

Rulelog as Theoretical Foundation for Universal Health Exchange Language[†]

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‡ <http://www.new-health-project.net/2013/06/12/universal-health-exchange-language-workshop-encinitas-june-25-26-2013/>

Goal: Model the relevant info

- **Preamble**
 - *Focus here on theoretical foundations*
 - *For health info, clinical decision support, research*
 - *Bootstrap existing/legacy tech*
- **Data (e.g., triples or cells in a database)**
- **Schemas & other ontologies: vocabulary and definitional info**
- **Mappings between ontologies/schemas, e.g.**
 - Info integration, interoperability
- **Policies (in broad sense), e.g.**
 - Info access authorization, incl. privacy/confidentiality/security
 - Treatment protocols
 - Regulations/law, contracts, reporting: e.g., around insurance
- **Causality, e.g., process descriptions**
- **HCI, esp. knowledge acquisition (KA) from English/natural-language**
 - Science
 - Policies

Logical Representations Available

- There's one main family of logical syntax available:
higher-order logic (HOL) formulas (we'll call this "rich" knowledge)
- **Two main semantics available, each with a set of reasoning techniques**
 - Note: Both use hilog FOL, not "real" higher-order, for practicality. It transforms into FOL.
 1. LP-based (declarative logic programs, with well founded semantics) – "the 99%"
 - Core of world's structured info management, incl. databases, business rules, SPARQL, OWL RL
 2. FOL-based – "the 1%". Designed for math. Used in verification.
- **Rulelog – the current acme of (1.)**
 - RIF-Rulelog is in draft as industry standard submission by RuleML to W3C and Oasis
 - Supersumes Datalog, SQL, SPARQL, Xquery, semantic production/ECA rules, OWL RL
- **Common Logic (CL) – the current acme of (2.)**
 - ISO standard. Partial implementations avail.
 - Supersumes RDF(S), OWL 2, FOL.

Textual Logic

- Logic-based text interpretation and text generation (i.e., NLP)
- On top of HOL formulas; text generation targets HOL
- Key idea: **textual terminology**
 - NL phrase corresponds 1-1 to logical term
 - Ontology thus emerges automatically, essentially
- Key idea: **rapid interactive disambiguation**
 - Of: parse, quantifiers, coreference, word-sense
 - An English sentence is interpreted into a single HOL formula, e.g., in Rulelog
- **Enables cost-effective deep-capture KA from English into rich logic**
 - Cf. recent Vulcan pilot study. E.g., ~\$1000. per page of text document.

More about Key Expressive Features

- *The ff. are all about meta knowledge*
- **Hidlog: rule id's + hilog (relies on logical functions; includes reification)**
 - For mappings, e.g., ontological, knowledge interchange, NLP
 - For provenance, incl. KB management, versioning, collaboration support
 - For modalities, e.g., “should” (deontic) in policies, “can” (alethic) in causality
 - As foundation for defeasibility
- **Defeasibility (a.k.a., exceptions; the core of logical nonmonotonicity)**
 - For policies, causality, NLP
 - Represents change in the world and change in knowledge (K). K is empirical, evolves.
 - Key for social scalability
- **Restraint – semantically represent pragmatic incompleteness**
 - For computational scalability, well-behavior
 - Voluntary, i.e., bounded rationality. Involuntary, e.g., remote query failure.
 - Selectiveness of reasoning-by-cases (srbc)
- **Rulelog has all of the above. CL has hilog only.**
 - Rulelog is the first logical KRR that is **defeasible + tractable + rich**
 - CL/FOL is perfectly brittle in face of conflict from errors, confusions, tacit context
 - Entails garbage

Probabilistic Uncertainty

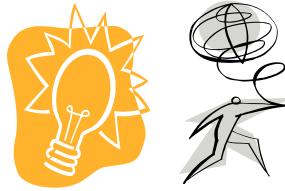
- Probabilistic uncertainty is representable in Rulelog, using meta features
- Reason about hilog atoms of the form: prob(formula, pvalue)
- Example of reasoning about cancer risk of patients
 - @genericRisk
prob(cancer(will(be(diagnosed(in(?patient(within(5(years))))))), 0.11) :- age(of(?patient(is(in(interval(55(to(60))))))).
 - @smokerRisk
prob(cancer(will(be(diagnosed(in(?patient(within(5(years))))))), 0.28) :- age(of(?patient(is(in(interval(55(to(60))))))) and history(of(?patient))(includes(heavy(smoking))).
 - _overrides(smokerRisk, genericRisk). /* smokerRisk rule has higher priority than genericRisk */
- Research is needed into how to yet more tightly couple with rich logic yet achieve scalability
 - Challenge for Markov Logic Networks and other FOL-based probabilistic approaches
 - Interesting direction: probabilistic extension of Rulelog, generalizing Probabilistic LP

Rulelog Implementation Stack

- **UI, esp. KA**
 - Textual logic
 - Logic-oriented, esp. explanation and advanced debugging
 - **Engine for reasoning**
 - Extensions for knowledge interchange
 - Extensions for omniformity (→ full Rulelog expressiveness)
 - Flora-2 (most Rulelog expressiveness) – open source
 - XSB Prolog (LP expressiveness) – open source
 - **Available implementations for highly expressive Rulelog:**
 - Flora-2 reasoner: open source implementation for most expressiveness (gd. research code)
 - On top of XSB Prolog reasoner: open source (gd. research code, used commercially)
 - Additional extensions for all of the above: (omniformity, UI, and knowledge interchange)
 - Were implemented in Vulcan's SILK but that's not avail. (tho' may be, esp. for research)
 - Commercial start-up: [Coherent Knowledge Systems](#) (formed by members of former SILK team)
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- Up the stack

For More Info

- See/listen-to the recent Ontolog Forum talk (6/20/13) by Benjamin Grosof
- It and other detailed material about Rulelog are available via the Coherent Knowledge Systems website's Publications page
 - <http://coherentknowledge.com/publications>)



Thank You

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