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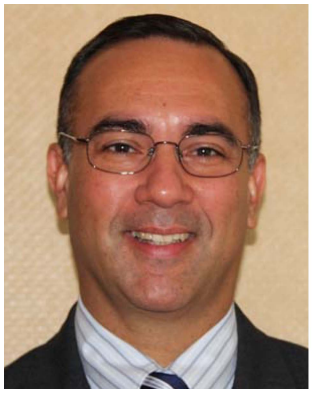

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Guest Editorial: Foreword to the Special Issue on *Evaluation of Uncertainty Representation and Reasoning Techniques*

In an era characterized by increasingly pervasive sensors, availability of large volumes of heterogeneous data and complex interactions between information systems, the problem of uncertainty representation and reasoning in high-level fusion information (HLIF) systems has attracted interest that extends beyond the Information Fusion (IF) community. For instance, fusing hard and soft information from diverse sensor or source types and the associated uncertainty is a task that still relies heavily on human intervention, creating a scalability conundrum that current technologies are incapable of solving. Despite the widespread acknowledgment that HLIF systems must support automated knowledge representation and reasoning in the presence of uncertainty, there is no consensus on the the appropriate approach to adopt (which theory, uncertainty function, fusion rule, etc), on the performance criteria that should guide the design of an HLIF system in terms of uncertainty handling, and on how to assess such criteria.

This special issue of JAIF aims at providing an overview of the most current efforts on evaluation of uncertainty representation and reasoning techniques in information fusion systems. In the opening paper of this issue, Costa et al. provide an overview of the Uncertainty Representation and Reasoning Evaluation Framework (URREF), which is currently in development by

the ISIF Evaluation of Techniques for Uncertainty Representation Working Group (ETURWG). As an evaluation framework, the URREF is comprised of different components designed to provide support to researchers, developers, and other practitioners of high-level information fusion systems in the task of assessing and characterizing how choices on uncertainty representation and reasoning impact their performance. This is a multi-facet problem whose comprehensive and exhaustive coverage is challenging, but whose most basic and common facets are addressed here. This paper establishes the basic concepts and definitions, together with their links, as common grounds to be considered.

Jousselme and Pallota, in the second paper of this special issue, explore one of the most critical facets of the problem, which is how to identify performance criteria for uncertainty evaluation. They frame the comparison of six uncertainty representation and reasoning techniques in the URREF, with an illustrative example of HLIF on maritime anomaly detection. Next, Locher and Costa propose an overarching discussion on the difficulties in understanding where and how each criterion is applicable across a general fusion process environment, including a generic fusion system model. In the process, they provide some insight to the URREF ontology, a key component of the framework that offers a formal structure for representing the semantics of uncertainty evaluation.

In the fourth paper of this issue, De Villiers et al. discuss the role of uncertainty evaluation in the lifecycle of HLIF systems, while emphasizing how uncertainty impacts modeling and decision-making within these systems. In the discussion, the flow of abstraction in fusion system inception, design and implementation is contrasted to the flow of information and the flow of decisions/actions during the routine operation of a fusion system. This contrast is a good lead to the subject of the following paper, by Dragos et al., which explores an issue that pervades all the information flow: how to estimate trust in information received by and output from HLIF systems. The paper emphasizes how the URREF ontology can be used to characterize and track uncertainties arising within the development of HLIF systems, focusing on how trust can be estimated in the process.

The next papers emphasize key aspects of uncertainty representation and reasoning in HLIF systems, setting the stage for a discussion on the application of the URREF to different domains and techniques. An example of the latter is shown by Josang in the sixth paper of this special issue, which addresses the importance of selecting a belief fusion operator that adequately matches the situation to be modeled and analyzed. Moving the discussion from technique to applications, the last two papers of this special issue illustrate the role of uncertainty evaluation in two different application domains, Avionics (Insaurralde and Blasch) and Situational Assessment (Hintz and Darcy). The first proposes an Avionics Analytics Ontology (AAO) to bring together different types of uncertainties including semantic from operators, sensing from navigation, and situation from weather modeling updates. The approach is aligned with the URREF via its use of some of the URREF ontology concepts. Finally, Hintz and Darcy close the special issue by presenting the problem of measuring uncertainty over time to control the knowledge entropy in a situation awareness system.

As it can be inferred from the papers presented in this special issue and their associated reference lists, the problem of evaluating uncertainty representation and reasoning techniques in HLIF is still far from being solved. Yet, the IF community is clearly moving ahead towards that goal and its research on the key topics is starting to bear fruits.

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