



Aalto-yliopisto
Perustieteiden
korkeakoulu

A study on evidence theory: a general representation of uncertainty (valmiin työn esittely)

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Työn saa tallentaa ja julkistaa Aalto-yliopiston avoimilla verkkosivuilla. Muilta osin kaikki oikeudet pidätetään.

Introduction

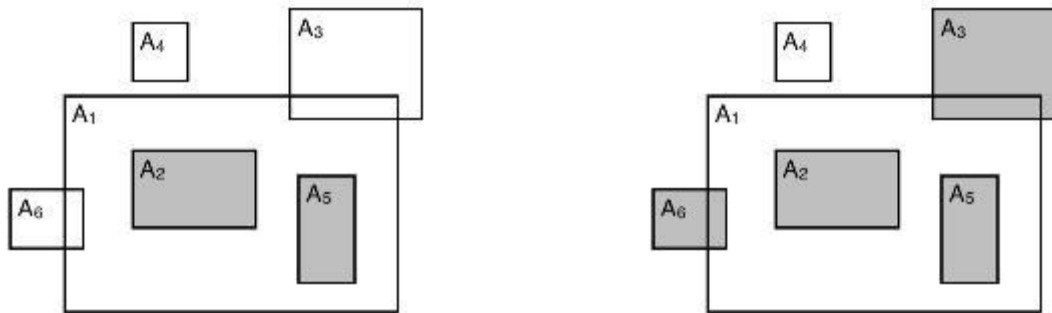
- No concise tutorial available before
- A framework for reasoning with uncertainty
- First introduced by Arthur P. Dempster, developed by Glenn Shafer in the 1960s and 1970s
 - Also called Dempster-Shafer theory of evidence
- Combining evidence into degrees of belief
- A general framework for formulating other methods
- Multiple application areas

Background

- Uncertainty is involved in all real world applications
- Two types of uncertainty
 - Aleatory (stochastic) and epistemic (subjective) uncertainty
- Incomplete or subjective information
- Not the first theory developed for modelling epistemic uncertainty

Mathematical foundation

- Normalized monotone measures
 - Belief (Bel), plausibility (Pl) and basic assignment (m)
 - $m: P_X \rightarrow [0, 1]$, normalized
 - $Bel(A_i) = \sum_{A_j \subseteq A_i} m(A_j)$, $Pl(A_i) = \sum_{A_j \cap A_i \neq \emptyset} m(A_j)$



- Plausibility and belief form a duality, e.g. $Pl(A) = 1 - Bel(\bar{A})$
- Different views for the same body of evidence

Combining evidence

- Information from multiple sources need to be combined
 - E.g multiple experts' opinions
- Many rules – no single universally accepted rule
 - Different results
- Associativity
 - Ability to update an already combined structure
- Counter-intuitive results
 - E.g medical diagnosis by two doctors

Special cases of evidence theory

- Possibility theory
 - Very similar to evidence theory
- Probability theory
 - Older than evidence theory
 - Often used, but not entirely suitable
 - Bayesian probability theory
 - Belief and plausibility can be interpreted in some cases as limits for probability
- Other theories

Applications and future

- Fields involving analysis by humans
- Current applications
 - Decision making
 - Classification
 - Meteorology
 - Medical diagnosis
- Prospects
 - Increasing computational power → more complex applications
 - Multiple other application possibilities