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## Forthcoming Papers

### Special Issue on Fuzzy Logic, edited by Henri Prade and Didier Dubois

#### **I. Bloch, T. Géraud and H. Maître, Representation and fusion of heterogeneous fuzzy information in the 3D space for model-based structural recognition—Application to 3D brain imaging**

We present a novel approach to model-based pattern recognition where structural information and spatial relationships have a most important role. It is illustrated in the domain of 3D brain structure recognition using an anatomical atlas. Our approach performs segmentation and recognition of the scene simultaneously. The solution of the recognition task is progressive, processing successively different objects, and using different pieces of knowledge about the object and about relationships between objects. Therefore, the core of the approach is the knowledge representation part, and constitutes the main contribution of this paper. We make use of a spatial representation of each piece of information, as a spatial fuzzy set representing a constraint to be satisfied by the searched object, thanks in particular to fuzzy mathematical morphology operations. Fusion of these constraints allows us to select, segment and recognize the desired object. © 2003 Published by Elsevier Science B.V.

#### **E. Hüllermeier, Possibilistic instance-based learning**

A method of instance-based learning is introduced which makes use of possibility theory and fuzzy sets. Particularly, a possibilistic version of the similarity-guided extrapolation principle underlying the instance-based learning paradigm is proposed. This version is compared to the commonly used probabilistic approach from a methodological point of view. Moreover, aspects of knowledge representation such as the modeling of uncertainty are discussed. Taking the possibilistic extrapolation principle as a point of departure, an instance-based learning procedure is outlined which includes the handling of incomplete information, methods for reducing storage requirements and the adaptation of the influence of stored cases according to their typicality. First theoretical and experimental results showing the efficiency of possibilistic instance-based learning are presented as well. © 2003 Published by Elsevier Science B.V.

#### **I. Miguel and Q. Shen, Fuzzy $r$ DFCSP and planning**

Constraint satisfaction is a fundamental Artificial Intelligence technique for knowledge representation and inference. However, the formulation of a static constraint satisfaction problem (CSP) with hard, imperative constraints is insufficient to model many real problems. Fuzzy constraint satisfaction

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provides a more graded viewpoint. Priorities and preferences are placed on individual constraints and aggregated via fuzzy conjunction to obtain a satisfaction degree for a solution to the problem. This paper examines methods for solving an important instance of dynamic flexible constraint satisfaction (DFCSP) combining fuzzy CSP and restriction/relaxation based dynamic CSP: fuzzy *rr*DFCSP. This allows the modelling of complex situations where both the set of constraints may change over time and there is flexibility inherent in the definition of the problem. This paper also presents a means by which classical planning can be extended via fuzzy sets to enable flexible goals and preferences to be placed on the use of planning operators. A range of plans can be produced, trading compromises made versus the length of the plan. The flexible planning operators are close in definition to fuzzy constraints. Hence, through a hierarchical decomposition of the planning graph, the work shows how flexible planning reduces to the solution of a set of fuzzy *rr*DFCSPs. © 2003 Published by Elsevier Science B.V.

### **E. Raufaste, R. da Silva Neves and C. Mariné, Testing the descriptive validity of possibility theory in human judgments of uncertainty**

Many works in the past showed that human judgments of uncertainty do not conform very well to probability theory. The present paper reports four experiments that were conducted in order to evaluate if human judgments of uncertainty conform better to possibility theory. At first, two experiments investigate the descriptive properties of some basic possibilistic measures. Then a new measurement apparatus is used, the  $\Psi$ -scale, to compare possibilistic vs. probabilistic disjunction and conjunction. Results strongly suggest that a human judgment is qualitative in essence, closer to a possibilistic than to a probabilistic approach of uncertainty. The paper also describes a qualitative heuristic, for conjunction, which was used by expert radiologists. © 2003 Published by Elsevier Science B.V.

### **D.G. Schwartz, Agent-oriented epistemic reasoning: Subjective conditions of knowledge and belief**

This paper introduces a formal system  $\Sigma$  of *subjective epistemic reasoning* that encodes a method of reasoning with conditions of *knowledge* and *belief*. The conditions are subjective in that they are taken from the perspective of an agent's perception of his own state of knowledge or belief with respect to his observable world. Belief is measured along a series of linguistic degrees, e.g., *strongly believes*, *fairly confidently believes*, *somewhat disbelieves*, etc., and *knowledge* is taken as unequivocal belief. The system employs a novel, dual-leveled language that follows fuzzy logic by interpreting the logical *or* and *and* as the arithmetical *max* and *min*. Numerous properties of  $\Sigma$ , illustrating its intuitive appeal for the intended purpose, are derived. © 2003 Published by Elsevier Science B.V.

### **M. Grabisch, Temporal scenario modelling and recognition based on possibilistic logic**

We propose in this paper a new approach for the modelling and recognition of temporal scenarios. A scenario is represented by three different structures. The first one models the logical dependency between the elements of the scenario, using possibilistic logic, while the second one is the minimal temporal graph representing all temporal constraints between the events. The third structure explains the way the matching between observations and scenarios has to be done. The consistency between the three structures is ensured. © 2003 Published by Elsevier Science B.V.

**C. Borgelt and R. Kruse, Operations and evaluation measures for learning possibilistic graphical models**

One focus of research in graphical models is how to learn them from a dataset of sample cases. This learning task can pose unpleasant problems if the dataset to learn from contains imprecise information in the form of sets of alternatives instead of precise values. In this paper we study an approach to cope with these problems, which is not based on probability theory as the more common approaches like, e.g., expectation maximization, but uses possibility theory as the underlying calculus of a graphical model. Since the search methods employed in a learning algorithm are relatively independent of the underlying uncertainty or imprecision calculus, we focus on evaluation measures (or scoring functions). © 2003 Published by Elsevier Science B.V.

**S. Benferhat and S. Kaci, Logical representation and fusion of prioritized information based on guaranteed possibility measures: Application to the distance-based merging of classical bases**

In the possibility theory framework, prioritized information can be logically expressed in different formats. The most usual way, used in standard possibilistic logic, is to associate necessity degrees with propositional formulas. This paper considers another representation and fusion of prioritized information using *guaranteed possibility measures*. Prioritized pieces of information are then represented by sets of weighted formulas, called  $\Delta$ -knowledge bases, where weights are lower bounds of guaranteed possibility degrees of formulas.

We first show that the basic notions of standard possibilistic logic have natural counterparts when dealing with  $\Delta$ -knowledge bases. In particular we present the inference machinery, and provide syntactic, but semantically meaningful, merging of  $\Delta$ -knowledge bases. In the second part of the paper, we show that distance-based merging propositional knowledge bases can be naturally encoded using  $\Delta$ -knowledge bases. Moreover, this encoding is more efficient than the necessity-based encoding of distance-based merging operator. © 2003 Published by Elsevier Science B.V.

**D. Dubois, H. Fargier and P. Perny, Qualitative decision theory with preference relations and comparative uncertainty: An axiomatic approach**

This paper investigates a purely qualitative approach to decision making under uncertainty. Since the pioneering work of Savage, most models of decision under uncertainty rely on a numerical representation where utility and uncertainty are commensurate. Giving up this tradition, we relax this assumption and introduce an axiom of *ordinal invariance* requiring that the Decision Maker's preference between two acts only depends on the relative position of their consequences for each state. Within this qualitative framework, we determine the only possible form of the corresponding decision rule. Then assuming the transitivity of the strict preference, the underlying partial confidence relations are those at work in non-monotonic inference and thus satisfy one of the main properties of possibility theory. The satisfaction of additional postulates of unanimity and anonymity enforces the use of a necessity measure, unique up to a monotonic transformation, for encoding the relative likelihood of events. © 2003 Published by Elsevier Science B.V.

**P. Félix, S. Barro and R. Marín, Fuzzy constraint networks for signal pattern recognition**

This paper deals with representation and reasoning on information concerning the evolution of a physical parameter by means of a model based on the Fuzzy Constraint Satisfaction Problem formalism, and with which it is possible to define what we call Fuzzy Temporal Profiles (FTP). Based on fundamentally linguistic information, this model allows the integration of knowledge on the evolution of a set of parameters into a knowledge representation scheme in which time plays a fundamental role.

The FTP model describes the behaviour of a physical parameter on the basis of a set of signal events, and which allows the evolution of the parameter between each pair of events to be modelled as signal episodes. Given the fundamentally linguistic nature of the information represented, the consistency analysis of this information is an essential task. Nevertheless, the obtention of the minimal representation of the network that defines an FTP is an NP-hard problem. In spite of this, we supply algorithms guaranteeing local levels of consistency that allow to correct a large proportion of the errors committed by a human expert in the linguistic description of the profile. Furthermore, we propose a new topology whose consistency can be guaranteed in polynomial time. We also study the applicability of this model in the recognition of signal patterns. © 2003 Published by Elsevier Science B.V.

**X. Luo, N.R. Jennings, N. Shadbolt, H.-F. Leung and J.H.-M. Lee, A fuzzy constraint based model for bilateral, multi-issue negotiations in semi-competitive environments**

This paper develops a fuzzy constraint based model for bilateral multi-issue negotiation in trading environments. In particular, we are concerned with the principled negotiation approach in which agents seek to strike a fair deal for both parties, but which, nevertheless, maximises their own payoff. Thus, there are elements of both competition and cooperation in the negotiation (hence semi-competitive environments). One of the key intuitions of the approach is that there is often more than one option that can satisfy the interests of both parties. So, if the opponent cannot accept an offer then the proponent should endeavour to find an alternative that is equally acceptable to it, but more acceptable to the opponent. That is, the agent should make a trade-off. Only if such a trade-off is not possible should the agent make a concession. Against this background, our model ensures the agents reach a deal that is fair (Pareto-optimal) for both parties if such a solution exists. Moreover, this is achieved by minimising the amount of private information that is revealed. The model uses prioritised fuzzy constraints to represent trade-offs between the different possible values of the negotiation issues and to indicate how concessions should be made when they are necessary. Also by using constraints to express negotiation proposals, the model can cover the negotiation space more efficiently since each exchange covers a region rather than a single point (which is what most existing models deal with). In addition, by incorporating the notion of a reward into our negotiation model, the agents can sometimes reach agreements that would not otherwise be possible. © 2003 Published by Elsevier Science B.V.

**R. Pino-Pérez and C. Uzcátegui, Preferences and explanations****M.L. Anderson, Embodied cognition: A field guide (Field Review)****R. Chrisley, Embodied artificial intelligence****M.L. Anderson, Representations, symbols, and embodiment**

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