## 57SIG – Issue 570 (FOL)

**In the 57th CIDOC CRM & 50th FRBR/LRMoo SIG Meeting**, the SIG reviewed the HW that MD had prepared: a guide on

* the color-coding & fonts used to represent logical constants, variables &quantifiers mentioned throughout the FOL expressions (text [below](#_First_Order_Logic))
* the stereotypical expressions by which said FOL axioms are rendered in prose (examples [below](#_FOL_annotated_examples))

**Discussion points**:

* there have been opposing proposals on where the FOL axioms should appear under: within class/property definitions vs. an appendix or a separate guideline document. The form of the document will be determined once that question has been settled:
  + if it appears as a standalone document, then it will need to incorporate guidelines on how to use it, rather than it being a list of FOL axioms rendered in prose
  + if the textual renditions appear within class/property definitions, then the “how to read them” should become part of the ***About the logical expressions used in the CIDOC CRM*** section in the Introduction of the CRM.
    - Also: the CRMbase and family models template will have to be updated accordingly (specify fonts and indentation for FOL rendition)
* The SIG needs to determine which expressions will be rendered in prose: will the textual renditions of only involve
  + complex FOL expressions (like super|sub)-property relations, shortcut vs fully articulated path inferences, and other property inferences that depend on the instances of classes they connect?
  + or every FOL expression there is in the text?

If the former, then the guidelines on how to read the simpler FOL statements (super|sub)-(class|property) and simple (transitivity|reflexivity|symmetry) (plus their converse) statements should appear in in the ***About the logical expressions used in the CIDOC CRM*** section of the Introduction to the CRM.

If the latter, the guideline should only be about the notation used in the transcriptions of FOL into prose.

* A standard reading of the FOL expressions, according to practices in logical handbooks, might work well for the shorter FOL expressions, like P11(x,y) ⇒ E5(x), but it doesn’t yield well-formed English sentences for the more intricate axioms, like the one for P161: (∃u) [E92(x) ∧ P157(x,u) ∧ E53(y) ∧ E53(z) ∧ E18(u) ∧ P157(y,u) ∧ P157(z,u) ∧ P161(x,y) ∧ P161(x,z) ] ⇒ (z = y).
  + A shorthand notation glossing over some easily inferred information can be beneficiary to people wanting to understand the FOL axioms but lack the proper training: for instance, omit:
    - “an instance of Exx” (in favor of the simpler “an Exx”)
  + Modal statements expressing necessity are once more disputed (in the sense that “what is necessarily true, is true”; and because renditions become more verbose and cumbersome to read through)
  + The color coding is not universally acknowledged as the best way to represent the relations between variables and what they refer back to, or the logical constants & quantifiers used in the axioms

**Decisions**:

The SIG voted in favor of the following, and assigned HW.

* The shorter versions are preferred over the “standard, complete” versions
* The domain-range statements are excluded from the textual renditions of property FOLs
* The textual renditions of FOL statements are to be put right below the FOL expressions in the definitions.

**HW** **assignments**:

* MD to finish drafting the textual renditions to appear in the document and share them with the SIG to be reviewed (and voted upon). Any suggestions for improvements should be given then.
* SdS to update the text in the introduction with a “how to read the FOL renditions in prose” section, stemming from [MDs guideline](#_First_Order_Logic).
* TV to update the template (specify fonts, indentation, etc.) for textual renditions of FOL expressions. The decision to inform Issue [644](https://cidoc-crm.org/Issue/ID-644-update-crm-templates-shortcuts).

#### First Order Logic Reading Guide

For those not trained in mathematics, formal logical expressions are hard to decipher and comprehend. In this text, we have chosen a particularly compact symbolic form, in order to visualize more clearly the essential inferences that the expressions describe.

However, all logical expressions can be brought into a sufficiently comprehensible linguistic form resolving the logical symbols by stereotype parts of speech when reading them. This works particularly well for short logical expressions.

For more complex logical expressions, an explicit linguistic form may become too extended, and the reader may again lose track of the overall meaning. Logical expressions use variables in different parts to refer to any item for which that part of the expression applies. Sometimes, a natural language rendering may become more comprehensible when relative pronouns (e.g. who, which, whose) are introduced in order to connect such items within an expression in a more compact form. Also, “instance of” can be replaced by “a”/”an”. Using the latter, we show below some more explicit versus more compact reading alternatives.

Note when reading FOL statements that they are ontological, i.e., they refer to how the assumed reality must be as premise, as far as the referred CRM concepts are applicable to this reality, regardless whether we have knowledge of this reality or not.

In the following, we explain the (English) reading method by example of sample definitions from the CIDOC CRM text. Instead of explaining the rules of correspondence between logical symbolism and parts of speech in words, we use blue to denote phrases corresponding to FOL syntactic elements, red and green for variables, black for concept labels, and red for “there exists”. We expand the concept identifiers by the full labels.

The “if…then…must be..” constitutes the inference described by and in the direction of the “⇒” arrow (also reading as “implies”).

#### FOL annotated examples

##### (super|sub)property FOLs

* **P11(x,y) ⇒ P12(x,y)**
  + **If an E5 Event x** (P11) **had participant an E39 Actor y, then this x** (P12) **occurred in the presence of y**

##### complex axiom FOLS

* **P8(x,y) ⇐ (∃z) [E53(z) ˄ P7i(z,x) ˄ P156i(z,y)]**
  + The last statement above interprets the paragraph highlighted in yellow in the scope note above as a FOL statement.
  + For reading this properly, you need the property names of P7i, P156i, and their domain and range conditions.
  + Start reading in the direction of the *“⇒” arrow*
    - **⇐ (∃z) [E53(z) ˄ P7i(z,x) ˄ P156i(z,y)]**
    - **If there exists an E53 Place z which** (P7i) **witnessed an E4 Period x and** (P156i) **is occupied by an E18 Physical Thing y, then this x** (P8) **took place on or within this y**Note that we use in the parentheses above the domain – range conditions of P7 and P156.