8th Symposium on Games and Decisions in Reliability and Risk

28-30 May 2025, Department of Decision Sciences, Bocconi University, Milan, Italy

Venue and directions:

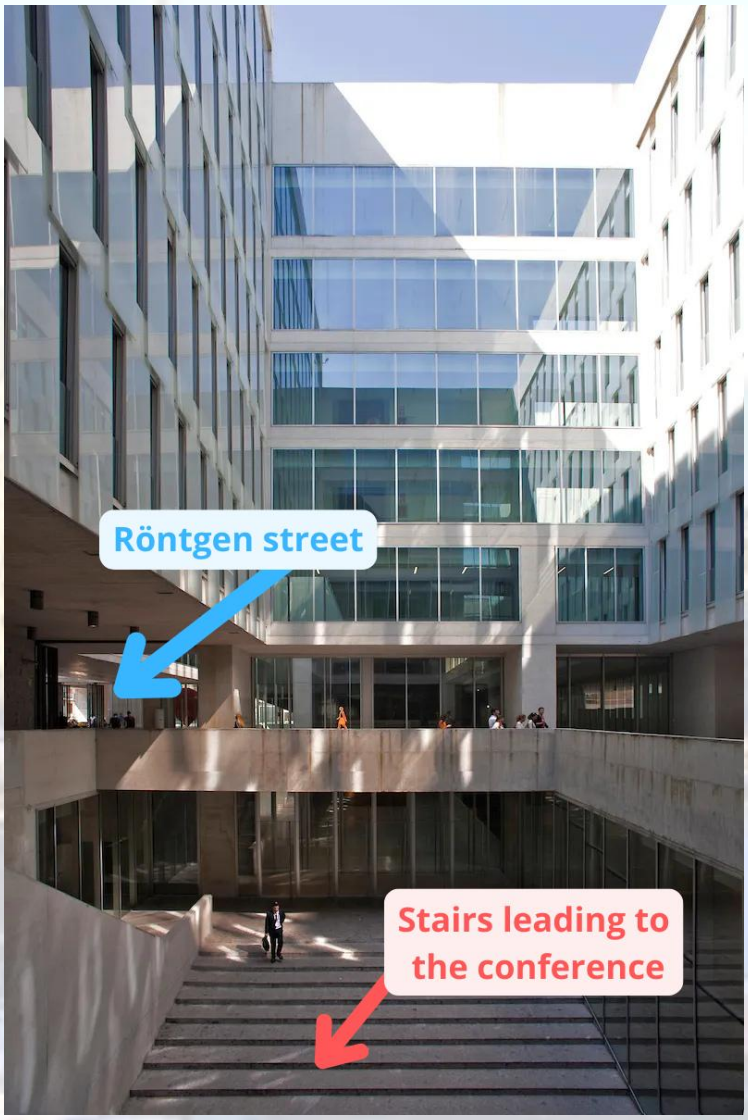
Venue:
Bocconi University, Via G. Roentgen 1, 20136 Milan, Italy

Rooms: AS01, AS02 (Galleria Aule Seminari/ Gallery Seminar Rooms, **Floor -2**)

Plenary sessions will be held in room AS01, while parallel sessions will take place in both AS01 and AS02.

To reach the rooms, enter the Bocconi campus via Via Roentgen 1 and follow the signs for "Seminar Rooms / Gallery." Before entering any building, look for the large staircase shown in the image below. Walk down the stairs to the bottom, where you will find glass doors. Enter through these doors, and you will find the rooms where the symposium talks will take place.

Coffee breaks, the aperitivo and the concert will be held next to the rooms where the talks are held. After the concert, we will walk together to the restaurant for the symposium dinner. The restaurant is located within the Bocconi campus, approximately 300 meters away.



DAY 1 - Wednesday, May 28, 2025

14:15 – 14:25 **Welcome Address** *Room AS01*

14:25 – 15:00 **Massimo Marinacci** (*Bocconi University*) *Room AS01*
Title: Notions of risk aversion

15:00 – 15:35 **Min Xie** (*City University of Hong Kong*) *Room AS01*
Title: Some challenging issues in risk, reliability, and resilience of complex systems

15:35 – 16:10 **Giulia Di Nunno** (*University of Oslo*) *Room AS01*
Title: Horizon risk in risk measuring

16:10-16:35 **Coffee Break**

16:35 – 17:10 **Canan Ulu** (*Georgetown University*) *Room AS01*
Title: Learning from Consideration Sets: Blackwell Sufficiency and Dynamic Assortments

17:10 – 17:35 **Roi Naveiro Flores** (*CUNEF University, Madrid*) *Room AS01*
Title: Sensitivity of Bayesian inference to data deletion and replication

17:35 – 18:00 **Francesca Ieva** (*Politecnico di Milano*) *Room AS01*
Title: Decision support systems in precision medicine and public health

18:00 – 20:00 **Aperitivo**

DAY 2 - Thursday, May 29, 2025

9:00 – 9:35 Pierpaolo Battigalli (*Bocconi University)* *Room AS01*
Title: Reduced strategies and cognitive hierarchies in the extensive and normal form

9:35 – 10:10 Laura Albert (*University of Wisconsin–Madison*) *Room AS01*
Title: Interdicting adversarial attack plans for protecting cyber-infrastructure

10:10 – 10:45 Enrico Zio (Politecnico di Milano) *Room AS01*
Title: Risk assessment of complex technological systems for (risk-)informing decisions

10:45-11:15 **Coffee Break**

	Contributed Session A *Room AS01*	**Contributed Session B** *Room AS02*
11:15 – 11:35	Fabio Spizzichino (*University Sapienza*) Title: Load-sharing models and characterizations of non-paradoxical voting situations	Lu Xuefei (*SKEMA Business School*) Title: Enhancing transparency in black-box models: an explainability approach using sensitivity analysis and counterfactual insights
11:35 – 11:55	Jose Manuel Camacho (*ICMAT-CSIC*) Title: Adversarial risk analysis for general security games: a computational approach	Michele Caprio (*University of Manchester*) Title: Imprecise probabilistic machine learning – being precise about imprecision

11:55 – 12:15	Sarah Sachs (*Bocconi University*) Title: Tracking solutions of time-varying variational inequalities with applications to game theory and parameter estimation	Robin Dillon-Merrill (*Georgetown University*) Title: Identification of sentinel near misses for predictive safety: leveraging AI for incident identification and risk forecasting
12:15 – 12:35	Yiqi Zhao (*University at Buffalo*) Title: A game-theoretic and MCDA framework for sustainable arctic development: balancing economic interests, security, and Indigenous rights	Pablo Garcia Arce (*ICMAT*) Title: TBA
12:35 – 12:55	Eduardo Fabres (*Federal University of Rio Grande do Sul*) Title: Caution and complexity aversion	Shakshi Singhal (*Xavier School of Management*) Title: A flexible software reliability growth model for non-uniform fault diagnosis using deep neural networks

12:55-14:30 **Lunch Break**

14:30 – 14:55 Gregor Zens (*International Institute for Applied Systems Analysis*) *Room AS01*

Title: Model uncertainty in latent Gaussian models with univariate link function

14:55 – 15:20 Filippo Ascolani (*Duke University*) *Room AS01*

Title: Posterior results on the stick-breaking representation for Dirichlet process mixtures of Gaussians

15:20 – 15:45 Kevin Burke (*University of Limerick*) *Room AS01*

Title: Automating variable selection in distributional regression

15:45-16:35 **Coffee Break**

	Contributed Session C *Room AS01*	**Contributed Session D** *Room AS02*
16:35-16:55	Guido Lagos *(Universidad Adolfo Ibanez)* Title: Simple v/s non-simple repair policies for systems under simultaneous failures of its components	Tevfik Aktekin (*University of New Hampshire*) Title: Bayesian sequential analysis of seasonal multivariate count time series: application to rideshare demand modeling
16:55-17:15	Mohammad Reihaneh (*IESEG School of Management*) Title: TBA	Tahir Ekin *(Texas State University)* Title: Adversarial risk mitigation in dynamic outlier detection: a Bayesian defense framework
17:15-17:35	Simon Wilson (*Trinity College Dublin*) Title: Cascading failure in a system with multiple component types	Lu Zitong (*City University of Hong Kong*) Title: A causal-based framework for root cause attribution
16:35-17:55		Emanuele Borgonovo *(Bocconi University)* Title: Reliability importance measures from complex computer simulations.

18:30-19:30 **Concert**

19:45-22:00 **Symposium Dinner**

DAY 3 - Friday, May 30, 2025

9:30 – 9:55 Daniel Garcia Rasines (*CUNEF University, Madrid*) *Room AS01*
Title: Pricing strategies with remanufacturing

9:55-10:30 **Coffee Break**

10:30-11:45 **Bayesian Deep Generative Models session** ***Room AS01***
(Organized by Vadim Sokolov)

Ritabrata Dutta (*Warwick University*)
Title: Generalized Bayesian data assimilation for deep generative models: a sequential Monte Carlo approach

Nicholas Polson (*University of Chicago Booth*)
Title: Generative modeling: a review

Vadim Sokolov (*George Mason University*)
Title: Generative models for reliability analysis

11:45-12:00 **Closing Remark**

Invited Talks – ABSTRACTS

Laura Albert (University of Wisconsin–Madison)

Title
Interdicting adversarial attack plans for protecting cyber-infrastructure

Abstract
Cybersecurity planning supports the selection of and implementation of security controls in resource-constrained settings to manage risk. Doing so requires considering adaptive adversaries with different levels of strategic sophistication in modeling efforts to support risk management. We study the problem of deploying cybersecurity mitigations to delay the completion times of attackers' projects. Existing literature studies how to select a portfolio of mitigations subject to a budget constraint to optimally delay such attackers but lacks consideration of the time it takes to implement the mitigations. We assume attackers are working on their projects at the same time the defender is working to complete mitigations to delay those attacks. The timing of when a mitigation is completed becomes vital, since if the attackers have already completed the actions a mitigation delays, the mitigation is no longer as useful. This paper introduces an integer programming model that combines a defender's resource constrained project scheduling problem (RCPSP) with adversaries' longest path problems. We consider alternative solution methods to examine the benefit of the proposed model.

Filippo Ascolani (Duke University)

Title:
Posterior results on the stick-breaking representation for Dirichlet process mixtures of Gaussians

Abstract
The stick-breaking representation is a popular way of defining the Dirichlet process by the associated sequence of probability weights. It is particularly appealing when the discrete random measure is convolved with a suitable kernel: in this context, the stick-breaking construction is often truncated and posterior inference can be performed using a finite number of parameters. Despite its relevance, little is known about the posterior distribution of the weights in a mixture framework. Assuming that the data are generated in a frequentist fashion and considering a Gaussian kernel, we combine prior properties and tools from the Bayesian asymptotic literature to deduce some results on the posterior behavior of the mixing measure: in particular we prove that if the "true" density is supersmooth then the set of relevant weights grows at most logarithmically with the number of observations. We use such results to shed some light on the clustering properties of Dirichlet process mixtures (e.g. number of clusters) and to provide posterior guarantees for computational methods based on truncation. This is a joint work with Surya Tokdar (Duke University)

Pierpaolo Battigalli (Bocconi University)

Title
Reduced Strategies and Cognitive Hierarchies in the Extensive and Normal Form

Abstract
In a recent paper, Lin & Palfrey (2024) developed a theory of cognitive hierarchies (CH) in sequential games and observed that this solution concept is not reduced-normal-form invariant. In this paper, I qualify and explain this observation. I show that the CH model is normal-form invariant, and that the differences arising from the application of the CH model to the reduced normal form depend only on how randomization by level-0 types is modeled. Indeed, while the uniform behavior strategy in the extensive form yields the uniform mixed strategy in the normal form, the latter does not correspond to the uniform randomization in the reduced normal form, because different reduced strategies may correspond to sets of equivalent strategies with different cardinalities. I also comment on (i) the invariance of the CH model to some transformations of the sequential game, and (ii) the independence of conditional beliefs about co-players' level-types.

Kevin Burke (University of Limerick)

Title
Automating variable selection in distributional regression

Abstract
Variable selection is an important scientific endeavour as it identifies important associations. Of course, this is more challenging than simply fitting a model for a given pre-specified set of covariates. From a scientific perspective, "distributional regression" models allow us to better understand the phenomenon under study compared to the classical mean-view of the world; for example, we can discover how covariates impact both the mean and variance of the response. However, variable selection is even more challenging in this setting since there is a regression equation for each of the distributional parameters. Stepwise regression procedures are quite computationally intensive in general, but so too are penalised regression procedures due to the need to select the penalty tuning parameter(s); the issue is compounded in distributional regression models due to the fact that there are multiple regression equations. Therefore, we introduce a tuning-parameter-free (and, hence, automated) procedure for selecting variables based on a differentiable approximation to an information criterion that we optimise directly. This method is especially advantageous in the distributional-regression setting, but is also useful in classical regression settings. For further details, see https://doi.org/10.1007/s11222-023-10204-8 .

Daniel Garcia Rasines (CUNEF University, Madrid)

Title
Pricing strategies with remanufacturing

Abstract
Pricing is one of the most critical decisions a company faces, especially in today's digital economy. Like many business decisions, it unfolds in a highly competitive and uncertain environment. This talk introduces a pricing framework based on Adversarial Risk Analysis within the context of remanufacturing, where an Original Equipment Manufacturer (OEM) competes with companies that collect, reassemble, and resell its products. In this market, the OEM must adapt its pricing strategy to the presence of remanufacturers—selling too many products may benefit competitors by increasing their supply. Additionally, the OEM must determine the ease of remanufacturability of its products, which impacts production costs, as well as the licensing fees. Our framework offers a structured approach to modeling buyer and competitor preferences, helping OEMs identify their optimal strategy.

Korel Gundem (George Washington University)

Title
Offline Dynamic Inventory and Pricing Strategy: Addressing Censored and Dependent Demand

Abstract
In this paper, we study the offline sequential feature-based pricing and inventory control problem where the current demand depends on the past demand levels and any demand exceeding the available inventory is lost. Our goal is to leverage the offline dataset, consisting of past prices, ordering quantities, inventory levels, covariates, and censored sales levels, to estimate the optimal pricing and inventory control policy that maximizes long-term profit. While the underlying dynamic without censoring can be modeled by Markov decision process (MDP), the primary obstacle arises from the observed process where demand censoring is present, resulting in missing profit information, the failure of the Markov property, and a non-stationary optimal policy. To overcome these challenges, we first approximate the optimal policy by solving a high-order MDP characterized by the number of consecutive censoring instances, which ultimately boils down to solving a specialized Bellman equation tailored for this problem. Inspired by offline reinforcement learning and survival analysis, we propose two novel data-driven algorithms to solving these Bellman equations and, thus, estimate the optimal policy. Furthermore, we establish finite sample regret bounds to validate the effectiveness of these algorithms. Finally, we conduct numerical experiments to demonstrate the efficacy of our algorithms in estimating the optimal policy. To the best of our knowledge, this is the first data-driven approach to learning optimal pricing and inventory control policies in a sequential decision-making environment characterized by censored and dependent demand. The implementations of the proposed algorithms are available at: https://anonymous.4open.science/r/Inventory_Pricing_Control-877C

Francesca Ieva (Politecnico di Milano)

Title
Decision support systems in precision medicine and public health

Abstract
In many clinical settings, the only possibly curative treatment can be performed once, and its timing needs to be tailored based on patients' characteristics. However, the medical decision on the waiting time before a treatment is often complex, as it depends on the risk of treatment failure and disease progression over time. In the absence of a trial, observational data becomes beneficial to study the effect of a timing policy. On the other hand, in many public health problems the variety of practices make hard to define gold standards and reference guidelines to be adopted uniformly so to avoid money waste. In all these cases, secondary databases become essential for the effective monitoring and evaluation of healthcare systems and the support of decisions enabling precision policies. In this talk, we propose a framework to estimate the conditional expected outcome after an intervention in a time-to-event setting to optimize its timing in a personalized manner, and present a solution for informing policies and decisions starting from real world evidence.

Massimo Marinacci (Bocconi University)

Title
Notions of risk aversion

Abstract
We discuss new foundations of risk aversion by showing that this attitude is fully captured by the propensity to seize insurance opportunities.

Roi Naveiro Flores (CUNEF University, Madrid)

Title
Sensitivity of Bayesian Inference to Data Deletion and Replication

Abstract
Research in adversarial machine learning (AML) has demonstrated that statistical models are vulnerable to maliciously manipulated data. While Bayesian machine learning has seen significant advancements, most AML studies continue to focus on classical methods. In this work, we extend the white-box model poisoning paradigm to target generic Bayesian inference, exposing its vulnerabilities in adversarial settings. We introduce a suite of attacks that enable an adversary to steer the Bayesian posterior toward a desired distribution through the strategic deletion and replication of true observations, even with only sampling access to the posterior. The analytic properties of these algorithms are established, and their effectiveness is empirically validated in both synthetic and real-world scenarios. With minimal effort, an attacker can meaningfully influence Bayesian beliefs, and by accepting greater risk, they can fully reshape these beliefs as desired. By carefully designing the adversarial posterior, our approach achieves precise "surgical" poisoning, corrupting only targeted inferences while leaving others largely intact.

Giulia Di Nunno (University of Oslo)

Title
Horizon risk in risk measuring

Abstract

Horizon risk is introduced as the assessing the exposure by a risk measure that is not adequate to the actual time horizon of the position. We consider the particularly the contest of investments in economics and finance. We clarify that also dynamic risk measures are subject to horizon risk, so we propose to work with fully-dynamic risk measures. We analyse and construct dynamic risk measures that appropriately take horizon risk into account.

We also combine horizon risk with other uncertainties of future market scenarios, such as interest rates uncertainty, thus we extend the arguments and suggest the use of a cash non-additive version of fully-dynamic risk measures. We construct such risk measures via backward stochastic differential equations or via shortfall-type representation. As illustration, we introduce the class of hq-entropic risk measures.

Canan Ulu (Georgetown University)

Title
Learning from Consideration Sets: Blackwell Sufficiency and Dynamic Assortments
(*Joint work with Bharadwaj Kadiyala and Dorothee Honhon*)

Abstract

Prior literature on consumer behavior suggests that consumers engage in a two-stage shopping behavior: in the first stage, they consider only a subset of the products offered for purchase (known as the consideration set) and in the second stage, they make a final purchase decision among the considered products based on their preferences. We model such purchase behavior using the Random Consideration Set (RCS) model (Manzini and Mariotti 2014). In this model, consumers consider each product independently with a given consideration probability. Motivated by environments in which consumers' consideration sets are observable (e.g., based on clickstream, home try-on programs, eye-tracking, and heatmap data sources), we consider how a decision maker should design product assortments to maximize profit while also learning about consumers' consideration probabilities over a finite time horizon. We show that the structure of the optimal assortment depends on two orders: the consumers' preference order and the product "informativeness" order, which we formalize using Blackwell sufficiency (Blackwell 1951). The optimal assortment has the well-known popular set characterization when the consumers' preference order and the product informativeness order are identical. Otherwise, we show that, if a product is in the optimal assortment, all products that are more informative and more preferred should also be in the optimal assortment. We provide empirical evidence for the existence of informative products in retail settings using data from JD.com.

Min Xie (City University of Hong Kong)

Title
Some Challenging Issues in Risk, Reliability, and Resilience of Complex Systems

Abstract
Risk and reliability have always been crucial for complex systems. When failures occur, the ability to recover quickly becomes essential, which is the essence of resilience. In today's rapidly evolving technological landscape, complex and intelligent systems face numerous new challenges as they become increasingly dynamic. In this talk, we will review the history of reliability research from a personal perspective and explore current and future research issues, particularly concerning systems that integrate artificial intelligence and machine learning. We will emphasize that a systems engineering approach, combined with statistical thinking, can enhance our understanding of resilience and enables us to help improve resilience in diverse real-world applications.

Gregor Zens (International Institute for Applied Systems Analysis)

Title
Model Uncertainty in Latent Gaussian Models with Univariate Link Function
(Joint work with Mark Steel, University of Warwick)

Abstract
Variable selection in non-Gaussian regression arises in numerous statistical applications. In this work, we consider a broad class of univariate link latent Gaussian models based on standard likelihoods (e.g., Poisson, binomial, Erlang), augmented with a latent normal linear regression on a scalar parameter. We allow for model uncertainty regarding the covariates included in the regression and formally characterize posterior existence under a convenient and widely used improper prior setup. We discuss model averaging and model selection based on efficient Markov chain Monte Carlo techniques as well as scalable extensions based on variational inference. Simulation studies illustrate the accuracy of the presented methods, and their practical utility is demonstrated using real-world datasets.

Enrico Zio (Politecnico di Milano)

Title
Risk assessment of complex technological systems for (risk-)informing decisions

Abstract

Our world is in continuous transition to meet the objectives and needs of efficiency, flexibility, sustainability etc, under social and environmental pressures. Technological nnovations are being developed for better-being and more benefits for all. These innovations are embedded within systems and systems of systems, whose structural, logic and operational complexity continuous to increase. In such evolving technological context, new and unknown hazards and threats emerge, which must be assessed to take related decisions on system licensing, operation and maintenance so as to prevent the occurrence of accidents, and prepare to mitigate and recover from their consequences were such accidents to occur. In

this lecture, I attempt to give a systemic and systematic view of all the above, and to offer some directions (with) examples of research and development in risk assessment for decision making, including the use of simulation for accident scenario identification and exploration, the exploitation of monitoring data for the dynamic updating of risk assessment and condition-based risk assessment, and the extension of the framework of risk assessment to resilience analysis. KEYWORD: Complex system, System of Systems, Critical infrastructure, Climate change, Risk assessment, Simulation, Condition-based risk assessment, Resilience, Bayesian networks, Artificial Intelligence, Grey-box modeling, Digital twins.

Bayesian Deep Generative Models – ABSTRACTS

Ritabrata Dutta (Warwick University)

Title: Generalized Bayesian data assimilation for deep generative models: a sequential Monte Carlo approach

Abstract: Data assimilation is a fundamental problem in updating forecasting models after observing new data, starting from weather forecasting to model-based reinforcement learning. In many of these fields deep generative simulator models for forecasting have seen significant success, but data assimilation for them remains an unsolved question. Due to the intractability of the likelihood function for these models, standard Bayesian recursive update of posterior given new data is not feasible. To address this, we propose a generalized likelihood-free Bayesian framework by defining a generalized posterior using predictive-sequential (prequential) scoring rules. When the scoring rule used to define the prequential scoring rule is strictly proper, we show a Bernstein–von Mises (BvM) type theorem to establish posterior consistency for the new generalized posterior defined via prequential scores. For data-assimilation, using this new generalized posterior we employ Sequential Monte Carlo (SMC), leveraging its ability to propagate posterior samples from previous updates as prior samples for subsequent updates. When combined with unadjusted pre-conditioned adapted stochastic gradient Langevin kernels, SMC enables efficient sampling from very high-dimensional parameter spaces, eg. parameter space defining a deep generative model. We illustrate our method by successfully applying them for some challenging weather forecasting tasks and for Bayesian model-based reinforcement learning.

Nicholas Polson (University of Chicago Booth)

Title: Generative modeling: a review

Abstract: Generative methods (Gen-AI) are reviewed with a particular goal of solving tasks in machine learning and Bayesian inference. Generative models require one to simulate a large training dataset and to use deep neural networks to solve a supervised learning problem. To do this, we require high-dimensional regression methods and tools for dimensionality reduction (a.k.a. feature selection). The main advantage of Gen-AI methods is their ability to be model-free and to use deep neural networks to estimate conditional densities or posterior quintiles of interest. To illustrate generative methods , we analyze the well-known Ebola data set.

Vadim Sokolov (George Mason University)

Title: Generative models for reliability analysis

Abstract: We will discuss the use of Quantile generative neural networks for reliability analysis, particularly for modeling failure times, assessing risk, and predicting extreme scenarios. A generative model allows to implicitly model the distribution of the data, which is particularly useful when the data is high-dimensional and complex. Main benefits of quantile models are robustness to outliers, since quantile model minimizes the impact of extreme values, making it suitable for reliability datasets where outliers (e.g., rare failure events) are common, further it allows to models heteroscedasticity (non-constant variance) in failure data We show how to use a generative model to estimate the reliability of the system and to estimate the posterior distribution of the reliability of the system.

Contributed Talks – ABSTRACTS

Tevfik Aktekin (University of New Hampshire)

Title: Bayesian sequential analysis of seasonal multivariate count time series: Application to rideshare demand modeling

Abstract: In this paper, we propose a novel Bayesian state space modelling strategy to sequentially analyze count time series data with special focus on updating, monitoring, and predicting rideshare demand. The proposed model is able to quantify multivariate features of rideshare demand at different locations, to capture inter- and intra-day cyclical behavior pooled across locations, and to take into account a stochastically changing common random environment. The modeling approach is accompanied by a computationally feasible sequential learning algorithm tailored for rideshare demand updating and predicting. To show the implementation of the proposed models and calibrate the sequential estimation algorithm, we use real rideshare demand data and further discuss practical implementation insights gained from our analysis.

Emanuele Borgonovo (Bocconi University)

Title: Reliability importance measures from complex computer simulations.

Abstract: TBA

Jose Manuel Camacho (ICMAT-CSIC)

Title: Adversarial Risk Analysis for General Security Games: A Computational Approach

Abstract: Security games provide a powerful framework for addressing strategic challenges in defense and homeland security (DHS). However, traditional game-theoretic approaches often assume common knowledge among agents: an unrealistic premise in real-world DHS contexts. Adversarial Risk Analysis (ARA) offers a Bayesian alternative that mitigates these limitations. In this work, we present a computational methodology for analyzing security games from an ARA perspective. Our approach models security scenarios using Bi-Agent Influence Diagrams, accommodating both discrete and continuous decision domains while supporting multiple decisions per agent. We leverage augmented probability simulation as a core computational technique and address the challenges posed by continuous decision spaces and multi-stage decision processes. We present a case study on disinformation warfare, showcasing how our methodology enhances decision-making in adversarial settings.

Michele Caprio (University of Manchester)

Title: Imprecise Probabilistic Machine Learning - Being Precise about Imprecision

Abstract: In this talk, I will (briefly) talk about the history of Imprecise Probabilities (IPs), from their inception in Philosophy, to their later adoption in Statistics and other sciences. After that, I'll make the case for why IPs are useful and indeed needed in (Probabilistic) Machine Learning methodology and theory. I will conclude with a recent result in Imprecise Probabilistic Machine Learning theory concerning the ergodic behavior of Imprecise Markov Semigroups. Such a result allows us to study the long-term behavior of smooth input transitions for Convolutional Autoencoders, in the presence of uncertainty and ambiguity.

Robin Dillon-Merrill (Georgetown University)

Title: Identification of Sentinel Near Misses for Predictive Safety: Leveraging AI for Incident Identification and Risk Forecasting

Abstract: Incident reporting systems (IRS) and near miss reporting systems (NMRS) are widely used in hazardous industries to identify early warning signs of accidents. However, the large volume of reports often complicates efforts to extract meaningful insights. This paper introduces a machine learning (ML) text analysis approach to classify near misses (NMs) into two categories: routine NMs and sentinel NMs, with sentinel NMs being more predictive of serious future accidents. Using a dataset of U.S. coal mining incident reports from 2000 to 2023, human coders labeled a subset of incidents, and these labels were used to train the ML model. The best-performing model, a random forest classifier, achieved an accuracy of 85.8%, with high sensitivity in identifying sentinel NMs in the rest of the data. The model was then applied to the full dataset to classify incidents and evaluate the predictive utility of sentinel NMs in identifying potential accident locations. The lagged sentinel NM count was the variable with the third highest feature importance in the ML models while lagged routine NM count was consistently much less important in predicting serious accidents. The findings suggest that ML can streamline the analysis of incident reports by enabling organizations to prioritize the most critical NMs, which are more likely to signal future accidents.

Tahir Ekin (Texas State University)

Title: Adversarial Risk Mitigation in Dynamic Outlier Detection: A Bayesian Defense Framework

Abstract: Traditional outlier detection methods are susceptible to evolving data patterns and adversarial manipulations, making them unreliable in dynamic environments. Addressing the attacker's decision problem and assessing the impact of adversarial strategies are critical to enhancing the robustness of outlier detection. The convergence of dynamic data-driven application systems and adversarial decision models offers a promising avenue for strengthening defenses. This manuscript examines adversarial attacks targeting clustering-based outlier detection and proposes a proactive defense framework. First, we analyze the adversary's data poisoning strategies, exploring various attack scenarios. Through a case study

in healthcare fraud detection, we illustrate the effectiveness of these attacks. We then introduce an adversarial risk analysis framework grounded in Bayesian decision theory and dynamic data-driven application systems. This framework equips defenders with the tools to proactively mitigate adversarial data manipulations, even under conditions of uncertainty and incomplete information.

Eduardo Fabres (Federal University of Rio Grande do Sul)

Title: Caution and complexity aversion

Abstract: This study develops a unified framework that connects complexity aversion with cautious decision-making under uncertainty. We integrate maxmin expected utility, as formalized by Maccheroni (2002) and Cerreia-Vioglio (2009), with complexity-averse preferences. We demonstrate that a robust utility representation is equivalent to a complexity-averse representation when the utility set is appropriately constrained. Specifically, we analyze the optimization problem where decision-makers maximize worst-case expected utility over a restricted set of utility functions, with constraints determined by lottery complexity. This leads to a separable representation of complexity-averse preferences, incorporating existing preference functionals based on support size, entropy, and procedural constraints. In this framework, the preference functional can be expressed as expected utility minus a complexity penalty term. By unifying cautious and complexity-averse preferences, we show that complexity aversion naturally emerges from robust decision-making. Our findings highlight how cognitive and complexity constraints shape behavior, influencing preference orderings through implicit robustness considerations. In particular, complexity may heighten perceived risk aversion. Cautious decision-making thus provides a foundational rationale for how complexity influences choices and extends existing complexity-averse preference functionals.

Xuefei Lu (SKEMA Business School)

Title: Enhancing Transparency in Black-Box Models: An Explainability Approach Using Sensitivity Analysis and Counterfactual Insights

Abstract: Machine learning models increasingly influence human decision-making, yet their black-box nature necessitates effective explainability methods. While existing explainable AI approaches identify influential features, they often fail to provide actionable guidance on how individuals can improve outcomes or alter their status. To address this gap, we propose a novel framework that integrates counterfactual analysis with Shapley effects, offering interpretable insights into feasible improvement directions. Our approach ensures that model predictions remain within realistic constraints by defining Shapley effects only on feasible points, avoiding confounding interactions at impossible locations. We also refine Shapley-based explanations in response to recent critiques on SHAPs, ensuring robustness and reliability. Numerical experiments demonstrate the method's effectiveness in delivering personalized, actionable recommendations while also providing system-level insights for risk management and bias detection.

ZitongLu (City University of Hong Kong)

Title: A causal-based framework for root cause attribution

Abstract: Although the pursuit of causality has been at the center of human understanding of the world, few approaches focus on clarifying the attribution approach theoretically, especially for the root cause attribution. While numerous methods in cause attribution (e.g. PN, PostCE) aim to identify causes of effects, they often struggle to pinpoint root causes. In this paper, we first discuss how causal mechanisms shape attribution problems, and further define the root causes. Then, we propose a causal-based framework for root cause attribution, termed the Probability of Root Cause. The identifiability and identification formulas of the probability of root cause are provided under monotonicity and no-confounding assumptions. The proposed approach can be applied for root cause analysis, medical diagnosis, mechanical fault diagnosis, and various areas.

Pablo Garcia Arce (ICMAT)

Title: TBA

Abstract: Adversarial machine learning emerges to enhance the security of machine learning algorithms, although it has mainly focused around classification methods and classical approaches. This paper introduces a pipeline to robustify Bayesian linear regression models against adversarial attacks. The pipeline integrates procedures to forecast likely attacks, protect models both during training and operations, as well as detecting attacks and changes in attack patterns, and, eventually, suggest the need for retraining. Several examples illustrate the application of the pipeline. We discuss extensions to protect general Bayesian regression models.

Guido Lagos (Universidad Adolfo Ibanez)

Title: Simple v/s non-simple repair policies for systems under simultaneous failures of its components

Abstract: In this work we derive exact and easy to compute expressions for simple repair policies of coherent systems subject to simultaneous failures of its components. Indeed, we consider a reliability system where each component can be in a working or failed state, and each configuration of these implies that the system is also in either a working or failed state. We assume that the system is monotone, i.e., roughly speaking, a system where more working components imply a higher higher "chance" of the system, of the system being working. Moreover, we consider that the components can fail simultaneously, say by shocks that take down several components at once. We model these shocks using the Lévy-frailty Marshall-Olkin distribution for the vector of lifetimes of the components. In this setting, we study simple repair policies, where we replace all failed components when there are r or more broken components or when the system fails. That is, we assume that failed components can be replaced, incurring a component-replacement cost, and also that the system can be repaired after failure, at a higher system-repair cost. In this way, there is a trade-off between saving the replacement cost of components by letting them fail, but at the risk of having a higher chance of the system failing and thus having to pay a higher system-repair cost. Our main result is an exact and easily computable expression for the long-term average cost of these repair policies.

Mohammad Reihaneh (IESEG School of Management)

Title: TBA

Abstract: The redundancy allocation problem (RAP) is a widely used approach for enhancing system reliability. This study explores the latest variation of RAP, specifically RAP with heterogeneous components under a mixed redundancy strategy. To address this problem, an exact branch-and-price (BP) algorithm is proposed, capable of solving all benchmark instances from the literature in under one CPU second. This algorithm is the first exact method introduced for RAP with a mixed strategy and marks the first application of the BP algorithm in reliability optimization. Additionally, the proposed BP algorithm can solve other RAP variants, including those with active or standby strategies, enabling a comparative analysis of the mixed strategy's advantages. Lastly, a new set of instances is generated to assess the algorithm's effectiveness in handling more complex cases.

Sarah Sachs (Bocconi University)

Title: Tracking solutions of time-varying variational inequalities with applications to game theory and parameter estimation.

Abstract: Variational inequalities are a generalization of optimization and equilibrium problems [1], as well as parameter estimation problems in, e.g., generalized linear models [2]. In this work [3], we consider time-varying variational inequalities (TV-VIP) and our objective is to track the solutions of these TV-VIP. This problem captures many real-world applications in the area of game theory, online learning and parameter estimation. Existing work on time-varying games and optimization provides tracking guarantees for strongly convex or strongly monotone problems with restrained variation. We extend existing results in two ways: In our first result, we provide tracking bounds for (1) variational inequalities with a sublinear solution path but not necessarily monotone functions, and (2) for periodic TV-VIP that do not necessarily have a sublinear solution path length. Our second main contribution is an extensive study of the convergence behavior and trajectory of discrete dynamical systems of periodic TV-VIP. We show that these systems can either exhibit provably chaotic behavior or can converge to the solution. Reference: [1]: Variational Analysis, R. T. Rochafellar, R. J. B. Wets [2]: Signal recovery by Stochastic Optimization, A. Juditsky, A. Nemirovski [3]: Tracking Solutions of time-varying variational inequalities, H. Hadiji, S. Sachs, C. Guzmi'n

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Shakshi Singhal (XLRI Xavier School of Management, Delhi NCR Campus)

Title: A Flexible Software Reliability Growth Model for Non-uniform Fault Diagnosis Using Deep Neural Networks

Abstract: The rise of AI and intelligent software systems in critical applications necessitates reliable software that delivers accurate, timely responses. With open-source software (OSS) forming a crucial foundation, quantifying reliability remains a key challenge. This research introduces a Software Reliability Growth Model (SRGM) based on the Gamma/Shifted Gompertz (G/SG) distribution to handle non-uniform

fault detection rates and provide flexible modeling. While G/SG distribution has applications in other domains, its potential in software reliability modeling remains unexplored. The study also develops a deep learning-based SRGM to enhance prediction accuracy. The methodology is validated using historical failure data from OSS projects like Firefox and Eclipse. Parameter estimation employs a Genetic Algorithm (GA), while cross-validation assesses forecast performance. The back-propagation algorithm estimates deep neural network model parameters for robust reliability growth curve modeling. Comparative analysis with classical SRGMs shows superior empirical performance of the proposed model. Results demonstrate that the deep learning approach effectively captures software development complexities, improving fault prediction reliability. Keywords: software reliability growth model, Gamma/shifted Gompertz model, non-uniform fault detection, deep learning, OSS

Fabio L. Spizzichino (Sapienza University)

Title: Load-sharing models and characterizations of non-paradoxical voting situations

Abstract: In the context of Voting Theory a basic concept is the one of Voting Situation. As it is well-known, the latter is a tool to describe the voters' preferences about different candidates. When a set of candidates - and a related voting situation- are given, the problem arises to determine the winner of an election. However there are different criteria to define the concept of "winner" (the Condorcet winner, the Borda-count winner and the Plurality-rule winner, in particular). And, generally, different criteria lead to appointing different winners. Furthermore, each criterium manifests its own drawbacks and related possibilities of paradoxes (such as the celebrated phenomenon of intransitivity in the Condorcet approach). In the talk some classes of voting situations will be studied, which exclude the possibility of corresponding types of paradoxes and, at a time, lead to selecting a unique winner, whatever choice of a criterium is made, among those criteria mentioned above. This study is developed by exploiting a sort of isomorphism between voting situations and the Time-Homogeneous Load-Sharing models. The latter constitute a special class of multivariate survival models, which arises in a natural way in the frame of longitudinal observations of lifetimes. It will be shown that particular subclasses of such models allow for characterizations of corresponding classes of voting situations. In such a context it will be also discussed a class of examples, leading to demonstrate why survival models, and longitudinal observation of lifetimes, are linked to the problems of voting theory. The topics in the talk are related to joint work with Emilio De Santis (Univ. La Sapienza) and Niccolò Tassi (Univ. of Granada).

Simon Wilson (Trinity College Dublin)

Title: Cascading failure in a system with multiple component types

Abstract: The question of cascading failure in a system of components is addressed. In such systems, failure of a component increases the stress on the remaining working components, modelled as an increase in their failure rate. If enough components fail then there tends to be a sudden 'cascade' of failure of components that leads to system failure. Such models are useful in modelling the reliability of network systems e.g. power supply or data networks. We consider a system where failure rates are constant in time, but where repair of components is also allowed. Different component types are allowed to have different

failure rates, and react differently to component failure. The system failure criterion is initially defined to be as soon as all components in one type fail. It is shown the number of failed components can be modelled as a continuous time Markov chain, with failure represented by a single absorbing state, and hence the failure time distribution is a phase-type. This is illustrated by simulation. The tractability if using other system failure criteria, and the practicality of this model as the number of component types increases, is also discussed. Fitting these models to data from the system is also illustrated.

Yiqi Zhao (University at Buffalo)

Title: A Game-Theoretic and MCDA Framework for Sustainable Arctic Development: Balancing Economic Interests, Security, and Indigenous Rights

Abstract: The rapid economic development in the Arctic, driven by its natural resources and strategic significance, poses substantial challenges. This study integrates game theory and multi-criteria decision analysis (MCDA) to scientifically examine the interplay between economic growth and indigenous interests, enhancing the robustness and analytical rigor of decision-making. The research employs sequential and non-cooperative game theory to model strategic interactions among governments, corporations, and indigenous communities, while MCDA evaluates and prioritizes diverse criteria to assess policy impacts comprehensively. This combined approach aids policymakers in balancing economic objectives with the protection of indigenous rights, sustainability, and regional stability. Indigenous concerns regarding cultural heritage, traditional lifestyle disruption, resource overexploitation, and environmental risks are addressed through MCDA-driven, data-informed analysis. Recommendations include promoting indigenous participation in policy-making, ensuring fair distribution of economic benefits, enforcing strict environmental safeguards, and supporting long-term community development. The findings demonstrate strategies that respect indigenous sovereignty and promote sustainable development.

Scientific Committee:

- David Banks (Duke University, US);
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- David Rios Insua (ICMAT-CSIC, EN);
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