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INTUITIVE REASONING FOR EPISTEMIC UNCERTAINTY

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A DISSERTATION

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Submitted to the Faculty
of the University of Moratuwa
in partial fulfillment of the requirements for
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Dasith Nivantha Senarathne

University of Moratuwa, Sri Lanka.
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Approved:

UOM Verified Signature

Dr. E.C. Kulasekere
Research Supervisor,
Senior Lecturer, Electronic and
Telecommunication Engineering

UOM Verified Signature

Prof. J.A.K.S. Jayasinghe
Professor of Electronic and
Telecommunication Engineering

UOM Verified Signature

Dr. A.A. Pasqual
Coordinator
MSc in Telecommunications 2006/07,
Senior Lecturer, Electronic and
Telecommunication Engineering

Abstract

Senaratne, Damith Nivantha (Master of Science in Telecommunications)

Intuitive Reasoning for Epistemic Uncertainty (December, 2007)

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Epistemic uncertainty, characterized by subjectiveness and partial availability of information, is associated with the domains of multi-sensor fusion, evidence processing, etc. Mathematical Theory of Evidence, pioneered by Glenn Shafer [1], is a branch of study seeking to analytically model and manipulate the epistemic uncertainty entertained by an agent.

The field is relatively young and cluttered with schemes that are used non-cohesively and often counter-intuitively. Further the issue is made worse as none of the schemes seems to be capable of modeling fully the uncertainty met in practice. Interestingly, humans are capable of intuitively handling such uncertainty in statements in their day-to-day activities. It is apparent that the reasons for deficiencies in existing models is the unjustified nature of their application approaches.

This research seeks to enhance the intuitiveness and flexibility in mathematical modeling of epistemic uncertainty. It identifies three aspects, which any model should address cautiously. Namely, the manner in which real world propositions are mathematically represented, the manner in which uncertainty entertained by an agent is conveyed as a number assignment, and the manner in which expressed uncertainty is combined and conditioned. Novel strategies that parallels the way humans reason and hence enhance the intuitiveness, are introduced to overcome shortcomings in the existing mathematical representation. Further it proposes representing support as functions of propositions which are formed using a Boolean algebra on a set of hypotheses representing the context. Handling of some complicated propositions is simplified

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by introducing *N-of*, a logical operator formalizing the human notion 'N of n'. The research also proposes methods that can be used to select an appropriate combination strategy based on the contextual relationships between the frames, for a given evidence. It is further noted that the counter intuitive results obtained using the existing combination function's is a direct consequence of one being unaware of this relationship. Latter part of the research focuses on the concept of pre-conditioning, where evidence is conditioned based on external information one deems as certain. It also examines how comparable evidence may be averaged based on pre-determined weights.

Although, a couple of novel concepts are introduced, the concepts retains backward compatibility with what is already established in this domain. Being modular, the proposed schemes can be selectively integrated with the existing techniques.

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To my parents ...

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Completing a full-time research is not just an individual achievement. Therefore I wish to take this opportunity to thank all stakeholders associated with this research.

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