CRM*inf*: the Argumentation Model

An Extension of CIDOC-CRM to support argumentation

Produced by Paveprime Ltd

and collaborators

Version 0.9

(draft)

May 2018

Contributors: Stephen Stead, Martin Doerr, Christian-Emil Ore and others

Table of Contents

1. The Argumentation Model

1.1. INTRODUCTION

1.1.1. Scope

This text defines the "Argumentation Model". 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, 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-

---

[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.

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

I2   -   -   -   Belief

E4   -   -   -   Period

E5   -   -   -   -   Event

E7   -   -   -   -   -   Activity

E13	-	-	-	-	-	-	Attribute Assignment
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*
I4	-	-	-	-	-	-	-	-	*Proposition Set*
E89	-	-	-	-	-	-	Propositional Object
I3	-	-	-	-	-	-	-	Inference Logic
E73	-	-	-	-	-	-	-	*Information Object*
I4	-	-	-	-	-	-	-	-	*Proposition Set*
E59	Primitive Value
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	I2 Belief
J2	concluded that (was concluded by)	I1 Argumentation	I2 Belief
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

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:

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.

Properties: [J2](#) concluded that (was concluded by): [I2](#) Belief

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: [E2](#) Temporal Entity

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:

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 dataset. 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): I2 Belief

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

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

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: 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 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)

J2 concluded that (was concluded by)

Domain: I1 Argumentation

Range: I2 Belief

Subproperty of: P116 starts (is started by)

Superproperty of:

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

Scope note: This property associates an instance of I2 Belief 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)

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)

1.7. REFERRED CLASSES AND PROPERTIES

Since our model refers to and reuses parts of the CIDOC Conceptual Reference Model (ISO21127) and CRMsci this section provides a comprehensive list of all constructs used from both ISO21127 and CRMsci. Also included are the definitions from version 5.1.2 of the CRM and version 1.2 of CRMsci. The complete definition of the CIDOC Conceptual Reference Model and CRMsci can be found on the official site: http://www.cidoc-crm.org/official_release_cidoc.html.

1.7.1. Referred CIDOC CRM Classes

This section contains the complete definitions of the classes of the CIDOC CRM Conceptual Reference Model version 5.1.2 referred to by the model. The additional elements from CRMinf are highlighted in red.

E1 CRM Entity

Superclass of: E2 Temporal Entity
                      E52 Time-Span
                      E53 Place
                      E54 Dimension
                      E77 Persistent Item
                      E92 Spacetime Volume

Scope note: This class comprises all things in the universe of discourse of the CIDOC Conceptual Reference Model.

It is an abstract concept providing for three general properties:
1. Identification by name or appellation, and in particular by a preferred identifier
2. Classification by type, allowing further refinement of the specific subclass an instance belongs to
3. Attachment of free text for the expression of anything not captured by formal properties

With the exception of E59 Primitive Value, all other classes within the CRM are directly or indirectly specialisations of E1 CRM Entity.

Examples:

    ■   the earthquake in Lisbon 1755 (E5)

In First Order Logic:
              E1(x)

Properties:
              P1 is identified by (identifies): E41 Appellation
              P2 has type (is type of): E55 Type
              P3 has note: E62 String
                     (P3.1 has type: E55 Type)
              P48 has preferred identifier (is preferred identifier of): E42 Identifier
              P137 exemplifies (is exemplified by): E55 Type
                     (P137.1 in the taxonomic role: E55 Type)

E2 Temporal Entity

Subclass of: E1 CRM Entity
Superclass of: E3 Condition State
                      E4 Period

Scope note: This class comprises all phenomena, such as the instances of E4 Periods, E5 Events and states, which happen over a limited extent in time. This extent in time must be contiguous, i.e., without gaps. In case the defining kinds of phenomena for an instance of E2 Temporal Entity cease to

happen, and occur later again at another time, we regard that the former E2 Temporal Entity has ended and a new instance has come into existence. In more intuitive terms, the same event cannot happen twice.

In some contexts, these are also called perdurants. This class is disjoint from E77 Persistent Item. This is an abstract class and has no direct instances. E2 Temporal Entity is specialized into E4 Period, which applies to a particular geographic area (defined with a greater or lesser degree of precision), and E3 Condition State, which applies to instances of E18 Physical Thing.

Examples:
- Bronze Age (E4)
- the earthquake in Lisbon 1755 (E5)
- the Peterhof Palace near Saint Petersburg being in ruins from 1944 – 1946 (E3)

In First Order Logic:

$$E2(x) \supset E1(x)$$

Properties:

P4 has time-span (is time-span of): E52 Time-Span
P114 is equal in time to: E2 Temporal Entity
P115 finishes (is finished by): E2 Temporal Entity
P116 starts (is started by): E2 Temporal Entity
P117 occurs during (includes): E2 Temporal Entity
P118 overlaps in time with (is overlapped in time by): E2 Temporal Entity
P119 meets in time with (is met in time by): E2 Temporal Entity
P120 occurs before (occurs after): E2 Temporal Entity
P173 starts before or at the end of (ends with or after the start of): E2 Temporal Entity
P174 starts before (starts after the start of): E2 Temporal Entity
P175 starts before or with the start of (starts with or after the start of) : E2 Temporal Entity
P176 starts before the start of (starts after the start of): E2 Temporal Entity
P182 ends before or at the start of (starts with or after the end of) : E2 Temporal Entity
P183 ends before the start of (starts after the end of) : E2 Temporal Entity
P184 ends before or with the end of (ends with or after the end of) : E2 Temporal Entity
P185 ends before the end of (ends after the end of): E2 Temporal Entity

E2 Temporal Entity

Subclass of: S15 Observable Entity
Superclass of: E4 Period
                 S16 State
                 I2 Belief

Scope note: This class comprises all phenomena, such as the instances of E4 Periods, E5 Events and states, which happen over a limited extent in time.

In some contexts, these are also called perdurants. This class is disjoint from E77 Persistent Item. This is an abstract class and has no direct instances. E2 Temporal Entity is specialized into E4 Period, which applies to a particular geographic area (defined with a greater or lesser degree of precision), and E3 Condition State, which applies to instances of E18 Physical Thing.

Examples:

- BronzeAge (E4)
- the earthquake in Lisbon 1755 (E5)
- the Peterhof Palace near Saint Petersburg being in ruins from 1944 – 1946 (E3)

Properties:

P4 has time-span (is time-span of): E52 Time-Span
P114 is equal in time to: E2 Temporal Entity
P115 finishes (is finished by): E2 Temporal Entity
P116 starts (is started by): E2 Temporal Entity
P117 occurs during (includes): E2 Temporal Entity
P118 overlaps in time with (is overlapped in time by): E2 Temporal Entity
P119 meets in time with (is met in time by): E2 Temporal Entity
P120 occurs before (occurs after): E2 Temporal Entity

E4 Period

Subclass of: E2 Temporal Entity
Superclass of: E5 Event
Scope note: This class comprises sets of coherent phenomena or cultural manifestations bounded in time and space.

It is the social or physical coherence of these phenomena that identify an E4 Period and not the associated spatio-temporal bounds. These bounds are a mere approximation of the actual process of growth, spread and retreat. Consequently, different periods can overlap and coexist in time and space, such as when a nomadic culture exists in the same area as a sedentary culture.

Typically this class is used to describe prehistoric or historic periods such as the "Neolithic Period", the "Ming Dynasty" or the "McCarthy Era". There are however no assumptions about the scale of the associated phenomena. In particular all events are seen as synthetic processes consisting of coherent phenomena. Therefore E4 Period is a superclass of E5 Event. For example, a modern clinical E67 Birth can be seen as both an atomic E5 Event and as an E4 Period that consists of multiple activities performed by multiple instances of E39 Actor.

There are two different conceptualisations of 'artistic style', defined either by physical features or by historical context. For example, "Impressionism" can be viewed as a period lasting from approximately 1870 to 1905 during which paintings with particular characteristics were produced by a group of artists that included (among others) Monet, Renoir, Pissarro, Sisley and Degas. Alternatively, it can be regarded as a style applicable to all paintings sharing the characteristics of the works produced by the Impressionist painters, regardless of historical context. The first interpretation is an E4 Period, and the second defines morphological object types that fall under E55 Type.

Another specific case of an E4 Period is the set of activities and phenomena associated with a settlement, such as the populated period of Nineveh.

Examples:

- Jurassic
- European Bronze Age
- Italian Renaissance
- Thirty Years War
- Sturm und Drang
- Cubism

Properties:

P7 took place at (witnessed): E53 Place
P8 took place on or within (witnessed): E18 Physical Thing
P9 consists of (forms part of): E4 Period
P10 falls within (contains): E4 Period
P132 overlaps with: E4 Period
P133 is separated from: E4 Period
P158 occupied: E92 Spacetime Volume

E5 Event

Subclass of: E4 Period
Superclass of: E7 Activity
                  E63 Beginning of Existence
                  E64 End of Existence
                  S18 Alteration
Scope note: This class comprises changes of states in cultural, social or physical systems, regardless of scale, brought about by a series or group of coherent physical, cultural, technological or legal phenomena. Such changes of state will affect instances of E77 Persistent Item or its subclasses.

The distinction between an E5 Event and an E4 Period is partly a question of the scale of observation. Viewed at a coarse level of detail, an E5 Event is an 'instantaneous' change of state. At a fine level, the E5 Event can be analysed into its component phenomena within a space and time frame, and as such can be seen as an E4 Period. The reverse is not necessarily the case: not all instances of E4 Period give rise to a noteworthy change of state.

Examples:
- the birth of Cleopatra (E67)
- the destruction of Herculaneum by volcanic eruption in 79 AD(E6)
- World War II (E7)
- the Battle of Stalingrad (E7)
- the Yalta Conference (E7)
- my birthday celebration 28-6-1995 (E7)
- the falling of a tile from my roof last Sunday
- the CIDOC Conference 2003 (E7)

Properties:

P11 had participant (participated in): E39 Actor
P12 occurred in the presence of (was present at): E77 Persistent Item

E7 Activity

Subclass of: E5 Event
Superclass of: E8 Acquisition
                  E9 Move
                  E10 Transfer of Custody
                  E11 Modification
                  E13 Attribute Assignment
                  E65 Creation
                  E66 Formation
                  E85 Joining
                  E86 Leaving
                  E87 Curation Activity
                  S1 Matter Removal

Scope note: This class comprises actions intentionally carried out by instances of E39 Actor that result in changes of state in the cultural, social, or physical systems documented.

This notion includes complex, composite and long-lasting actions such as the building of a settlement or a war, as well as simple, short-lived actions such as the opening of a door.

Examples:
- the Battle of Stalingrad
- the Yalta Conference
- my birthday celebration 28-6-1995
- the writing of "Faust" by Goethe (E65)
- the formation of the Bauhaus 1919 (E66)
- calling the place identified by TGN '7017998' 'Quyunjig' by the people of Iraq

Properties:

> P14 carried out by (performed): E39 Actor
> (P14.1 in the role of: E55 Type)
> P15 was influenced by (influenced): E1 CRM Entity
> P16 used specific object (was used for): E70 Thing
> (P16.1 mode of use: E55 Type)
> P17 was motivated by (motivated): E1 CRM Entity
> P19 was intended use of (was made for): E71 Man-Made Thing
> (P19.1 mode of use: E55 Type)
> P20 had specific purpose (was purpose of): E5 Event
> P21 had general purpose (was purpose of): E55 Type
> P32 used general technique (was technique of): E55 Type
> P33 used specific technique (was used by): E29 Design or Procedure
> P125 used object of type (was type of object used in): E55 Type
> P134 continued (was continued by): E7 Activity

E13 Attribute Assignment

Subclass of: E7 Activity
Superclass of: E14 Condition Assessment
E15 Identifier Assignment
E16 Measurement
E17 Type Assignment
E91 Co-Reference Assignment
S4 Observation
S5 Inference Making/I5 Inference Making
I1 Argumentation

Scope note: This class comprises the actions of making assertions about properties of an object or any relation between two items or concepts.

This class allows the documentation of how the respective assignment came about, and whose opinion it was. All the attributes or properties assigned in such an action can also be seen as directly attached to the respective item or concept, possibly as a collection of contradictory values. All cases of properties in this model that are also described indirectly through an action are characterised as "short cuts" of this action. This redundant modelling of two alternative views is preferred because many implementations may have good reasons to model either the action or the short cut, and the relation between both alternatives can be captured by simple rules.

In particular, the class describes the actions of people making propositions and statements during certain museum procedures, e.g. the person and date when a condition statement was made, an identifier was assigned, the museum object was measured, etc. Which kinds of such assignments and statements need to be documented explicitly in structures of a schema rather than free text, depends on if this information should be accessible by structured queries.

Examples:
- the assessment of the current ownership of Martin Doerr's silver cup in February 1997

Properties:

> P140 assigned attribute to (was attributed by): E1 CRM Entity
> P141 assigned (was assigned by): E1 CRM Entity

E28 Conceptual Object

Subclass of: E71 Man-Made Thing
Superclass of: E55 Type
E89 Propositional Object
E90 Symbolic Object

Scope note: This class comprises non-material products of our minds and other human produced data that have become objects of a discourse about their identity, circumstances of creation or historical

implication. The production of such information may have been supported by the use of technical devices such as cameras or computers.

Characteristically, instances of this class are created, invented or thought by someone, and then may be documented or communicated between persons. Instances of E28 Conceptual Object have the ability to exist on more than one particular carrier at the same time, such as paper, electronic signals, marks, audio media, paintings, photos, human memories, etc.

They cannot be destroyed. They exist as long as they can be found on at least one carrier or in at least one human memory. Their existence ends when the last carrier and the last memory are lost.

Examples:
- Beethoven's "Ode an die Freude" (Ode to Joy) (E73)
- the definition of "ontology" in the Oxford English Dictionary
- the knowledge about the victory at Marathon carried by the famous runner
- 'Maxwell equations' [preferred subject access point from LCSH, http://lccn.loc.gov/sh85082387, as of 19 November 2012]
- 'Equations, Maxwell' [variant subject access point, from the same source]

Properties: P149 is identified by (identifies): E75 Conceptual Object Appellation

E59 Primitive Value

Superclass of: E60 Number
E61 Time Primitive
E62 String
I6 Belief Value

Scope Note: This class comprises primitive values used as documentation elements, which are not further elaborated upon within the model.

As such they are not considered as elements within our universe of discourse. No specific implementation recommendations are made. It is recommended that the primitive value system from the implementation platform be used to substitute for this class and its subclasses.

Examples:
- ABCDEFG (E62)
- 3.14 (E60)
- 0
- 1921-01-01 (E61)

E70 Thing

Subclass of: E77 Persistent Item
Superclass of: E71 Man-Made Thing
E72 Legal Object
S10 Material Substantial

Scope note: This general class comprises usable discrete, identifiable, instances of E77 Persistent Item that are documented as single units.

They can be either intellectual products or physical things, and are characterized by relative stability. They may for instance either have a solid physical form, an electronic encoding, or they may be logical concept or structure.

Examples:
- my photograph collection (E78)
- the bottle of milk in my refrigerator (E22)
- the plan of the Strassburger Muenster (E29)
- the thing on the top of Otto Hahn's desk (E19)
- the form of the no-smoking sign (E36)
- the cave of Dirou, Mani, Greece (E27)

Properties

P43 has dimension (is dimension of): E54 Dimension

P101 had as general use (was use of): E55 Type
P130 shows features of (features are also found on): E70 Thing
        (P130.1 kind of similarity: E55 Type)

E71 Man-Made Thing

Subclass of:	E70 Thing
Superclass of:	E24 Physical Man-Made Thing
	E28 Conceptual Object

Scope note: units.
    This class comprises discrete, identifiable man-made items that are documented as single units.

    These items are either intellectual products or man-made physical things, and are characterized by relative stability. They may for instance have a solid physical form, an electronic encoding, or they may be logical concepts or structures.

Examples:
- Beethoven's 5th Symphony (E73)
- Michelangelo's David
- Einstein's Theory of General Relativity (E73)
- the taxon 'Fringilla coelebs Linnaeus,1758' (E55)

Properties
    P102 has title (is title of): E35 Title
        (P102.1 has type: E55 Type)
    P103 was intended for (was intention of): E55 Type

E72 Legal Object

Subclass of:	E70 Thing
Superclass of:	E18 Physical Thing
	E90 Symbolic Object

Scope note:
    This class comprises those material or immaterial items to which instances of E30 Right, such as the right of ownership or use, can be applied.

    This is true for all E18 Physical Thing. In the case of instances of E28 Conceptual Object, however, the identity of the E28 Conceptual Object or the method of its use may be too ambiguous to reliably establish instances of E30 Right, as in the case of taxa and inspirations. Ownership of corporations is currently regarded as out of scope of the CRM.

Examples:
- the Cullinan diamond (E19)
- definition of the CIDOC Conceptual Reference Model Version 2.1 (E73)

Properties:
    P104 is subject to (applies to): E30 Right
    P105 right held by (has right on): E39 Actor

E73 Information Object

Subclass of:	E89 Propositional Object
	E90 Symbolic Object
Superclass of:	E29 Design or Procedure
	E31 Document
	E33 Linguistic Object
	E36 Visual Item
	I4 Proposition Set

Scope note:
    This class comprises identifiable immaterial items, such as a poems, jokes, data sets, images, texts, multimedia objects, procedural prescriptions, computer program code, algorithm or mathematical formulae, that have an objectively recognizable structure and are documented as single units.

An E73 Information Object does not depend on a specific physical carrier, which can include human memory, and it can exist on one or more carriers simultaneously.

Instances of E73 Information Object of a linguistic nature should be declared as instances of the E33 Linguistic Object subclass. Instances of E73 Information Object of a documentary nature should be declared as instances of the E31 Document subclass. Conceptual items such as types and classes are not instances of E73 Information Object, nor are ideas without a reproducible expression.

Examples:
- image BM000038850.JPG from the Clayton Herbarium in London
- E. A. Poe's "The Raven"
- the movie "The Seven Samurai" by Akira Kurosawa
- the Maxwell Equations

Properties:

E77 Persistent Item

Subclass of: S15 Observable Entity
Superclass of: E39 Actor
E70 Thing

Scope note: This class comprises items that have a persistent identity, sometimes known as "endurants" in philosophy.

They can be repeatedly recognized within the duration of their existence by identity criteria rather than by continuity or observation. Persistent Items can be either physical entities, such as people, animals or things, or conceptual entities such as ideas, concepts, products of the imagination or common names.

The criteria that determine the identity of an item are often difficult to establish -; the decision depends largely on the judgement of the observer. For example, a building is regarded as no longer existing if it is dismantled and the materials reused in a different configuration. On the other hand, human beings go through radical and profound changes during their life-span, affecting both material composition and form, yet preserve their identity by other criteria. Similarly, inanimate objects may be subject to exchange of parts and matter. The class E77 Persistent Item does not take any position about the nature of the applicable identity criteria and if actual knowledge about identity of an instance of this class exists. There may be cases, where the identity of an E77 Persistent Item is not decidable by a certain state of knowledge.

The main classes of objects that fall outside the scope the E77 Persistent Item class are temporal objects such as periods, events and acts, and descriptive properties.

Examples:
- Leonard da Vinci
- Stonehenge
- the hole in the ozone layer
- the First Law of Thermodynamics
- the Bermuda Triangle

E89 Propositional Object

Subclass of: E28 Conceptual Object
Superclass of: E73 Information Object
E30 Right
I3 Inference Logic

Scope note: This class comprises immaterial items, including but not limited to stories, plots, procedural prescriptions, algorithms, laws of physics or images that are, or represent in some sense, sets of propositions about real or imaginary things and that are documented as single units or serve as topic of discourse.

This class also comprises items that are "about" something in the sense of a subject. In the wider sense, this class includes expressions of psychological value such as non-figural art and musical

themes. However, conceptual items such as types and classes are not instances of E89 Propositional Object. This should not be confused with the definition of a type, which is indeed an instance of E89 Propositional Object.

Examples:
- Maxwell's Equations
- The ideational contents of Aristotle's book entitled 'Metaphysics' as rendered in the Greek texts translated in … Oxford edition…
- The underlying prototype of any "no-smoking" sign (E36)
- The common ideas of the plots of the movie "The Seven Samurai" by Akira Kurosawa and the movie "The Magnificent Seven" by John Sturges
- The image content of the photo of the Allied Leaders at Yalta 1945 (E38)

Properties:

P148 has component (is component of): E89 Propositional Object
P67 refers to (is referred to by): E1 CRM Entity
      (P67.1 has type: E55 Type)
P129 is about (is subject of): E1 CRM Entity

E90 Symbolic Object

Subclass of: E28 Conceptual Object
               E72 Legal Object
Superclass of: E73 Information Object
               E41 Appellation
Scope note:

This class comprises identifiable symbols and any aggregation of symbols, such as characters, identifiers, traffic signs, emblems, texts, data sets, images, musical scores, multimedia objects, computer program code or mathematical formulae that have an objectively recognizable structure and that are documented as single units.

It includes sets of signs of any nature, which may serve to designate something, or to communicate some propositional content.

An instance of E90 Symbolic Object does not depend on a specific physical carrier, which can include human memory, and it can exist on one or more carriers simultaneously. An instance of E90 Symbolic Object may or may not have a specific meaning, for example an arbitrary character string.

In some cases, the content of an instance of E90 Symbolic Object may completely be represented by a serialized digital content model, such as a sequence of ASCII-encoded characters, an XML or HTML document, or a TIFF image. The property *P3 has note* allows for the description of this content model. In order to disambiguate which symbolic level is the carrier of the meaning, the property *P3.1 has type* can be used to specify the encoding (e.g. "bit", "Latin character", RGB pixel).

Examples:
- 'ecognizabl'
- The "no-smoking" sign (E36)
- "BM000038850.JPG" (E75)
- image BM000038850.JPG from the Clayton Herbarium in London (E38)
- The distribution of form, tone and colour found on Leonardo da Vinci's painting named "Mona Lisa" in daylight (E38)
- The Italian text of Dante's "Divina Commedia" as found in the authoritative critical edition La Commedia secondo l'antica vulgata a cura di Giorgio Petrocchi, Milano: Mondadori, 1966-67 (= Le Opere di Dante Alighieri, Edizione Nazionale a cura della Società Dantesca Italiana, VII, 1-4)(E33)

Properties:

P106 is composed of (forms part of): E90 Symbolic Object

1.7.2. Referred CIDOC CRMSCI Classes

This section contains the complete definitions of the classes of the CIDOC CRMsci Scientific Observation Model version 1.2 referred to by the model. The additional elements from CRMinf are highlighted in red.

S4 Observation

Subclass of: I1 Argumentation
                 E13 Attribute Assignment
Superclass of: S21 Measurement
                 S19 Encounter Event

Scope note: This class comprises the activity of gaining scientific knowledge about particular states of physical reality gained by empirical evidence, experiments and by measurements. We define observation in the sense of natural sciences, as a kind of human activity: at some Place and within some Time-Span, certain Physical Things and their behavior and interactions are observed, either directly by human sensory impression, or enhanced with tools and measurement devices. The output of the internal processes of measurement devices that do not require additional human interaction are in general regarded as part of the observation and not as additional inference. Manual recordings may serve as additional evidence. Measurements and witnessing of events are special cases of observations. Observations result in a belief about certain propositions. In this model, the degree of confidence in the observed properties is regarded to be "true" per default, but could be described differently by adding a property *P3 has note* to an instance of S4 Observation, or by reification of the property *O16 observed value*. Primary data from measurement devices are regarded in this model to be results of observation and can be interpreted as propositions believed to be true within the (known) tolerances and degree of reliability of the device. Observations represent the transition between reality and propositions in the form of instances of a formal ontology, and can be subject to data evaluation from this point on.

Properties:
                 O8 observed (was observed by): S15 Observable Entity
                 O9 observed property type (property type was observed by): S9 Property Type
                 O16 observed value (value was observed by): E1 CRM Entity

S5 Inference Making

Subclass of: E13 Attribute Assignment
Superclass of: S6 Data Evaluation
                 S7 Simulation or Prediction
                 S8 Categorical Hypothesis Building

Equivalent to I5 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:

S6 Data Evaluation

Subclass of: S5 Inference Making/I5 Inference Making

Scope note: This class comprises the action of concluding propositions on a respective reality from observational data by making evaluations based on mathematical inference rules and calculations using established hypotheses, such as the calculation of an earthquake epicenter. S6 Data Evaluation is not defined as S21/E16 Measurement; Secondary derivations of dimensions of an object from data measured by different processes are regarded as S6 Data Evaluation and not determining instances of Measurement in its own right. For instance, the volume of a statue concluded from a 3D model is an instance of S6 Data Evaluation and not of Measurement.

Properties:
        O10 assigned dimension (dimension was assigned by): E54 Dimension
        O11 described (was described by): S15 Observable Entity

S7 Simulation or Prediction

Subclass of: S5 Inference Making/I5 Inference Making

Scope note: This class comprises activities of executing algorithms or software for simulating the behavior and the properties of a system of interacting components that form part of reality or not by using a mathematical model of the respective interactions. In particular it implies making predictions about the future behaviors of a system of interacting components of reality by starting simulation from an actually observed state, such as weather forecasts. Simulations may also be used to understand the effects of a theory, to compare theoretical predictions with reality, or to show differences with another theory.

Properties:

S8 Categorical Hypothesis Building

Subclass of: S5 Inference Making/I5 Inference Making

Scope note: This class comprises the action of making categorical hypotheses based on inference rules and theories; By categorical hypotheses we mean assumptions about the kinds of interactions and related kinds of structures of a domain that have the character of "laws" of nature or human behavior, be it necessary or probabilistic. Categorical hypotheses are developed by "induction" from finite numbers of observation and the absence of observations of particular kinds. As such, categorical hypotheses are always subject to falsification by new evidence. Instances of S8 Categorical Hypothesis Building include making and questioning categorical hypotheses.

Properties:

S15 Observable Entity

Subclass of: E1 CRM Entity
Superclass of: E2 Temporal Entity

E77 Persistent Item

Scope note:

This class comprises instances of E2 Temporal Entity or E77 Persistent Item, i.e. items or phenomena that can be observed, either directly by human sensory impression, or enhanced with tools and measurement devices, such as physical things, their behavior, states and interactions or events.

Conceptual objects can be present in events by their carriers such as books, digital media, or even human memory. By virtue of this presence, properties of conceptual objects, such as number of words can be observed on their carriers. If the respective properties between carriers differ, either they carry different instances of conceptual objects or the difference can be attributed to accidental deficiencies in one of the carriers. In that sense even immaterial objects are observable. By this model we give credit to the fact that frequently, the actually observed carriers of conceptual objects are not explicitly identified in documentation, i.e., the actual carrier is assumed having existed but is unknown as an individual.

Properties:

O12 has dimension (is dimension of): E54 Dimension

1.7.3. Referred CIDOC CRM Properties

This section contains the complete definitions of the properties of the CIDOC CRM Conceptual Reference Model version 5.1.2 referred to. We apply the same format conventions as in mentioned above.

P12 occurred in the presence of (was present at)

Domain: E5 Event
Range: E77 Persistent Item
Superproperty of: E5 Event. P11 had participant (participated in): E39 Actor
                   E7 Activity. P16 used specific object (was used for): E70 Thing
                   E9 Move. P25 moved (moved by): E19 Physical Object
                   E11 Modification. P31 has modified (was modified by): E24 Physical Man-Made Thing
                   E63 Beginning of Existence. P92 brought into existence (was brought into existence by): E77 Persistent Item
                   E64 End of Existence. P93 took out of existence (was taken out of existence by): E77 Persistent Item
                   E79 Part Addition. P111 added (was added by): E18 Physical Thing
                   E80 Part Removal. P113 removed (was removed by): E18 Physical Thing
Quantification: many to many, necessary (1,n:0,n)

Scope note: This property describes the active or passive presence of an E77 Persistent Item in an E5 Event without implying any specific role.

                   It connects the history of a thing with the E53 Place and E50 Date of an event. For example, an object may be the desk, now in a museum on which a treaty was signed. The presence of an immaterial thing implies the presence of at least one of its carriers.
Examples:
          ▪ Deckchair 42 (E19) was present at The sinking of the Titanic (E5)

P15 was influenced by (influenced)

Domain: E7 Activity
Range: E1 CRM Entity
Superproperty of: E7 Activity. P16 used specific object (was used for): E70 Thing
                   E7 Activity. P17 was motivated by (motivated): E1 CRM Entity
                   E7 Activity. P134 continued (was continued by): E7 Activity
                   E83 Type Creation. P136 was based on (supported type creation): E1 CRM Entity
Quantification: many to many (0,n:0,n)

Scope note: This is a high level property, which captures the relationship between an E7 Activity and

anything that may have had some bearing upon it.

The property has more specific sub properties.

Examples:
- the designing of the Sydney Harbour Bridge (E7) was influenced by the Tyne bridge (E22)

P16 used specific object (was used for)

Domain: E7 Activity
Range: E70 Thing
Subproperty of: E5 Event. P12 occurred in the presence of (was present at): E77 Persistent Item
                E7 Activity. P15 was influenced by (influenced): E1 CRM Entity
Superproperty of: E7 Activity.P33 used specific technique (was used by):E29 Design or Procedure
                E15 Identifier Assignment. P142 used constituent (was used in): E90 Symbolic Object
                E79 Part Addition. P111 added (was added by):E18 Physical Thing
                I5 Inference Making. J3 applies (was applied by): I3 Inference Logic
                I7 Belief Adoption. J7 is based on evidence (is evidence for): E73 Information Object
Quantification: many to many (0,n:0,n)

Scope note: This property describes the use of material or immaterial things in a way essential to the performance or the outcome of an E7 Activity.

This property typically applies to tools, instruments, moulds, raw materials and items embedded in a product. It implies that the presence of the object in question was a necessary condition for the action. For example, the activity of writing this text required the use of a computer. An immaterial thing can be used if at least one of its carriers is present. For example, the software tools on a computer.

Another example is the use of a particular name by a particular group of people over some span to identify a thing, such as a settlement. In this case, the physical carriers of this name are at least the people understanding its use.

Examples:
- the writing of this scope note (E7) used specific object Nicholas Crofts' computer (E22) mode of use Typing Tool; Storage Medium (E55)
- the people of Iraq calling the place identified by TGN '7017998' (E7) used specific object "Quyunjig" (E44) mode of use Current; Vernacular (E55)

Properties: P16.1 mode of use: E55 Type

P17 was motivated by (motivated)

Domain: E7 Activity
Range: E1 CRM Entity
Subproperty of: E7 Activity. P15 was influenced by (influenced): E1 CRM Entity

Superproperty of: I5 Inference Making. J1 used as premise (was premise for): I2 Belief
                I7 Belief Adoption. J6 adopted (adopted by): I2 Belief
Quantification: many to many (0,n:0,n)

Scope note: This property describes an item or items that are regarded as a reason for carrying out the E7 Activity.

For example, the discovery of a large hoard of treasure may call for a celebration, an order from headquarters can start a military manoeuvre.

Examples:
- the resignation of the chief executive (E7) was motivated by the collapse of SwissAir

(E68).

- the coronation of Elizabeth II (E7) was motivated by the death of George VI (E69)

P116 starts (is started by)

Domain: E2 Temporal Entity
Range: E2 Temporal Entity
Quantification: many to many (0,n:0,n)
Superproperty of: I1 Argumentation. J2 concluded that (was concluded by): I2 Belief

Scope note: This property allows the starting point for a E2 Temporal Entity to be situated by reference to the starting point of another temporal entity of longer duration.

                This property is only necessary if the time span is unknown (otherwise the relationship can be calculated). This property is the same as the "starts / started-by" relationships of Allen's temporal logic (Allen, 1983, pp. 832-843).

Examples:

- Early Bronze Age (E4) starts Bronze Age (E4)

1.8. BIBLIOGRAPHY

Doerr, M., Kritsotaki, A., & Boutsika, A. (2011). Factual argumentation - a core model for assertions making. *Journal on Computing and Cultural Heritage (JOCCH)* , *3*(3), 34, New York, NY, USA : ACM

CRMsci, version 1.2 - Doerr, M. and Kritsotaki, A. 2014