Games & Decisions in Risk & Reliability 7

Provisional Book of Abstracts

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Invited senior papers

Mike West and Emily Tallman

Title: Bayesian Predictive Decision Synthesis

Abstract:
Goal-focused perspectives on model uncertainty expand traditional statistical thinking about comparing and combining statistical models for forecasting and resulting decisions. The framework of Bayesian predictive decision synthesis (BPDS) represents some recent developments in this area. BPDS extends Bayesian predictive synthesis (BPS) and empirical goal-focused approaches to model uncertainty analysis. The key concept is to explicitly integrate decision goals into model weightings in predictive decision settings. BPDS is operationalised using relaxed entropic tilting, with opportunity to customise analysis via context-relevant utility functions in applications. Target applied contexts include Bayesian design for prediction and control in areas such as macroeconomic policy, and in sequential time series forecasting for financial portfolio decisions. Examples in the talk complement discussion of foundations, theory and aspects of the methodology of BPDS.

Kimberly F. Sellers

Title: Have perceptions regarding fuzzy sets and probability theory become... fuzzy?

Abstract: Approximately 20 years ago, Nozer Singpurwalla began pursuits regarding research that involved and/or incorporated fuzzy sets. Resulting discussions at the time induced strong philosophical discussions regarding probability theory and fuzzy set theory. Do those opinions still hold true today, or have they diminished with time? This talk will investigate the progression in the connections between probability and fuzzy set theory over the last two decades.

Emanuele Borgonovo

Title: Reliability Importance Measures: From Local to Global

Abstract:
We propose a review of various notions of reliability importance. We identify a path through the notion of conditioning. We discuss their engineering as well as their managerial meaning and their interpretation in the context of aleatory and epistemic uncertainty. We move from local to global approaches. For problems with multiple reliability criteria, we consider a new proposal based on the mathematical theory of optimal transport.

Nick Polson

Title: Inverse Bayesian Computation

Abstract:

In this paper we provide a deep learning approach to inverse Bayesian computation (IBC). The method can be used to solve a number of commonly used high dimensional Bayesian inference problems and expected utility maximisation. Connections with su cient statistics and other inverse Bayesian methods are explored. A practical approach using deep quantile neural networks is provided. We illustrate our methodology on a number of simple applications. Finally, we discuss directions for future research.

Elisa Maria Alessi

Title: Collision risk in space and current strategies

Abstract:
The Earth orbital space is a common resource, under pressure due to the recent proliferation of satellites, operational and non. It is now consolidated the awareness of the growth of the space debris population and the need of governing it. The new space economy, with the increase in the number of actors, will require the development of new solutions for all the phases of a space mission and the adoption of a new paradigm of Space Traffic Management to preserve the space environment for the future generations.
In this talk, I will introduce the space debris problem and I will focus on one of the main in-orbit mitigation operations, that is, the collision avoidance. The Low Earth Orbit region (up to 2000 km of altitude) is so populated by artificial objects that collision avoidance maneuvers are now a standard procedure of space operators. The process takes two steps: first, it is evaluated the Probability of Collision (PoC) between two objects, by processing the data provided by the Space Surveillance and Tracking network network; if the PoC is higher than a given threshold then a maneuver is modeled, its effect analyzed and eventually applied.
The risk of collision between two artificial objects around the Earth is assessed by means of algorithms that process automatically the Conjunction Data Messages (CDMs) provided by USSTRATCOM. The CDM contains the information of the predicted collision following the orbit determination process and the propagation of the orbit of the two objects up to the time of closest approach (tca). The CDM provides the relative velocity and position at tca, the covariance matrices associated with the two objects resulting from the orbit determination and the main physical parameters of the two objects that matter for carrying out the numerical propagation and evaluating the collision probability. In this phase, the uncertainty due to the orbital observations can lead to different evaluations of the miss distance and the PoC.
If one of the operators, responsible for the satellites that are interested by the conjunction, considers the risk too high, then a maneuver is applied, mainly to maximize the miss distance. Other options are however possible, for instance to find a trade-off between risk reduction and maneuver cost. It is then crucial to model and assess the PoC after the maneuver, both with respect to the other object involved in the given conjunction and with any other objects that might be orbiting in the same region in the short term.
The ideal algorithm for collision avoidance, not yet existing, would look for the minimum data requirements that can ensure a reliable strategy and for an optimal tradeoff between ground and on-board efforts.

Nalini Ravishanker, Patrick Toman, Ahmed Soliman, Sanguthevar Rajasekaran, Nathan Lally and Hunter D'Addeo

Title: Causal Analysis of IoT Temperature Streams to Understand Riskiness of Insured Customers

Abstract: Advancement in Internet of Things (IoT) technologies are increasingly being leveraged by firms which incorporate Wireless Sensor Network (WSN) based solutions as essential components of their monitoring systems. In this work, we focus on IoT temperature sensors deployed insurance firms with the expressed goal of preventing water-pipe burst (freeze loss) via real time customer alerts. In these settings, insurance firms are primarily interested in two questions: (a) are customers responsive to alerts sent by the system? (b) given that an alert has been sent, how long does it take for the sensor to return to ``normal'' behavior? To answer these questions, we propose two distinct methods. First, we fit a Gaussian Process model to the temperature time series to assess whether customers appreciably respond to an alert within a given time window. By comparing the model's post-alert forecasts with observed post-alert sensor streams, we can assess customer intervention. Second, we propose a time series motif mining procedure which simultaneously (a) identifies a sensor's typical state of behavior and (b) estimates the duration of time post-alert for the sensor to return its typical state. By combining the results from these methods, we develop a taxonomy of customer riskiness to help the insurance firm.

Simon Wilson, Reme Sillero and Séan Ó'Ríordáin

Title: Cross version and project software reliability prediction

Abstract:
The idea that one might predict software reliability in a particular version release of a project by using data on the occurrence of bugs in a previous version is attractive, largely because it allows one to make use of more data and exploit dependencies in the reliability of successive versions. More ambitiously, one might try to predict the reliability of a project using data from other projects, which allows one to use large repositories of software data, either within the organisation or publicly available, to aid defect prediction. This is known in the literature as cross project defect prediction (CPDP).

Significant challenges remain to be addressed for the latter problem. Predictive performance can be poor, particularly in the case where project metrics are not consistent. In this talk we first look at Bayesian modelling of cross-version software reliability, and then discuss how this can be extended to CPDP, particularly under the challenging condition that the different projects are measured with potentially different metrics.

Ahti Salo

Title: Modelling Incomplete Information in Adversarial Risk Analysis

Abstract:
Models of adversarial risk analysis (ARA) help tackle decision problems with several players who have conflicting objectives and whose actions influence what consequences will be faced by each player. In ARA, the aim of the analyst is to support one of the players. This player may be, for example, the Defender who can take pre-emptive actions before the Attacker decides whether or not to proceed with an act of aggression.

In developing ARA models for such a Defender, the analyst usually has more information about the Defender than that of the Attacker. This makes it pertinent to explore how the ARA results would change when allowing for a range of alternative assumptions about the Attacker, as captured by decision models with incomplete information, for instance. Specifically, when the Defender considers what portfolio of pre-emptive actions should be implemented, it can be instructive to determine all portfolios of actions that are non-dominated in view of alternative assumptions about the actions and preferences of the Attacker. A detailed examination of these portfolios reveals which actions are robust, in the sense that they would be selected for all plausible assumptions about the Attacker. We illustrate this approach with a realistic case study on military planning.

In ARA modelling, it is common to assume that the information structure is fixed, meaning that it is known (i) in what sequence the players choose their actions and, moreover, (ii) what information is available to the players as they choose their actions within this sequence. Yet these assumptions do not always hold. They are rather challenging to remove, because without them one cannot apply conventional computational techniques based on the stepwise elimination of nodes in the influence diagram representation of the ARA model.

In this setting, Decision Programming (Salo et al., Eur J Oper Res 299/1, 2022) is a promising approach to solving multi-stage decision problems represented as influence diagrams in which interdependencies between decisions, uncertainties and consequences are shown as directed acyclic networks. In contrast to earlier approaches to solving influence diagrams (such as building the equivalent decision tree), Decision Programming does not necessitate the restrictive 'no-forgetting' assumption. It also eliminates some of the limitations of earlier techniques in that it identifies all non-dominated solutions in problems with multiple objectives and accommodates many kinds of logical, resource and risk constraints. We illustrate Decision Programming with numerical examples from ARA models in which the players' actions have an impact on the information structure.

Fabio L. Spizzichino and Emilio De Santis

Title: Relations among paradoxical situations in applied fields and con- structions based on Load-sharing models

Abstract:
Based on results presented in the recent paper [1], this talk will have a two-fold purpose:
- pointing out strict connections among paradoxes, possibly emerging in different fields such as survival analysis, voting theory, system's reliability, game theory, and target-based individual choices under uncertainty
- discussing results about the use of Load-sharing models in constructively showing the existence of paradoxical situations.
In a completely natural way, load-sharing models arise as simple dependence models in the reliability field. In this perspective, we point out how the logic of reliability theory can have a conceptual role within different fields, even far from the study of random lifetimes.

We start by considering a vector (Xl, .., Xm) of, generally interdependent, non-negative random variables satisfying the no-tie condition JP(Xi = Xj) = O, Vi /= j. Denoting by Xl:m, ..., Xm:m the corresponding order statistics, we then consider both the {1, .., m}-valued random variables Jl, ..., Jm defined by

$$J_h = i \{=\} X_{h:m} = X_i \qquad (1)$$

and the family

$$A \_ \{a_j(A); A \text{ ç } \{1, .., m\}, j \text{ E } A\}, \qquad (2)$$

where the numbers aj(A) are defined by aj(A) := JP(miniEA Xi = Xj).

In different contexts, the numbers aj(A), for A ç {1, .., m}, can be seen as winning probabilities. The family A is determined by PJ , the joint probability distribution of J _ (Jl, ..., Jm).

In different applications it is interesting to analyze, for any fixed pair {i, j}
(i, j E {1, ..., m}), which of the two variables Xi, Xj stochastically precedes the other. For two random variables Y, Z, remind that Y is said to precede stochas- tically Z whenever JP(Y ≤ Z) 2" JP(Z ≤ Y). Limiting then attention to only subsets A C {1, ..., m} with cardinality /A/ = 2, one can associate a direct graph ({1, ..., m}, E) to the family A, by defining E ç {1, ..., m} x{1, ..., m} as the set of oriented arcs such that

$$(i, j) \text{ E } E \{=\} (a_i\{i, j\}) \text{ 2" } a_j(\{i, j\}).$$

Borrowing from the language used in voting theory, ({1, ..., m}, E) can then be seen as a majority graph.

For our purposes we are however interested in analyzing, over each subset

A ç {1, ..., m} with any cardinality 2 ≤ /A/ ≤ m, the ranking C(A, ·) : A ---+
{1, 2, ..., /A/} triggered by the numbers aj(A). The family of all such rankings has been termed a ranking pattern and is denoted by the symbol C, or CA.

It is readily seen that, looking at all the rankings contained in a ranking pattern C, several types of paradoxical inequalities can be observed. In par- ticular the majority graph ({1, ..., m}, E) can typically manifest phenomena of intransitivity. Furthermore it may be noticed that, for some subset A and for a triple of indexes i, j, k, with i, j E A, k E/ A, it may simultaneously happen

$$C(A, i) > C(A, j), \qquad C(A \cup \{k\}, i) < C(A \cup \{k\}, j). \tag{3}$$

It is a remarkable circumstance that such paradoxes are analogous to those which arise in some standard contexts of voting theory. In this respect, it will be pointed out that a sort of isomorphism can be established between the probabil- ity distributions PJ (with J defined in (1)) and the voting situations that are considered in those voting contexts. Similar analogies can also be established by considering the target-based interpretation of decisions under uncertainty. Such an approach can provide an interpretation of individual choices even in the cases of non-existence of a utility function.

Looking in particular at (3), examples of ranking patterns which are really paradoxical and quite astonishing, will be sketched in the first part of the talk.

Now, the following issues emerge:

Given an arbitrary ranking pattern C, can we really prove the existence of a probability distribution PJ such that, for the corresponding family A, one has CA = C?

Such an existence result would show that, in an appropriate sense, any arbitrary "paradox" in the family A can actually be produced by variables Xl, ..., Xm with a suitable joint distribution. This might be seen as a proof of social indeterminacy and can provide a rather general solution to several existence problems that have been studied in voting theory.

Let us now fix, on the space of all the permutations of 1, ..., m, an arbitrar- ily pre-assigned probability measure p. Different problems in systems' reliability (related with concepts of signature or with concepts of importance indexes) lead to the question whether one can find a joint probability distribution for the vec-

tor (Xl, .., Xm) such that the corresponding distribution PJ coincides with p. This existence result might also be of interest in the construction of paradoxical

situations in the field of simple games.

A second part of the talk will necessarily be a bit more technical. After re- viewing basic definitions and properties of multivariate conditional hazard rates and of load-sharing models, we will formulate the existence results mentioned in the above items A) and B). Main features of such results are the following: the proofs are constructive and the families of probability measures, which re- spectively offer the problems' solutions, will respectively coincide with special classes of load-sharing models.

In the conclusions, an attempt will be made to illustrate the logical reasons why such - extremely special- dependence models reveal so flexible and apt to provide the pursued solutions.

[1] E. De Santis, F. Spizzichino (2023). Construction of aggregation para- doxes through Load-sharing models. Adv. Appl. Probab., 55, 223-244.

Invited junior papers

William N. Caballero, Matthew de LaRosa and Alexander Fisher

Title: Indiscriminate Disruption of Conditional Inference on Multivariate Gaussians

Abstract:
The multivariate Gaussian distribution is a fundamental probabilistic model. It underpins numerous machine learning methods (e.g., Bayesian optimization and Gaussian Bayesian networks) and is commonly used in myriad academic disciplines (e.g., biology and economics). However, given recent advances in adversarial machine learning, it is important to revisit the effects a malicious actor may have on inferences derived from a multivariate Gaussian. Therefore, within this research, we consider a self-interested attacker who wishes to maximally disrupt a decisionmaker's conditional inference by poisoning a set of evidence variables. However, to avoid detection, the attacker also wishes for the attack to appear plausible wherein such plausibility is determined by the density of the poisoned evidence. We consider both a whitebox and greybox setting such that the attacker has complete and incomplete knowledge about the decisionmaler's multivariate Gaussian distribution, respectively. The problems are shown to reduce to quadratic and stochastic quadratic programs. We derive proofs about the problems' convexity, and we provision associated solution methods as well. Computational testing is also provided to showcase the impacts of such attacks on a simple illustrative example and a realistic case study.

Nicolas Fayard

Title: A framework for average and expected capability sets

Abstract:
Decision making problems can be affected by the presence of multiple objectives and multiple scenarios which could occur in the future. We consider the case in which, additionally, there is no preferential information enabling to construct importance parameters for the criteria, but likelihoods about the different scenarios can be obtained.
From a decision support perspective, a suitable tool would be to present a merger of the possible solutions holding for each scenario taking into account their likelihoods. We present and compare two procedures aimed at solving this problem satisfying several fundamental properties characterising the outcomes.

Tahir Ekin

Title: Adversarial Forecasting: A Bayesian decision theoretic approach

Abstract:
Forecasting methods typically assume clean and legitimate data streams. However, adversaries may attempt to influence data and alter forecasts, which in turn may impact decisions. In order to improve defenses, it is crucial to consider the adversaries' goals, knowledge and capabilities, and the uncertainty therein. This manuscript presents the adversary's poisoning decision problem where he manipulates batch data inputted into forecasting methods. Proposed adversarial risk analysis-based decision theoretic framework allows incomplete information and adversarial perturbations on the data inputs. In particular, adversarial auto-regressive models are presented and demonstrated with examples. The findings show the vulnerability of forecasting models under adversarial perturbations. We also briefly discuss defender strategies that could improve forecast quality under attacks.

Samuel Luxenberg

Title: Adversarial Risk Analysis for Differential Games: Application to Effort Strategies in Basketball

Abstract:
Differential games (DGs) are strategic interactions that occur within the context of some environment that evolves continuously over time. If we inject some uncertainty into this evolution, i.e., via stochastic differential equations, we arrive at the notion of a stochastic differential game (SDG). Solutions to these games combine techniques from (stochastic) optimal control and game theory. In most cases, the game-theoretic solutions suffer from the same common knowledge and perfect rationality assumptions applied to more traditional game theory problems. However, in situations where these assumptions are not realistic, an alternative approach is needed. In this talk, we propose such an alternative set of solutions to some analytically solvable SDGs based on the principles of Bayesian adversarial risk analysis (ARA). We then use these ideas to introduce and study the notion of optimal team effort strategies throughout the course of a continuously evolving basketball game.

Roi Naveiro Flores

Title: Simulation-based Bayesian Optimization

Abstract:
Optimizing black-box functions of categorical variables has important applications. Bayesian optimization is widely used in this type of problem. It involves adjusting a probabilistic predictive model of the objective and using an acquisition function to guide the optimization process. We propose a new algorithm to sequentially optimize the acquisition function inspired in simulated annealing. We address convergence issues and demonstrate its effectiveness empirically.

Contributed papers

Shahram Sarkani, Thomas A. Mazzuchi and Christopher Scolese

Title: Mathematical Formulation for Risk Matrices to Capture Project Cost Uncertainty

Abstract:
Risk matrices are used routinely to display and track risk for development activities ranging from construction to spacecraft mission development. However, risk matrices have been applied inconsistently resulting in ambiguity in the assessment and communication of risk. Discussions of the risk matrix in the literature have focused principally on how to display static data, i.e., risk at a given point in time, to display individual risks, and how to establish a risk review process to obtain consistent measures. This study will develop a methodology to improve the risk matrix and risk process by recognizing and formally modeling the representation of uncertainty in both the probability and the cost associated with risk scenarios. The methodology uses most of the well know closed support distributions to model uncertainty in cost and in probability and links these via the Diagonal Band Copula to account for their dependence. The techniques will be illustrated by using two real projects from two NASA missions; Glory and NPP.

José M. Camacho and David Arroyo

Title: A framework for risk management in systems with AI components.

Abstract:
The upcoming release of the NIST Artificial Intelligence risk management framework and the European Union AI Act raises new and intriguing questions about the risk analysis of AI-based systems. To address these issues, this study presents a comprehensive cybersecurity risk management framework for information systems incorporating AI components. The proposed framework provides a scheme to simulate potential attacks on these systems and assess their impacts. Additionally, we present a cyber mitigation selection approach for risk management purposes. We conclude with a case study related to protecting Autonomous Driving Systems.

Alejandro Balbás, Beatriz Balbás and Raquel Balbás.

Title: Bidual representationS of convex functionals with applications in risk analysis

Abstract.
Downside and deviation risk measures are becoming more and more important in many disciplines with clear interfaces with Applied Mathematics, Actuarial and Financial Mathematics, and Operations Research. Almost all of them are convex functionals, and their dual representations have played critical roles in most of their applications (risk management, pricing and hedging, risk optimization, etc.), but, to the best of our knowledge, bidual representations were never profoundly studied. New linear bidual representations will be provided, and their great capacity to linearize many problems will be proved, with special focus on risk optimization. This is important because there are very tractable necessary and sufficient optimality conditions and resolution algorithms in Linear Programming. Moreover, in the linearization process, one will have to introduce new decision variables providing us with very important information, such as sensitivities with respect to the selected risk measure and sensitivities with respect to the selected model (model risk). The mathematical theory will be presented under the framework of the general Banach spaces.

Nuria Torrado

Title: Preventive maintenance strategy optimization model for parallel systems

Abstract.
Preventive maintenance is one of the most popular maintenance strategies in reliability theory, whose purpose is to prevent system failure before it occurs. Most of the research works on optimal strategies for preventive maintenance have considered systems consisting of the same type of components. Recently, Hashemi et al. [2] investigated coherent systems with multiple types of independent components. In real situations, units never operate in isolation and can even share workloads, so it is important to take these dependencies into account. For the case of dependent components, Eryilmaz and Ozkut [1] investigated two optimization problems for parallel systems with multiple types of components. Specifically, they provided analytical expressions for two average cost rate functions, one for the optimal number of components and another for the optimal replacement time before system failure. In all these cases, the researchers compute numerically the optimal values for some specific cases, in order to optimize the corresponding objective functions.

However, they do not provide any optimal solution valid for the general problem nor conditions that ensure their existence and uniqueness.

In this poster, we discuss some challenging open problems and conjectures recently proposed in [1] for parallel systems with dependent components of multiple types. Moreover,
we present necessary conditions for the existence of the unique optimal value which minimizes the mean cost rate for two optimization problems.

The results presented in this poster have been recently published in [3]

References
1. Eryilmaz S, Ozkut M (2020). Optimization problems for a parallel system with multiple types of dependent components. Reliability Engineering and System Safety 199, article 106911.

2. Hashemi M, Asadi M, Zarezadeh S (2020). Optimal maintenance policies for coherent systems with multi-type components. Reliability Engineering and System Safety 195, article 106674.
3. Torrado N (2022). Optimal component-type allocation and replacement time policies for parallel systems having multi-types dependent components. Reliability Engineering and System Safety 224, article 108502.

Johan Rene van Dorp and Ekundayo Shittu

Title: The the-side beta distribution with applications in applications in project risk analysis

Abstract: A two-sided (TS) framework of distributions for asymmetric continuous distributions is developed with both bounded and unbounded support. The TS framework provides for a direct link between (i) the unbounded Asymmetric Laplace, (ii) Gaussian distributions and (iii) the bounded generalized Two-Sided Power (GTSP) distribution. In its development, a novel three-parameter asymmetric two-sided distribution is with bounded support is constructed via a half-beta distribution. Denoting that distribution the Two-Sided Beta (TSB) distribution, it is characterized by a mode (or anti-mode) parameter together with two branch power parameters. TSB distributions serve as a smooth alternative for GTSP distributions. Some properties of TSB family of distributions shall be derived. Two separate algorithms to solve for the power parameters of the TSB distribution shall be presented. The first algorithm ensures matching of the most likely value, specified through expert judgment, as well as the PERT mean and PERT variance, popular in project management. The latter result is a novel PERT contribution by itself. The second algorithm solves for the power parameters from a lower and upper quantile constraint. The application of the TSB distribution shall be demonstrated in illustrative PERT example(s).

Alejandro Balbás, Beatriz Balbás and Raquel Balbás

Title: Integrating actuarial and financial risks for insurance companies

Abstract: The optimal combination of reinsurance and financial investment will be studied under specific dynamics of the involved financial instruments and the financial market does not have to be free of frictions. Furthermore, it will be pointed out how the optimal combination above may provide us with new premium principles making the insurer global risk vanish. The risk will be managed with a coherent risk measure, and the new premium principles will seem to reflect several properties, which are desirable from both the analytical and the economic perspectives. From the analytical viewpoint, the premium principles will be continuous, homogeneous and increasing. From the economic viewpoint, the premium principles will lead to cheaper prices with respect to both the insurance market and the financial one. General necessary and sufficient optimality conditions will be given, as well as closed forms for the solutions under appropriate assumptions. Several methods preventing unbounded optimization problems will warrant special attention.

Crosato Lisa, Josep Domènech, and Caterina Liberati

Title: Improving SMEs default prediction: combining conventional and unconventional data.

Abstract: In the modern financial landscape, there is an increasing interest in using unconventional data sources for predicting Small and Medium Enterprises (SME) default. SMEs, indeed, have a pivotal role in the EU economy constituting 99.8% of all enterprises in the EU-28 non-financial business sector (European Commission (2019)). So far, credit scoring models have been built using only balance sheets indicators, although it has been demonstrated that smaller sized firms do not always comply with financial transparency.
In this, work we explore the usage of corporate websites as a further source of information for detection of SMEs default (Crosato, Domenech, & Liberati, 2021). Working with unconventional data raises several challenges in terms of data retrieval, selection and cleaning. On the other hand, it allows to overcome the deterioration of the balance sheet indicators, that generally are published with 2 years of delay with respect to their reference time. We relied on our study on a sample of Spanish SMEs (about 900 firms) whose websites were scraped to obtain online indicators based on the HTML code, as in as in Blazquez and Domenech (2018). The online indicators, merged with balance sheet data, were then analyzed using Machine Learning algorithms (as Random Forest and LS-SVM) and Logistic Regression (as a benchmark) having as input variables both sets of information. Results show the improvement in terms of misclassification rate when the accounting information is augmented by website features. We also provide valuable insights into companies' websites characteristics related with firms' financial health. Finally, we show that online indicators are able to predict the future status of some uncommon firms whose accounting indicators would have led to the wrong prediction.

Alejandro Balbás, Beatriz Balbás and Raquel Balbás

Title: Expectile linked expected shortfall bounds

Abstract: Downside risk measures play a very interesting role in Actuarial Science and Mathematical Finance. In particular, the value at risk (VaR) and the expected shortfall (ES) have become very important instruments in order to address risk management problems, capital requirements, portfolio selection, optimal reinsurance, pricing and hedging issues, risk transference, risk sharing, etc. In contrast, expectile risk measures are not as widely used, though they are both coherent and elicitable. This paper shows another interesting property affecting expectiles. Indeed, expectiles enable us to give VaR and ES upper bounds applying to every level of confidence. In other words, expectiles allow us to control VaR and ES regardless of the level of confidence. In general, once an actuarial or financial strategy is selected by dealing with VaR or ES with a specific confidence level, nothing is known about the effectiveness of such a strategy if the confidence level becomes different. Nevertheless, the use of expectiles may overcome this caveat. Illustrative actuarial applications will be presented.

Johan Rene van Dorp and Ekundayo Shittu

Title: The two-sided beta distribution with applications in project risk analysis

Abstract: A two-sided (TS) framework of distributions for asymmetric continuous distributions is developed with both bounded and unbounded support. The TS framework provides for a direct link between (i) the unbounded Asymmetric Laplace, (ii) Gaussian distributions and (iii) the bounded generalized Two-Sided Power (GTSP) distribution. In its development, a novel three-parameter asymmetric two-sided distribution is with bounded support is constructed via a half-beta distribution. Denoting that distribution the Two-Sided Beta (TSB) distribution, it is characterized by a mode (or anti-mode) parameter together with two branch power parameters. TSB distributions serve as a smooth alternative for GTSP distributions. Some properties of TSB family of distributions shall be derived. Two separate algorithms to solve for the power parameters of the TSB distribution shall be presented. The first algorithm ensures matching of the most likely value, specified through expert judgment, as well as the PERT mean and PERT variance, popular in project management. The latter result is a novel PERT contribution by itself. The second algorithm solves for the power parameters from a lower and upper quantile constraint. The application of the TSB distribution shall be demonstrated in illustrative PERT example(s).

Y Junglee, A.E. Clark , B Erni

Title: Bayesian Analysis of Historical Functional Linear Models with application to air pollution forecasting

Abstract: Historical functional linear models are used to analyse the relationship between a functional response and functional predictors. Here we develop a functional data analysis model that handles multiple functional covariates with measurement error and sparseness that can be used to predict functional response surfaces.

The method uses the connection between non-parametric smoothing and Bayesian methods to reduce sensitivity to the number of basis functions used to model the functional regression coefficients of the model. We investigate two methods of estimation. First, propose to smooth the predictors independently from the regression model in a two-stage analysis, and secondly, jointly with a regression model. The efficiency of the MCMC algorithms is increased by implementing a Cholesky decomposition to sample from high-dimensional Gaussian distributions and taking advantage of the orthogonal properties of the functional principal components used to model the functional covariates.

A simulation study suggests substantial improvements in both the recovery of the functional regression surface and the true underlying functional response with higher coverage probabilities when compared to a classical model under which measurement error is unaccounted for. We also found that a two-stage analysis outperforms the joint model under certain conditions.

A major challenge with the collection of environmental data is that they are prone to measurement error. Hence, our methodology provides a reliable functional data analytic framework for modelling such data. As an application of our method, we forecast the level of daily atmospheric pollutants at certain locations in the City of Cape Town. The forecasts provided by the Bayesian two-stage model are highly competitive when compared to the functional autoregressive models which are traditionally used for functional time series.

Canan Ulu, Alessandra Cillo, Emanuele Borgonovo, Alessandro Ortis and Sebastiano Battiato

Title: Should Advisors Signal Access to Algorithms?

Abstract: We investigate how individuals react to advice coming from a human-in-the-loop system where advisors who give the advice have access to algorithms. For example, if a brand manager for a new product specifies the demand model they are using, will it make it more likely that management will utilize their forecasts in decision making? If an epidemiologist specifies the models they are using when coming up with forecasts on how influenza is going to spread this year, does it make it more or less likely that individuals will utilize that information?
We run multiple studies to understand advice utilization when the advice comes from i) a human-in-the-loop system, ii) directly from an algorithm with no human advisor involvement or iii) from other human advisors. We ask participants to forecast standardized test scores for high school students, number of views various images receive on a photo sharing website and whether an image belongs to a real person or not.
Our results suggest that people appreciate direct algorithmic advice as much as (sometimes more than) advice from a human-in-the-loop system in forecasting tasks. Both the advice from an algorithm and the advice from a human-in-the-loop system are appreciated more than the advice from other human advisors. The appreciation of direct algorithmic advice is more pronounced when the algorithm produces confident forecasts and wanes when proper human experts are part of the human-in-the-loop system.

Di Zhang, Refik Soyer, Hedibert Lopes

Title: A Dynamic Multivariate Integer Autoregressive Model for Count Time Series and its Bayesian Analysis

Abstract: The integer autoregressive (INAR) processes play a vital role in modeling count series. In this paper, we integrate a random environment that follows a state-space evolution into the univariate INAR(1) model from McKenzie (1985), and we term our model Dynamic Multivariate INAR(1). The random environment provides an efficient and scalable multivariate generalization of the univariate INAR(1) model with dynamic multivariate negative binomial predictive distributions. Furthermore, it also allows the Dynamic Multivariate INAR(1) model to account for time-varying contemporary dependency structures. We propose a Monte Carlo Markov Chain method and a Particle Learning algorithm for parameter learning and inference of state variables. In an experiment based on a real dataset, we show that the Dynamic Multivariate INAR(1) model substantially outperforms competing models in terms of one-step-ahead out-of-sample forecasts.

Julia R. Falconer, Eibe Frank, Devon L. L. Polaschek, Chaitanya Joshi

Title: Eliciting Informative Priors Using Expert Decision Making

Abstract: Eliciting informative prior distributions for Bayesian inference from experts can often be complex and challenging. Existing methods have drawbacks such as experts needing knowledge of statistical concepts and expert bias being difficult to detect and counteract. In this work, we propose a new method to elicit informative priors that eliminates some of these drawbacks. This method seeks to elicit a predictive prior by modelling an expert's past decisions. It is suitable for applications that require an expert to perform repetitive decision-making tasks. While the circumstances and the outcome for each of the decisions may be unique in its own way, when considered together, the past decisions may be able to illuminate the decision-maker's thinking and enable elicitation of a prior distribution by modelling past decisions. An important by-product is that such modelling also allows to investigate biases present in the expert's thinking process. In this talk, we will describe the basic idea and illustrate it using a simple yet important example. We will also show how further benefit can be gained by using a deep learning model to output a prior distribution that reflects the expert's uncertainty. These expert priors can then be used to aid in critical decision making applications such as those in the security and crime sciences.

Sonali Das and Najmeh Nakhaei Rad

Title: A Conditional Bayesian Cylindrical Approach to Predict Direction Of Seasonal Extreme Wind Speed

Abstract: In this paper we propose a Bayesian approach to predict wind direction for extreme seasonal wind speeds. From a deployment of resources perspective during high fire danger index seasons that include extreme wind speed, it is vital to know the direction of these high-speed winds for efficient and effective response. With this aim, we extend a conditional approach to a cylindrical model, which is a combination of Gumbel distribution, as the extreme value distribution, and the circular sine-skewed von Mises distribution (Kalaylioglu, 2022), to capture the direction for extreme wind speeds. Using the posterior predictive distribution, we predict the direction of extreme wind speed for four seasons using hourly wind data from Polokwane, South Africa.

Reference:

Kalaylioglu, Z., 2022. Analysis of correlated circular and extremal data with a flexible cylindrical distribution. Environmental and Ecological Statistics, 29(1), pp.207-222.

Enrique Calderín-Ojeda, Emilio Gómez-Déniz and Francisco J. Vázquez-Polo

Title: Premium Calculation via Conditional Tail Expectation under Asymmetric Loss

Abstract: In this contribution, premiums based on the Conditional Tail Expectation and asymmetric loss functions to account for the risk of both underestimation and overestimation losses are calculated. After selecting a suitable loss function, the risk premium is calculated as the quantity minimizing an objective function related to the conditional tail expectation of the loss. The premium satisfies desirable properties, i.e. it is a coherent risk measure, and it helps the practitioner to quantify the global risk of the insurer. Then, this methodology is applied to quantify the risks associated to the total claims amount that are modelled via composite models. Comparisons with the usual Value-at-Risk and Tail Value-at-Risk are carried out.

Rafael Ballester-Ripoll and Manuele Leonelli

Title: A global sensitivity analysis approach in Bayesian networks

Abstract: Global sensitivity analysis quantifies the importance of model inputs and their interactions with respect to a model's output. It provides an overall view of the influence of inputs on outputs as opposed to a local view, where only one input at a time is investigated. Applications of global sensitivity analysis include model screening (i.e. removal of non-important variables), interpretation, factor prioritization, measuring uncertainty propagation, and identification of inter-variable interactions. In probabilistic graphical models and specifically Bayesian networks, local sensitivity approaches are most common and have been extensively studied. In this talk, we will discuss a methodology we recently introduced for the computation of Sobol indices for variables associated with the vertices of a network. Our method takes advantage of the similarities between tensor networks and probabilistic graphical models and is part of an ongoing effort to foster interactions between these two communities. Our implementation is freely available and can formally account for correlated inputs. Analyses of structural reliability and project risk management illustrate the methods.

Víctor Gallego

Title: Zero-Shot Preference Models for Language Model Tuning with Reinforcement Learning

Abstract:
Recently, large language models (LLMs) such as the GPT family have experienced tremendous successes in both foundations and applications, pervading many different socio-economic areas. However, as these models increase in parameter size and computational requirements, it becomes more challenging for users to personalize them for specific tasks or preferences.

In this talk, we address the problem of directing the text generations of a LLM towards a desired behavior, aligning the generated text with the preferences of the human operator. We propose using another language model as a preference model, representing the desired preferences of the user. This preference model provides the reward, or utility, as a learning signal to further fine-tune the base LLM using reinforcement learning. For sufficiently general preference models, this can be accomplished in a zero-shot way, without providing labeled data, just with a textual prompt by the user describing their preferences. We leverage several ideas from constrained optimization to further improve this optimization process, making the distribution of personalized generations more robust.

Extensive evidence of the capabilities of this framework is provided through experiments in different domains related to text generation, including reducing hate-speech, improving positive sentiment, complaints generation in tweets, and enhancing the aesthetics of a text2image model. We compare different architectures for the language models, ranging from 300M to 6B parameters in size, with different preference model specifications, demonstrating that our framework consistently outperforms the baselines.

Alejandro Saavedra-Nieves and Encarnación Algaba-Durán

Title: A connection-based analysis of covert networks using the position value

Abstract:
Risk analysis and cooperative game theory are strongly connected, see Cox (2009). Through the use of well-known solution concepts for TU-games, new risk measures can be proposed in networks. Among others, the position value (Borm et al., 1992) gives a measure of the relevance of a player in a network, integrating additionally the degree measure of each player in it. In real world, it is particularly important to consider the natural influence of connections of a player in a network. However, until now, its applications were very limited due to the high computational complexity. In this talk, we provide a method, based on sampling theory, to estimate the position value, which is analysed in terms of the theoretical properties of the resulting estimator. Besides, we establish specific statistical results for bounding the absolute error in this approximation. To illustrate the advantages and interest of the proposed methodology, as well as the variety of problems that can be analyzed in this framework, we applied it in two very different settings, the Spanish national team and the Zerkani network responsible for the terrorist attacks of Paris (2015) and Brussels (2016).

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Lizanne Raubenheimer, Neill Smit, Thomas A. Mazzuchi and Refik Soyer

Title: A generalized Eyring-Weibull model in accelerated life testing

Abstract:
In this paper, inference from accelerated life tests where the lifetime follows a Weibull distribution, is considered. A Bayesian approach is used, with the generalized Eyring model as the time transformation function. This model allows for the use of one thermal stressor and one nonthermal stressor. Markov chain Monte Carlo (MCMC) methods are used to obtain posterior samples due to the mathematically intractable posteriors.