ΣsciM 2021

BOOK OF ABSTRACTS

13th European Symposium on Computational Intelligence and Mathematics

October 3rd – 6th, 2021 • Budapest, Hungary

Editors:

László T. Kóczy, Jesús Medina

Associate Editors:

Roberto G. Aragón, Fernando Chacón-Gómez, Janusz Kacprzyk,

M. Eugenia Cornejo-Piñero, David Lobo, Eloísa Ramírez-Poussa

Book of abstracts of ESCIM 2021

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Program of the

13th European Symposium
on Computational Intelligence and Mathematics

October 3rd - 6th 2021. Budapest, Hungary

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Keynote speech:

On fuzzy natural logic and its applications

Vilém Novák

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Abstract: L. A. Zadeh, the founder of the fuzzy set theory, demonstrated in many of his papers that his approach makes it possible to develop a unique mathematical model of the semantics of some expressions of natural language and to apply it in solution of various practical problems. Recall one of the most successful applications — the fuzzy control in which control is realized by transforming operators (i.e., expert) knowledge formulated in natural language into an algorithm.

The fundamental role in these applications is played by expressions of natural language such as «small, very weak, medium, extremely large, significantly expensive» etc. Recall that they form a special class of linguistic expressions called *evaluative linguistic expressions*. In this talk, we will place them into a wider program of the so-called *Fuzzy Natural Logic* (FNL). Its goal is to develop a mathematical model of human reasoning whose typical feature is the use of natural language. Among results of FNL, besides the theory of evaluative expressions, belongs also sophisticated theory of intermediate (linguistic) quantifiers, or a special inference method called *Perception-based Logic Deduction* (PbLD), which provides the algorithm that behaves as if "understanding" linguistic expressions.

Besides the above theory, we also mention applications of FNL in control, multiple-criteria decision-making, forecasting, and mining information from time series.

Decidability of real-valued **S4** Gödel logic

Martín Diéguez[1] and David Fernández-Duque[2]

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Abstract: We introduce semantics for crisp and fuzzy Gödel **S4** based on bi-relational frames. We then show that each version of the logic is sound and complete for its respective class of frames and enjoys the finite model property. From this we conclude that both the crisp and fuzzy versions of Gödel **S4** are decidable.

Keywords: Gödel Logic · Completeness · Fuzzy Logic · Modal Logic

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Basic logic versus multi-adjoint logic

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Abstract: This paper presents a comparative study between the well-known basic logic (BL) introduced by Petr Hájek and the multi-adjoint logic (ML), which arose for responding the need to introduce an axiomatization associated with multi-adjoint algebras.

Keywords: Bounded poset · BL-algebra · multi-adjoint algebra · propositional logic · fuzzy logic

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Fuzzy logic programming with generalized quantifiers

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Abstract: This paper introduces a new definition of the immediate consequence operator considered in many fuzzy logic programming frameworks, focused on weakening the universal feature of the supremum operator. This new definition has been possible taking advantage of the notion of generalized quantifiers, which provides weaker quantifiers than the universal one.

Keywords: Logic programming · immediate consequence operator · generalized quantifiers

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Fuzzy relations: the fundament for fuzzy rough approximation, fuzzy concept analysis and fuzzy mathematical morphology

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Abstract: We present a unified approach to the theory of forward and backward operators induced by L-fuzzy relation and illustrate their role in theory of generalized fuzzy rough sets, in the study of oriented fuzzy concept lattices and in fuzzy mathematical morphology.

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Information bireducts and its relationship with reducts

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Abstract: Information bireducts are useful tools in Rough Set Theory in order to simultaneously reduce the sets of objects and attributes in a dataset. Specifically, information bireducts provide non-redundant subtables preserving the original discernibilities. This paper presents different properties of information bireducts taking special interest in its relationship with reducts.

Keywords: Rough Set Theory · Information tables · Reducts · Bireducts

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Keynote speech:

Adjoint algebras. Theory and applications.

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Abstract: One important goal for obtaining useful information from databases
is to select the most suitable operators to be considered in the computations.
The more versatile and tractable the operators are, the better can be adapted
to the data and so, more knowledge can be extracted. For example, in image
processing, the noise is very notable and different general operators such as,
pre-aggregations, ordered directionally monotone functions, etc., have been in-
troduced in order to obtain better results. Adjoint triples are other general oper-
ators which have been used to introduce flexible tools for defining fuzzy versatile
frameworks in logic programming, formal concept analysis, rough set theory,
fuzzy relation equations and mathematical morphology. Adjoint triples arise as
an interesting generalization of t-norms and their residuated implications, since
they preserve their main properties and retain only the minimal mathematical
requirements for guaranteeing operability. Specifically, they are tuples composed
of an adjoint conjunctor and two residuated implications. Knowing in depth these
operators will allow us to solve a larger number of real problems, which clearly
highlight the importance of studying this kind of operators

This presentation provides a wide study on adjoint algebras including the-
oretical definitions and properties, as well as a comparison with other different
general (non-commutative) algebraic structures such as sup-preserving aggre-
gations, quantales, u-norms, uninorms and general implications considered in
extended-order algebras. In addition, different applications of fuzzy mathemat-
ical tools, whose underlying algebraic structure is an adjoint algebra, will be
mentioned.

On the applicability of fuzzy lines in circular Hough transform in lesion segmentation on liver CT images

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Abstract: Most of the lesions that grow in the liver and need to be found on a CT take are roundish, though especially in the case of malignant lesions the irregularity of the shape is also rather common. Classical Hough transform, however, which is one of the most used methods for finding circles, usually fails to find the contours of these objects, because of the larger or smaller irregularity of the shapes. Introducing a fuzzification in the edge filtered version of the image, which is usually the basis of a Hough transform, makes the Hough transform more flexible for using in liver CT image analysis.

Keywords: Hough transform · fuzzy Hough transform · roundish object · liver lesion · CT image analysis

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Directional properties of semi-aggregation functions

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Abstract: We relate notions of directional monotonicity and of directional shift-invariantness with the classical directional derivatives. Based on a fixed direction $\vec{r}$, possible shift constants are determined. Several examples illustrate our ideas and results.

Keywords: Aggregation function · directional derivative · directional monotonicity · directional shift-invariantness

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Generalized Phi-Transform of Aggregation Functions on Bounded Lattices

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Abstract: In 2019, Jin et al. presented a new construction method for aggregation functions that is based on the so-called bijective chains, generalizing the standard isomorphic φ-transforms of aggregation functions. It covers, among others, several known construction methods, such as particular cases of ordinal sums of aggregation functions, e.g., of t-norms, copulas, t-conorms, etc. In this paper, we introduce a new construction method to aggregation functions on bounded lattices.

Keywords: Aggregation function · Ordinal sum · Bounded lattice · φ-transform

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Sugeno Integral for Atanassov Intuitionistic Fuzzy Sets

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Abstract: We continue previous work on the recently proposed relationship between L-fuzzy measures, integrals and isotone concept-forming operators on a Girard monoid in order to define a generalized notion of Sugeno integral for Atanassov Intuitionistic L-fuzzy sets. We also provide some examples on the practical interpretation of the proposed notion.

Keywords: Intuitionistic fuzzy sets · Sugeno measure integral

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Keynote speech:

Outliers-based aggregation

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Abstract: Inspired by the basic fuzzy connectives min (t-norm TM) and max (t-conorm SM), we introduce and study outliers-based extended aggregation functions. Simply said, A is an (a, b)-outliers-based extended aggregation function if for each arity $n \geq a + b$, its output values depend on the number a of minimal and b of maximal input values only. We focus on associative outliers-based extended aggregation functions, including t-norms, t-conorms, uninorms, nullnorms, as well as on outliers-based extended OWA operators and related outliers-based extended aggregation functions. Also, some distinguished integrals are considered. Observe that there is unique $(1, 0)$-outliers-based t-norm, namely the strongest t-norm TM, but plenty of $(2, 0)$-outliers-based t-norms, including the drastic product TD and the nilpotent minimum TnM, among others. Results for t-conorms are obtained by duality, which changes (a, b)-outliers case into the (b, a)-outliers case. These results help also in characterization of outliers-based uninorms and nullnorms.

Facilitating the simulation of domestic energy systems through linguistic representations

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Abstract: The demand and cost of energy and the emerging of new clean energy have promoted the use of a variety of energy sources in the home, which requires the formulation of new policies or strategies to manage these energy sources in the most cost-effective manner. This work aims to propose an intelligent energy management system that can be used in civil and commercial buildings to simulate the choice of energy at a given time, and to select the best energy from different available energies, so as to meet the most economical way to feed the electricity consumption of the house. The technical core of this work is how to make the best choice from the perspective of energy costs various related factors changing over time. Taking into account the network configurations that power houses and have different energy sources (such as photo-voltaic panels, batteries or the grid itself, etc.) and their constraints, as well as the energy cost objective function, we convert this grid modeling or energy configuration problem to an energy cost Constraint Satisfaction Problem (CSP), in order to achieve simulation under different conditions. In addition, considering the complexity of the parameters for some inexperienced users, when establishing certain specific parameter configurations, we propose to use natural language to represent these parameters, so as to use fuzzy logic methods to deal with the ambiguity and imprecision related to these variables. The experimental simulates the difference while the family has its own fixed energy configuration and the case of the optimized the energy configuration according to the grid configuration. The system can also help simulate various grid configurations in order to find the best or most suitable configuration before making any investment.

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Experiments with the Discrete Bacterial Memetic Evolutionary Algorithm for solving the Cumulative Capacitated Vehicle Routing Problem

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Abstract: In this paper we present our initial experiments with the Discrete Bacterial Memetic Evolutionary Algorithm for solving the Cumulative Capacitated Vehicle Routing Problem. The algorithm was tested on instances proposed in the literature. However our method was able to find the optimal solution for small (around 50 nodes) instances, but its convergence speed is low. In the last sec-tion some of our ideas to improve the performance of the algorithm were presented.

Keywords: discrete optimization · Cumulative Capacitated Vehicle Routing Problem · metaheuristic · vehicle routing

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Fuzzy Inference System-like Aggregation Operator (FISAO) for Fuzzy Signatures

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Abstract: This paper deals with a novel fuzzy aggregation operator. This aggregation operator is suggested to such fuzzy signatures, where the correlation between the leafs or branches can not be handled by classical operators as weighted relevance aggregation operator or weighted generalized mean, more with fuzzy rules. This paper presents the suggested Fuzzy inference system-like aggregation operator (FISAO), shows its axiomatic conformity and depicts its use through an experimental example.

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Looking for fuzzy extensions of closure operators

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Abstract: Closure operators and closure systems are key concepts in both pure and applied mathematics. Fuzzy closure operators [1,3] appear in several areas of fuzzy logic and its applications, including fuzzy mathematical morphology [9,13], fuzzy relational equations [8], approximate reasoning [6,7] and fuzzy logic in narrow sense [11]. One of the main areas in which these notions are used is lattice theory [5] and, particularly, Formal Concept Analysis (FCA) [10]. The results of FCA concerning these structures were extended to the fuzzy framework in [2].

Throughout this paper we work on a complete fuzzy lattice, i.e., there is no explicit use of powerset structure. While fuzzy closure operators have a standard definition in this framework, this is not the case for closure systems. Considering them as crisp sets, we find the most cited definition by Bělohlávek [1], which makes use of the powerset structure; but also one extending the idea of a ∧-subsemilattice in [4] and a third one in terms of minima of certain sets, which follows the ideas used in weaker structures as fuzzy (pre)posets, in [14]. Fortunately, all these definitions, which come from different ideas, are equivalent. A direct extension of the notion of closure system is to consider them as fuzzy sets where the membership of every element is the degree to which that element is closed. In this sense, there are several definitions too. For instance, there is that of L-closure L-systems by Bělohlávek [1], one by Liu and Lu [12] and one extending the ∧-subsemilattice structure mentioned above [14]. These definitions do not behave as well as the previous ones. In fact, these are not equivalent in general. Nevertheless, none of these definitions is in a one-to-one relation with closure operators. It is under the condition of extensionality that some of these definitions are equivalent and the duality between fuzzy closure systems and closure operators can be proved.

Once a definition of fuzzy closure system is fixed, the closure operator structure, typically a crisp mapping, can also be extended. The extension of a mapping is a relation and, in order to maintain the properties of a closure, it needs to be inflationary, isotone and idempotent. With this idea in mind, the properties of fuzzy closure relations and their relationship with fuzzy closure systems are studied.

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Context of a local congruence concept reduction

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Abstract: In formal concept analysis, attribute reductions lead to equivalence relations on concept lattices. Lately, local congruences arose to enhance the structure of the equivalence classes. In this paper, we show a procedure that details the impact of the application of local congruences on concept lattices obtained from attribute reductions.

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One-sided concept lattices by blocks

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Abstract: One-sided concept lattices is an interesting approach to manage information stored in databases. This theory considers a blended nature of the studied sets such that one set is crisp and the other one is fuzzy. Another important theory to manage and extract knowledge is rough set theory, trough an information system. In this paper, we present a first approach in order to connect one-sided concept lattices and information systems.

Keywords: One-sided concept lattice · tolerance relation · fuzzy sets · rough set theory

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Discrete universal fuzzy integrals

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Abstract: Using hypergraphs of survival functions, we propose a rather general method for construction of discrete fuzzy integrals. Our method is based on vertical/horizontal decompositions of hypergraphs and on rectangle mappings suitably evaluating rectangles of the considered decompositions. By means of appropriate binary aggregation functions we define two types of rectangle mappings and three types of discrete fuzzy integral constructions. All introduced methods coincide in the case of the product aggregation function, and then the related integral is the Choquet integral. Several examples are given.

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Energy determined membership function of viscoelastic models

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Abstract: Mechanical response of viscoelastic materials to an imposed mechanical load stands somewhere between two boundaries - elastic and viscous. Within the viscoelasticity theory the viscoelastic these materials represented by their models are studied. When we allocate zero and one to purely elastic and purely viscous property respectively, we can farther stipulate a V-membership function quantifying the measure of viscous behaviour of the material represented by the model. In this paper the isothermal state is studied. Accordingly, the total amount of energy is split to stored and dissipated one, which defines the ratio of elastic and viscous strength of the model. Hereby, each viscoelastic model can be regarded from the fuzzy viewpoint. Thermodynamics plays the essential role here.

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Keynote speech:

Data-Driven Fuzzy Modeling Inspired by Manifolds

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Abstract: The talk will focus on efficient data-driven modeling associated with the inverse problem and feature extraction. We show how the theories of 1-manifolds and F-transforms contribute to these delineated areas.

The manifold hypothesis states that the shape of observed data is relatively simple and that it lies on a low-dimensional manifold embedded in a higher-dimensional space. We contribute to the problem of manifold learning. We show that a space whose topological structure is characterized by a fuzzy partition naturally leads to so called Riemannian spaces or Riemannian manifolds.

Advances in forgery detection of driving licences using truthfulness degrees

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Abstract: We develop a methodology which allows to detect forgeries in driving licences based on an analysis of two serial codes usually included in licences issued in European countries. Results from the initial analysis show the usefulness of the methodology, and that the best code for detection depends on the particularities of the licence in each issuing country.

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A formal method for driver identification

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Abstract: This paper presents a preliminary study of the application of formal concept analysis to automatic driver identification. Specifically, a methodology based on attribute implications has been considered and its main features have been studied. From a particular dataset, the proposed methodology focuses on driver recognition by analyzing the values of a subset of variables related to driving style.

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Analysis and identification of forensic events using non-parametric density estimation

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Abstract: The goal of this article is to show how the non-parametric probability density estimation method can be used to visualize the occurrence of criminal events. For this purpose, an algorithm of kernel estimators using effective Epanechnikov function is applied. The purpose of this procedure is to reveal where criminal incidents occur most frequently. Data representing the location of crimes in the city of Baltimore, Maryland between 1963-2014 are selected for the investigation. After information processing, only the most relevant incidents are regarded, i.e.: aggravated assault, auto theft, burglary, common assault, larceny, larceny from auto and street robbery. It is shown, that based upon the algorithm used in this research, it is possible to visualize areas on the city map where the highest probability of a particular crime is determined.

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Fuzzy signature based model in material handling management

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Abstract: Scheduling and management of material handling in functional production system are among the biggest challenges of logistics. Among several methods, linear programming gives exact solution to these kinds of problems, however, linear programming is rigid and requires specially trained personnel to operate. Fuzzy logic based systems − besides they work similarly to human thinking − seems to be easily implementable in such problems. In this paper we present a fuzzy signature based approach constructed on expert knowledge. Its results are compared to the results of linear programming in the same situations.

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On Choquet integral in ranking crimes

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Abstract: This paper is devoted to show the applicability of the Choquet integral in classification or ranking problems. Specifically, a methodology for the automatic prioritization of suspicious data or rank different data, which is based on integral aggregation operators with a fuzzy measure in its core, is presented. The proposed approach is illustrated by an experimental example of forensics data.

Keywords: Aggregation operator · Fuzzy measure · Choquet integral

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The Effects of Knowledge Extraction Approaches on Cryptanalysis Studies and Analysis of the Success of Chaos-Based Countermeasures

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Abstract: Although each new approach and scientific progress provides many advantages and innovations from theory to practice, its disadvantages should be evaluated comprehensively from different perspectives. In this study, the effects of knowledge extraction approaches on the cryptanalysis process have beenevaluated. It is known that the secret key of the encryption algorithm can be obtained by using knowledge extraction approaches, especially with application- oriented attacks such as side channel analysis. It is known that chaotic masks can be used as a countermeasure to prevent the success of these attacks. In this study, side-channel analyzes of the chaos-based substitution box structures that have been proposed in recent years have been carried out. The side channel analysis results of the existing studies in the literature have been carried out for the first time in this study. The results obtained showed that the approaches in the field of knowledge extraction should be handled more comprehensively in the crypt-analysis processes, and also pointed out that a new evaluation criterion should be analyzed for future studies for chaos-based design studies.

Keywords: Knowledge Extraction · Cryptanalysis · Chaotic Mask · Substitution Box

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