Abstract: Challenges in Explicit Modeling and Representation of the Frame of Discernment in Dempster-Shafer Theory for Tactical Intelligence

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Dempster-Shafer Theory (DST) is a mathematical framework for reasoning under uncertainty and has been widely employed in various domains, including tactical intelligence. This paper addresses the challenges associated with explicit modeling and representation of the frame of discernment when applied to tactical intelligence scenarios.

DST provides an alternative to probability theory with a set of basic events known as the Frame of Discernment. In addition, DST provides a combination rule allowing evidence fusion without prior information. From this perspective, DST can represent and process uncertain information more effectively than probability theory.

The framing of discernment defines the set of all possible hypotheses of the world and plays a crucial role in DST-based reasoning. However, constructing an accurate and comprehensive frame of discernment is a non-trivial task due to several inherent complexities.

Firstly, tactical intelligence involves numerous entities and events, leading to an immense number of potential hypotheses. Explicitly modeling and representing such complex frames of discernment becomes computationally demanding and may suffer from combinatorial explosion.

Secondly, uncertainty often arises from incomplete or unreliable data sources. Incorporating such uncertain information into the frame of discernment becomes challenging, as it requires careful consideration of the information's quality, source credibility, and potential dependencies among different sources.

Lastly, tactical intelligence often involves heterogeneous sources of information, such as human intelligence, signals intelligence, and open-source intelligence. Incorporating these diverse information sources within a common frame of discernment poses significant difficulties.

This paper explores the issues of explicit modeling and representation in Dempster-Shafer Theory and examines alternate approaches, such as, Judea Pearl's Bayesian belief networks, and Lofti Zadeh's possibility theory.