CRM*inf*: the Argumentation Model

An Extension of CIDOC-CRM to support argumentation

Produced by Paveprime Ltd

and collaborators

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1. The Argumentation Model

1.1. INTRODUCTION

1.1.1. Scope

This document describes work

This text defines the "Argumentation Model",*which uses and extends the CIDOC Conceptual Reference Model (CRM, ISO21127). The CIDOC-CRM definition document should be read before this document. References to the CRM in this document are taken from CRM version XX maintained by CIDOC.* It is a formal ontology intended to be used as a global schema for integrating metadata about argumentation and inference making in descriptive and empirical sciences[1] such as biodiversity, geology, geography, archaeology, cultural heritage, conservation, research IT environments and research data libraries. Its primary purpose is facilitating the management, integration, mediation, interchange and access to data about reasoning by a description of the semantic relationships between the premises, conclusions and activities of reasoning.

It uses and extends the CIDOC CRM (ISO21127) as a general ontology of human activity, things and events happening in space-time. It uses the same encoding-neutral formalism of knowledge representation ("data model" in the sense of computer science) as the CIDOC CRM, which can be implemented in RDFS, OWL, on RDBMS and in other forms of encoding. Since the model reuses, wherever appropriate, parts of CIDOC Conceptual Reference Model, we provide in this document also a comprehensive list of all constructs used from ISO21127, together with their definitions following the version 5.1.2 maintained by CIDOC.

The Argumentation Model is reducing the IAM model in Doerr, Kritsotaki and Boutsika (2011) and embedding it in the CRM Sci. It simplifies IAM by making the inference structure (such as a mathematical proof) and the belief in this structure implicit to the argumentation event. It develops explicit scope notes for the concepts in this model. It maintains the flexibility of the IAM with respect to the system of belief values to be employed. It is motivated and has been validated by examples of argumentation about facts (in contrast to categorical theory building) from archaeological reasoning and reasoning on text elements and annotations in manuscripts. It takes further into account reasoning about facts in scientific data in the form of observation, measurement, data evaluation and citation in biodiversity, geology, archeology, cultural heritage conservation and clinical studies.

Besides application-specific extensions, this model is intended to be complemented by CRMsci, a more detailed model and extension of the CIDOC CRM for metadata about scientific observation,

[1] Descriptive sciences are all the sciences that collect, observe and describe phenomena and then find straightforward correlations between them without a particular scientific hypothesis in mind. Empirical sciences aim to explain the observed phenomena and to draw hypothetical conclusions about their behaviour and their relationships under given circumstances. Since the argumentation and inference making in both sciences is based on observation of sensory data, they can be considered to be "empirical sciences" in a wider sense. In this perspective, those sciences that perform experiments to test their conclusions about observed phenomena can be regarded as a subcategory of "empirical sciences". Thus, according to our view, descriptive and empirical sciences are not competitive but complementary.

measurements and processed data in descriptive and empirical sciences, also currently available in a first stable version [CRMsci, version 1.2 - Doerr, M. and Kritsotaki, A. 2014].

This is an attempt to maintain a modular structure of multiple ontologies related and layered in a specialization – generalization relationship, and into relatively self-contained units with few cross-correlations into other modules, such as describing quantities. This model aims at staying harmonized with the CIDOC CRM, i.e., its maintainers submit proposals for modifying the CIDOC CRM wherever adequate to guarantee the overall consistency, disciplinary adequacy and modularity of CRM-based ontology modules.

An instance of I2 Belief comes into existence when an instance of I1 Argumentation concludes it (through one of its sub-classes S4 Observation, I5 Inference Making or I7 Belief Adoption). Only one E39 Actor may hold a particular instance of I2 Belief, though the E39 Actor may, of course, be an instance of E74 Group. Such an instance of E74 Group may lose or gain members (via one or more instances of E85 Joining or E86 Leaving) without affecting the belief the group representatively maintains. The members supporting the common belief may not necessarily be all individually convinced of it. This does not invalidate the belief of the Group.

The instance of E39 Actor that holds the I2 Belief is the instance that carried out the instance of I1 Argumentation that resulted in the instance of I2 Belief. If other instances of E39 Actor wish to adopt the I6 Belief Value about part or all of the I4 Proposition Set attached to an instance of I2 Belief then a new instance of I7 Belief Adoption must be used to create a new instance of I2 Belief. This new instance of I2 Belief will have the same I6 Belief Value as the original instance of I2 Belief and must share at least some of the propositions in the original I4 Proposition Set.

An instance of I2 Belief goes out of existence when the instance of E39 Actor changes its I6 Belief Value about one or more of the propositions in the associated instance of I4 Proposition Set. Should the instance of E39 Actor continue to hold the same opinion about other propositions in the associated I4 Proposition Set then a new instance of I5 Inference Making would create a new instance of I2 Belief. The new instance of I5 Inference Making would use the original instance of I2 Belief as a premise.

1.1.2. Status

The model presented in this document has so far been validated in the British Museum Discovering Sloan project. This document describes a consolidated version from this experience, with the aim to present it for review and further adoption to the widest possible community. The model is not “finished”, some parts such as the subclasses of inference making are not fully developed in terms of properties, and all constructs and scope notes are open to further elaboration.

1.1.3. Naming Conventions

All the classes declared were given both a name and an identifier constructed according to the conventions used in the CIDOC CRM model. For classes that identifier consists of the letter I followed by a number. Resulting properties were also given a name and an identifier, constructed according to the same conventions. That identifier consists of the letter J followed by a number, which in turn is followed by the letter “B” every time the property is mentioned “backwards”, i.e., from target to domain. “I” and “J” do not have any other meaning. They correspond respectively to letters “E” and “P” in the CIDOC CRM naming conventions, where “E” originally meant “entity” (although the CIDOC CRM “entities” are now consistently called “classes”), and “P” means “property”.

Whenever CIDOC CRM classes are used in our model, they are named by the name they have in the original CIDOC CRM.

Elements in red in CRM and CRMsci Classes and Properties are additions/extensions coming from the Argumentation model.

1.2. CLASS AND PROPERTY HIERARCHIES

The CIDOC CRM model declares no “attributes” at all (except implicitly in its “scope notes” for classes), but regards any information element as a “property” (or “relationship”) between two classes. The semantics are therefore rendered as properties, according to the same principles as the CIDOC CRM model.

Although they do not provide comprehensive definitions, compact monohierarchical presentations of the class and property IsA hierarchies have been found to significantly aid in the comprehension and navigation of the model, and are therefore provided below.

The class hierarchy presented below has the following format:

- Each line begins with a unique class identifier, consisting of a number preceded by the letter “I”, “S” or “E”.
- A series of hyphens (“-”) follows the unique class identifier, indicating the hierarchical position of the class in the IsA hierarchy.
- The English name of the class appears to the right of the hyphens.
- The index is ordered by hierarchical level, in a “depth first” manner, from the smaller to the larger sub hierarchies.
- Classes that appear in more than one position in the class hierarchy as a result of multiple inheritance are shown in an *italic typeface*.

The property hierarchy presented below has the following format:

- Each line begins with a unique property identifier, consisting of a number preceded by the letter “J”.
- A series of hyphens (“-”) follows the unique property identifier, indicating the hierarchical position of the property in the IsA hierarchy.
- The English name of the property appears to the right of the hyphens.
- The domain class for which the property is declared.

1.2.1. Argumentation Model Class Hierarchy aligned with part of the CIDOC CRM and CRMsci Class Hierarchies

E1 CRM Entity

S15 - Observable Entity

E2 - - Temporal Entity

I8 - - - Conviction

I9 - - - - Provenanced Comprehension

I2 - - - - Belief

- - - Period

E5 - - - - Event

E7 - - - - - Activity

I1 - - - - - - Argumentation

S4 - - - - - - - - Observation

I5 - - - - - - - - Inference Making

S5 - - - - - - - - Inference Making

S6 - - - - - - - - - Data Evaluation

S7 - - - - - - - - - Simulation or Prediction

S8 - - - - - - - - - Categorical Hypothesis Building

I7 - - - - - - - - Belief Adoption

E77 - - Persistent Item

E70 - - - Thing

E72 - - - - Legal Object

E90 - - - - - Symbolic Object

E73 - - - - - - Information Object

I4 - - - - - - - Proposition Set

E71 - - - - Man-Made Thing

E28 - - - - - Conceptual Object

E90 - - - - - - - *Symbolic Object*

E73 - - - - - - - - *Information Object*

I10 - - - - - - - - - - - *Provenance Statement*

E89 - - - - - - - Propositional Object

I3 - - - - - - - - Inference Logic

E73 - - - - - - - - *Information Object*

I4 - - - - - - - - - *Proposition Set*

I10 - - - - - - - - - - *Provenance Statement*

I6 - Belief Value

1.2.2. Argumentation Model PROPERTY Hierarchy

Property id	Property Name	Entity – Domain	Entity - Range
J1	used as premise (was premise for)	I5 Inference Making	I8 Conviction
J2	concluded that (was concluded by)	I1 Argumentation	I8 Conviction
J3	applies (was applied by)	I5 Inference Making	I3 Inference Logic
J4	that (is subject of)	I2 Belief	I4 Proposition Set
J5	holds to be	I2 Belief	I6 Belief Value
J6	adopted (adopted by)	I7 Belief Adoption	I2 Belief
J7	is based on evidence from (is evidence for)	I7 Belief Adoption	E73 Information Object
J8	understands (is understood by)	I9 Provenanced Comprehension	E73 Information Object
J9	believes in provenance (provenance is believed by)	I9 Provenanced Comprehension	I10 Provenance Statement
J10	reads as	I9 Provenanced Comprehension	I4 Proposition Set
J11?	used manifestation of type (was type of manifestation used by)	I7 Belief Adoption	F3 Manifestation Product Type
J12?	used (was used by)	I7 Belief Adoption	F5 Item

1.3. ARGUMENTATION MODEL CLASS DECLARATION

The classes are comprehensively declared in this section using the following format:

- Class names are presented as headings in bold face, preceded by the class's unique identifier;
- The line "Subclass of:" declares the superclass of the class from which it inherits properties;
- The line "Superclass of:" is a cross-reference to the subclasses of this class;
- The line "Scope note:" contains the textual definition of the concept the class represents;
- The line "Examples:" contains a bulleted list of examples of instances of this class.
- The line "Properties:" declares the list of the class's properties;
- Each property is represented by its unique identifier, its forward name, and the range class that it links to, separated by colons;
- Inherited properties are not represented;
- Properties of properties, if they exist, are provided indented and in parentheses beneath their respective domain property.

1.4. CLASSES

I1 Argumentation

Subclass of: E7 Activity

Superclass of: S4 Observation

I5 Inference Making/S5 Inference Making

I7 Belief Adoption

Scope note: This class comprises the activity of making honest inferences or observations. An honest inference or observation is one in which the E39 Actor carrying out the I1 Argumentation justifies and believes that the I6 Belief Value associated with resulting I2 Belief about the I4 Proposition Set is the correct value at the time that the activity was undertaken and that any I3 Inference Logic or methodology was correctly applied.

Only one instance of E39 Actor may carry out an instance of I1 Argumentation,though the E39 Actor may, of course, be an instance of E74 Group.

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Properties: J2 concluded that (was concluded by): I8 Conviction

Examples:

- My classification and dating of this bowl (I5)
- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD (I7)

I2 Belief

Subclass of: I8 Conviction

Superclass of

Scope note: This class comprises the notion that the associated I4 Proposition Set is held to have a particular I6 Belief Value by a particular E39 Actor. This can be understood as the period of time that an individual or group holds a particular set of propositions to be true, false or somewhere in between..

Properties: J4 that (is subject of): I4 Proposition Set

J5 holds to be: I6 Belief Value

Examples:

- My belief that Dragendorff type 29 bowls are from the 1st Century AD
- Dragendorff's belief that type 29 bowls are from the 1st Century AD

I3 Inference Logic

Subclass of: E89 Propositional Object

Superclass of:

Scope note: This class comprises the rules used as inputs to I5 Inference Making.

In this context the term "logic" is used in the *most general sense* of the Greek term, and not in the mathematical sense only. Examples are the direct application of formal logic, mathematical theories and calculus, formal or informal default reasoning based on default values associated with categories, probabilistic reasoning based mathematical models and assumed or observed frequencies for certain categories, application of theoretical social models and comparisons with "cultural parallels", etc. An instance of Inference Logic could also be a reference to the exact software release of a Bayesian reasoner, a rule such as "later layers are on top of earlier layers", or even a term like "social intuition", if this is scholarly acceptable. (after Doerr, Kritsotaki and Boutsika 2011). Indeed anything that is scientifically or academically acceptable as a method for drawing conclusions may be included for instance human pattern recognition.

A particular instance of I3 Inference Logic would be the algorithm implemented in a particular revision of a software package.

Instances of I3 Inference Logic not only comprise the method of reasoning, but also the set of categorical laws or axioms used in the argumentation. Often both are inextricably interwoven, for instance in a software implementation.

Examples:

- Dating using a reference typology
- Use of parallels

I4 Proposition Set

Subclass of: E73 Information Object

Superclass of: I10 Provenance Statement

Scope note: This class comprises the sets of formal, binary propositions that an I2 Belief is held about. It could be implemented as a named graph, a spreadsheet or any other structured data-set. Regardless of the specific syntax employed, the effective propositions it contains should be made up of unambiguous identifiers, concepts of a formal ontology and constructs of logic.

Properties:

Examples:

- The Dragendorff Samian typology
- Type 29 bowls are from the 1st Century AD (need to formulate as a set of CRM statements)

I5 Inference Making

Subclass of: I1 Argumentation

Superclass of: S6 Data Evaluation

S7 Simulation or Prediction

S8 Categorical Hypothesis Building

Equivalent to S5 Inference Making

Scope note: This class comprises the action of making honest propositions and statements about particular states of affairs in reality or in possible realities or categorical descriptions of reality by using inferences from other statements based on hypotheses and any form of formal or informal logic. It includes evaluations, calculations, and interpretations based on mathematical formulations and propositions.

It is characterized by the use of an existing I2 Belief as the premise that together with a set of I3 Inference Logic draws a further I2 Belief as a conclusion.

Documenting instances of I5 Inference Making primarily enables tracing the dependency of knowledge from conclusion to premise through subsequent inferences, possibly back to primary evidence, so that the range of influence of knowledge revision at any intermediate stage of complex inference chains on current convictions can be narrowed down by query. The explicit reference to the applied inference logic further allows scholars or scientists to assess if they can or would follow the documented argument. The class is not intended to promote the use of computationally decidable systems of logic as replacements of scholarly justifications of arguments, even though it allows for documenting the use of decidable logic, if that was deemed adequate for the problem at hand. Principles of scholarly justifications of arguments are also regarded as kinds of inference logic.

Properties: J1 used as premise (was premise for): I8 Conviction

J3 applies (was applied by): I3 Inference Logic

Examples:

- My classification and dating of this bowl

I6 Belief Value

Subclass of: E59 Primitive Value

Superclass of:

Scope note: This class comprises any encoding of the value of the truth of an I2 Belief. It may be expressed in terms of discrete logic, modal logic, probability, fuzziness or other adequate representational system.

A minimum requirement of flexibility is for 3 values: True; False; Unknown

Examples:

- True
- False

I7 Belief Adoption

Subclass of: I1 Argumentation

Superclass of:

Scope note: This class comprises the action of an E39 Actor adopting a particular instance of I2 Belief to create a new instance of I2 Belief that shares some of the same propositions in the original I4 Proposition Set and the associated I6 Belief Value.

The basis of I7 Belief Adoption is trust in the source of the instance of I2 Belief rather than the application of the rules in instances of I3 Inference Logic.

Typical examples are the citation of academic papers or the reuse of data sets.

Where an instance of I7 Belief Adoption is based on personal communication (marked as pers.comm. in the studied text) this should be represented by using P2 *has type*: “Pers.Comm.” directly from the instance of I7 Belief Adoption.

Properties: J6 adopted (adopted by): I2 Belief

J7 is based on evidence (is evidence for): E73 Information Object

J11 used manifestation (was manifestation used by): F3 Manifestation

J12 used (was used by): F5 Item

Examples:

- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD

I8 Conviction

Subclass of: E2 Temporal Entity

Superclass of: I2 Belief

I9 Provenanced Comprehension

Scope note: This class comprises convictions by individuals or groups about the truth or not of some state of affairs.

Examples:

- My belief that Gaius Suetonius Tranquillus was deliberately lying about Nero.

In First Order Logic:

I8(x) ⊃ E2(x)

I9 Provenanced Comprehension

Subclass of: I8 Conviction

Superclass of:

Scope note: This class comprises beliefs in the correct reading or scholarly interpretation of the overt message intended by an instance of E73 Information Object ("source"), in which the interpretation of the source is formulated as a set of formal propositions or regarded to be unambiguously given in the form natural language.

An instance of I9 Provenanced Comprehension implies believing the authenticity of the respective instance of E73 Information Object relative to an explicitly stated provenance, but does not mean believing the respective propositions. Rather, the truth of the cited message is the subject of another scholarly interpretation process. It further does not pertain to arguing about hidden or cryptic meanings of a source, which is the subject of a further scholarly interpretation process.

Properties: J8 understands (is understood by): E73 Information Object

J9 believes in provenance (provenance is believed by): I10 Provenance Statement

J10 reads as: I4 Proposition Set

Examples:

- My citation and belief that the extant book De Vita Caesarum attributed to Gaius Suetonius Tranquillus stated 121AD that Nero was singing in Rome while it was burning from July 19 in

64 AD[2].

In First Order Logic:

I9(x) ⊃ I8(x)

I10 Provenance Statement

Subclass of: I4 Proposition Set

Superclass of:

Scope note: This class comprises statements about the provenance of an instance of E73 Information Object with known content at the time of making the provenance statements. An instance of I10 Provenance Statement must contain propositions about the presence of a carrier of the respective instance of E73 Information Object in an event or spatiotemporal context of reference. Characteristically, it may pertain to the writing by a known author at a known or unknown date or place, or to the existence of the text known to some public regardless the truth of authorship.

Examples:

- The Latin content of the extant book De Vita Caesarum attributed to Gaius Suetonius Tranquillus was published in Rome 121AD and not alienated in its propositional content by essential transcription errors until its currently known form.
- The exemplar of The Merchant of Venice, Quarto 1 (1600) owned by The British Library, shelf number BL C.34.k.22 was published 1600AD by Thomas Heyes.

In First Order Logic:

I10(x) ⊃ I4(x)

I11 Situation

Subclass of: I4 Proposition Set

Superclass of:

Scope note: This class comprises the persistence of particular value ranges of the properties of a particular thing or things over a timespan. The identity of an instance of I11 Situation is given by prescribing kinds of properties and a particular timespan and optionally the spatial area. This prescription of properties enables the possibility of observing the values of those properties prescribed, that hold in the specified time-span and spatial area.

In general, there are no natural boundaries to the combination of the kinds of properties, the space and the timespan under consideration in the definition of a situation, other than the interest and ability of the observer. Therefore, this class is purely epistemological in nature, describing arbitrary units of observation of the world.

Examples:

- ,.

In First Order Logic:

[2] https://en.wikipedia.org/wiki/The_Twelve_Caesars

$I11(x) \supset I4(x)$

1.5. ARGUMENTATION MODEL PROPERTY DECLARATION

The properties are comprehensively declared in this section using the following format:

- Property names are presented as headings in bold face, preceded by unique property identifiers;
- The line "Domain:" declares the class for which the property is defined;
- The line "Range:" declares the class to which the property points, or that provides the values for the property;
- The line "Subproperty of:" is a cross-reference to any properties that this is a subproperty of;
- The line "Superproperty of:" is a cross-reference to any subproperties the property may have;
- The line "Scope note:" contains the textual definition of the concept the property represents;
- The line "Examples:" contains a bulleted list of examples of instances of this property.

1.6. PROPERTIES

J1 used as premise (was premise for)

Domain: I5 Inference Making

Range: I8 Conviction

Subproperty of: P17 was motivated by (motivated)

Superproperty of:

Quantification: many to many, necessary (1,n:0,n)

Scope note: This property associates an instance of I8 Conviction with the instance of I5 Inference Making that used it as a premise..

Examples:

- My classification and dating of this bowl (I5) used as premise my belief that Dragendorff type 29 bowls are from the 1st Century AD (I2)
- My classification and dating of this bowl (I5) used as premise my belief in the observations of this bowl (I2)
-
-

In First Order Logic:

$$J1(x,y) \supset I5(x)$$

$$J1(x,y) \supset I8(y)$$

$$J1(x,y) \supset P17(x,y)$$

J2 concluded that (was concluded by)

Domain: I1 Argumentation
Range: I8 Conviction
Subproperty of: P116 starts (is started by)
Superproperty of:
Quantification: one to many, necessary, dependent (1,n:1,n)

Scope note: This property associates an instance of I8 Conviction with the instance of I1 Argumentation

that concluded it.

Examples:

- My classification and dating of this bowl (I5) concluded that my belief that this bowl is from the 1st Century AD (I2)

In First Order Logic:

J2(x,y) ⊃ I1(y)
J2(x,y) ⊃ I8(y)
J2(x,y) ⊃ P116(x,y)

J3 applies (was applied by)

Domain: I5 Inference Making

Range: I3 Inference Logic

Subproperty of: P16 used specific object (was used for)

Superproperty of:

Quantification: many to many, necessary(1,n:0,n)

Scope note: This property associates an instance of I3 Inference Logic with the instance of I5 Inference Making that used it to draw its conclusion.

Examples:

- My classification and dating of this bowl (I5) applies Use of a typology (I3)

J4 that (is subject of)

Domain: I2 Belief

Range: I4 Proposition Set

Subproperty of:

Superproperty of:

Quantification: many to many, necessary (1,n:0,n)

Scope note: This property associates an instance of I4 Proposition Set with the instance of I2 Belief that holds an opinion about it.

Examples:

- Dragendorff's belief that type 29 bowls are from the 1st Century AD (I2) that Type 29 bowls are from the 1st Century AD (I4)

J5 holds to be

Domain: I2 Belief

Range: I6 Belief Value

Subproperty of:

Superproperty of:

Quantification: many to one, necessary (1,1:0,n)

Scope note: This property associates an instance of I2 Belief with the I6 Belief Value that reflects the opinion of the instance of I2 Belief about the I4 Proposition Set associated with it.

Examples:

- Dragendorff's belief that type 29 bowls are from the 1st Century AD (I2) holds to be True (I6)
-

J6 adopted (adopted by)

Domain: I7 Belief Adoption

Range: I2 Belief

Subproperty of: P17 was motivated by (motivated)

Superproperty of:

Quantification: many to many, necessary (1,n:0,n)

Scope note: This property associates an instance of I2 Belief with the instance of I7 Belief Adoption that used it as the source of the I6 Belief Value and propositions used in the resulting new I2 Belief.

Examples:

- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD (I7) adopted Dragendorff's belief that type 29 bowls are from the 1st Century AD (I2)

J7 is based on evidence from (is evidence for)

Domain: I7 Belief Adoption

Range: E73 Information Object

Subproperty of: P16 used specific object (was used for)

Superproperty of:

Quantification: many to many (0,n:0,n)

Scope note: This property associates an instance of I7 Belief Adoption with the instance of E73 Information Object that was the source of or evidence for the I4 Proposition Set that was adopted.

Examples:

- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD (I7) *is based on evidence from* Hans Dragendorff, "Terra sigillata. Ein Beitrag zur Geschichte der griechischen und römischen Keramik", *Bonner Jahrbücher* 96 (1895), 18-155 (E73)

J8 understands (is understood by)

Domain: I9 Provenanced Comprehension
Range: E73 Information Object
Subproperty of:
Superproperty of:
Quantification: many to one, necessary (1,1:0,n)

Scope note: This property associates an instance of I9 Provenanced Comprehension with the instance of E73 Information Object it interprets with respect to its intended overt message.

- My citation that Nero was singing in Rome while it was burning *understands* the extant book De Vita Caesarum by Gaius Suetonius Tranquillus

In First Order Logic:

J8(x,y) ⊃ I7(x)
J8(x,y) ⊃ E73(y)

J9 believes in provenance (provenance is believed by)

Domain: I9 Provenanced Comprehension
Range: I10 Provenance Statement
Subproperty of:
Superproperty of:
Quantification: many to one, necessary (1,1:0,n)

Scope note: This property associates an instance of I9 Provenanced Comprehension with the instance of I10 Provenance Statement that defines the believed provenance of the instance of E73 Information Object referred to in the instance of I9 Provenanced Comprehension.

Examples:

- My citation that Nero was singing in Rome while it was burning *believes in provenance* that the content of the extant book De Vita Caesarum by Gaius Suetonius Tranquillus was published in Rome 121AD

In First Order Logic:

J9(x,y) ⊃ I9(x)
J9(x,y) ⊃ I10(y)

J10 reads as

Domain: I9 Provenanced Comprehension
Range: I4 Proposition Set
Subproperty of:
Superproperty of:
Quantification: many to one, necessary (1,1:0,n)

Scope note: This property associates an instance of I9 Provenanced Comprehension with the instance of I4 Proposition Set that formulates the interpretation.

Examples:

- My citation that Nero was singing in Rome while it was burning *reads as* "Nero, while watching Rome burn, exclaimed how beautiful it was, and sang an epic poem about the sack of Troy while playing the lyre"

In First Order Logic:

J9(x,y) ⊃ I9(x)
J9(x,y) ⊃ I4(y)

J11 used manifestation (was manifestation used by)

Domain: I8 Conviction
Range: F3 Manifestation
Subproperty of:
Superproperty of:
Quantification: many to many (0,n:0,n)

Scope note: This property associates an instance of I8 Conviction with the instance of F3 Manifestation that carried the instance of F2 Expression that contained the instances of E89 Propositional Object that make up the I4 Proposition Set being embraced. It assumes that a non-contentious reading of the instance of F2 Expression has allowed the instances of E89 Propositional Object to be elicited and enumerated.

This property is a shortcut over the long path: I7 Belief adoption:*J6 adopted*:I2 Belief: *J4 that (is subject of):*I4 Proposition Set: *P148 has component (is component of):*E89 Propositional Object:*P148i has component (is component of):*F1 Work: *R3 is realised in (realises):*F2 Expression: R4i is *embodied in*:F3 Manifestation

Examples:

- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD (I7) *J11 used manifestation (was manifestation used by)* "Terra sigillata. Ein Beitrag zur Geschichte der griechischen und römischen Keramik", *Bonner Jahrbücher* 96 (1895), 18-155 (F3)
- Martin's citation that Nero was singing in Rome while it was burning *J11 used manifestation (was manifestation used by)* manifestation of De Vita Caesarum by Gaius Suetonius Tranquillus

In First Order Logic:
J11(x,y) ⊃ I8(x)
J11(x,y) ⊃ F3(y)

J12 used (was used by)

Domain: I8 Conviction
Range: F5 Item
Subproperty of:
Superproperty of:
Quantification: many to many (0,n:0,n)

Scope note: This property associates an instance of I8 Conviction with the particular instance of F5 Item that carried the instance of F2 Expression that contained the instances of E89 Propositional Object that make up the I4 Proposition Set being embraced.

This property is a shortcut over the long path: I7 Belief Adoption:*J6 adopted*: I2 Belief: J2i *was concluded by:* I5/S5 Inference Making: *J1 used as premise (was premise for):* E25 Human-Made Feature: *O16 observed value (value was observed by):* S4 Observation: *O8 observed (was observed by):*F5 Item

Examples:

- My adoption of the belief that Dragendorff type 29 bowls are from the 1st Century AD (I8) *J12 used (was used by)* The Institute of Archaeologies' copy of "Terra sigillata. Ein Beitrag zur Geschichte der griechischen und römischen Keramik", *Bonner Jahrbücher* 96 (1895), 18-155 (F5)
- Martin's citation that Nero was singing in Rome while it was burning *J12 used (was used by)* Martin's copy of De Vita Caesarum by Gaius Suetonius Tranquillus

In First Order Logic:

$J12(x,y) \supset I8(x)$

$J12(x,y) \supset F5(y)$

1.7. BIBLIOGRAPHY

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