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

*Katri Selonen*

20.04.2015

Ohjaaja: *Matteo Brunelli*

Valvoja: *Raimo P. Hämäläinen*
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 ($m$)
  - $m: \mathcal{P}_{X} \rightarrow [0, 1]$, 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