Managing Uncertain Knowledge on the Fuzzy Semantic Web

Jidi Zhao, Harold Boley, and Weichang Du

Motivation

※**Limitations of Precise Reasoning**
- ※concepts without well-defined boundaries often have to be defined with 'artificial' boundaries
- ※originally uncertain relationships have to be forced into precise relationships for knowledge representation
- ※distorting reality and expert thinking
- ※giving up important properties
- ※loss of authentic representation

※**Uncertainty Reasoning**
- ※uncertainty is an intrinsic feature of real-world knowledge
- ※based on known uncertain facts (evidence)
- ※applying uncertain axioms and rules
- ※resulting in conclusions that are uncertain to some degree
- ※better resembling human reasoning in its use of approximate information and uncertainty to generate decisions

Solution

※**Fuzzy Description Logic fALCHIN**
- ※a fuzzy extension to the Description Logic ALCHIN
- ※based on Vague Sets
- ※ **fALCHIN** includes fuzzy concepts, roles, and constructors

※**Fuzzy Knowledge Base**
- ※fuzzy axioms and fuzzy assertions

※**Core Reasoning Algorithm**
- ※based on tableau algorithm with fuzzy extension

※**Various Inference Services and Procedures**

※**F-OWL (Fuzzy OWL)**
- ※a fuzzy extension to OWL 1 & 2
- ※abstract concrete syntax / functional-style syntax
- ※core semantics based on fALCHIN

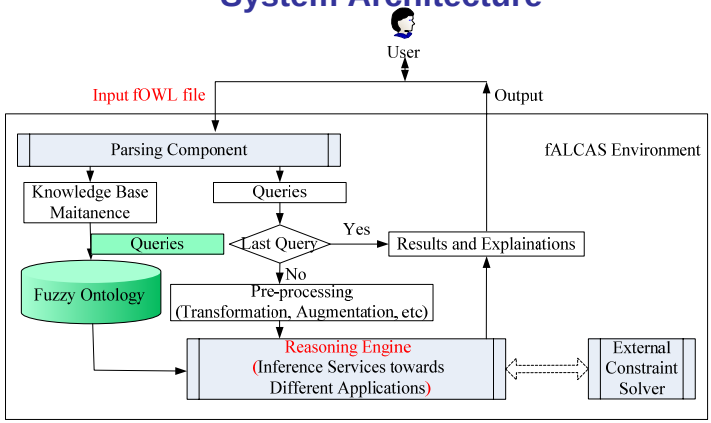
※**Prototype Implemented in Prolog: fALCAS**

Description Logics and OWL

※**Description Logics:**
- ※logic-based knowledge representation formalisms
- ※about the conceptual knowledge of arbitrary domains
- ※DLs basics include
  concepts, roles, individuals, constructors, axioms and assertions

※**OWL : Web Ontology Language**
- ※W3C's OWL 1 & 2 recommendations for the Semantic Web
- ※based on Description Logics
- ※three OWL 1 species: OWL Lite, OWL DL, and OWL Full
- ※three OWL 2 profiles: OWL 2 EL, OWL 2 QL, and OWL 2 RL

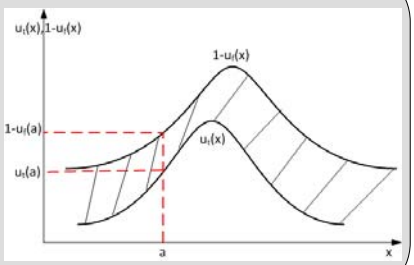
System Architecture



Fuzzy Logic and Vague Sets

※ **Fuzzy Logic:**
※ membership function u(x) with single value (D->[0,1])
※ no accuracy measurement

※ **Vague Sets:**
※ interval-valued
※ $[u_t(x), 1-u_f(x)]$
※ truth-membership function : $u_t(x)$
※ false-membership function: $u_f(x)$
※ positive and negative evidence
※ accuracy measurement



Application Services

Medical Application Scenarios
※Consistency Checking (general)
※Fuzzy Instance Entailment (patient eligibility)
- ※instance role entailment
- ※instance concept entailment

※Fuzzy Concept Subsumption and Similarity (symptom and diagnosis comparison)
※Fuzzy Retrieval (patient documents)
- ※top-k instances retrieval
- ※threshold- θ instances retrieval