

# Distributed Information Fusion Networks for Threat Detection and Assessment

University of Miami (Lead): Premaratne K and Shyu M-L <http://ddelab.eng.miami.edu>  
University of Notre Dame (Non-Lead): Bauer PH <http://www.nd.edu/~moses>



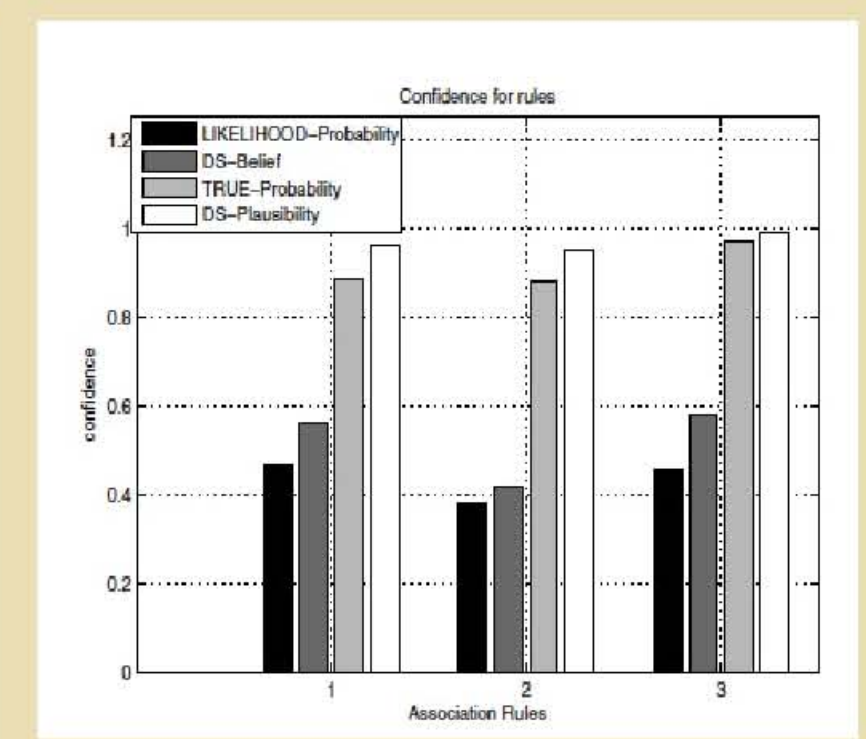
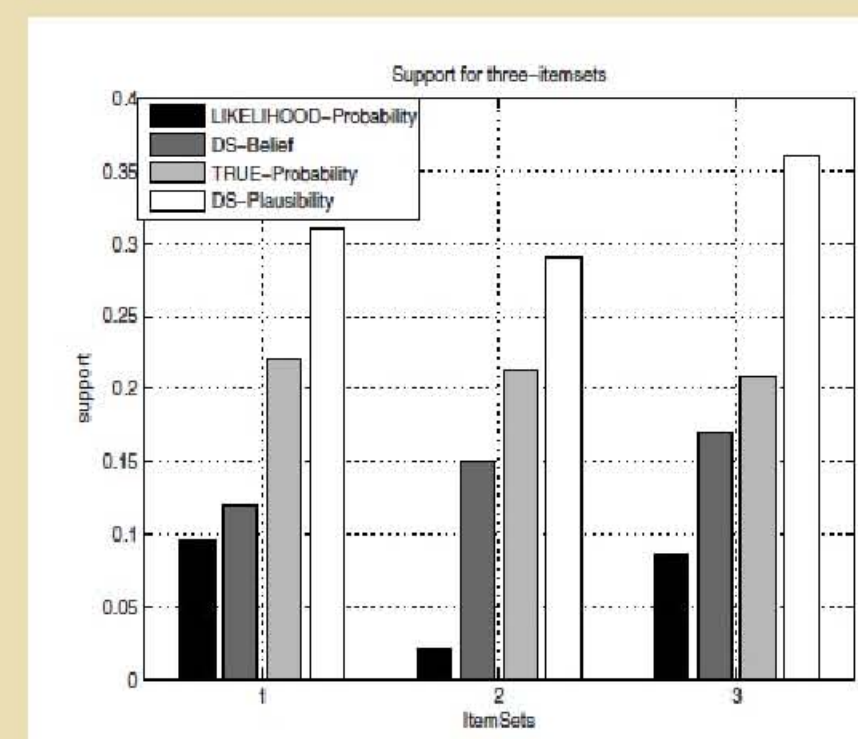
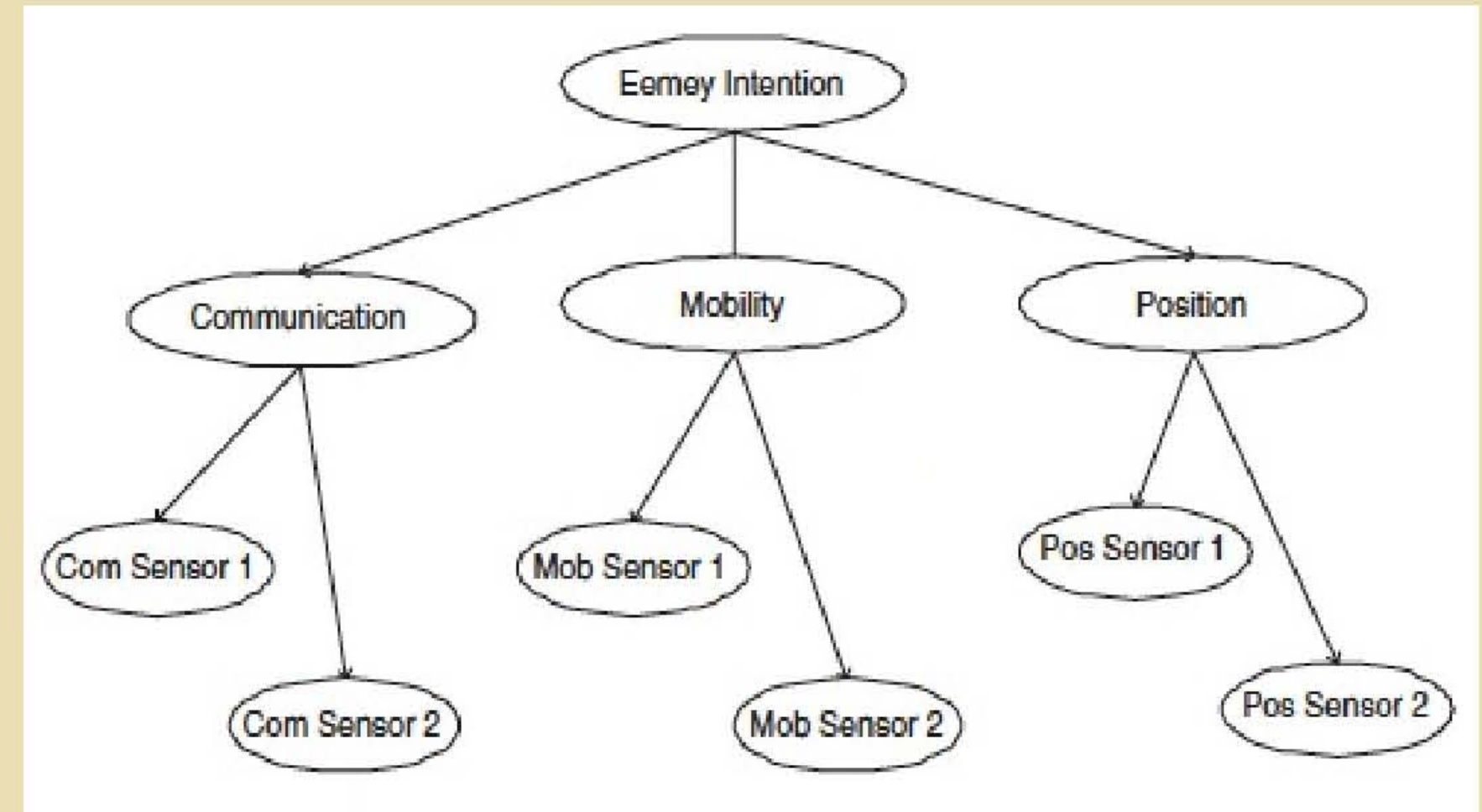
## Managing Data Imperfections in Situation Assessment Applications

Large numbers of various types of evidence sources are increasingly being made available and used in situation assessment (e.g., in military battlefields).

**Highly reliable decisions require a better strategy for managing data imperfections.** How can we

- model data imperfections?
- extract useful knowledge and make robust reliable decisions using this model?

Sidestepping these issues via **various “assumptions” about data imperfections may yield a decision-making process lacking integrity thus potentially leading to costly mistakes.**



Belief network model of a naval anti-surface warfare scenario: inherent uncertainty is better captured by the DS theoretic model.

## Approach and Impact

### New Approach:

- ◆ Dempster-Shafer (DS) belief theoretic evidence updating strategy.
- ◆ DS Bayes-like theorem.
- ◆ DS theoretic relational database (DS-DB) and a data structure that facilitates its construction.
- ◆ DS theoretic notions for association rule mining and classification of imperfect data.
- ◆ *Evidence filtering*, a new concept for spatio-temporal and multi-modal event detection from streaming data.

### Research Impact:

- ◆ Handles incoming evidence reliability, knowledge base ‘inertia’ and ‘integrity,’ source heterogeneity, and stored/streaming data.
- ◆ likelihood + priors → posterior based decisions.
- ◆ Neither antecedent nor consequent being restricted to be ‘crisp,’ rules that may otherwise remain undiscovered can be extracted.
- ◆ Selective fusion of spatio-temporal evidence across multiple sensing modalities to infer on ‘frequency’ characteristics of low-signature events.

## Challenges

- ◆ How can we efficiently respond to specific queries (e.g., what is the belief of a given data record?) and carry out association rule mining from a DS-DB?
- ◆ What are the DS theoretic counterpart notions to *itemset*, *frequent itemset*, *itemset support* and *rule confidence*?
- ◆ How do we generate rules and combine them to classify an incoming record?
- ◆ How do we measure the performance of a DS theoretic classifier?