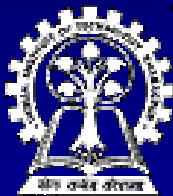


# Reasoning under Uncertainty: Issues and Other Approaches

Course: CS40022

Instructor: Dr. Pallab Dasgupta



Department of Computer Science & Engineering  
Indian Institute of Technology Kharagpur

# Default reasoning

- Some conclusions are made by default unless a counter-evidence is obtained
  - ◆ Non-monotonic reasoning
- Points to ponder
  - ◆ Whats the semantic status of default rules?
  - ◆ What happens when the evidence matches the premises of two default rules with conflicting conclusions?
  - ◆ If a belief is retracted later, how can a system keep track of which conclusions need to be retracted as a consequence?

# Issues in Rule-based methods for Uncertain Reasoning

## ■ Locality

- ◆ In logical reasoning systems, if we have  $A \Rightarrow B$ , then we can conclude B given evidence A, *without worrying about any other rules*. In probabilistic systems, we need to consider *all* available evidence.

# Issues in Rule-based methods for Uncertain Reasoning

## ■ Detachment

- ◆ Once a logical proof is found for proposition B, we can use it regardless of how it was derived (*it can be detached from its justification*). In probabilistic reasoning, the source of the evidence is important for subsequent reasoning.

# Issues in Rule-based methods for Uncertain Reasoning

- Truth functionality
  - ◆ In logic, the truth of complex sentences can be computed from the truth of the components. Probability combination does not work this way, except under strong independence assumptions.

A famous example of a truth functional system for uncertain reasoning is the *certainty factors model*, developed for the Mycin medical diagnostic program

# Dempster-Shafer Theory

- Designed to deal with the distinction between *uncertainty* and *ignorance*.
- We use a belief function  $Bel(X)$  – probability that the evidence supports the proposition
- When we do not have any evidence about  $X$ , we assign  $Bel(X) = 0$  as well as  $Bel(\neg X) = 0$

# Dempster-Shafer Theory

For example, if we do not know whether a coin is fair, then:

$$\text{Bel}(\text{Heads}) = \text{Bel}(\neg\text{Heads}) = 0$$

If we are given that the coin is fair with 90% certainty, then:

$$\text{Bel}(\text{Heads}) = 0.9 \times 0.5 = 0.45$$

$$\text{Bel}(\neg\text{Heads}) = 0.9 \times 0.5 = 0.45$$

*Note that we still have a gap of 0.1 that is not accounted for by the evidence*

# Fuzzy Logic

- Fuzzy set theory is a means of specifying how well an object satisfies a vague description
  - ◆ Truth is a value between 0 and 1
  - ◆ Uncertainty stems from lack of evidence, but given the dimensions of a man concluding whether he is fat has no uncertainty involved



# Fuzzy Logic

- The rules for evaluating the fuzzy truth,  $T$ , of a complex sentence are

$$T(A \wedge B) = \min( T(A), T(B) )$$

$$T(A \vee B) = \max( T(A), T(B) )$$

$$T(\neg A) = 1 - T(A)$$