

Towards the Second Edition of ISO 24707 Common Logic

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Miniseries on Ontologies, Rules, and Logic Programming for Reasoning and Applications

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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.

An interpretation I consists of

- a set UR_I , the universe of reference
- a set UD_I , the universe of discourse, such that
 - ▶ $UD_I \neq \emptyset$;
 - ▶ $UD_I \subseteq UR_I$;
- a mapping $int_I : V \rightarrow UR_I$;
- a mapping rel_I from UR_I to subsets of UD_I^* .

How Is Common Logic Being Used?

Open Ontology Repositories

- COLORE (Common Logic Ontology Repository)
`colore.oor.net`
`stl.mie.utoronto.ca/colore/ontologies.html`
- OntoHub
`www.ontohub.org`
`https://github.com/ontohub/ontohub`

How Is Common Logic Being Used?

Ontology-based Standards

- Process Specification Language (ISO 18629)
- Date-Time Vocabulary (OMG)
- Foundational UML (OMG)
- Semantic Web Services Framework (W3C)
- OntoOp (ISO WD 17347)

Software Support for Common Logic

- Heterogeneous Tool Set (HETS)
- Samian Platform, Kojeware Corp
- MACLEOD
`https://github.com/thahmann/macleod`
- OntologyPortal
- RECON

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.

colore.oor.net/ontologies/periods/mappings/periods2approximate_point.clif

Problems with Definitional Extensions

Given a CLIF theory T , the addition of the sentence

$(\text{forall } (x) (\text{iff } (p \ x) \ \text{phi}))$

leads to new theorems in the language of T :

$(\text{exists } (p) (\text{forall } (x) (\text{iff } (p \ x) \ \text{phi})))$

so that the extension is not conservative.

Semantics of `cl:module`

In ISO 24707:2007, `cl:module` was intended to allow the specification of domain restrictions.

Examples:

- *colore.oor.net/ontologies/ordered_geometry/linear_wog.clif*
- `(cl:text (forall (x) (exists (y) (lt y x)))
 (cl:module PositiveIntegers
 (forall (x) (not (lt x 1))))))`

Problems with Functions in Domain Restrictions

The following sentence

```
(cl:module Person
(not (exists (x) (spouse Bill x))))
```

entails

```
(Person (spouse Bill))
```

because as a function, spouse is required to be total on the domain Person.

Problems with Domain Restrictions

```
(cl:text
(Real -1)
(not (Real i))
(= sqrt(-1) i)
(domain Real)
)
```

is not satisfiable – `Real` cannot be a domain since `sqrt` is not total on it.

Segregated and Unsegregated Dialects

```
(cl:text 01  
(forall (x y z) (if (and (P x y) (P y z)) (P x z))))))
```

```
(cl:text 02  
(cl:imports 01)  
(forall (x y) (iff (reflexive x) (x y y)))  
(reflexive P))
```

However, importation in CL was restricted to texts written in the same dialect (e.g. segregated vs unsegregated).

Circular Imports

```
(cl:imports A)
(cl:text A (cl:import B))
(cl:text B (cl:import A))
```

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?

colore.oor.net/ontologies/between/
colore.oor.net/ontologies/combined_time/

```
(forall (x y z)
  (if (between (beginof (between x y)) z (endof (between x y)))
      (between (endof (between x y)) z (beginof (between x y)))))
```


Current Status

The current document contains the most recent version of the abstract syntax and semantics for Common Logic.

The proposed 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

Proposed Revision to Abstract Syntax and Semantics

- 1 Introduce discourse statements as a new syntactic category
(inDiscourse P1 ... Pn)
(outDiscourse P1... Pn)
to state that the elements denoted by the names are within the universe of discourse or not within the universe of discourse.
- 2 Domain restriction replaces module as the syntactic category used to restrict the domain of discourse to some intended domain:
(domain N (txt ...))
- 3 An interpretation also contains a title mapping ttl_I from the vocabulary V of the language \mathcal{L} to the set of texts of \mathcal{L} , and text titling replaces named text as the syntactic category used to associate text with their titles.
(ttl foo (txt ...))

Addressing the Problems

- Definitional extensions now exist because we can restrict which names are out of the universe of discourse.
- Domain restrictions enable the integration of ontologies even if they do not share the same universe of discourse.
- Circular imports are allowed syntactically and well-defined semantically.

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