Uncertainty

What is Reasoning ?

- Reasoning is the act of deriving a conclusion from certain premises using a given methodology.
- Reasoning is a process of thinking
- Reasoning is logically arguing
- Reasoning is drawing inference
- It must figure out what it needs to know from what it already knows.

What is Uncertainty?

- Uncertainty is essentially lack of information to formulate a decision.
- Uncertainty may result in making poor or bad decisions.
- As living creatures, we are accustomed to dealing with uncertainty – that's how we survive.
- Dealing with uncertainty requires reasoning under uncertainty along with possessing a lot of common sense.

Sources of Uncertainty

- Laziness: **too hard to determine exceptionless rules**
  - takes too much work to determine all of the relevant factors
  - too hard to use the enormous rules that result
- Theoretical ignorance: **don't know all the rules**
  - problem domain has no complete theory (medical diagnosis)
- Practical ignorance: **do know all the rules** BUT
  - haven't collected all relevant information for a particular case

Types of Uncertainty

1. Uncertainty in Prior Knowledge
2. Uncertainty in Perception
3. Uncertainty in Action

Monotonic and Non-monotonic Reasoning

- a logic is monotonic if the truth of a proposition does not change when new information (axioms) are added.
- Formal logic is a set of rules for making deductions that seem self evident.
- The traditional logic is monotonic.

- The human reasoning is non-monotonic in nature.
- This means, we reach to conclusions from certain premises that we would not reach if certain other sentences are included in our premises.

Monotonic and Non-monotonic Reasoning

- A logic is non-monotonic if the truth of a proposition may change when new information (axioms) are added.
- The non-monotonic human reasoning is caused by the fact that our knowledge about the world is always incomplete.
- Therefore we often revise our conclusions, when new information becomes available.
- **Example:**
  - Birds typically fly.
  - Tweety is a bird.

  - Tweety (presumably) flies.

Certainty Factor Theory (CF)

- Certainty factors measure the confidence that is placed on a conclusion based on the evidence known so far.
- Certainty factors combine belief and disbelief into a single number based on some evidence
- A certainty factor is the difference between the following two components :

$$CF = MB[h:e] - MD[h:e]$$

A positive CF means the evidence supports the hypothesis since MB > MD.

Certainty Theory (CF)

1. **Measures of Belief (MB)**

   Number that reflects the measure of increased belief in a hypothesis H based on evidence E

   $$0 \leq MB \leq 1$$

2. **Measures of Disbelief (MD)**

   Number that reflects the measure of increase disbelief in a hypothesis H based on evidence E

   $$0 \leq MD \leq 1$$

Certainty Theory (CF)

3. **Certainty Factor**

Number that reflects the net level of belief in a hypothesis given available information

$$CF = MB - MD$$

$$-1 \leq CF \leq 1$$

Certainty Theory (CF)

- Uncertain evidence is given CF or certainty factor value ranging from -1 (completely false) to 1 (completely true).
- Negative values degree of disbelief
- Positive values degree of belief
- Range of CF values

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false	Possibly False	Unknown	Possible True	True
-1		0		1
Measures of disbelief			Measures of belief	

Certainty Theory: Values Interpretation

Definitely Not	-1.0
Almost certainly not	-0.8
Probably not	-0.6
Maybe not	-0.4
Unknown	-0.2 to 0.2
Maybe	0.4
Probably	0.6
Almost Certainly	0.8
Definitely	1.0