Posters Abstracts

7th School on Belief Functions and their Applications

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Session 2

Wednesday, 22 October 2025, 16:00-17:15

Salvador Madrigal Castillo

Handling Uncertainty in Probabilistic Classifier Chains for Multi-Label Classification Using Evidence Theory
Salvador Madrigal Castillo, Cyprien Gilet, Vu-Linh Nguyen, Sébastien Destercke, University of Technology of Compiègne

Abstract: This work explores the use of Evidence Theory to handle uncertainty in Probabilistic Classifier Chains (PCC) for multi-label classification. Instead of estimating the full joint conditional probability, the proposed approach uses partial joint probabilities from multiple classifier chains and represents the remaining uncertainty through mass functions combined via Dempster's rule.

Silvia Lorenzini

Quantile-constrained Choquet-Wasserstein p-box approximation of arbitrary belief functions
Andrea Cinfrignini, Silvia Lorenzini, Davide Petturiti, Barbara Vantaggi, University of Perugia

Abstract: Quantile-constrained Choquet-Wasserstein p-box approximation of arbitrary belief functions We consider the problem of approximating an arbitrary belief function with a "closest" probability box (or p-box) which satisfies certain upper bounds on its corresponding lower and upper quantile

functions. The theory of p-boxes is a distinguished part of the more general Dempster- Shafer theory of belief functions. In fact, every belief function induces a p- box by restricting it (together with its dual plausibility function) to the set of left half-lines, while every p-box generates a belief function through the procedure of natural extension. However, starting from an arbitrary belief function and taking the induced p-box, we may introduce more ambiguity in the model, as the belief function obtained by natural extension is generally dominated by the original belief function. In other words, starting from a belief function and deriving the natural extension of its p-box, typically results in a model with greater imprecision. Furthermore, the structure of a p-box allows us to define the lower and upper Value-at-Risk (VaR) measures as the quantiles associated with the lower and upper CDFs, respectively. The VaR measure, in its classical definition, is widely used in finance and insurance to estimate the maximum potential loss of an investment or portfolio over a given period of time, with a certain level of confidence. Since the process of passing from the original belief function to the natural extension leads to an increase of imprecision, this generally implies that the resulting VaR measures are largely far from the originals ones. The goal is to keep the information incorporated in the original belief function and not to depart from the starting VaR measures. Therefore, we propose an approximation of the quoted belief function imposing that the approximating belief function preserves "as much as possible" the positional structure of jumps of the input and satisfies given constraints on the quantile functions. The quoted problem can be faced through suitable generalizations of classical optimal transport and the related Wasserstein distance. Hence, we first consider a version of optimal transport problem in the framework of Dempster-Shafer theory, which consists in minimizing the Choquet integral of a cost function, among a suitable set of joint belief functions with given marginals. Next, we define the corresponding pessimistic Choquet- Wasserstein pseudodistance of order q, with $q \in [1, +\infty)$. Finally, we look for a belief function that: (1) minimizes the pessimistic Choquet-Wasserstein pseudo-distance of order q with respect to the starting belief function; (2) is the natural extension of a p-box; (3) preserves the positional structure of jumps of the original belief; (4) satisfies the constraints on the lower and upper VaR measures. In general, the resolution of the above optimization problem is a difficult task. For this, we propose an algorithm to find an approximation of the optimal solution through a generalization of the Dykstra's algorithm.

Victor F. Lopes de Sousa

Explainable evidential clustering
Victor F. Lopes de Sousa, Université de Montpellier

Abstract: Unsupervised classification is a core problem in machine learning. Because real-world data are often imperfect, non-additive frameworks, such as evidential clustering, grounded in Dempster-Shafer theory, explicitly handle uncertainty and imprecision. These frameworks are particularly well suited to high-stakes decisions, which tend to require both interpretability and cautiousness. However, while decision-tree surrogates have enabled transparent explanations for hard clustering, explainability for evidential clustering remains largely unexplored. We address this gap by formalizing representativeness, a utility-based criterion that captures decision-makers' preferences over explanation misassignments, and introducing evidential mistakeness, a loss function tailored to credal partitions. Building on these foundations, we propose the Iterative Evidential Mistakeness Minimization (IEMM) algorithm, which learns decision-tree explainers for evidential clustering by optimizing representativeness under uncertainty and imprecision. We provide theoretical conditions for effective explanations in both hard and evidential settings and show how utility parameters can be set to reflect different decision attitudes. Experiments on synthetic and real-world datasets demonstrate that IEMM improves the performance of existing methods by producing representative and preference-aligned explanations of evidential clusterings, supporting cautious, transparent analysis in the presence of imperfect data.

Alberto Zamora Mendieta

Counter-Adversarial estimation and the square root reproducing kernel Hilbert space extended Kalman filter
Alberto Zamora Mendieta, Texas A&M University

Abstract: Accurate state estimation for spacecraft operating in space remains a fundamental challenge due to the presence of nonlinear and uncertain dynamics, external disturbances, and limitations in sensor reliability. These difficulties are further compounded by threats, such as signal interference and spoofing, which can severely degrade navigation performance. Traditional estimation methods, like the extended Kalman filter (EKF), often struggle under these conditions due to their reliance on fixed models

and limited adaptability. To address these challenges, the fusion (inverse) square root reproducing kernel Hilbert space extended Kalman filter (SR-REKF) is introduced as a robust and adaptive estimation framework designed for uncertain and adversarial environments.

Dorra Sassi

From probabilistic to credibilistic student modeling: enhancing student modeling with belief functions
Dorra Sassi, University of Rennes

Abstract: Student modeling traditionally relies on Bayesian Knowledge Tracing (BKT), where mastery probabilities are updated based on observed learner responses. Our Credal Knowledge Tracing (CrKT) approach extends BKT by integrating belief functions. In traditional BKT, student answers are expected to be precise, whereas in our approach, students can express uncertainty by selecting multiple answers in case of doubt and indicating their confidence in their responses. This allows the system to represent doubt, partial knowledge, and conflicting evidence in a principled way, while avoiding the need to account for guessing probabilities inherent in BKT. Building on this, our framework further enriches CrKT by incorporating the role of pedagogical resources. When an error occurs, our approach estimates the semantic similarity between the learner's incorrect answer and explanatory resources (e.g., targeted feedback, worked examples). This similarity score is then used to adjust the redistribution of belief masses, reinforcing correct hypotheses when relevant support is available. The result is a dynamic update mechanism that accounts not only for learner performance but also for the contextual alignment of instructional materials. This evolution of CrKT illustrates how belief functions can bridge assessment and remediation: CrKT quantifies learner mastery under uncertainty, and we extend it by linking evidence with tailored resources. Together, they demonstrate the potential of belief-based models to unify diagnosis and pedagogy in intelligent tutoring systems.

Linda Maria Lechner

Characterization of moisture levels in Fen grassland Using open geodata and the transferable belief model (TBM)
Linda Maria Lechner, Eike Stefan Dobers, Neubrandenburg University of

Applied Sciences

Abstract: The sustainable management of fen grasslands under intensive agricultural use is crucial for finding solutions to the climate crisis, since emissions from drained peatlands account for 7managing spatially high diverse fen grassland properly, site specific information with high spatial resolution, for example on moisture levels of grassland, is beneficial. In context of practical farming, such information is rarely available for grassland. However, many grassland farmers have abundant local experiences regarding their fields and their internal variability of site properties. In these data sparce conditions, the TBM can be a promising approach for gaining more information on an explicit location using already existing spatial environmental data and regional or local knowledge. The poster applies the TBM on a spatial scale to assess moisture conditions in a fen grassland catchment located in the Prignitz region of Brandenburg in northeast Germany. A digital elevation model and soil estimation data (Bodenschätzung) were used as sources of evidence and interpreted regarding moisture levels on grassland. The intuitive expert knowledge distinguished three hypothesis on moisture levels: “wet”, “fresh” and “dry”. By interpreting the partly uncertain and incomplete geodata, union sets as well as empty sets were considered. The resulting map of moisture level hypotheses was validated by Sentinel-2 data from early summer 2023 where the lack of soil moisture in grassland displayed clearly in a vegetation index describing the biomass status (Enhanced Vegetation Index, EVI). The results show that the TBM can be used to create a classified map for moisture levels in fen grassland, which can be plausibly explained by the EVI-scene used for validation. The union sets and the weight of conflict (woc) from the TBM provide additionally differentiating information on certainty of several areas. This might enhance the trustworthiness of the resulting map, especially when the method is used in applied contexts, and may therefore facilitate the transformation of plant production systems in the future.

Serigne Mamadou Diène

Towards the use of the contextual discounting in an evidential neural network

Serigne Mamadou Diène, Artois University

Abstract: In this poster, an extension of the Evidential Neural Network (ENN) introduced by Denoeux is proposed by replacing the classical dis-

counting operation with a refinement of the latter, called the contextual discounting (CD) operation, which allows for class-specific reliability degrees and yields a more expressive representation of uncertainty. This extension, named CD-ENN, is trained using the cross-entropy of the normalized contour function, making it efficient to learn its additional parameters. Experimental results on UCI datasets show that CD-ENN outperforms the original ENN in terms of predictive performance, as measured by the recently introduced generalized negative log-likelihood criterion.

Fatima-Ezzahra Maad

Fatima-Ezzahra Maad, INSA Rouen Normandie, LITIS lab

Abstract: We investigate transfer learning for collaborative driving in uncertain environment. We focus on scenarios where a vehicle enters to a new environment and needs experts' knowledge. Within a multi-expert setting, each expert contributes decision-making capabilities based on uncertainty estimation to ensure reliability.