

Information and documentation — A reference ontology for the interchange of cultural heritage information

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National foreword

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Information and documentation — A reference ontology for the interchange of cultural heritage information

*Information et documentation — Une ontologie de référence pour
l'échange d'informations du patrimoine culturel*



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21127 was prepared by Technical Committee ISO/TC 46, *Information and documentation*, Subcommittee SC 4, *Technical interoperability*, in collaboration with the International Council of Museums Committee for Documentation (ICOM CIDOC).

Introduction

This International Standard is the culmination of more than a decade of standards development work by the International Committee for Documentation (CIDOC) of the International Council of Museums (ICOM). Work on this International Standard began in 1996 under the auspices of the ICOM-CIDOC Documentation Standards Working Group. Throughout its development, the model has been known as the “CIDOC Conceptual Reference Model” or CRM. References to the CRM can be considered throughout as synonymous with ISO 21127.

The primary purpose of this International Standard is to offer a conceptual basis for the mediation of information between cultural heritage organizations such as museums, libraries and archives. This International Standard aims to provide a common reference point against which divergent and incompatible sources of information can be compared and, ultimately, harmonized.

ISO 21127 is a domain ontology ¹⁾ for cultural heritage information: a formal representation of the conceptual scheme, or “world view”, underlying the database applications and documentation systems that are used by cultural heritage institutions. It is important to note that this International Standard aims to clarify the logic of what cultural heritage institutions do in fact document; it is not intended as a normative specification of what they *should* document. The primary role of this International Standard is to enable information exchange and integration between heterogeneous sources of cultural heritage information. It aims to provide the semantic definitions and clarifications needed to transform disparate, localized information sources into a coherent global resource, be it within an institution, an intranet or on the Internet.

The specific aims of this International Standard are to:

- Serve as a common language for domain experts and IT developers when formulating requirements.
- Serve as a formal language for the identification of common information contents in different data formats; in particular to support the implementation of automatic data transformation algorithms from local to global data structures without loss of meaning. These transformation algorithms are useful for data exchange, data migration from legacy systems, data information integration, and mediation of heterogeneous sources.
- Support associative queries against integrated resources by providing a global model of the basic classes and their associations to formulate such queries.
- Provide developers of information systems with a guide to good practice in conceptual modelling.

The CRM ontology is expressed as a series of interrelated concepts with definitions. This presentation is similar to that used for a thesaurus. However, the ontology is not intended as a terminology standard and does not set out to define the terms that are typically used as data in cultural heritage documentation. Although the presentation provided here is complete, it is an intentionally compact and concise presentation of the ontology's 80 classes and 130 unique properties. It does not attempt to articulate the inheritance of properties by subclasses throughout the class hierarchy (this would require the declaration of several thousand properties, as opposed to 130). However, this definition does contain all the information needed to infer and automatically generate a full declaration of all properties, including inherited properties.

1) In the sense used in computer science, i.e. it describes in a formal language the relevant explicit and implicit concepts and the relationships between them ^[1].

Information and documentation — A reference ontology for the interchange of cultural heritage information

1 Scope

This International Standard establishes guidelines for the exchange of information between cultural heritage institutions. In simple terms this can be defined as the curated knowledge of museums.

A more detailed definition can be articulated by defining both the intended scope, a broad and maximally inclusive definition of general principles, and the practical scope, which is defined by reference to a set of specific museum documentation standards and practices.

The intended scope of this International Standard is defined as the exchange and integration of heterogeneous scientific documentation relating to museum collections. This definition requires further elaboration:

- The term “scientific documentation” is intended to convey the requirement that the depth and quality of descriptive information that can be handled by this International Standard need be sufficient for serious academic research. This does not mean that information intended for presentation to members of the general public is excluded, but rather that this International Standard is intended to provide the level of detail and precision expected and required by museum professionals and researchers in the field.
- The term “museum collections” is intended to cover all types of material collected and displayed by museums and related institutions, as defined by ICOM ²⁾. This includes collections, sites, and monuments relating to fields such as social history, ethnography, archaeology, fine and applied arts, natural history, history of sciences and technology.
- The documentation of collections includes the detailed description of individual items within collections, groups of items and collections as a whole. This International Standard is specifically intended to cover contextual information (i.e. the historical, geographical, and theoretical background that gives museum collections much of their cultural significance and value).
- The exchange of relevant information with libraries and archives, and harmonization with their models, falls within the intended scope of this International Standard.
- Information required solely for the administration and management of cultural institutions, such as information relating to personnel, accounting and visitor statistics, falls outside the intended scope of this International Standard.

The practical scope ³⁾ of this International Standard is the set of reference standards for museum documentation that have been used to guide and validate its development. This International Standard covers the same domain of discourse as the union of these reference documents; this means that data correctly encoded according to any of these reference documents can be expressed in a compatible form, without any loss of meaning.

2) The ICOM Statutes provide a definition of the term “museum” at <<http://icom.museum/statutes.html#2>>.

3) The practical scope of the CIDOC CRM, including a list of the relevant museum documentation standards, is discussed in more detail on the CIDOC CRM website at <<http://cidoc.ics.forth.gr/scope.html>>.

2 Conformance

Users intending to take advantage of the semantic interoperability offered by this International Standard should ensure conformance with the relevant data structures. Conformance pertains either to data to be made accessible in an integrated environment, or to contents intended for transport to other environments. Any encoding of data in a formal language that preserves the relations of the classes, properties and inheritance rules defined by this International Standard is regarded as conformant.

Conformance with this International Standard does not require complete matching of all local documentation structures, nor that all concepts and structures present in this International Standard be implemented. This International Standard is intended to allow room both for extensions, needed to capture the full richness of cultural information, and for simplification, in the interests of economy. A system will be deemed partially conformant if it supports a subset of subclasses and subproperties defined by this International Standard. Designers of the system should publish details of the constructs that are supported.

The focus of this International Standard is on the transport and mediation of structured information. It does not provide or require interpretation of unstructured free-text information into a structured, logical form. Free-text information, while supported, falls outside the scope of conformance considerations.

Any documentation system will be deemed conformant with this International Standard, regardless of the internal data structures it uses, if a deterministic logical algorithm can be constructed that transforms data contained in the system into a directly compatible form without loss of meaning. No assumptions are made as to the nature of this algorithm. "Without loss of meaning" signifies that designers and users of the system are satisfied that the data representation corresponds to the semantic definitions provided by this International Standard.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply. We have selected these terms for ease of understanding by non-computer experts from the various terminologies in use for object-oriented models.

3.1 class

category of items that share one or more common properties

NOTE Class properties serve as criteria to identify items that belong to the class. These properties need not be explicitly formulated in logical terms, but can be described in a text (called a scope note) that refers to a common conceptualisation of domain experts. The sum of these properties is called the intension of the class. A class can be the domain or range of none, one, or more properties formally defined in a model. The formally defined properties need not be part of the intension of their domains or ranges: such properties are optional. An item that belongs to a class is called an instance of this class. A class is associated with an open set of real-life instances, known as the extension of the class. Here "open" is used in the sense that it is generally beyond our capabilities to know all instances of a class in the world and, indeed, that the future can bring new instances into being at any time (Open World). Therefore a class cannot be defined by enumerating its instances. A class plays a role analogous to a grammatical *noun*, and can be completely defined without reference to any other construct (unlike properties, which need to have an unambiguously defined domain and range). For example, "Person" is a class. A "Person" can have the property of being a *member of* a "Group", but this is not a necessary condition for being a "Person". We will never know all "Persons" who have lived in the past, and there will be more "Persons" in the future. Classes are usually organized as a *class hierarchy*. The relationship between a subclass and its superclass is known as the *IsA* relationship (a concatenation of the words "is a"). For example, a ship *IsA* vehicle.

3.2 complement

(of a class A) set of all instances of its superclass, B, that are not instances of class A

NOTE In terms of set theory, the complement of a class is the extension of the superclass minus the extension of the class. Compatible extensions of this International Standard need not declare any class as the complement of one or more other classes. To do so would violate the goal of describing an Open World. For example, for all possible cases of human *gender*, "male" need not be declared as the complement of "female" or vice versa.

3.3**disjoint**

having no common instances in any possible world

NOTE 1 Classes are disjoint if the intersection of their extensions is necessarily an empty set.

NOTE 2 See also 5.4.

3.4**domain**

class for which a property is formally defined

NOTE Instances of a property are applicable to instances of its domain class. A property needs to have exactly one domain, though the domain class can always contain instances for which the property is not instantiated. The domain class is analogous to the grammatical *subject* of a phrase while the property is analogous to the *verb*. Which class is selected as the domain and which as the range is arbitrary, as is the choice between active or passive voice. Property names in the CRM are designed to be semantically meaningful and grammatically correct when read from domain to range. The inverse property name, given in parentheses, is also designed to be semantically meaningful and grammatically correct when read from range to domain.

3.5**extension**

set of all real life instances belonging to a class that fulfil the criteria of its intension

NOTE 1 The extension of a class is an “open” set in the sense that it is generally beyond our capabilities to know all instances of a class in the world. The future can bring new instances into being at any time (Open World). An information system may at any point in time refer to some instances of a class, which form a subset of its extension.

NOTE 2 See also 5.6.

3.6**inheritance**

duplication of properties from a class to its subclasses

NOTE Inheritance of properties from superclasses to subclasses entails that if an item x is an instance of a class A , then all properties that need hold for the instances of any of the superclasses of A need also hold for item x , and that all optional properties that can hold for the instances of any of the superclasses of A can also hold for item x .

3.7**instance**

item having properties that meet the criteria of the intension of the class

NOTE “The Mona Lisa” is an instance of the class of “physical man-made objects”. An instance of a property is a factual relation between an instance of the domain and an instance of the range of the property that matches the criteria of the intension of the property. For example, “the Louvre *is current owner of* the Mona Lisa” is an instance of the property “is current owner of”. The number of instances of a class declared in an information system is usually less than the total number of instances in the real world. For example, although *you* are an instance of “person”, you are not mentioned in all information systems describing “persons”.

3.8**intension**

intended meaning of a class

NOTE The intension of a class consists of one or more common properties, or traits shared by all instances of the class. These properties need not be explicitly formulated in logical terms, but can simply be described in a text (a scope note) that refers to a conceptualization shared by domain experts.

3.9**interoperability**

capability of different information systems to communicate some of their contents

NOTE Interoperability can imply that

- a) two systems can exchange information, and/or
- b) multiple systems can be accessed with a single method.

Generally, *syntactic* interoperability is distinguished from *semantic* interoperability. *Syntactic* interoperability means that the information encoding and the access protocols of the relevant systems are compatible, so that information can be processed as described above without error. However, syntactic interoperability alone does not ensure that each system processes the data in a manner consistent with the intended meaning. For example, one system can use a table called "Actor" and another one called "Agent". Data from the two tables might remain separated, even though they can have exactly the same meaning. To overcome this situation, *semantic* interoperability has to be added. The CRM relies on existing *syntactic* interoperability and is concerned only with adding *semantic* interoperability.

3.10 monotonic

⟨of a knowledge base⟩ having a set of conclusions derived via inference rules that does not reduce, irrespective of the whatever additional propositions can be inserted

NOTE 1 Monotonic reasoning is a term derived from knowledge representation. In practical terms, as experts enter correct statements to an information system, the system need not regard any of the existing statements as invalid. The CRM ontology is designed for monotonic reasoning and so enables conflict-free merging of huge stores of knowledge.

NOTE 2 See also 5.1.

3.11 multiple inheritance

possibility for a class to have more than one immediate superclass

NOTE The extension of a class with multiple immediate superclasses is a subset of the intersection of all extensions of its superclasses. The intension of a class with multiple immediate superclasses extends the intensions of all its superclasses, i.e. its *traits* are more restrictive than any of its superclasses. If multiple inheritance is used, the resulting "class hierarchy" is a directed graph and not a tree structure. If it is represented as an indented list, then some classes will inevitably be repeated at different positions in the hierarchy. For example, "person" is both an "actor" and a "biological object".

3.12 open world

assumption that the information stored in a knowledge base is incomplete with respect to the universe of discourse it aims to describe

NOTE A term derived from knowledge representation. The incompleteness of a knowledge base can be due to the inability of the maintainer to provide sufficient information, or to more fundamental problems of cognition in the system's domain. Such problems are characteristic of cultural information systems since our records about the past are necessarily incomplete. In addition, some items cannot be clearly assigned to a given class. In particular, the absence of a certain property for an item described in the system does not necessarily entail that the item does not possess the property. For example, if one item is described as "biological object" and another as "physical object", this does not imply that the latter is not also a "biological object". Therefore, complements of a class with respect to a superclass cannot be *derived* in general from an information system based on the open world assumption.

3.13 primitive concept

concept that is declared and for which the meaning is clear, but which cannot be derived from other concepts

NOTE Primitive concept is a term derived from knowledge representation. For example, *mother* can be described as a female who has given birth to a child, so *mother* is not a primitive concept. *Event* however is a primitive concept. The CRM is composed primarily of primitive concepts.

3.14 property

defining characteristic that serves to define a relationship of a specific kind between two classes

NOTE A property is characterized by an intension, which is conveyed by a scope note. A property plays a role analogous to a *verb* in that it need be defined with reference to both a domain and range, which are analogous to the *subject* and *object* in a phrase (unlike classes, which can be defined independently). Which class is selected as the domain and which as the range, is arbitrary, as is the choice between active and passive voice. In other words, a property can be interpreted in both directions, with two distinct but related interpretations. Properties can themselves have properties that relate to other classes. (This feature is used in this model only in order to describe dynamic subtyping of properties.) Properties can also be *specialized* in the same manner as classes, resulting in *IsA* relationships between subproperties and their superproperties. For example, “physical man-made thing *depicts* CRM entity” is equivalent to “CRM entity *is depicted by* physical man-made thing”.

3.15

query containment

query *X* contains another query *Y* if, for each possible population of a database, the answer set to query *X* also contains the answer set to query *Y*

NOTE If query *X* and *Y* were classes, then *X* would be a superclass of *Y*.

3.16

range

class that comprises all the potential values of a property

NOTE Instances of a property can only link to instances of its range class. A property needs to have exactly one range, though the range class can also contain instances that are not values of the property. The range class is analogous to the grammatical *object* of a phrase, while the property is analogous to the *verb*. Which class is selected as domain, and which as range, is arbitrary, as is the choice between active and passive voice. Property names in the CRM are designed to be semantically meaningful and grammatically correct when read from domain to range. The inverse property name, given in parentheses, is designed to be semantically meaningful and grammatically correct when read from range to domain.

3.17

scope note

textual description of the intension of a class or property

NOTE Scope notes are not formal modelling constructs but are provided to help explain the intended meaning and application of the CRM's classes and properties. Basically, they refer to a conceptualization shared by domain experts and disambiguate different possible interpretations. Illustrative examples of classes and properties are also provided with the scope notes for explanatory purposes.

3.18

shortcut

formally defined single property that represents a *deduction* or *join* of a data path in the CRM

NOTE 1 The scope notes of shortcut properties provide a verbal description of the equivalent deduction. Shortcuts are introduced for those cases where common documentation practice refers only to the deduction rather than to the fully developed path. For example, museums often only record the “dimension” of an object without documenting the E16 measurement activity that observed it. The CRM allows shortcuts as cases of less detailed knowledge, while preserving in its schema the relationship to the full information.

NOTE 2 See also 5.3.

3.19

strict inheritance

properties inheritance that allows no exceptions

NOTE Some systems can declare that “elephants are grey”, and regard a white elephant as an exception. Under strict inheritance rules it would hold that if all elephants were indeed grey, then a white elephant could not be an elephant. Obviously not all elephants are grey; being grey is not part of the intension of the concept elephant but an optional property. The CRM applies strict inheritance as a normalization principle.

3.20

subclass

specialization of another class, i.e. the superclass

NOTE A subclass inherits *all* the properties of its superclass (i.e. strict inheritance), in addition to having none, one, or more additional properties of its own. A subclass can have more than one immediate superclass, and consequently inherits the properties of all of its superclasses (i.e. multiple inheritance). A subclass has an *IsA* relationship to its superclass(es): every instance of the subclass is also, by definition, an instance of the superclass(es). For example, every “person” *IsA* “biological object”.

3.21

subproperty

specialization of another property, i.e. the superproperty

NOTE 1 All instances of a subproperty are also instances of its superproperty. The intension of a subproperty extends the intension of its superproperty, i.e. its *traits* are more restrictive than that of its superproperty. The domain of a subproperty is a subclass of the domain of its superproperty. The range of a subproperty is a subclass of the range of its superproperty. Instances of a subproperty inherit the definition of *all* of the properties declared for its superproperty without exceptions (strict inheritance), in addition to having none, one, or more properties of their own.

NOTE 2 A subproperty can have more than one immediate superproperty and consequently inherits the properties of all of its superproperties (multiple inheritance). The *IsA relationship* or *specialization* between two or more properties gives rise to the structure we call a *property hierarchy*. The *IsA relationship* is transitive and can not be cyclic. In some object-oriented languages, including C++, there is no equivalent to the specialization of properties.

3.22

superclass

generalization of one or more other classes, i.e. the subclasses

NOTE A superclass *subsumes* all instances of its subclasses, and can also have additional instances that do not belong to any of its subclasses. The intension of the superclass is less restrictive than any of its subclasses. The *subsumption relationship* or *generalization* is the inverse of the *IsA relationship* or *specialization*. In some contexts (e.g. the programming language C++) the term *parent class* is used synonymously with superclass. For example, “biological object *subsumes* person” is synonymous with “biological object is a *superclass* of person”. Fewer properties are needed to identify an item as a “biological object” than to identify it as a “person”.

3.23

superproperty

generalization of one or more other properties, i.e. the subproperties

NOTE A superproperty *subsumes* all instances of its subproperties, and can also have additional instances that do not belong to any of its subproperties. The intension of the superproperty is less restrictive than any of its subproperties. The *subsumption relationship* or *generalization* is the inverse of the *IsA relationship* or *specialization*.

4 Structure and presentation

4.1 Property quantifiers

Quantifiers for properties are provided for the purpose of semantic clarification only, and should *not* be treated as implementation recommendations. This International Standard has been designed to accommodate alternative opinions and incomplete information; *all* properties should therefore be implemented as optional and repeatable for their domain and range (“many to many (0,n:0,n)”). The term “cardinality constraints” is avoided here as it typically pertains to implementations.

Table 1 lists all possible property quantifiers occurring in this document according to their notation, together with a textual explanation. In order to provide optimal clarity, two widely accepted notations are used in this International Standard, i.e. one verbal, the other numerical. The verbal notation uses phrases such as “one to many”, and the numerical notation expressions such as “(0,n:0,1)”. The terms “one”, “many” and “necessary” are fairly intuitive; the term “dependent” is less obvious. It denotes a situation where a range instance cannot exist without an instance of the respective property. In other words, the property is “necessary” for its range.

Table 1 — Property quantifiers

Quantifier	Description
many to many (0,n:0,n)	Unconstrained: an individual domain instance and range instance of this property can have zero, one, or more instances of the property. In other words, the property is optional and repeatable for its domain and range.
one to many (0,n:0,1)	An individual domain instance of this property can have zero, one, or more instances of the property, but an individual range instance cannot be referenced by more than one instance of this property. In other words, the property is optional for its domain and range, but repeatable for its domain only. This situation is sometimes called a “fan-out”.
many to one (0,1:0,n)	An individual domain instance of this property can have zero or one instance of the property, but an individual range instance can be referenced by zero, one, or more instances of the property. In other words, the property is optional for its domain and range, but repeatable for its range only. This situation is sometimes called a “fan-in”.
many to many, necessary (1,n:0,n)	An individual domain instance of this property can have one or more instances of the property, but an individual range instance can have zero, one, or more instances of the property. In other words, the property is necessary and repeatable for its domain, and optional and repeatable for its range.
one to many, necessary (1,n:0,1)	An individual domain instance of this property can have one or more instances of the property, but an individual range instance cannot be referenced by more than one instance of the property. In other words, the property is necessary and repeatable for its domain, and optional but not repeatable for its range. This situation is sometimes called a “fan-out”.
many to one, necessary (1,1:0,n)	An individual domain instance of this property shall have exactly one instance of the property, but an individual range instance can be referenced by zero, one, or more instances of the property. In other words, the property is necessary and not repeatable for its domain, and optional and repeatable for its range. This situation is sometimes called a “fan-in”.
one to many, dependent (0,n:1,1)	An individual domain instance of this property can have zero, one, or more instances of the property, but an individual range instance shall be referenced by exactly one instance of the property. In other words, this property is optional and repeatable for its domain, but necessary and not repeatable for its range. This situation is sometimes called a “fan-out”.
one to many, necessary, dependent (1,n:1,1)	An individual domain instance of this property can have one or more instances of the property, but an individual range instance shall be referenced by exactly one instance of the property. In other words, the property is necessary and repeatable for its domain, and necessary but not repeatable for its range. This situation is sometimes called a “fan-out”.
many to one, necessary, dependent (1,1:1,n)	An individual domain instance of this property shall have exactly one instance of the property, but an individual range instance can be referenced by one or more instances of the property. In other words, this property is necessary and not repeatable for its domain, and necessary and repeatable for its range. This situation is sometimes called a “fan-in”.
one to one (1,1:1,1)	An individual domain instance and range instance of this property shall have exactly one instance of the property. In other words, the property is necessary and not repeatable for its domain and for its range.
NOTE Some properties are defined as being necessary for their domain or as being dependent on their range. If such properties are not specified for an instance of the respective domain or range, it means that the property exists, but that the value on one side of the property is unknown. In the case of optional properties, no distinction is made between a value being unknown or the property not being applicable at all. For example, one can know that an object has an owner, but not know who the owner is, or know that an object has no owner. The model makes no distinction between these two cases. A textual note can be used for clarification if needed.	

4.2 Naming conventions

The following naming conventions have been applied hereafter:

- Classes are identified by numbers ⁴⁾ preceded by the letter “E” (historically classes were sometimes referred to as “Entities”), and are named using noun phrases (nominal groups) in title case (initial capitals). For example, *E63 Beginning of Existence*.
- Properties are identified by numbers preceded by the letter “P,” and are named in both directions, using verbal phrases in lower case. Properties with the character of states are named in the present tense, such as “has type”, whereas properties relating to events are named in past tense, such as “carried out”. For example, *P126 employed (was employed by)*.
- Property names should be read in their non-parenthetical form for the domain-to-range direction, and in parenthetical form for the range-to-domain direction.
- Properties with a range that is a subclass of *E59 Primitive Value* (such as *E1 CRM Entity.P2 has note: E62 String*) have no parenthetical name form as reading the property name in the range-to-domain direction is not regarded as meaningful.
- Properties that have identical domain and range are either symmetric or transitive. Instantiating a symmetric property implies that the relation holds for both the domain-to-range and the range-to-domain directions. An example of this is *E53 Place.P122 borders with: E53 Place*. The names of symmetric properties have no parenthetical form, because reading in the range-to-domain direction is the same as the domain-to-range reading. Transitive asymmetric properties, such as *E4 Period. P9 consists of (forms part of): E4 Period*, do have a parenthetical form that relates to the meaning of the inverse direction.
- The choice of property domains, and hence the order of their names, is established in accordance with the following priority list:
 - 1) Temporal Entity and its subclasses;
 - 2) Thing and its subclasses;
 - 3) Actor and its subclasses;
 - 4) Other.

5 Modelling principles

5.1 Monotonicity

Because this International Standard's primary role is the meaningful integration of information in an Open World, it aims to be monotonic in the sense of Domain Theory. Existing constructs, and deductions made from them, shall always remain valid and well-formed, i.e. even if new constructs and extensions are added.

For example, one may add a subclass of *E7 Activity* to describe the use of a certain name for a place over a certain time-span by a particular group. By this extension, no existing *IsA Relationships* or property inheritances are compromised.

In addition, this International Standard aims to enable the formal preservation of monotonicity when augmenting a compatible system. Existing instances, their properties, and deductions made from them, should always remain valid and well-formed even as new instances are added to the system.

4) Some gaps are present in the numbering sequence used for classes and properties. This is intentional: numbers assigned in previous versions of the CRM to deprecated classes and properties have not been re-used.

For example, if someone describes correctly that an item is an instance of *E19 Physical Object* and, subsequently, it is correctly characterized as an instance of *E20 Biological Object*, the system should not stop treating it as an instance of *E19 Physical Object*.

In order to formally preserve monotonicity in cases where opinions diverge, all formally defined properties should be implemented with unconstrained cardinality (many:many) so that conflicting instances of properties are merely accumulated. Knowledge stored in a conformant system can thus serve as a research base, accumulating relevant alternative opinions around well-defined entities. Conclusions about the truth or falsehood of the instances stored remain the subject of open-ended scientific or scholarly hypothesis building.

For example, “El Greco” and even “King Arthur” should be treated as instances of *E21 Person* and be dealt with as existing within the domain of discourse once they are entered into a knowledge base. Alternative opinions about properties, such as their birthplace and the details of their lives, may be accumulated without decisions concerning their veracity being required during data compilation.

5.2 Minimality

Although the scope of this International Standard is very broad, the ontology itself is constructed as economically as possible.

- A class is not declared unless it is required as the domain or range of a property not appropriate to its superclass, or it is a key concept in the *practical scope*.
- Classes and properties that share a superclass are *non-exclusive* by default. For example, an object may be both an instance of *E20 Biological Object* and *E22 Man-made Object*.
- Classes and properties are either primitive, or constitute key concepts in the practical scope.
- Complements of classes are not declared.

5.3 Shortcuts

Some properties are declared as shortcuts of longer, more comprehensively articulated paths that connect the same domain and range classes as the shortcut property via one or more intermediate classes. For example, the property *E18 Physical Thing. P52 has current owner: E39 Actor*, is a shortcut for a fully articulated path from *E18 Physical Thing* through *E8 Acquisition* to *E39 Actor*. An instance of the fully-articulated path always implies an instance of the shortcut property. However, the inverse may not be true; an instance of the fully-articulated path cannot always be inferred from an instance of the shortcut property.

5.4 Disjointness

Classes are disjoint if they share no common instances in any possible world. There are many examples of disjoint classes in the CRM.

A comprehensive declaration of all possible disjoint class combinations afforded by the CRM has not been provided here; it would be of questionable practical utility and would easily become inconsistent with the goal of providing a concise definition. However, the two following examples of disjoint class pairs are fundamental to an effective comprehension of the CRM ontology.

5.4.1 E2 Temporal Entity is disjoint from E77 Persistent Item

Instances of the class *E2 Temporal Entity* perish, whereas instances of the class *E77 Persistent Item* endure. Even though instances of *E77 Persistent Item* have a limited existence in time, they are fundamentally different in nature from instances of *E2 Temporal Entity* because they preserve their identity between events. Declaring enduring and perishing entities as disjoint classes is consistent with the distinctions made in data structures that fall within the CRM's practical scope.

5.4.2 E18 Physical Thing is disjoint from E28 Conceptual Object

Instances of *E18 Physical Thing* and *E28 Conceptual Object* differ in many fundamental ways; for example, the production of instances of *E18 Physical Thing* implies the incorporation of physical material, whereas the production of instances of *E28 Conceptual Object* does not. Similarly, instances of *E18 Physical Thing* cease to exist when destroyed, whereas an instance of *E28 Conceptual Object* perishes only when it is forgotten and its last physical carrier is destroyed.

5.5 Types

Virtually all structured descriptions of museum objects begin with a unique object identifier and information about the “type” of the object, often in a set of fields with names like “Object Type”, “Object Name”, “Category”, “Classification”, etc. All these fields are used for terms that declare the object to be a member of a particular class or category of items, and are described by the CRM as instances of *E55 Type*. Since the instances of this class are themselves classes, *E55 Type* is in fact a *metaclass*.

The class *E1 CRM Entity* is the domain of the property *P2 has type (is type of)*, which has the range *E55 Type*. Consequently, every class in the CRM, with the exception of *E59 Primitive Value*, inherits the property *P2 has type (is type of)*. This provides a general mechanism for refining the classification of CRM instances to any level of detail, by linking to external vocabulary sources, thesauri, classification schema, or ontologies that function as *extensions* to the class and property hierarchies. These external vocabularies do not themselves fall within the scope of the CRM ontology.

The class *E55 Type* also serves as the range of properties that relate to categorical knowledge commonly found in cultural documentation. For example, the property *P125 used object of type (was type of object used in)* enables the CRM to express statements such as “this casting was produced using a mould”, meaning that an unknown or unmentioned instance of “mould” was used. This enables the specific instance of the casting to be associated with the entire class of manufacturing devices known as moulds. Further, objects of type “mould” can be related via *P2 has type (is type of)* to the same term. This indirect relationship may actually help in detecting an unknown object in an integrated environment. On the other hand, a particular mould may be directly associated with a casting via *P16 used specific object (was used for)*. Statistical questions as to how many objects in a certain collection were made with moulds can be answered correctly by following both paths through P16-P2 and P125. This consistent treatment of categorical knowledge significantly enhances the ontology's ability to integrate cultural information.

Some properties in this International Standard are associated with an additional property. These are numbered with a “.1” extension. These do not appear in the property hierarchy list but are included as part of the property declarations and referred to in the class declarations. For example, *P62.1 mode of depiction: E55 Type* is associated with *E24 Physical Man-made Thing*. *P62 depicts (is depicted by): E1 CRM Entity*. The range of these properties of properties always falls within the type hierarchy *E55 Type*. Their purpose is to allow dynamic extensions to their parent property through the use of property subtypes declared as instances of *E55 Type*. This function is analogous to that of the *P2 has type (is type of)* property, which all classes inherit from *E1 CRM Entity*. System implementations and schemas that do not support properties of properties may use dynamic subtyping of the parent properties instead.

Finally, types play a central role in the history of human understanding; they are intellectual products, and documentation about their history and justification by physical evidence (particularly in disciplines such as archaeology and natural history) falls squarely within the intended scope of the CRM ontology. Therefore types are modelled as “conceptual objects”, in parallel with their structural role as metaclasses. This approach elegantly addresses the dual nature of types in a manner consistent with material culture and natural history documentation.

5.6 Extensions

Since the intended scope of this International Standard is a subset of the “real” world, it is potentially unlimited. Consequently, the model has been designed to be extensible through the linkage of compatible external type hierarchies.

For extensions with the CRM ontology to remain compatible, data structured using an extension shall also remain valid as an instance of an existing class or property. In practical terms this implies query containment: any query based on concepts defined by this International Standard should retrieve the same result set, whether or not extensions have been implemented. For example, a query such as “list all events” should recall all instances that fall within the scope of *E5 Event*, regardless of how they are classified by extended semantics.

A sufficient condition for the compatibility of an extension to this International Standard is that existing classes subsume all classes of the extension, and that all properties of the extension are either subsumed by existing properties, or are part of a path for which an existing property is a shortcut.

5.7 Coverage of intended scope

Of necessity, some concepts covered by this International Standard are less thoroughly elaborated than others: *E39 Actor* and *E30 Right*, for example. This is a natural consequence of staying within the practical scope in an intrinsically unlimited domain of discourse. These “underdeveloped” concepts can be considered as hooks for compatible extensions.

The CRM ontology provides a number of mechanisms to ensure that coverage of the intended scope is nonetheless complete.

- a) Existing high-level classes can be extended, either structurally as subclasses or dynamically using the type hierarchy.
- b) Existing high-level properties can be extended, either structurally as subproperties or in some cases dynamically, using properties of properties that allow subtyping.
- c) Additional information that falls outside the semantics formally defined by this International Standard can be recorded as unstructured data using *E1 CRM Entity.P3 has note: E62 String*.

With mechanisms a) and b), the existing concepts subsume and thereby cover the extensions.

With mechanism c), information is accessible at the appropriate point in the respective knowledge base. This approach is preferable when detailed, targeted queries are not expected. In general, only those concepts used for formal querying need to be explicitly modelled.

6 Class declarations

All classes are declared in this clause using the following format:

- Class names are presented as headings in bold face, preceded by the class' 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 **Properties** declares the list of the class' properties.
- Each property is represented by its unique identifier, its forward and reverse names, and the range class that it links to, separated by a colon.
- Inherited properties are not represented.
- Properties of properties are shown indented and in parentheses beneath their respective domain property.

E1 CRM Entity

Subclass of	
Superclass of	E2 Temporal Entity E52 Time-Span E53 Place E54 Dimension E77 Persistent Item
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: a) Identification by name or appellation. b) Classification by type, allowing further refinement of the specific subclass to which an instance belongs. c) 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 specializations of E1 CRM Entity.
Examples	The earthquake in Lisbon 1755 (E5)
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)

E2 Temporal Entity

Subclass of	E1 CRM Entity
Superclass of	E3 Condition State E4 Period
Scope note	This class comprises all phenomena, such as instances of E4 Period and E5 Event, which happen over a limited extent in time. In some contexts, these are also called perdurants. This class is disjoint from E77 Persistent Item. E2 Temporal Entity is an abstract class and has no direct instances. It 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 to 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

E3 Condition State

Subclass of	E2 Temporal Entity
Superclass of	
Scope note	This class comprises the states of objects characterized by a certain condition over a time-span. It describes the prevailing physical condition of any material object or feature during a specific E52 Time Span. The nature of that condition can be described using <i>P2 has type</i>. For example, the E3 Condition State “condition of the SS Great Britain between 22 September 1846 and 27 August 1847” can be characterized as E55 Type “wrecked”.
Examples	The “Amber Room” in Tsarskoje Selo being completely reconstructed from summer 2003 until now The Peterhof Palace near Saint Petersburg being in ruins from 1944 to 1946 The condition of my turkey in the oven at 14:30 on 25 December, 2002 (P2 has type E55 Type “still not cooked”)
Properties	P5 consists of (forms part of): E3 Condition State

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. Artistic style may be modelled as E4 Period. There are two different conceptualisations of “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 consistent with 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): E19 Physical Object 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

E5 Event

Subclass of	E4 Period
Superclass of	E7 Activity E63 Beginning of Existence E64 End of Existence
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 Lisbon by earthquake in 1755 (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

E6 Destruction

Subclass of	E64 End of Existence
Superclass of	
Scope note	This class comprises events that destroy one or more instances of E18 Physical Thing such that they lose their identity as the subjects of documentation. Some destruction events are intentional, while others are independent of human activity. Intentional destruction may be documented by classifying the event as both an E6 Destruction and E7 Activity. The decision to document an object as destroyed, transformed or modified is context-sensitive. a) If the matter remaining from the destruction is not documented, the event is modelled solely as E6 Destruction. b) An event should also be documented using E81 Transformation if it results in the destruction of one or more objects and the simultaneous production of others using parts or material from the original. In this case, the new items have separate identities. Matter is preserved, but identity is not. c) When the initial identity of the changed instance of E18 Physical Thing is preserved, the event should be documented as E11 Modification.
Examples	The destruction of Lisbon by earthquake in 1755 The destruction of Nineveh (E6, E7) The breaking of a champagne glass yesterday by my dog The shooting of the last wolf in Germany in 1729 (E6, E7)
Properties	P13 destroyed (was destroyed by): E18 Physical Thing

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
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)
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): E7 Activity P21 had general purpose (was purpose of): E55 Type P125 used object of type (was type of object used in): E55 Type P134 continued (was continued by): E7 Activity

E8 Acquisition

Subclass of	E7 Activity
Superclass of	
Scope note	This class comprises transfers of legal ownership from one or more instances of E39 Actor to one or more other instances of E39 Actor. The class also applies to the establishment or loss of ownership of instances of E18 Physical Thing. It does not, however, imply changes of any other instances of E30 Right. Nor does it require the donor and/or recipient to be included, known or even to exist. Depending on the circumstances, it may describe a) the beginning of ownership, b) the end of ownership, c) the transfer of ownership, d) the acquisition from an unknown source, or e) the loss of title due to destruction of the item. It may also describe events where a collector appropriates legal title, for example by annexation or field collection. The interpretation of the museum notion of “accession” differs between institutions. The CRM therefore models legal ownership and physical custody separately. Institutions will then model their specific notions of accession and deaccession as combinations of these.
Examples	The collection of a hammer-head shark, <i>genus Sphyrna</i> (Carchariniformes), by John Steinbeck and Edward Ricketts at Puerto Escondido in the Gulf of Mexico on March 25th, 1940 The acquisition of El Greco's “The Apostles Peter and Paul” by the State Hermitage in Saint Petersburg The loss of my stuffed <i>Fringilla coelebs</i> due to insect damage last year
Properties	P22 transferred title to (acquired title through): E39 Actor P23 transferred title from (surrendered title of): E39 Actor P24 transferred title of (changed ownership by): E18 Physical Thing

E9 Move

Subclass of	E7 Activity
Superclass of	
Scope note	This class comprises changes of the physical location of the instances of E19 Physical Object. Note that the class E9 Move inherits the property P7 took place at (witnessed): E53 Place. This property should be used to describe the trajectory or a larger area within which a move takes place, whereas the properties P26 moved to (was destination of), P27 moved from (was origin of) describe the start and end points only. Moves may also be documented to consist of other moves (via P9 consists of (forms part of)), in order to describe intermediate stages on a trajectory. In that case, start and end points of the partial moves should match appropriately between each other and with the overall event.
Examples	The relocation of London Bridge from the UK to the USA The movement of the exhibition “Treasures of Tutankhamen” 1976 to 1979
Properties	P25 moved (moved by): E19 Physical Object P26 moved to (was destination of): E53 Place P27 moved from (was origin of): E53 Place

E10 Transfer of Custody

Subclass of	E7 Activity
Superclass of	
Scope note	This class comprises transfers of physical custody of objects between instances of E39 Actor. E10 Transfer of Custody does not require the donor and/or recipient to be included, known or even to exist. Depending on the circumstances it may describe: a) the beginning of custody, b) the end of custody, c) the transfer of custody, or d) the declared loss of an object. The distinction between the legal responsibility for custody and the actual physical possession of the object should be expressed using the property <i>P2 has type (is type of)</i>. A specific case of transfer of custody is theft. The interpretation of the museum notion of “accession” differs between institutions. The CRM therefore models legal ownership and physical custody separately. Institutions will then model their specific notions of accession and deaccession as combinations of these.
Examples	The delivery of the paintings by Secure Deliveries Inc. to the National Gallery The return of Picasso’s “Guernica” to Madrid’s Prado in 1981
Properties	P28 custody surrendered by (surrendered custody through): E39 Actor P29 custody received by (received custody through): E39 Actor P30 transferred custody of (custody transferred through): E18 Physical Thing

E11 Modification

Subclass of	E7 Activity
Superclass of	E12 Production E79 Part Addition E80 Part Removal
Scope note	This class comprises all instances of E7 Activity that create, alter, or change E24 Physical Man-Made Thing. This class includes the production of an item from raw materials, and other so far undocumented objects, and the preventive treatment or restoration of an object for conservation. Since the distinction between modification and production is not always clear, modification is regarded as the more generally applicable concept. This implies that some items may be consumed or destroyed in a modification event, and that others may be produced as a result of it. An event should also be documented using E81 Transformation if it results in the destruction of one or more objects and the simultaneous production of others using parts or material from the originals. In this case, the new items have separate identities. If the instance of the E29 Design or Procedure utilized for the modification prescribes the use of specific materials, they should be documented using properties of the design or procedure, rather than via P126 employed (was employed in) E57 Material.
Examples	The construction of the SS Great Britain (E12) The impregnation of the Vasa warship in Stockholm for preservation after 1956 The transformation of the Enola Gay into a museum exhibit before 1995 (E11, E81) The last renewal of the gold coating of the Toshogu shrine in Nikko, Japan
Properties	P31 has modified (was modified by): E24 Physical Man-Made Thing P32 used general technique (was technique of): E55 Type P33 used specific technique (was used by): E29 Design or Procedure P126 employed (was employed in): E57 Material

E12 Production

Subclass of	E11 Modification E3 Beginning of Existence
Superclass of	
Scope note	This class comprises activities that are designed to, and succeed in, creating one or more new items. It specializes the notion of modification into production. The decision as to whether or not an object is regarded as new is context-sensitive. Normally, items are considered “new” if there is no obvious overall similarity between them and the consumed items and material used in their production. In other cases, an item is considered “new” because it becomes relevant to documentation by a modification. For example, the scribbling of a name on a potsherd may make it a voting token. The original potsherd may not be worth documenting, in contrast to the inscribed one. This entity can be collective, e.g. the printing of a thousand books would normally be considered a single event. An event should also be documented using E81 Transformation if it results in the destruction of one or more objects and the simultaneous production of others using parts or material from the originals. In this case, the new items have separate identities and matter is preserved, but identity is not.
Examples	The construction of the SS Great Britain The recasting of the Little Mermaid at the harbour of Copenhagen The seventh edition of Rembrandt’s etching “Woman sitting half-dressed beside a stove”, 1658, Bartsch Number 197
Properties	P108 has produced (was produced by): E24 Physical Man-Made Thing

E13 Attribute Assignment

Subclass of	E7 Activity
Superclass of	E14 Condition Assessment E15 Identifier Assignment E16 Measurement E17 Type Assignment
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 characterized as “shortcuts” 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 shortcut, 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

E14 Condition Assessment

Subclass of	E13 Attribute Assignment
Superclass of	
Scope note	This class describes the act of assessing the state of preservation of an object during a particular period. The condition assessment may be carried out by inspection, measurement or through historical research. This class is used to document circumstances of the respective assessment that may be relevant to interpret its quality at a later stage, or to continue research on related documents.
Examples	Last year’s inspection of humidity damage to the frescos in the St. George chapel in our village
Properties	P34 concerned (was assessed by): E18 Physical Thing P35 has identified (identified by): E3 Condition State

E15 Identifier Assignment

Subclass of	E13 Attribute Assignment
Superclass of	
Scope note	This class comprises actions assigning or deassigning object identifiers. Examples of such identifiers include Find Numbers and Inventory Numbers. Documenting the act of identifier assignment and deassignment is especially useful when objects change custody or the identification system of an organization is changed. In order to keep track of the identity of an object in such cases, it is important to document by whom, when and for what purpose an identifier is assigned to an object.
Examples	Replacement of the inventory number TA959a by GE34604 for a 17th century lament cloth at the Museum Benaki, Athens
Properties	P36 registered (was registered by): E19 Physical Object P37 assigned (was assigned by): E42 Object Identifier P38 deassigned (was deassigned by): E42 Object Identifier

E16 Measurement

Subclass of	E13 Attribute Assignment
Superclass of	
Scope note	This class comprises actions measuring physical properties and other values that can be determined by a systematic procedure. Examples include measuring the monetary value of a collection of coins or the running time of a specific video cassette. The E16 Measurement may use simple counting or tools, such as yardsticks or radiation detection devices. The interest is in the method and care applied, so that the reliability of the result may be judged at a later stage, or research continued on the associated documents. The date of the event is important for dimensions, which may change value over time, such as the length of an object subject to shrinkage. Details of methods and devices are best handled as free text, whereas basic techniques such as “carbon 14 dating” should be encoded using P2 has type (is type of) E55 Type.
Examples	Measurement of height of silver cup 232 on the 31st August 1997 The carbon 14 dating of the Neolithic spear NE1974-5032 in 1991
Properties	P39 measured (was measured by): E70 Thing P40 observed dimension (was observed in): E54 Dimension

E17 Type Assignment

Subclass of	E13 Attribute Assignment
Superclass of	
Scope note	This class comprises the actions of classifying items of whatever kind. Such items include objects, specimens, people, actions, and concepts. This class allows for the documentation of the context of classification acts in cases where the value of the classification depends on the personal opinion of the classifier, and the date that the classification was made. This class also encompasses the notion of “determination,” i.e. the systematic and molecular identification of a specimen in biology.
Examples	The first classification of object GE34604 as Lament Cloth, October 2nd The determination of a cactus in Martin Doerr’s garden as <i>Cereus hildmannianus</i> K.Schum., July 2003
Properties	P41 classified (was classified by): E1 CRM Entity P42 assigned (was assigned by): E55 Type

E18 Physical Thing

Subclass of	E72 Legal Object
Superclass of	E19 Physical Object E24 Physical Man-Made Thing E26 Physical Feature
Scope note	This class comprises all persistent physical items with a relatively stable form, man-made or natural. Depending on the existence of natural boundaries of such things, the CRM distinguishes the instances of E19 Physical Object from instances of E26 Physical Feature, such as holes, rivers, pieces of land, etc. Most instances of E19 Physical Object can be moved (if not too heavy), whereas features are integral to the surrounding matter. The CRM is generally not concerned with amounts of matter in fluid or gaseous states.
Examples	The Cullinan Diamond (E19) The cave “Ideon Andron” in Crete (E26) The Mona Lisa (E22)
Properties	P44 has condition (condition of): E3 Condition State P45 consists of (is incorporated in): E57 Material P46 is composed of (forms part of): E18 Physical Thing P49 has former or current keeper (is former or current keeper of): E39 Actor P50 has current keeper (is current keeper of): E39 Actor P51 has former or current owner (is former or current owner of): E39 Actor P52 has current owner (is current owner of): E39 Actor P53 has former or current location (is former or current location of): E53 Place P58 has section definition (defines section): E46 Section Definition P59 has section (is located on or within): E53 Place

E19 Physical Object

Subclass of	E18 Physical Thing
Superclass of	E20 Biological Object E22 Man-Made Object
Scope note	This class comprises items of a material nature that are units for documentation and have physical boundaries that separate them completely in an objective way from other objects. The class also includes all aggregates of objects made for functional purposes of whatever kind, independent of physical coherence, such as a set of chessmen. Typically, instances of E19 Physical Object can be moved (if not too heavy). In some contexts, such objects, except for aggregates, are also called “bona fide objects” [2], i.e. naturally defined objects. The decision as to what is documented as a complete item, rather than by its parts or components, may be purely administrative or may be a result of the acquisition history of the item.
Examples	John Smith Aphrodite of Milos The Palace of Knossos The Cullinan Diamond Apollo 13 at the time of launch
Properties	P47 is identified by (identifies): E42 Object Identifier P48 has preferred identifier (is preferred identifier of): E42 Object Identifier P54 has current permanent location (is current permanent location of): E53 Place P55 has current location (currently holds): E53 Place P56 bears feature (is found on): E26 Physical Feature P57 has number of parts: E60 Number

E20 Biological Object

Subclass of	E19 Physical Object
Superclass of	E21 Person
Scope note	This class comprises individual items of a material nature, which live, have lived or are natural products of or from living organisms. Artificial objects that incorporate biological elements, such as Victorian butterfly frames, can be documented as both instances of E20 Biological Object and E22 Man-Made Object.
Examples	Me Tutankhamen Boukephalas Petrified dinosaur excrement PA1906-344
Properties	

E21 Person

Subclass of	E20 Biological Object E39 Actor
Superclass of	
Scope note	This class comprises real persons who live or are assumed to have lived. Legendary figures that may have existed, such as Ulysses and King Arthur, fall into this class if the documentation refers to them as historical figures. In cases where doubt exists as to whether several persons are in fact identical, multiple instances can be created and linked to indicate their relationship. The CRM does not propose a specific form to support reasoning about possible identity.
Examples	Tutankhamen Nelson Mandela
Properties	

E22 Man-Made Object

Subclass of	E19 Physical Object E24 Physical Man-Made Thing
Superclass of	E84 Information Carrier
Scope note	This class comprises physical objects purposely created by human activity. No assumptions are made as to the extent of modification required to justify regarding an object as man-made. For example, an inscribed piece of rock or a preserved butterfly are both regarded as instances of E22 Man-Made Object.
Examples	Mallard (the World's fastest steam engine) The Portland Vase The Coliseum
Properties	

E24 Physical Man-Made Thing

Subclass of	E18 Physical Thing E71 Man-Made Thing
Superclass of	E22 Man-Made Object E25 Man-Made Feature E78 Collection
Scope note	This class comprises all persistent physical items that are purposely created by human activity. This class comprises man-made objects, such as a swords, and man-made features, such as rock art. No assumptions are made as to the extent of modification required to justify regarding an object as man-made. For example, a “cup-and-ring” carving on bedrock is regarded as instance of E24 Physical Man-Made Thing.
Examples	The Forth Railway Bridge (E22) The Channel Tunnel (E25) The Historical Collection of the Museum Benaki in Athens (E78)
Properties	P62 depicts (is depicted by): E1 CRM Entity (P62.1 mode of depiction: E55 Type) P65 shows visual item (is shown by): E36 Visual Item P128 carries (is carried by): E73 Information Object

E25 Man-Made Feature

Subclass of	E24 Physical Man-Made Thing E26 Physical Feature
Superclass of	
Scope note	This class comprises physical features that are purposely created by human activity, such as scratches, artificial caves, artificial water channels, etc. No assumptions are made as to the extent of modification required to justify regarding a feature as man-made. For example, rock art or even a “cup-and-ring” carving on bedrock is regarded as instance of E25 Man-Made Feature.
Examples	The Manchester Ship Canal Michael Jackson’s nose following plastic surgery
Properties	

E26 Physical Feature

Subclass of	E18 Physical Thing
Superclass of	E25 Man-Made Feature E27 Site
Scope note	This class comprises identifiable features that are physically attached in an integral way to particular physical objects. Instances of E26 Physical Feature share many of the attributes of instances of E19 Physical Object. They may have a one-, two- or three-dimensional geometric extent, but there are no natural borders that separate them completely in an objective way from the carrier objects. For example, a doorway is a feature but the door itself, being attached by hinges, is not. Instances of E26 Physical Feature can be features in a narrower sense, such as scratches, holes, reliefs, surface colours, reflection zones in an opal crystal or a density change in a piece of wood. In the wider sense, they are portions of particular objects with partially imaginary borders, such as the core of the Earth, an area of property on the surface of the Earth, a landscape or the head of a contiguous marble statue. They can be measured and dated, and it is sometimes possible to state who or what is or was responsible for them. They cannot be separated from the carrier object, but a segment of the carrier object may be identified (or sometimes removed) carrying the complete feature. This definition coincides with the definition of “fiat objects” [2], with the exception of aggregates of “bona fide objects”.
Examples	The temple in Abu Simbel before its removal, which was carved out of solid rock Albrecht Durer's signature on his painting of Charles the Great The damage to the nose of the Great Sphinx in Giza Michael Jackson's nose prior to plastic surgery
Properties	

E27 Site

Subclass of	E26 Physical Feature
Superclass of	
Scope note	This class comprises pieces of land or sea floor. In contrast to the purely geometric notion of E53 Place, this class describes constellations of matter on the surface of the Earth or other celestial body, which can be represented by photographs, paintings, and maps. Instances of E27 Site are composed of relatively immobile material items and features in a particular configuration at a particular location.
Examples	The Amazon river basin Knossos The Apollo 11 landing site Heathrow Airport The submerged harbour of the Minoan settlement of Gournia, Crete
Properties	