁴ *University of Catania*

The availability of effective artificial intelligence tools is pushing organizations to pay attention to and possibly adopt algorithms as a source of advice. Whether decision makers trust algorithmic advice is not unequivocal and depends on aspects such as the nature of the task, decision-maker expertise, and the level of control decision makers have on algorithms. In this work, we investigate whether advice from human-in-the-loop systems is appreciated, and we compare advice utilization from such systems to direct algorithmic advice and advice from other people.

In five experiments, where we use the judge advisor system paradigm for prediction tasks, we change the type of information provided to the participants, the task's subjectivity, the forecast's type, and the decision makers' expertise. We find that the appreciation of advice from human-in-the-loop systems is on par with that of direct algorithmic advice and is higher than the appreciation of advice from other people, except for experts who discount advice regardless of its source. Our results contribute to the discussion on algorithm aversion and appreciation by extending it to the domain of human-in-the-loop systems and they have implications on how managers can utilize different advice sources.

Incentive-Compatible and Strongly Fair Cake Cutting

Submission ID-129

[Jens Witkowski](#) ¹, Rupert Freeman ²

¹ *Frankfurt School*

² *University of Virginia Darden School of Business*

The classical cake cutting setting is concerned with dividing a resource, modeled by the $[0,1]$ interval, and allocating subintervals to different agents. Preferences of agents are represented by a function over the $[0,1]$ interval with the agent's utility corresponding to the area under the curve for those subintervals they get allocated. A recent result shows that there does not exist a deterministic cake cutting mechanism that is both incentive compatible and even only one of envy-free or proportional. In this work, leveraging proper scoring rules, we design a randomized cake cutting mechanism that is ex ante incentive compatible, ex post strongly proportional, and ex post strongly envy-free. (Ex ante means the property needs to hold in expectation, ex post means it needs to hold in all instantiations, and strongly means that, roughly speaking, every agent does strictly better than they would in the naive solution that simply allocates the entire cake uniformly at random.) Observe that this result is tight in the sense that additionally achieving ex post incentive compatibility is impossible as it would violate the aforementioned impossibility result.

Learning gap: Noisy signals as Experienced or Described information.

Submission ID-060

[David Gonzalez Jimenez](#)

Erasmus School of Economics, Erasmus University Rotterdam

The study of how individuals update after receiving information about noisy signals is one of the most studied areas of updating in decision-making. Typically, on these studies individuals are given the signal distribution and the correlation between signal and state space. However, this might be quite an artificial setting, in most situations individuals learn about the correlation between signal and state space with their own experience. For example, there might be diseases that share symptoms, but doctors learn from their own experience which might be more common in the population they are treating. In this project I investigate how information processing differs in described signals vs experienced signals. I do this by adapting a typical Decision from experience-decision from description methodology to noisy signals and using the hedging method of Baillon et al. (2018) to derive uncertainty attitudes and beliefs. I compare the individuals updating and uncertainty attitudes in the experience information case vs the described information case, and what is the effect on the attitudes of different correlations between signal and state space change.

Wed.4.D: Value of Information

Session Chair: Emanuele Borgonovo

Reassurance in information acquisition

Submission ID-040

[Jeeva Somasundaram](#)¹, Luc Wathieu²

¹ IE Business School, Madrid, Spain.

² Mc Donough School of Business, Georgetown University, USA.

Marketers traditionally encourage consumers to seek information about their offerings by emphasizing the usefulness (or instrumental value) of acquiring such information. This paper presents a new approach that taps into consumers' psychological need for reassurance as a motivation for information acquisition. Our main finding is that when consumers face a large but unlikely potential loss, they are drawn to seek information, not to adapt their decision but to experience reassurance. We explore this phenomenon theoretically using a disappointment model and then validate our findings and their marketing implications across seven studies (N=3,430) involving diverse situations such as the timing of exam result disclosures, the choice between compound lotteries, the decision to undertake COVID-19 testing, the decision to engage in virtual product trials, and the post-purchase monitoring of technology updates and promotional discounts. For firms, this research offers two pivotal insights. First, there exists a segment of consumers who will demand non-instrumental information (or tests)—those who perceive a looming but improbable loss. Second, encouraging reassurance-based information-seeking behavior may require counterintuitive tactics, such as bolstering consumers' confidence in their initial choices or projecting irreversibility by making returns less convenient.

Constructing Ensemble Estimates for the Risk Averse Decision Maker

Submission ID-095

[Andrea Hupman](#)

University of Missouri-St. Louis

A common technique to improve machine learning predictions is to create an ensemble estimate from the combination of multiple models. This work examines methods to construct ensemble estimates with the goal of increasing the value of information to a risk-averse decision maker who faces a two-action decision. We use simulation and sensitivity analysis to examine how properties of the data such as varying levels of multicollinearity among predictor variables, in concert with properties of the decision situation such as the relative value of the alternatives and the risk aversion, affect the construction of ensembles that will improve the decision maker's situation. Insights from the analysis are illustrated in the context of real-world examples derived from sample datasets available through the Kaggle and the UCI Machine Learning Repository.

On Some Definitions And Clarifications For The Value Of Information

Submission ID-041

[Ali Abbas](#)

University of Southern California

Abstract:

The value of information (Howard 1967) is an important concept in decision analysis. It identifies the maximum amount of money that a decision maker is willing to pay to receive perfect information about an uncertainty of interest. An abundance of literature provides alternate definitions and approximations for the value of information. Examples include (i) the difference in expected utility of the decision with and without the information, and (ii) the difference in valuation (certain equivalent) of the decision with and without the information. We derive propositions to show that these definitions are not equivalent and also identify the particular instances for which they are. We also comment on some recently proposed simplifications for the value of information calculation using constructed scales. Several examples illustrate the issues encountered with alternate formulations.

The Shapley Value of Information

Submission ID-102

[Emanuele Borgonovo](#)¹, Francesca Beccacece¹, Margherita Cigola¹, Giovanni Rabitti²

¹ Department of Decision Sciences, Bocconi University, Via Roentgen 1 Milan, Italy

² Heriott-Watt University School of Mathematical & Computer Sciences

We consider how the total value expected value of perfect information (total Vol, henceforth) in a decision problem can be apportioned to one or more of the given uncertainties. We start with Howard's 1988 decomposition which shows that the information value can be decomposed in a series of conditional terms. However, the decomposition is not unique and depends on the order with which uncertainties are included. We prove that one regains uniqueness defining a notion of Shapley value for information value. With this notion, the partial Vol of each uncertainty becomes unique and the sum of the partial Vols equals the total Vol. We discuss the meaning and interpretation of the new quantity and we show that its application improves the interpretation of a Vol analysis.

Wed.4.E: Multicriteria Decision Analysis

Session Chair: Evangelos Triantaphyllou

An Innovative and Effective Approach for Determining the Most Critical Criteria When Additive MCDM Models Are Used

Submission ID-030

¹ Louisiana State University, Division of Computer Science, Baton Rouge, LA, USA

² Tulane University, Medical School, Section of Hematology and Medical Oncology, New Orleans, LA, USA

³ Complete Decisions, LLC, Baton Rouge, LA, USA

Solving MCDM problems requires the elicitation of data that can be difficult to quantify. Even when most of the data are easily quantifiable, quantifying the criteria weights can be a challenging task. Criteria weights are by nature subjective, hard to quantify, but nevertheless crucial in the decision-making process. This study considers MCDM approaches that are based on the use of additive expressions when ranking alternatives. Traditional sensitivity analysis approaches determine how the ranking of alternatives is impacted under various scenarios or what is the minimum change of current criteria weights that can cause ranking changes. Our study reveals that traditional sensitivity analysis approaches can be dramatically misleading and may fail to identify the most critical criteria. An innovative approach to sensitivity analysis is proposed that can effectively capture the notion of the most critical criteria. This is accomplished when only a single weight changes or when multiple weights can change simultaneously. Determining the most critical criteria successfully can guide the weight determination process towards a more accurate elicitation of the criteria weights and thus it can achieve better final decisions. Therefore, any application area that uses additive MCDM methods can directly benefit from the results of this study.

Interactive multi-objective optimization for supporting climate smart forestry

Submission ID-121

Juho Roponen

University of Jyväskylä

Increasing the amount of carbon sequestered by forests has been proposed as a solution for reducing the net CO₂ emissions in the EU. However, the increased carbon storage usually comes at the cost of reduced short-term income, and thus, implementing new forestry management strategies that facilitate these changes can be challenging, especially in the Nordic countries where forest ownership is highly fragmented among many private forest owners. This presentation discusses how interactive multi-objective optimization can be used to explore and quantify the trade-offs faced by the forest owners, focusing on profitability, land value, weather risks, and carbon capture. We showcase the DESDEO open-source software framework, as well as the new interactive methods for supporting forest owners. The goal of our research is to create tools to aid the forest owners to make informed impactful climate-smart decisions. We aim to impact the carbon stored in larger landscapes involving many forest owners and bring them together in workshops to also collect information their willingness to give up profits in favour of higher CO₂ capture. In the future, we hope to use this information and the developed tools to research potential compensation schemes that could incentivize higher carbon retention in the forest lands.

Compensation within the Outranking Approach PROMETHEE

Submission ID-071

Sebastian Schär, Jutta Geldermann

University of Duisburg-Essen, Chair of Business Administration and Production Management

Compensation in multiple criteria decision aggregation procedures is commonly understood as allowing a gain in one criterion to offset a loss in another. Generally, the compensatory behaviour is determined by the selected multicriteria approach. Depending on the approach chosen, the possibility for compensation can also be further influenced by the design and parametrization of the preference model. For example, in multi-attribute value theory approaches, it is well established in the literature that the design of the aggregation model affects the possibility for compensation. If necessary, the compensatory behaviour can be limited by the aggregation function to match the stakeholders' preferences.

However, different statements exist in the literature regarding the compensatory properties of the PROMETHEE methods, which belong to the set of outranking approaches. We analyse the compensatory behaviour of the PROMETHEE family of methods. Specifically, we identify instances where compensation can occur within the PROMETHEE methods and quantify the degree of compensation as far as possible. We also highlight how to prevent compensation for specific criteria. By doing so, we aim to provide guidelines for analysts and applicants to model the compensatory behaviour according to stakeholders' preferences when applying the PROMETHEE methods.

Should Data Derived from Pairwise Comparisons be Trusted? Perhaps not Much

Submission ID-050

¹ Louisiana State University, Division of Computer Science, Baton Rouge, LA, USA

² Tulane University, Medical School, Section of Hematology and Medical Oncology, New Orleans, LA, USA

³ Complete Decisions, LLC, Baton Rouge, LA, USA

Pairwise comparisons offer an intuitive and practical approach for eliciting qualitative / subjective data from decision makers for many MCDM applications. Their use is based on various psychological studies. Their proliferation was achieved after Saaty used them as an integral part of his AHP approach, including its numerous variants. Given two entities, say A₁ and A₂, to be compared, a decision maker has to use a discrete ratio scale of choices to approximate the value of their ratio, denoted as value(A₁/A₂). A problem may occur when the value(A₁/A₂) is assigned to some value, say V₁, from the discrete ratio scale, while the value(A₂/A₁) is assigned to a value V₂ which is not the reciprocal of V₁. We state that in such cases a violation of the reciprocity condition occurs. Our study reveals that such violations may occur frequently when considering simulated (synthetic) or real-world data. Such violations can occur frequently under a deliberately optimistic assumption according to which the decision maker is ultra-accurate when he/she considers one pairwise comparison at a time. The impact of such violations can be dramatic. Understanding the nature and magnitude of this problem is crucial before trying to remedy it.