Common Logic (ISO 24707)

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What Is Common Logic?

- Common Logic (published as “ISO/IEC 24707:2007 — Information technology Common Logic: a framework for a family of logic-based languages”) is a language based on first-order logic, but extending it in several ways that ease the formulation of complex ontologies that are definable in first-order logic.
Abstract Syntax

- We describe the syntax of Common Logic abstractly here in order to not be committed to any particular dialects syntactic conventions
- Metamodel for specifying relationships among the syntactic categories
  - mathematical specification
  - UML
Concrete Syntaxes

1. Common Logic Interchange (CLIF)
2. Conceptual Graph Interchange Format (CGIF)
3. XCL
Semantics

- The semantics of Common Logic is defined in terms of a satisfaction relation between Common Logic text and mathematical structures called interpretations.
- Each interpretation has a set $UR$ which is the universe of reference and a set $UD$ which is a universe of discourse.
- Non-discourse names are understood not to denote entities in the universe of discourse.
- A dialect with non-discourse names is called segregated.
CL Semantics: Example 1

ur = \{ \text{before}, \text{timepoint}, \text{Monday}, \text{Tuesday}, \text{Wednesday} \}

ud = \{ \text{Monday}, \text{Tuesday}, \text{Wednesday} \}
CL Semantics: Example 2

(forall (p)
  (iff (transitive p)
    (forall (x y z)
      (if (and (p x y)
         (p y z))
        (p x z))))))

(transitive before)
(transitive older-than)
(transitive hotter-than)
CL Semantics: Example 2

\[ UR = \{ \text{transitive, older than, hotter than, before, timepoint} \]
\[ \quad \text{Monday, Tuesday, Wednesday} \} \]
\[ UD = \{ \text{transitive, older than, hotter than, before,} \]
\[ \quad \text{Monday, Tuesday, Wednesday} \} \]
A dialect is syntactically fully conformant if its parsings recognize expressions for every category of the abstract syntax.

It is conformant as a syntactic sub-dialect if it recognizes at least one of the CL categories; but any dialect shall recognize some form of sentence category.
Semantic Conformance

- Any CL dialect shall have a model-theoretic semantics, defined on a set of interpretations, called dialect interpretations, which assigns one of the two truth-values true or false to every sentence, phrase (except comment) or text in that dialect.

- A dialect is exactly semantically conformant when, for any syntactically legal sentence, phrase (except comment) or text $T$ in that dialect, the following two (separate) conformance conditions are true:
  - For every dialect interpretation $J$ of $T$, there exists a Common Logic interpretation $I$ of $T$ with $I(T) = J(T)$
  - For any Common Logic interpretation $I$ of $T$, there exists a dialect interpretation $J$ of $T$ with $I(T) = J(T)$
How Is Common Logic Used?

Ontologies

- An ontology is a computer-interpretable specification that is used by an agent, application, or other information resource to declare what terms it uses, and what the terms mean.
- There are many domains which require a logic that is at least as expressive as first-order logic, and Common Logic is the predominant language for the specification of ontologies in these domains.
The objective of the Common Logic Ontology Repository (COLORE) project is to construct an open repository of first-order ontologies that will serve as a testbed for ontology evaluation and integration techniques, and that can support the design, evaluation, and application of ontologies in first-order logic.

As of November 3, 2013, there are 1364 ontologies in COLORE, which can be found at colore.oor.net  
stl.mie.utoronto.ca/colore/ontologies.html

COLORE is also a participant in the Open Ontology Repository (OOR) Initiative (oor.net).
How Is Common Logic Used?

Semantic Interoperability

- Common Logic specifies a family of logic languages designed for use in the representation and interchange of information and data among disparate computer systems.

- Languages in the family share the same declarative semantics, so that it is possible to understand the meaning of expressions in these languages without appeal to an interpreter for manipulating those expressions.
Proposed Revisions to Common Logic

Syntactic Issues

1. Fixing the list of syntactic errors that have already been identified in Defect Report
2. Correction and completion of the XML syntax in Annex C
3. More general approach to annotation of cl-texts
Proposed Revisions to Common Logic

Semantic Issues

1. Modification of semantics to allow the existence of definitional extensions in CL
2. Circular imports
3. Semantics of cl-module
4. Questions about segregated dialects and interoperability
5. Clarification of conformance conditions
6. Namespacing
Definitional Extensions

A definitional extension of a logical theory $T$ is the extension of $T$ with a set of sentences which are conservative definitions in $T$.

These are often used to specify mappings between ontologies.
Semantics of cl-module

In ISO 24707:2007, cl-module allowed us to specify domain restrictions.

colore.oor.net/ontologies/ordered_geometry/linear_wog.clif/
Segregated and Unsegregated Dialects

(txt (inDisc Real sqrt)
(Real -1)
(not (Real i))
(= sqrt(-1) i)
(domain Real (outDisc exp)
(forall (x) (> (exp x) 0))
)
Circular Imports

Consider two ontologies: one for medicine and another for sports. The medical ontology needs to refer to a variety of terms from the sports ontology (e.g., “Roller-blading is a leading cause of wrist fractures in teens.”) and the sports ontology must also refer to medical terms (e.g., “Weight-lifters may use anabolic steroids to increase muscle growth.”).

*Example from “Tools For Assembling Modular Ontologies in Ontolingua”, Adam Farquhar, Richard Fikes, James Rice.*
Namespacing

How can we distinguish among different relations/functions with the same name?

\texttt{colore.oor.net/ontologies/between/}
\texttt{colore.oor.net/ontologies/combined\_time/}

\[\text{(forall } (x \ y \ z)\]
\[\text{(if } (\text{between } (\text{beginof } (\text{between } x \ y)) \ z \ (\text{endof } (\text{between } x \ y)))\]
\[\text{(between } (\text{endof } (\text{between } x \ y)) \ z \ (\text{beginof } (\text{between } x \ y))))\]

Grüninger ( SC32 WG2 Meeting)  Common Logic (ISO 24707)  November 13, 2013  20 / 26
Current Status

This document is the most recent version of the abstract syntax and semantics for Common Logic in Clause 6. This semantics addresses the following issues which were identified as within the scope of ISO 24707 Second Edition:

- Modification of semantics to allow the existence of definitional extensions in CL
- Semantics of cl-module
- Questions about segregated dialects and interoperability
Current Status

Remaining Work

- The concrete syntaxes for CLIF (Annex A), CGIF (Annex B), and XCL (Annex C) have not yet been updated in this Working Draft to reflect the new abstract syntax or semantics.
- The following issues which were identified as within the scope of ISO 24707 Second Edition are not addressed in this Working Draft:
  - Namespacing
  - Clarification of conformance conditions
  - More general approach to annotation of cl-texts
  - Numerical quantifiers
Plan for Completion

- Submission of Working Draft for CD by February 2014
- This document will be incomplete, and will be missing
  - XCL concrete syntax
  - More general approach to annotation of cl-texts
Bonus Round
Relationship to ISO 19763

- We can use the PSL Ontology (ISO 18629) to provide Common Logic axiomatizations of the process models and metamodels in ISO 19763-5.
- This includes Common Logic axiomatizations of UML activity diagrams, BPMN, IDEF3.
Ontology-based Standards

- I am currently the President of the International Association of Ontology and its Applications (IAOA)
- The role of the Standardisation Coordination Technical Committee within IAOA is to foster interactions between the ontology and standards communities, and to facilitate the application of ontologies and ontological analysis to existing and emerging standards.