The AO-Cat Ontology

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Revision history

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24/02/2021		The AO-Cat Team	Added digital images: class AO_Digital_Image and

			properties is_mirror_of, has_visual_component and has_primary_visual_component
03/03/2022		C. Meghini	Changed the range of from and until properties to xsd:gYear to make them compliant with what we get from PeriodO.
30/05/2022		C. Meghini	Added property has_country_code for spatial regions.
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1 Introduction

The AO-Cat Ontology is a formal ontology of the resources managed by the ARIADNE Research Infrastructure, ARIADNE RI. AO-Cat was developed within the ARIADNEplus (A+ for short) project. This report documents the development of AO-Cat, by presenting the rationale behind it and its final status at the close ot the ARIADNEplus project, although it is likely to evolve further in future projects.

1.1 Lineage

AO-Cat derives from the ARIADNE Catalogue Data Model (ACDM for short), employed in the predecessor ARIADNE project to model archaeological resources, and from the PARTHENOS Entities Model (PEM), employed in the PARTHENOS project to model the resources managed by a research infrastructure. In its initial version, AO-Cat is a contraction of the ACDM driven by the conceptualization underlying the PEM. In addition, AO-Cat inherits from the PEM its tight relation to the CRM, which is used to represent any aspect of archaeological resources not covered by the ACDM or the PEM. Those aspects that are not covered by any of the three models mentioned so far, will be dealt with by introducing *ad hoc* terms in AO-Cat.

1.2 Syntax and Semantics

The AO-Cat is expressed in terms of conceptual modelling notions: it defines classes and properties and uses them to axiomatize the domain of discourse. The types of axioms comprising AO-Cat are a subset of the OWL 2 DL axiom types [ref OWL 2 DL Intro], to avoid making the ontology too restrictive. In particular,

- the axioms on classes include only super- or sub-class axioms;
- the axioms on properties include domain and range axioms, and sub- and super-properties axioms.

The OWL 2 DL Direct Semantics applies [ref OWL 2 DL Direct Semantics] to AO-Cat. Scope notes and examples are included in both class and property definitions for illustrating semantics in an informal way.

Syntactically, AO-Cat classes and properties are IRIs in the ARIADNE namespace, which is identified by the IRI:

https://ariadne-infrastructure.eu/aocat/

Class and property IRIs in AO-Cat are written as qualified names [ref XML syntax] using no prefix, meaning that the ARIADNE namespace IRI is used as a base IRI that applies to all of them. For example, the class of temporal regions is named in AO-Cat as

http://ariadne-infrastructure.eu/ns/AO_Temporal_Region and in this document is written as AO_Temporal_Region.

For readability, AO-Cat axioms are stated in a simpler notation than that of OWL 2 DL [ref OWL 2 DL Structural Specs]. In particular, class axioms are stated using a common template giving:

- the name of the class, given as the title of the section presenting the property; AO-Cat classes are all named following a single schema: the string "AO_" is used as a prefix, followed by a name that indicates the type of resource captured by the class. Thus, AO_Event names the class of events, AO_Object that of objects and so on.
- the sub- and super-classes of the class are given for convenience.
- scope notes stating the informal semantics of the class.
- where appropriate, usage notes stating when an instance of the class should be created.
- examples of resources that are instances of the class.
- the properties having the class as domain; the same information is given upon defining properties, but it is repeated here for convenience; properties inherited from super-classes are not repeated.
- the mapping to CRM or PEM class(es).
- where appropriate, the classes in popular ontologies the class maps to.

Similarly, property axioms are stated using a common template giving:

- the name of the property, given as the title of the section presenting the property; AO-Cat properties are named similarly to the way classes are named, except that no prefix is used.
- the domain(s) of the property; following standard semantics, where several domains are given, their intersection is meant.
- the range(s) of the property; following standard semantics, where several ranges are given, their intersection is meant
- the name of the inverse of the property, for properties ranging over classes.
- the sub- and super-properties of the property; both are given for convenience.
- scope notes stating the informal semantics of the property.
- examples of relationships that are instances of the property.
- the obligation of the property, specifying whether the property is Optional, Mandatory or Recommended.
- the CRM or PEM property(ies) or chain of properties the property maps to. A chain of property (called "shortcut" in CRM) is given as the sequence of the properties in chain, separated by the classes that are the range of the n-th property and the domain of the (n+1)-th. For example: the AO-Cat property has_identifier is a shortcut of the fully developed path
crm:P1_is_identified_by → crm:E42_Identifier → crm:P2_has_type → crm:E55_Type
- where appropriate, the properties in popular ontologies the class maps to (hints).

Classes and properties in other ontologies are written as prefixed qualified names. The prefix in the following Table are used:

Prefix	Ontology	Namespace
dc	Dublin Core Metadata Elements	http://purl.org/dc/elements/1.1/
dct	Dublin Core terms	http://purl.org/dc/terms/
foaf	Friend of a Friend	http://xmlns.com/foaf/0.1/
rdfs	RDF Schema	http://www.w3.org/2000/01/rdf-schema#
skos	Simple Knowledge Organization System	http://www.w3.org/2004/02/skos/core#
xsd	XML Schema	http://www.w3.org/2001/XMLSchema#
crm	CIDOC Conceptual Reference Model	http://www.cidoc-crm.org/cidoc-crm/
crmpe	The PARTHENOS Entity Model	http://parthenos.d4science.org/CRMext/CRMpe/
crmdig	CRMdig is a compatible extension of CIDOC CRM to encode metadata about the steps and methods of production ("provenance") of digitization products and synthetic digital representations.	http://www.ics.forth.gr/isl/CRMext/CRMdig.rdfs/
geo	Basic Geo (WGS84 lat/long) Vocabulary	http://www.w3.org/2003/01/geo/wgs84_pos#
lvont	Lexvo ontology for languages	http://lexvo.org/ontology#

1.3 Structure of the document

The document is structured as follows.

- Section 2 outlines the requirements that motivate AO-Cat and justify its vocabulary and axioms.
- Section 3 presents AO-Cat from a general point of view, relating its classes and properties to the requirements.
- Section 4 (Appendix 1) presents the AO-Cat classes and the relative class axioms.
- Section 5 (Appendix 2) presents the AO-Cat properties and the relative property axioms.
- Section 6 (Appendix 3) presents the final list of ARIADNE_subjects at the close of ARIADNEplus

2 Requirements

This Section briefly outlines the requirements that are expected to be fulfilled by the A+ Catalogue and more generally by the ARIADNE Content Cloud (AC for short) which the Catalogue is a part of (later termed Knowledge Base)

There are two basic requirements:

1. Enabling cross-border/cross-institution resource discovery, i.e. *finding* data.
2. Enabling interoperability–across partners, countries, data types, data schemas, i.e. *enabling research.*

Concerning resource discovery, the A+ Catalogue should support:

- *What* searches, searches based on a topic. For topics the Getty AAT should be used as the common conceptual backbone, in addition to local reference resources.
- *When* searches, searches based on a temporal period. For temporal periods, the PeriodO vocabulary should be used as it maps periods to absolute dates on a common time scale. In addition, local vocabularies providing region-related period appellations should be represented in the AC and allowed in searches by cultural period e.g. "Iron Age"
- *Where* searches, searches based on a spatial region. For spatial regions, the World Geodetic System 1984 (commonly abbreviated as WGS84) representation should be used.
- Enhanced map‑based searching.
- Enhanced queries, specific to data types.

More search types that should be supported will be defined by a user needs study undertaken by the project.

Concerning enabling research, in addition to the above types of search, the AC is expected to store information about digital objects belonging to a large range of data types, forming a heterogeneous set, as data is diverse in character and content. These data types include, but are not restricted to:

- Databases
- Reports
- Finds
- Images
- GIS
- LiDAR data
- Datasets e.g. excavation archives

- Sub‑domains, *e.g.,* scientific data; these should be modelled as CRM Application profiles, that is subsets of the CRM that we use for item level integration (cf ARIADNE coins)
- Linguistic resources, such as ontologies and vocabularies relevant to the archaeological domain.

In addition, different levels of granularity must be accounted for, supporting collection and item level interoperability, *e.g.,* sites and the individual artefacts they contain; individual dates; cemeteries and the individual graves they contain.

Moreover, links to distributed digital and paper resources about the described resources should also be maintained.

Finally, archaeological fieldwork events should be accounted for, categorized following standard vocabularies and properly connected to the relevant archaeological resources. Thus we use the classification ARIADNE_subject to define different resource types. For example, Site/monument refers to a specific monument e.g. Stonehenge, which may have been subject to multiple archaeological investigations, or recording events, leading to resource types "Fieldwork", "Fieldwork report" and "Fieldwork archive", as schematized in Figures 1 and 2, where each event category is annotated with the number of the sub-task of ARIADNEplus Task 4.4.0 addressing it:
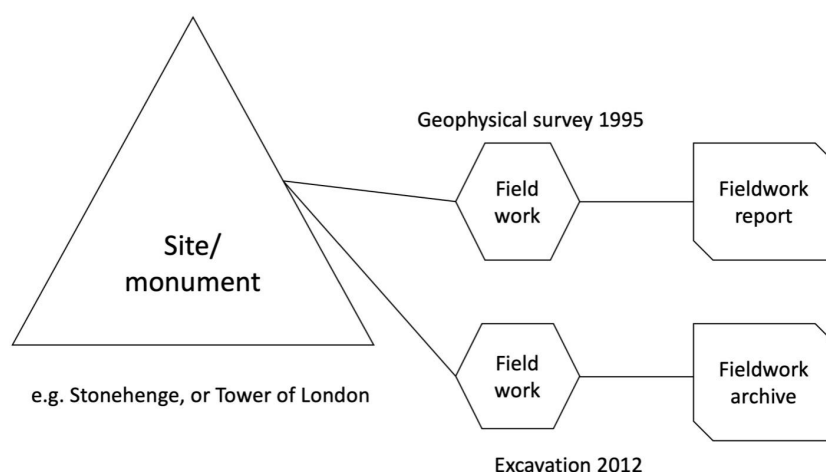
Figure 1. Entities and relationships in the archaeological domain

The diagram follows the UK MIDAS heritage standard terminology[1], whereby a 'Monument' is a physical entity where activity took place in the past, possibly over several periods e.g. Stonehenge; whereas a Fieldwork 'Event' normally refers to an archaeological recording

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[1] http://www.heritage-standards.org.uk/midas-heritage/

event at that monument, such as an excavation or field survey. e.g. "Excavations at Stonehenge by Richard Atkinson 1950-64". In other cases e.g. the "Tiber Valley Survey", a single archaeological event (the survey) may lead to the discovery of multiple new archaeological monuments, or sites (Figure 2)
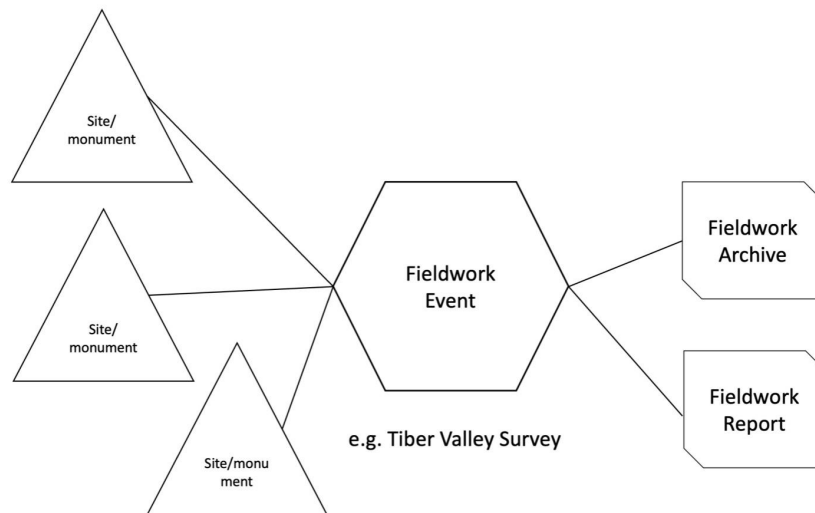
Figure 2. Entities and relationships in the archaeological domain - example of where a single recording event leads to the discovery of several new monuments

The services described above should be offered both to humans, via the A+ Portal and supporting multilingualism, and to artificial agents, via APIs. Those APIs should provide access to the whole AC (including the Catalogue) as Linked Open Data, thereby allowing other organisations to implement their own portal or service.

2.1 Adding visual items to AO-Cat descriptions

During the project execution, the following requirements have emerged:

- to display one or more images (thumbnails, in fact) along with the data about a resource on the Portal. Any kind of resource can have associated thumbnails. In particular:
  - an individual data resource can have thumbnails portraying the resource it is about (i.e., the recto and verso of a coin)
  - a collection data resource can have thumbnails relative to any subset of the items it contains
  - the thumbnails associated to a service can be, for instance, the logo of the service.
- Amongst the provided thumbnails, providers would like to have the possibility of indicating a *primary* image, to be used wherever a single image needs to be selected for the record (for instance, in a search result).

- The displayed thumbnails must be web resources on the provider's site, i.e. they must be identified by a local URI and accessible through that URI on the provider's site.
- Providers are given the option of copying the thumbnails to be displayed into the AC (for a fixed maximum size), or keeping these thumbnails exclusively in their own storage, to be pulled at display time by the Portal software. The latter solution will be encouraged by the ARIADNE guidelines, to avoid the problem of storing too many images in the AC, and the consequent copyright or update problems.
- Each thumbnail copied into the ARIADNE Content Cloud is given a URI on the ARIADNE namespace; that URI must be associated with the link to the original thumbnail on the provider's site for reference.
- Each thumbnail copied into the ARIADNE Content Cloud must be licensed under license CC0 by the provider.
- In order to mitigate the problem of broken links, we should include in the display part of the software (e.g., the software of the Portal) something that does not display the thumbnail for a broken link (and perhaps takes note of this error), trying to keep the so introduced delay at a minimum.

3 Matching the requirements

This Section briefly explains how the requirements presented in Section 2 have been taken into account to define the main AO-Cat classes and the properties that have those classes as domains.

3.1 The AO-Cat namespace

It was decided to define a new namespace for the AO-Cat classes and properties as opposed to re-using the namespace of an existing ontology (the CIDOC CRM would have been a natural choice) so as to be able to define freely the classes and properties needed to match the requirements. In general we concluded that the vocabulary of the CRM, including that of the CRM extensions, was adequate to the needs of ARIADNE. In this sense the AO-Cat is simply an application profile of the CRM and its terms are systematically mapped to those of the CRM, so that at any time it is possible to know the relative position of the AO-Cat ontology with respect to the CRM.

3.2 AO_Entity

This is the most general class of AO-Cat, all classes being sub-classes of AO_Entity. As such, AO_Entity has as instances all resources that have any role in the ARIADNE infrastructure. AO_Entity is defined for capturing domains or ranges of properties that cover the whole ARIADNE information space, such as for instance the range of the is_about property.

There are a few properties that have AO_Entity as domain, and therefore apply to all resources:

- has_type, a type of the resource in any classification system.
- has_title, a title of the resource.
- has_description, a textual description of the resource in natural language.

AO_Entity is the range of property is_about, having AO_Data_Resource (see below) as domain, to express the fact that a data resource may document any entity in ARIADNE.

3.3 ARIADNE Infrastructural Resources

The most general infrastructural resource class in AO-Cat is AO_Resource, representing all the digital resources the ARIADNE research infrastructure deals with. The rest of this Section gives some fundamental principles that AO-Cat follows in modelling infrastructural resources, including the sub-classes of AO_Resource.

3.3.1 Resource identification

An ARIADNE resource is a web resource, therefore it is identified in the AC by an HTTP IRI in the ARIADNE domain, which is given by:

https://www.ariadne-infrastructure.eu/

The identifier of the resource in this namespace is called the "primary" resource identifier and is computed at aggregation time from the local identifier of the resource.
In addition to the primary identifier, the AC also represents the identifier of the resource in the namespace of the provider. This identifier, which is called the "local" resource identifier is associated to the resource via property

has_original_id

which has simply character strings as values, to allow maximum generality. It is understood that the local identifier of a resource is the identifier used by the publisher of the resource, which is the Agent making the resource publicly available (see below).
Finally, the AC also allows representing other identifiers of a resource than the one in the publisher namespace, via the property

has_identifier

Also this property ranges over character strings for generality. As a consequence, it is not possible to represent any additional knowledge about these other identifiers other than the knowledge that can be inferred from the identifiers themselves.

3.3.2 Resource typing

Any ARIADNE Resource has a type which can be specified in two different ways.

- One way is via the property has_type, which associates an instance of AO_Entity with a type represented as an AO_Concept, as already seen.
- The other way is via the sub-classes of AO_Resource, also introduced next.

The former way is preferred when the type of the resource does not have any significance other than that of a tag attached to the resource. The latter way is preferred when resources of different types can have different properties.

3.3.3 Resource description

In addition to the properties inherited from AO_Entity, a number of descriptive properties are defined for an ARIADNE resource:

- was_issued, the date when the record of the resource was firstly acquired.
- was_modified, the date when the record of the resource was lastly modified.

- has_publisher, the agent responsible for making the resource publicly accessible.
- has_contributor, a contributor of a description of the resource to the AC.
- has_creator, a creator of the resource.
- has_owner, the owner of the resource.
- has_responsible, any person who is scientifically responsible of the resource.

These properties have been chosen based on the experience gained in the first ARIADNE project, and are described in detail in Appendix 2.

3.3.4 Data Resources

The ARIADNE data space includes data resources belonging to a wide range of data types, because archaeologists typically employ a wide, open-ended range of information technologies in their research, producing data belonging to a corresponding open-ended range of types. For the moment, AO-Cat treats these data types simply as tags because no specific property is defined for a specific data type. As such, they are represented as instances of class AO_Concept and are associated to instances of AO_Data_Resource using the property has_type.

As for AO_Resource, several descriptive properties are defined for data resources, and as such have AO_Data_Resource as domain. These are:

- has_language, the language of the resource.
- was_created_on, the date in which the resource was created.
- has_landing_page, the original landing page of the AO_Data_Resource, if any.
- has_access_policy, a statement of access policy for the resource.
- has_access_rights, a statement of access rights on the resource.
- has_extent, the size of the resource.

Data resources are also characterized in terms of the entity they are about. The connection between a data resource and the entity the resource is about is captured by property refers_to.

- refers_to associates a data resource with an entity that the resource refers to, by making assertions, whether implicitly or explicitly and regardless of the format, about that entity.

As a special case of reference, there is also the property is_about.

- is_about associates a data resource with the primary entity that the data resource documents, including of course events. Notice that the documenting data resource may be an external resource, identified by a IRI, or DOI, or any other identifier, to capture the requirement that the ARIADNE AC should have links to distributed digital and paper resources in the outer world.

In turn, is_about is categorized into three sub-properties making it possible to trace the provenance of the association between the data resource and entity it is about:

- has_native_subject models the association directly imported from the provider of the data.
- has_derived_subject models the association computed by the ARIADNE aggregator by mapping the native subject to an ATT term, to match the requirement that "the Getty AAT should be used as the common conceptual backbone, in addition to local reference resources".
- has_ARIADNE_subject models the association between the data resource and one of the fundamental ARIADNE categories.

The taxonomy of aboutness properties in AO-Cat is given in Figure 3.
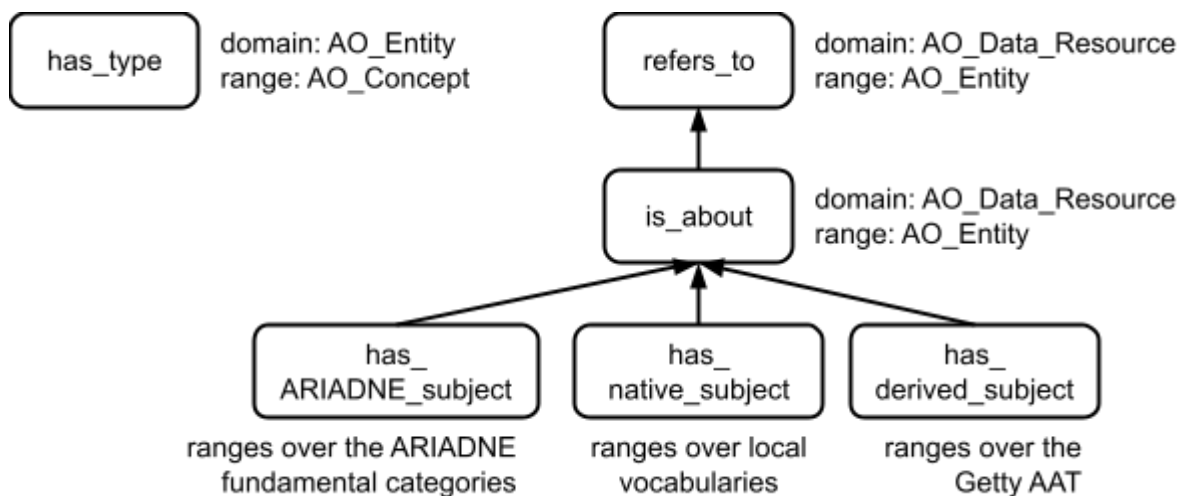
Figure 3.

In addition to topicality, required to support *What* searches, the requirements highlight two important aspects of a data resource:

- the spatial coverage, required to support *Where* searches;
- the temporal coverage, required to support *When* searches.

To account for these aspects, AO-Cat introduces the following properties:

- has_spatial_coverage, associating an instance of AO_Data_Resource with a spatial region;
- has_temporal_coverage, associating an instance of AO_Data_Resource with a temporal region.

Spatial and temporal regions are therefore required in AO-Cat, and the classes and properties to model them are introduced later in this Section.

3.3.4.1 Precision of spatial region specification

Some providers may wish to accompany the information on the spatial region covered by a data resource by a further specification of precision. This may be due to several reasons, such as:

- The data provider has sensitive spatial data which they do not wish to make publicly available, maybe to protect the precise location of a site. Therefore they should only supply to ARIADNE the data at a resolution which they are willing to make publicly available. e.g. for the UK Portable Antiquities Scheme this is the parish administrative unit, and we would then use Geonames to provide a centroid point for the parish.
- The data provider may only hold data for site location at an imprecise level, so we need to make it clear when we plot locations on a map, that the point represents the site location to the nearest e.g. 10km.

In order to cope with these and with similar cases, we introduce a property:

- has_spatial_precision

associating a data resource with a specification of the precision that characterizes the spatial coverage of the resource. Note that a resource may cover at most one spatial region, therefore such precision specification can always unambiguously be referred to the appropriate region.

As to the range of property has_spatial_precision, we observe that some providers are able to say exactly how accurate the points they supply are, while others are only able to give a qualitative assessment. On balance it has been decided to allow providers to give a quantitative specification, for three reasons:

1. Whenever that information is available, the AO-Cat makes it possible to represent it.
2. A quantitative specification will be very useful when displaying the points on a map.
3. A quantitative specification will avoid creating a special vocabulary for a qualitative specification, such as "high" "medium" "low".

For the specification of quantitative information, we thus introduce class AO_Dimension, a subclass of crm:E54 Dimension, as the range of property has_spatial_dimension. There are two properties that have AO_Dimension as domain:

- has_value, sub-property of crm:P90 has value, for associating a numeric value with the specification, range is rdfs:Literal
- has_unit, sub-property of P91 has unit, for associating a unit of measurement with the specification, range is AO_Concept.

In addition to these properties, property has_type, already introduced, can be used for associating a type with the specification.

The requirements highlight the importance of accounting for the different levels of granularity of the data space, therefore AO-Cat distinguishes data resources into two basic kinds (the complete resource class taxonomy is given in Figure 4):

- individual data resources, which are atomic in the sense that they are not further decomposable in other resources as far as the ARIADNE infrastructure is concerned; these are represented as instances of class AO_Individual_Data_Resource, a sub-class of AO_Data_Resource;
- collections, which are wholes composed of parts that are data resources themselves, and as such they may be collections; collections are represented as instances of class AO_Collection.

Archaeological records provided to ARIADNE by its members are modelled as individual data resources, and property is_about is used to associate each record with the entities (including events) it primarily carries information about. There are two special kinds of individual data resources:

- documents, to accommodate which class AO_Document is created as a subclass of AO_Individual_Data_Resource. In particular, AO_Document is the class of all the documents ARIADNE needs to deal with, such as for instance the grey literature, published journal articles, radiocarbon dating resource, and possibly others, whose content may possibly be part of the AC.
- digital images, described in detail in section 3.3.4.2.1 Digital images below.

Notice that archaeological records are not a separate kind of individual data resources because they are not significant resources from an infrastructural point of view, they just represent aggregations built on the providers' information systems for capturing local requirements.
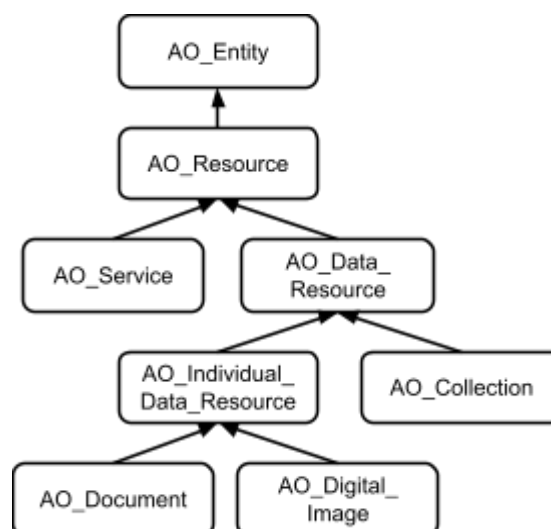

Figure 4. Resource class hierarchy in AO-Cat

The AO-Cat property has_part is introduced to associate a collection with its members.

3.3.4.2.1 Digital images

Digital images are represented in AO-Cat for capturing the requirements expressed in Section 2.1 Adding visual items to AO-Cat descriptions.

Each digital image is an instance of class AO_Digital_Image, a new class that is added to AO-Cat for the purpose of modelling thumbnails and other digital images in the AC. AO_Digital_Image is a direct sub-class of AO_Individual_Data_Resource and of crm:E90 Symbolic Object.

Property is_mirror_of is used to associate a digital image in the AC with the image it is a copy of on the provider's site. The domain of this property is AO_Digital_Image while its range is rdfs:Resource; the property is not mandatory, but it is functional so that a digital image is the mirror of at most one image. This property is a sub-property of owl:sameAs and a shortcut of the more developed path in the CRM involving class E91 Co-Reference Assignment and property P155 has co-reference target.

Property has_visual_component, having AO_Resource as domain and AO_Digital_Image as range, is defined to associate a resource with a digital image that is part of the resource and that provides some visual information about the resource. The property is not mandatory and no cardinality constraint is defined on it, so that a resource can have zero, one or more digital images as visual components. The property is a sub-property of crm:P106 is composed of. In order to let providers select a *primary* image to be associated to the resource, a special property is defined, named has_primary_visual_component, a sub-property of has_visual_component having the same domain and the same range and, in addition, being functional (*i.e.*, a record can have at most one primary image).

The diagram below illustrates the model for images that are copied into the AC, using a coin in the DIME database (https://www.metaldetektorfund.dk/fund/?dimeid=106900) as an example. In the diagram:

- classes are in light blue, while arcs are labelled by the property corresponding to their colors, given in the bottom part of the figure
- ai:idr_106900 is an individual data resource, namely a record provided by the project DIME for sharing through the ARIADNE infrastructure. In the AC, this resource:
  - refers to the coin ai:coin_106900, an instance of AO_Object
  - has the digital images ai:di_1 to ai:di_4 as visual components; these images are the same as the DIME resources dime_1 to dime_4, respectively.
- the actual images are obtained via dereferentiation of the corresponding URIs by the appropriate web server, either on the ARIADNE infrastructure (for the URIs of the form ai:di_*n*) or on the DIME project site (for the URIs of the form dime_*n*).
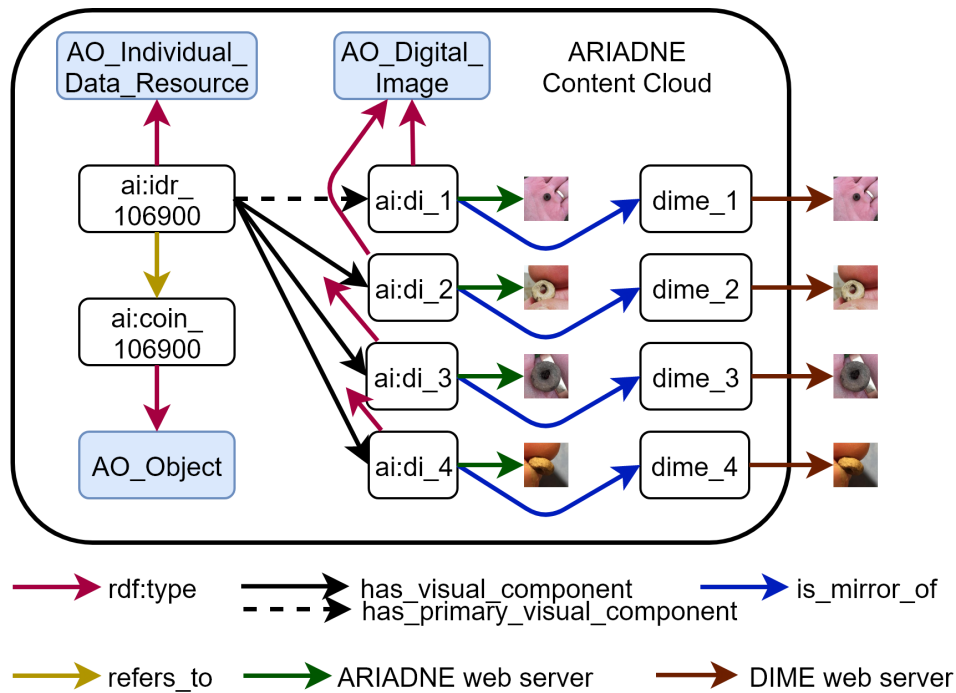
Whenever the record is modified on the DIME site, for instance by replacing one or more of the 4 images (dime_*i*) by different images identified by different URIs, that record must be re-aggregated. The same must be done if anyone of the four images is modified on the DIME site but the URIs that identify the modified images remain the same, because the image associated to the URI is copied into the AC.

For generality, the model does not make any assumption about the relationships between the images that are part of the record (ai:di_1 to ai:di_4 in the example) and the object (ai:coin_106900) that the record refers to. If desired, such relationships can be asserted as additional information. In the above example, in CRM terms anyone of the four images that are the content of the digital images ai:di_j is a visual representation of the coin; this can be asserted by using property P138 represents between the coin and the content of each digital image. Such level of detail is not necessary to capture the requirements stated above, therefore the classes and properties for representing this information are not part of the present model.

The following diagram illustrates the model for images that are **not** copied into the AC. For perspicuity, the same object as the one used in the previous diagram is used, assuming the corresponding thumbnails are not copied into the AC:
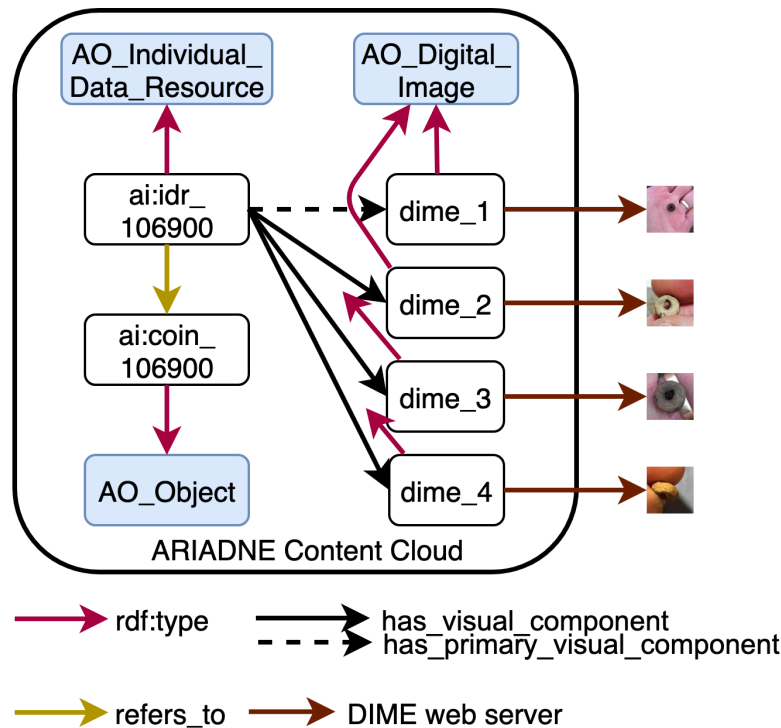
The main difference is that the four images are not part of the AC, they are just referred to in statements, where they are identified using the URIs of the providers.

3.3.5 Services

The class AO_Service has services as instances. Following the PEM definition [PEM Specifications 3.1], a service is "an offer by some actor of their willingness and ability to execute an activity or series of activities upon request"

The descriptive properties defined on services are:

- is_accessible_at
- has_functionality
- has_consumed_media
- has_produced_media
- has_consumed_format
- has_produced_format
- has_supported_language
- has_technical_support

3.4 Objects

Objects play an important role in the archaeological domain: much of the activity, *e.g.*, in an excavation, concerns objects: discovery, analysis, classification, dating, and so on. As such, objects form an important category for contextualizing the digital resources of the ARIADNE infrastructure and therefore this category needs a place in the AO-Cat.

Class AO_Object is defined for the purpose of classifying in the ARIADNE AC all physical objects that are relevant to ARIADNE. Three properties are defined for it:

- has_time_interval, to relate an object to a temporal region relevant to the object, such as the period when the object was created.
- has_space_region, to relate an object to a spatial region relevant to the object, such as the place where the object is located.
- was_present_at, to relate an object to an archaeological event relevant to the object, such as the excavation event that led to a discovery of the object.

3.5 Concepts

There are many concept spaces that can be used to describe the topics a data or a service resource is about. Generally speaking, these topics are grouped in three main categories in the ARIADNE AC.

- the ARIADNE fundamental categories
- the terms of the ATT Thesaurus
- any term used in the data of some provider.

The list of ARIADNE fundamental categories is a pragmatic classification, which is defined "bottom-up" according to the types of data supplied by partners. In ARIADNE we had nine such "bottom-up" categories, but in ARIADNEplus we aggregated a much wider range of data types and extended the range of ARIADNE subjects.

We use the AAT of course as a more structured and hierarchical controlled vocabulary for searching, but the ARIADNE_subjects provide a means of filtering results e.g. individual artefacts vs sites.

Each ARIADNEplus subject has a unique icon and a short name to be displayed in the portal. The same ARIADNEsubject and icon is used for the collection and item level entries, *e.g.* a database of burials will have the same subject/icon as an individual burial record within it.

The final list of ARIADNEplus subjects is provided in Appendix 3.

AO-Cat provides the class AO_Concept to represent topics in each category. Moreover, to allow providers to associate the necessary information with each concept, AO_Concept is declared equivalent to skos:concept. As a consequence, all properties defined by SKOS on concepts can be applied to any instance of AO_Concept. For instance,

- the properties skos:broader and skos:narrower can be used to model concept taxonomies;
- the properties skos:broadMatch, skos:closeMatch, skos:exactMatch, skos:narrowMatch, skos:relatedMatch can be used to specify the kind of mapping leading to the instance of the concept;

- the property skos:inScheme can be used to specify the ontology or the terminology where a concept comes from.

The reason why it was decided to re-use SKOS (as opposed to define the above properties in AO-Cat) is that SKOS is by now a *de facto* standard, thoroughly tested in many years of application in a wide range of contexts; so, there was no reason to doubt that SKOS would not be adequate to the concept modelling needs of ARIADNE.

3.6 Spatial regions

The generic AO-Cat class for spatial regions is AO_Spatial_Region. Three properties are defined for the instances of this class:

- has_coordinate_system
- has_place_name
- has_country_code

Based on the experience of the many content providers in the A+ Consortium and of the previous ARIADNE project, four main representations of a spatial region are provided by AO-Cat, each assigned to a specific sub-class of AO_Spatial_Region. These subclasses are (see Figure 5 below):

- AO_Spatial_Region_Point, having as instances regions that are points. The properties defined on points are:

  - has_latitude
  - has_longitude

- AO_Spatial_Region_Polygon, having as instances regions that are polygons, represented in some format typically managed by a GIS. No commitment is made by AO-Cat on a specific notation for these regions, they are treated simply as abstract objects with a specific property:

  - has_polygonal_representation

  giving the XML document representing the polygonal region.

- AO_Spatial_Region_BBox, having as instances regions that are bounded boxes, represented by four points giving the vertices of the box. The properties defined on points are:

  - has_bounding_box_min_lat
  - has_bounding_box_min_lon
  - has_bounding_box_max_lat
  - has_bounding_box_max_lon

- AO_Spatial_Region_StdName having as instances regions that are simply identified by a standard name in some vocabulary. The standard name is given by the property:

  - has_place_IRI
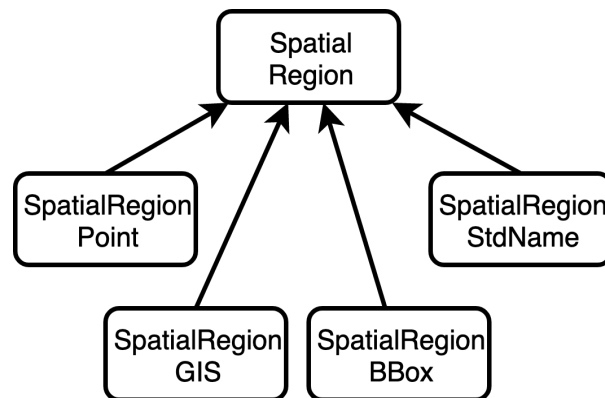
Figure 5

3.7 Temporal regions

Time is represented and named in many different ways in the archaeological domain, often inextricably associated with space. Fortunately, reference resources have been created in the last decade, which make the task of accounting for time much easier for a research infrastructure such as ARIADNE.

According to the requirements, AO-Cat should support both time points, defined as absolute dates with respect to a reference system, and time intervals, defined as temporal extents having a beginning, an end and a non-zero duration. In addition, time intervals identified by names (e.g., *"Neolithic"*) should be supported, whether these names are drawn from a standard or a local vocabulary.

For the representation of time points, AO-Cat relies on the "date" data type of the XML Schema type system, written as xsd:date.

For the representation of time intervals and their names, AO-Cat relies on the PeriodO gazetteer service[2] which allows the definition a temporal interval as a web resource, associated to a label and to two absolute dates giving the earliest start and the latest stop of the interval. The service also allows to cluster period resources in collections, thus facilitating the exploration of the gazetteer data space[3].

The AO-Cat class AO_Temporal_Region has time intervals as instances. Each such instance can be described by means of the following four properties:

- has_period, giving the PeriodO time interval as an IRI.

---

[2] https://perio.do/en/
[3] including about six thousand period definitions as of June 14, 2019.

- has_native_period, giving the local identifier of the period, as an instance of AO_Concept.
- from, giving the beginning of the interval as an (RDF literal of type) xsd:date.
- until, giving the end of the interval as an (RDF literal of type) xsd:date.

3.8 Events and Activities

Much of the archaeological research activity concerns field work. Field work results in digital data resources being collected or created for the purpose of documenting the research activity, presenting its results, or arguing in various ways, for instance expressing hypotheses or refuting other scholars' hypotheses. Digital data resources may also be the result of analyses that are conducted in a research laboratory.

In AO-Cat, these research activities are generally modelled as activities, in the sense of the "actions intentionally carried out by actors 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" [CIDOC CRM Specs 6.2]. AO-Cat follows the conceptual structure of the CRM and models activities as special kinds of events, where an event is a "change 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" [CIDOC CRM Specs 6.2].

Events and activities play an important role in contextualizing the data resources held by a research infrastructure, and ARIADNE of course is no exception.

This said, it must be noted that not **all** events and activities involving an ARIADNE resource are equally well documented to deserve an explicit representation. For instance, the making of a vase found during an archaeological excavation documented in the ARIADNE Content Cloud is an activity of the remote past about which very little is known. It is a common practice then to abstract that activity away, or hide it, and associate whatever we happen to know about it directly with the object resulting from the activity, the vase in the present case. These operations, abstracting the activity and associating the knowledge about the event directly to the resulting object, is sometimes termed "shortcut-ting"

In sum, AO-Cat provides the classes AO_Event and AO_Activity to explicitly represent the events and the activities (respectively) that are well enough documented to be a resource in the ARIADNE research infrastructure; while it provides properties such as has_temporal_region or has_spatial_coverage (already introduced) to represent knowledge about not well documented activities and to associate that knowledge directly to data resources.

The following properties are defined on instances of AO_Event and inherited by instances of AO_Activity:

- occurs_in, to associate an event with the spatial region where the event has taken place.
- happens_during, to associate an event with the temporal region when the event has taken place.
- contains_event, to associate a composite event (such as the war of Troy) with any event that is part of it (such as the duel between Achilles and Hector).

The last property is introduced to represent the fact that a collection, which is a composite data resource, may document a single activity, while the members of the collection may document parts of that activity. These parts are events themselves that are contained in the activity documented by the collection, and that containment relation is captured by property contains_event.

3.9 Agents

Agents play important roles in the ARIADNE knowledge base: they are responsible for making resources available and publicly accessible; they hold various types of responsibilities for those resources; finally, they carry out activities. For these reasons, AO-Cat defines the class Agent to model entities that can act.

Moreover, from an archaeological perspective it is important to distinguish between two kinds of agents: the person and the organisation: Julian Richards as the individual and researcher and/or excavation director (who might have an ORCID or other id) and University of York as the organisation that was legally responsible for the excavation or its funding, or publication etc. This distinction is captured in AO-Cat by two subclasses of Agent:

- Person, modelling individual humans, and
- Group, modelling "gatherings or organizations of agents that act collectively or in a similar way due to any form of unifying relationship" [CRM Spec 6.2].

The following properties are defined on instances of Agent, regardless whether the agent is a person or a group:

- has_name, giving the name of the agent.
- has_agent_identifier, giving any identifier of an agent outside of the ARIADNE namespace.
- has_email, giving the email address of the agent.
- has_homepage, giving a web page for the agent.
- has_insitution, giving the institution(s) of the agent.

3.10 Modelling the basic pattern

We are now in the position of discussing how AO-Cat deals with a basic pattern in archaeological modelling, such as the one presented above in Figure 1.

The core entities in the Figure are the two events in the centre. They are modelled as instances of class AO_Event, while
- the monument in the big triangle is modelled as an instance of AO_Object and
- the archive in the small rectangle is an instance of AO_Data_Resource.
- The relations between the monument and each event occurrence is represented by instances of property was_present_at, while
- the relation between the archive and the event is represented by an instance of property is_about.

3.11 Summary

The Figure below recapitulates the first level of the AO-Cat class taxonomy.
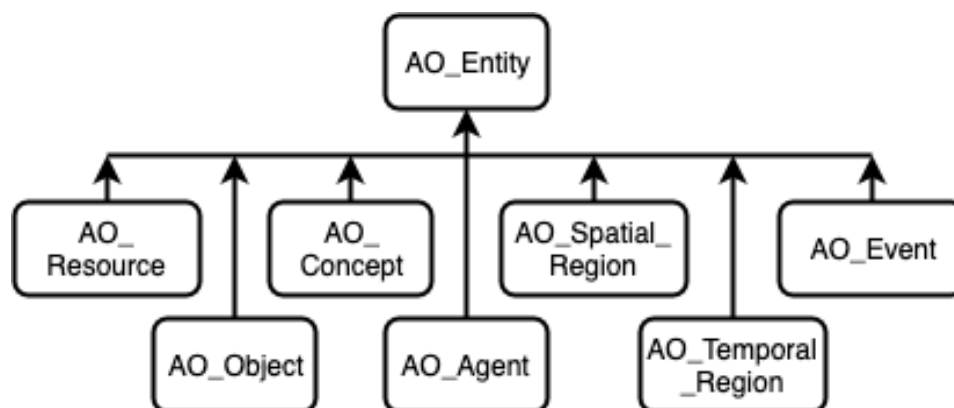
This document has presented the final version of the AO-Cat ontology, as used in the ARIADNE Infrastructure to model archaeological resources. Section 1 provided basic information about the lineage, the syntax and the semantics of AO-Cat, while Section 2 summarized the representational requirements that inform AO-Cat. Section 3 provided a global view of the ontology, describing its main classes and properties in a discursive way, and putting these in relation to the requirements. The following appendices provide the full specificattion of the ontology. Section 4 (Appendix 1) lists the AO-Cat Classes. Section 5 (Appendix 2) lists the AO-Cat Properties, and Section 6 (Appendix 3) lists the agreed ARIADNE) subjects.

4 Appendix 1: AO-Cat Classes

4.1 AO_Entity

Subclass of:

Superclass of: AO_Resource, AO_Object, AO_Concept, AO_Event, AO_Agent, AO_Spatial_Region, AO_Temporal_Region

Scope Note: AO_Entity has as instances all entities in the ARIADNE infrastructure

Domain of: has_identifier

has_type

has_title

has_description

Maps to: AO_Resource is a subclass of crm:E1_CRM_Entity

4.2 AO_Resource

Subclass of: AO_Entity

Superclass of: AO_Data_Resource; AO_Service

Scope Note: AO_Resource has as instances all archaeological resources that are represented in the AC. These resources are categorized in the following classes (see Figure below):

- AO_Data_Resource, representing all types of digital data object described in the Catalogue for discovery, access and integration. Two disjoint classes of data resources are further distinguished:
  - AO_Individual_Data_Resource, including all data resources that are considered as not further decomposed; these include datasets, databases, GIS, and so on.
  - AO_Collection, representing aggregations of data resources considered as wholes, possibly including other collections.
- AO_Service, representing the services owned by the A+ partners and, possibly, made available to other partners within the project on the ARIADNE infrastructure. This class is also suitable for describing new services created within the project.

Examples: AO_Data_Resource: a stratigraphic database, a collection of images from an excavation event, a report on the discovery of Roman burials in Provence
AO_Service: the ARIADNE Visual Media service.

Domain of: was_issued

was_modified

has_publisher

has_contributor

has_creator

has_owner
has_responsible
has_visual_component
Maps to: AO_Resource is a subclass of crm:E1_CRM_Entity

The four classes of resources mentioned above are described in detail in the rest of this Section.

4.2.1 AO_Data_Resource

Subclass of: AO_Resource
Superclass of: AO_Collection, AO_Individual_Data_Resource
Scope Note: This class specializes the AO_Resource class and is intended to describe the digital resources of the ARIADNE RI that are data. The type of an instance of this class (e.g., GIS, database, collection and the like) is specified through the has_type property. This is an abstract class: its instances are all and only the instances of its subclasses.
Examples: a stratigraphic database, a collection of images from an excavation event, a report on the discovery of Roman burials in Provence.
Maps to: AO_Data_Resource is a subclass of crmpe:PE22_Persistent_Dataset (which is a subclass of crm:E73_Information_Object) and is a subclass of crm:E33_Linguistic_Object
Domain of: has_original_id
is_about
has_ARIADNE_subject
has_native_subject
has_derived_subject
has_language
was_created_on
has_landing_page
has_access_policy
has_access_rights
has_extent
has_temporal_coverage
has_spatial_coverage

4.2.2 AO_Individual_Data_Resource

Subclass of: AO_Data_Resource
Superclass of: AO_Document
Scope Note: This class is a specialization of the class AO_Data_Resource, and has as instances data resources that from the ARIADNE RI point of view are atomic, that is no further decomposed. The complementary class is that of AO_Collection (see below), having as instances data resources that are composed of other data resources.
Examples: An archaeological record. A dataset. An image.

Maps to:	AO_Individual_Data_Resource is implicitly a subclass of crmpe:PE22_Persistent_Dataset (being a subclass of AO_Data_Resource)

4.2.3 AO_Document

Subclass of:	AO_Individual_Data_Resource
Superclass of:	
Scope Note:	This class is a specialization of the class AO_Individual_Data_Resource, and has as instances documents of interest to the ARIADNE RI.
Examples:	A grey literature report. A scientific journal issue.
Maps to:	AO_Document is implicitly a subclass of crmpe:PE22_Persistent_Dataset (being a subclass of AO_Individual_Data_Resource)

4.2.4 AO_Collection

Subclass of:	AO_Data_Resource
Superclass of:	
Scope Note:	This class is a specialization of the class AO_Data_Resource, and has as instances collections in the archaeological and archaeological-related domains. An archaeological collection is an aggregation of resources, called the members in the collection, instances of AO_Data_Resource. As a consequence, collections can have other collections as members.
Examples:	A group of resources documenting an excavation and composed of a report, a stratigraphic database and a collection of images.
Maps to:	Collection is implicitly a subclass of crmpe:PE22_Persistent_Dataset (being a subclass of AO_Data_Resource)
Domain of:	has_part

4.2.5 AO_Service

Subclass of:	AO_Resource
Superclass of:	
Scope Note:	This class specializes the AO_Resource class and is intended to describe services in the archaeological domain. A service is "an offer by some actor of their willingness and ability to execute an activity or series of activities upon request" [PEM Specifications 3.1]. Types of services are: stand-alone service, web service, front-office services and back-office service, as specified by the has_type property.
Examples:	The ARIADNE discovery service.
Maps to:	AO_Service is equivalent to crmpe:PE8_E-Service which is a subclass of crm:E7_Activity
Domain of:	is_accessible_at
	has_functionality
	has_consumed_media
	has_produced_media
	has_consumed_format
	has_produced_format

has_supported_language
has_technical_support

4.3 AO_Object

Subclass of: AO_Entity
Superclass of:
Scope Note: This class includes as instances physical objects **of interest** to the ARIADNE infrastructure.
Examples: The walls of Troy
Maps to: AO_Object is a subclass of crm:E18_Physical_Thing
Domain of: has_time_interval
has_space_region
was_present_at

4.4 AO_Event

Subclass of: AO_Entity
Superclass of: AO_Activity
Scope Note: This class includes as instances events **of interest** to the ARIADNE RI, that is, events that play a role in the ARIADNE AC. An event is a "change 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" [CIDOC CRM Specs 6.2].
Usage Note: It is the data curator who decides whether or not an event is of interest to ARIADNE and as such should or should not be modelled as an instance of this class. A typical criterion is whether or not the event is sufficiently well documented. If yes, then the event needs to be created to associate the resources with it. If not, the event remains "implicit". For example, the making of a vase found in the context of an excavation and that has no data resources associated with it, is an event not of interest to ARIADNE. Consequently, it should not be created explicitly and the knowledge about it (e.g., who made the vase) should be modelled as direct properties of the vase (e.g., dc:creator). In contrast, the excavation itself might be of interest to ARIADNE if there are data resources associated with it; in this case, the excavation should be explicitly represented as an instance of this class.
Examples: The excavation of the walls of Troy for which the AC has data resources or the eruption of the Vesuvio that destroyed Pompei.
Maps to: AO_Event is a subclass of crm:E5_Event
Domain of: occurs_in
happens_during
contains_event

4.4.1 AO_Activity

Subclass of: AO_Event

Superclass of:

Scope Note: This class includes as instances activities **of interest** to the ARIADNE RI, that is, events that play a role in the ARIADNE AC. Activities are "actions intentionally carried out by actors that result in changes of state in the cultural, social, or physical systems documented" [CIDOC CRM Specs 6.2].

Usage Note: The same usage note as AO_Event applies.

Examples: The excavation of the walls of Troy for which the AC has data resources.

Maps to: AO_Event is a subclass of crm:E7_Activity

4.5 AO_Agent

Subclass of: AO_Entity

Superclass of: AO_Person, AO_Group

Scope Note: "This class comprises people, either individually or in groups, who have the potential to perform intentional actions of kinds for which someone may be held responsible." [CIDOC CRM Specs 6.2].

Examples: The Principal Investigator or Director of an excavation event, the author of a scientific article.

Maps to: AO_Agent is a subclass of crm:E39_Actor

Domain of: has_name
                 has_agent_identifier
                 has_email
                 has_homepage

4.5.1 AO_Person

Subclass of: AO_Agent

Superclass of:

Scope Note: This class comprises individual human beings.

Examples: The Principal Investigator or Director of an excavation event, the author of a scientific article.

Maps to: AO_Person is a subclass of crm:E21_Person

Domain of: has_institution

4.5.2 AO_Group

Subclass of: AO_Agent

Superclass of:

Scope Note: This class comprises "gatherings or organizations that act collectively or in a similar way due to any form of unifying relationship" [CRM Spec 6.2].

Examples: The Archaeological Data Service

Maps to: AO_Group is a subclass of crm:E74_Group

4.6 AO_Temporal_Region

Subclass of: AO_Entity
Superclass of:
Scope Note: This class comprises temporal extents, having a beginning, an end and a non-zero duration. Temporal regions can have one of the following forms:

1. a temporal interval (e.g., from 155 BC to 243 AD). In this case the properties from and until are used to give the boundaries of the temporal interval
2. any period identified by a name (*e.g.*, *"*Neolithic*"*) expressed via the has_period or has_native_period property

- In the case where BC dates have to be supplied, a minus (-) sign could be used as indicated in the expanded Year representation of ISO 8601 (http://www.iso.org/iso/catalogue_detail?csnumber=40874).

- In the case where reduced precision must be applied (e.g. where no day information is available) the respective part could be omitted (according to ISO 8601 reduced precision guidelines).

Examples: The interval in which the excavation of the walls of Troy has taken place
Maps to: AO_Temporal_Region is a subclass of crm:E52_Time-Span.
Domain of: has_period
                 has_native_period
                 from
                 until

4.7 AO_Spatial_Region

Subclass of: AO_Entity
Superclass of: AO_Spatial_Region_Point,   AO_Spatial_Region_Polygon,
                 AO_Spatial_Region_BBox, AO_Spatial_Region_StdName
Scope Note: This class comprises spatial regions having one of the following forms:
                 1. a point on the surface of the Earth identified by latitude and longitude;
                 2. a polygon as represented by GIS systems;
                 3. a rectangular region on the surface of the Earth identified by its four vertices;
                 4. any region identified by a IRI in a standard gazetteer, such as Geonames for modern places, Pleiades for ancient places.
                 Each of these forms is modelled by a different sub-class of this class, as detailed in the rest of this Section. In addition, a spatial region may have a name, regardless of any other representation it may have. If the same region is represented in two different ways, then it will be an instance of the two corresponding classes.

Examples: The spatial region including Troy in the X sec. B.C.
Maps to: AO_Spatial_Region is a subclass of crm:E53_Place
Domain of: has_coordinate_system
               has_place_name

4.7.1 AO_Spatial_Region_Point

Subclass of: AO_Spatial_Region
Superclass of:
Scope Note: This class comprises spatial regions given as points on the surface of the Earth identified by latitude and longitude.
Examples:
Maps to:
Domain of: has_latitude
                has_longitude

4.7.2 AO_Spatial_Region_Polygon

Subclass of: AO_Spatial_Region
Superclass of:
Scope Note: This class comprises spatial regions given as a polygon as represented by GIS systems.
Examples:
Maps to:
Domain of: has_polygonal_representation

4.7.3 AO_Spatial_Region_BBox

Subclass of: AO_Spatial_Region
Superclass of:
Scope Note: This class comprises spatial regions given as rectangular regions on the surface of the Earth identified by its four vertices.
Examples:
Maps to:
Domain of: has_bounding_box_min_lat
                has_bounding_box_min_lon
                has_bounding_box_max_lat
                has_bounding_box_max_long

4.7.4 AO_Spatial_Region_StdName

Subclass of: AO_Spatial_Region
Superclass of:
Scope Note: This class comprises spatial regions identified by a name expressed via the has_place_name property;
Examples:
Maps to:
Domain of: has_place_name

4.8 AO_Concept

Subclass of: AO_Entity

Superclass of:

Scope Note: This class comprises terms in thesauri, controlled vocabularies or any other reference resource providing concepts in a domain of interest. Since AO_Concept is equivalent to skos:Concept, all properties defined in SKOS can be used to represent the relevant aspects of a concept. For instance, the properties skos:broader and skos:narrower can be used to model concept taxonomies, while skos:broadMatch, skos:closeMatch, skos:exactMatch, skos:narrowMatch, skos:relatedMatch can be used to specify the kind of mapping leading to the instance of the concept, if any.

Examples: Any term in the Getty Art & Architecture Thesaurus

Maps to: AO_Concept is equivalent to crm:E55 Type and to skos:Concept

4.9 AO_Dimension

Subclass of: AO_Entity

Superclass of:

Scope Note: This class comprises values of quantifiable properties that can be determined by some measure, i.e. the radius of an approximated spatial region

Examples: a circle with a radius of 10 kilometers

Maps to: AO_Dimension is a sub-class of crm:E54 Dimension

4.10 AO_Digital_Image

Subclass of: AO_Entity

Superclass of: AO_Individual_Data_Resource

Scope Note: This class comprises digital images contributed to the ARIADNE Content cloud for the purpose of illustrating other resources.

Examples: (examples given in Section 2.1 Digital images)

Maps to: AO_Digital_Image is a subclass of crmdig:D9_Data_Object (subclass of crm:E71_information_Object and E54_Dimension)

Domain of: is_mirror_of

5 Appendix 2: AO-Cat Properties

Inverse properties are specified only for properties whose range is not a datatype.

5.1 has_identifier

Domain:	AO_Entity
Range:	xsd:string
Subproperty of:	
Superproperty of:	
Obligation:	Optional
Scope Note:	This property associates an ARIADNE entity with an identifier for that entity in some namespace other than the ARIADNE namespace (where the primary identifier of the entity belongs) and other than the provider's namespace (which is associated to data resources by property has_original_id). The range of this property is xsd:string for generality.
Maps to:	has_identifier is a shortcut of the fully developed path crm:P1_is_identified_by → crm:E42_Identifier
Hints:	values of dct:identifier can be used to compute the ARIADNE identifier.

5.2 has_type

Domain:	AO_Entity
Range:	AO_Concept
Subproperty of:	
Superproperty of:	
Inverse:	is_type_of
Obligation:	Mandatory
Scope Note:	This property associates an ARIADNE Entity with a term from a controlled vocabulary.
Example:	Event E has type "Rescue Excavation" (https://heritagedata.org/live/schemes/agl_et/concepts/145157.html)
Maps to:	has_type is equivalent to crm:P2_has_type
Hints:	this property is a sub-property of dct:type

5.3 has_title

Domain:	AO_Entity
Range:	rdfs:Literal
Subproperty of:	
Superproperty of:	
Obligation:	Mandatory with multiple instances (related to language, we may have one title for each relevant language). It is strongly suggested to use literals with a language tag for each provided title, such as "La bella addormentata"@it.

Scope Note:	This property associates an AO Entity with one title identifying the resource in a specific language. A resource may have more that one title, but they must all be in different languages.
Maps to:	has_title is a shortcut of the fully developed path
	crm:P102_has_title → crm:E35_Title
Hints:	this property is a sub-property of dct:title

5.4 has_description

Domain:	AO_Entity
Range:	xsd:string
Subproperty of:	
Superproperty of:	
Obligation:	Desirable
Scope Note:	This property associates an ARIADNE entity with a free text description of that entity.
Maps to:	This property is a subproperty of crm:P3_has_note
Hints:	this property is a sub-property of dct:description and of rdfs:comment

5.5 was_issued

Domain:	AO_Resource
Range:	xsd:dateTime
Subproperty of:	
Superproperty of:	
Obligation:	Mandatory
Scope Note:	This property associates an ARIADNE resource with the date of formal issuance (e.g., publication) of the resource by the publisher.
Maps to:	This property is a shortcut of the fully developed path
	→L10i→D7[10]→P4→E52→P81→XSD:DateTime
	→L10i→D7[10]→P2→E55["Issuance"]

5.6 was_modified

Domain:	AO_Resource
Range:	xsd:dateTime
Subproperty of:	
Superproperty of:	
Obligation:	Mandatory
Scope Note:	This property associates an ARIADNE resource with the most recent date on which the resource was modified by the publisher.
Maps to:	It is assumed that the Modification is a new creation and the resource is the resulting output of the new Digital Machine Event. Therefore, this property is interpreted as a shortcut of the fully developed path
	→L11i_was_output_of→D7[11]_Digital_Machine_Event→P4_has_time-span→E52_Time-Span→P82_at_some_time_within→xsd:date
	→L11i_was_output_of→D7[11]_Digital_Machine_Event→P2_has_type→E55_Ty

pe["Modification"]

5.7 has_part

Domain: AO_Collection
Range: AO_Data_Resource
Subproperty of:
Superproperty of:
Inverse: is_part_of
Obligation: Desirable
Scope Note: Associates an ARIADNE collection with a AO_Data_Resource resource that the collection contains. The relation between a collection in its members must be a tree having the collection as its root and any finite depth, due to the fact that a collection may have another collection as a member.
Maps to: This property is equivalent to crmpe:PP20_has_persistent_dataset_part which is a subproperty of crm:P106_is_composed_of but it restricts the domain to Collections only. It doesn't apply for AO_Data_Resource and AO_Individual_Data_Resource.
Hints: This property is a sub-property of dct:hasPart

5.8 has_publisher

Domain: AO_Resource
Range: AO_Agent
Subproperty of:
Superproperty of:
Inverse: is_publisher_of
Obligation: Mandatory
Scope Note: Associates any ARIADNE resource with an agent responsible for making the resource publicly accessible (via download, or API, or other).
Maps to: This property is a shortcut of the fully developed paths
→L10i_was_input_of→D7[12]_Digital_Machine_event→P01i_is_domain_of→PC14_carried_out_by→P02_has_range→E39_Actor

→L10i_was_input_of→D7[12]→P01i_is_domain_of→PC14_carried_out_by→P14.1_in_the_role_of→E55["Publisher"]

→L10i_was_input_of→D7[12]_Digital_Machine_event→P2_has_type→E55_Type["Ariadne Content Provision"]
Hints: This property is a sub-property of dct:publisher

5.9 has_contributor

Domain: AO_Resource
Range: AO_Agent
Subproperty of:

Superproperty of:

Inverse: is_contributor_of

Obligation: Mandatory

Scope Note: Associates any ARIADNE resource with an agent primarily responsible for contributing the description of the resource to the ARIADNE Content Cloud.

Maps to: This property is a shortcut of the fully developed paths →P94i_was_created_by→E65[13]Creation→P01i_is_domain_of→PC14_carried _out_by→P02_has_range→E39_Actor

→P94i_was_created_by→E65[13]Creation→P01i_is_domain_of→PC14_carried _out_by→P14.1_in_the_role_of→E55["Contributor"]

→P94i_was_created_by→E65[13]Creation→P2_has_type→E55_Type["Ariadne Content Creation"]

Hints: This property is a sub-property of dct:contributor

5.10 has_creator

Domain: AO_Resource

Range: AO_Agent

Subproperty of:

Superproperty of:

Inverse: is_creator_of

Obligation: Mandatory

Scope Note: Associates any ARIADNE resource with an agent primarily responsible for creating the resource.

Maps to: This property is a shortcut of the fully developed paths →P94i_was_created_by→E65[13]Creation→P01i_is_domain_of→PC14_carried _out_by→P02_has_range→E39_Actor

→P94i_was_created_by→E65[13]Creation→P01i_is_domain_of→PC14_carried _out_by→P14.1_in_the_role_of→E55["Creator"]

→P94i_was_created_by→E65[13]Creation→P2_has_type→E55_Type["Ariadne Content Creation"]

Hints: This property is a sub-property of dct:creator

5.11 has_owner

Domain: AO_Resource

Range: AO_Agent

Subproperty of:

Superproperty of:

Inverse: is_owner_of

Obligation: Mandatory

Scope Note: Associates any ARIADNE resource with the legal owner of the resource, who holds the legal responsibility.

Maps to: This property is a shortcut of the fully developed paths
→P104_is_subject_to→E30_Right→P75i_is_possessed_by→E39_Actor
→P104_is_subject_to→E30_Right→P2_has_type→E55_Type["ownership"]

5.12 has_responsible

Domain: AO_Resource
Range: AO_Agent
Subproperty of:
Superproperty of:
Inverse: is_responsible_of
Obligation: Mandatory
Scope Note: Associates any ARIADNE resource with an agent holding the scientific responsibility of the resource, such as the person or team who had enough competence and creativity to conceive the service or to gather the data on a field.
Maps to: This property is a shortcut of the fully developed paths
→L10i_was_input_of→D7[12]_Digital_Machine_event→P01i_is_domain_of→PC14_carried_out_by→P02_has_range→E39_Actor

→L10i_was_input_of→D7[12]→P01i_is_domain_of→PC14_carried_out_by→P14.1_in_the_role_of→E55["Scientific or Technical Responsible"]

→L10i_was_input_of→D7[12]_Digital_Machine_event→P2_has_type→E55_Type["Ariadne Content Provision"]

5.13 has_visual_component

Domain: AO_Resource
Range: AO_Digital_image
Subproperty of:
Superproperty of: has_primary_visual_component
Inverse: is_visual_component_of
Obligation: Optional
Scope Note: This property associates a resource with a digital image that gives some information about the resource.
Examples: (example given in Section 2.1 Adding visual items to AO-Cat descriptions)
Maps to: this property is a sub-property of crm:P106 is component of
Hints:

5.14 has_primary_visual_component

Domain: AO_Resource
Range: AO_Digital_image
Subproperty of: has_visual_component
Superproperty of:

Inverse: is_primary_visual_component_of
Obligation: Optional
Scope Note: This property associates a resource with a digital image that gives some information about the resource and that has to be preferred over other images associated to the same resource whenever a single image is required.
Examples: (example given in Section 2.1 Adding visual items to AO-Cat descriptions)
Maps to:
Hints:

5.15 has_original_id

Domain: AO_Data_Resource
Range: xsd:string
Subproperty of:
Superproperty of:
Obligation: Mandatory
Scope Note: This property associates a data resource with the local identifier of the resource supplied by the content provider.
Examples:
Maps to: has_original_id is a shortcut of the fully developed path
                   crm:P1_is_identified_by → crm:E42_Identifier[1]→ crm:P2_has_type_→
                   crm:E55_Type["originalID"]

5.16 refers_to

Domain: AO_Data_Resource
Range: AO_Entity
Subproperty of:
Superproperty of: is_about
Inverse: is_referenced_by
Obligation: Optional
Scope Note: This property associates a AO_Data_Resource to the AO_Entity(ies) the resource refers to
Maps to: Subproperty of crm:P67_refers_to
Hints: This property is a sub-property of the inverse of dct:isReferencedBy

5.17 is_about

Domain: AO_Data_Resource
Range: AO_Entity
Subproperty of: refers_to
Superproperty of: has_ARIADNE_subject, has_native_subject, has_derived_subject
Inverse: is_subject_of
Obligation: Mandatory

Scope Note:	This property associates a AO_Data_Resource to the AO_Entity the resource is about.
Maps to:	Subproperty of crm:P129_is_about
Hints:	This property is a sub-property of dc:subject

5.18 has_ARIADNE_subject

Domain:	AO_Data_Resource
Range:	AO_Concept
Subproperty of:	is_about
Superproperty of:	
Inverse:	is_ARIADNE_subject_of
Obligation:	Mandatory
Scope Note:	This property associates a AO_Data_Resource with one the fundamental archaeological categories defined by ARIADNE. These are the high level "resource types", or semantic categories which are used in the ARIADNE portal to filter search results, *e.g.* "Site and monuments databases or inventories", "Event/intervention resources" *etc.*
Maps to:	has_ARIADNE_subject is a shortcut of the fully developed path →P129_is_about→E55_Type→P2_has_type→E55_Type["Ariadne Subject"]
Hints:	This property is a sub-property of dc:subject

5.19 has_native_subject

Domain:	AO_Data_Resource
Range:	AO_Concept
Subproperty of:	is_about
Superproperty of:	
Inverse:	is_native_subject_of
Obligation:	Mandatory
Scope Note:	This property associates a AO_Data_Resource with an original subject in the providing institution
Maps to:	has_native_subject is a shortcut of the fully developed path →P129_is_about→E55_Type→P2_has_type→E55_Type["Native Subject"]
Hints:	This property is a sub-property of dc:subject

5.20 has_derived_subject

Domain:	AO_Data_Resource
Range:	AO_Concept (Getty AAT Term)
Subproperty of:	is_about
Superproperty of:	
Inverse:	is_derived_subject_of
Obligation:	Mandatory (automatically computed by existing mapping to AAT)
Scope Note:	This property associates a AO_Data_Resource with a subject automatically derived by mapping a native subject of the resource to a

term in the Getty AAT vocabulary. The native subject may have the SKOS relations (skos:broadMatch, skos:closeMatch,skos:exactMatch,skos:narrowMatch, skos:relatedMatch) to the Getty AAT vocabulary.

Maps to:	has_derived_subject is a shortcut of the fully developed path →P129_is_about→E55_Type→P2_has_type→E55_Type["Derived Subject"]
Hints:	This property is a sub-property of dc:subject

5.21 has_language

Domain:	AO_Data_Resource
Range:	AO_Concept (linked to lexvo.org)
Subproperty of:	
Superproperty of:	
Inverse:	is_language_of
Obligation:	Mandatory
Scope Note:	This property is used to associate a data resource with the language of the resource, if any, specified according to a selected vocabulary.
Maps to:	Equivalent to crm:P72_has_language
Hints:	This property is a sub-property of dc:language and its range is a super-class of class lvont:Language

5.22 was_created_on

Domain:	AO_Data_Resource
Range:	xsd:dateTime
Subproperty of:	
Superproperty of:	
Obligation:	Mandatory
Scope Note:	This property is used to specify the creation date of the AO_Data_Resource. This is the date when the AO_Data_Resource was first made available online by the Publisher, (not the date of the fieldwork or laboratory analysis for instance). In some cases (e.g. where data or metadata did not already exist online) it will be the same date as the creation of the metadata for ARIADNE
Maps to:	This property is a shortcut of the fully developed path →P94i_was_created_by→E65_Creation→P4_has_time-span→E52_Time-Span →P81_ongoing_throughout→xsd:date
Hints:	This property is a sub-property of dct:created (and consequently of dc:date)

5.23 has_landing_page

Domain:	AO_Data_Resource
Range:	rdfs:Resource

Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property is used to specify the original landing page of the AO_Data_Resource, if any.
Examples: The Archaeology Data Service has landing page e.g. http://archaeologydataservice.ac.uk/archsearch/record.jsf?titleId=104031 e.g. https://doi.org/10.5284/1052661
Maps to: This property is a shortcut of the fully developed path
→PP8i_is_dataset_hosted_by→PE15_Data_E-Service→PP49_provides_access _point→PE29_Access_Point

5.24 has_access_policy

Domain: AO_Data_Resource
Range: rdfs:Resource
Subproperty of:
Superproperty of:
Obligation: Desirable
Scope Note: This property is used to specify the URI to the statement of policy (typically, on an organization's website) for the data resource.
Examples: The DANS Organization has access policy as stated in http://dans.knaw.nl/en/about/organisation-and-policy/legal-information
Maps to: This property is a shortcut of the fully developed path
→P104_is_subject_to→E30_Right→P2_has_type→E55_Type["Access Policy]

5.25 has_access_rights

Domain: AO_Data_Resource
Range: xsd:string
Subproperty of:
Superproperty of:
Obligation: Mandatory
Scope Note: This property contains information about who can access the resource or an indication of its security status.
Examples: The data resource xyz has access rights "CC BY-NC-SA 2.5 SI"
Maps to: This property is a shortcut of the fully developed path
→P104_is_subject_to→E30_Right→P2_has_type→E55_Type["Access Rights"]
Hints: This property is a sub-property of dct:accessRights

5.26 has_extent

Domain: AO_Data_Resource
Range: xsd:string
Subproperty of:
Superproperty of:

Obligation: Optional
Scope Note: This property specifies the size of the AO_Data_Resource (i.e., number of members in a collection, number of records in a dataset, etc.).
Examples: Collection X has extent [100 item]
Maps to: Equivalent to crm:P43_has_dimension
Hints: This property is a sub-property of dct:extent

5.27 has_temporal_coverage

Domain: AO_Data_Resource
Range: AO_Temporal_Region
Subproperty of:
Superproperty of:
Inverse: is_temporal_coverage_of
Obligation: Desirable
Scope Note: This property associates a data resource with the temporal region covered by the content of the resource.
Maps to: Equivalent to crm:P129_is_about with a restricted range E4_Period
Hints: This is a sub-property of dct:temporal

5.28 occurs_in

Domain: AO_Event
Range: AO_Spatial_Region
Subproperty of:
Superproperty of:
Inverse: is_spatial_region_of
Obligation: Mandatory
Scope Note: This property associates an ARIADNE Event with the spatial region in which the event occurred.
Maps to: Equivalent to crm:P7_took_place_at

5.29 happens_during

Domain: AO_Event
Range: AO_Temporal_Region
Subproperty of:
Superproperty of:
Inverse: is_temporal_region_of
Obligation: Desirable
Scope Note: This property associates an ARIADNE Event with the temporal region at which the event occurred.
Maps to: Equivalent to crm:P4_has_time-span

5.30 contains_event

Domain: AO_Event
Range: AO_Event
Subproperty of:
Superproperty of:
Inverse: is_contained_in
Obligation: Optional
Scope Note: This property associates an ARIADNE Event with another ARIADNE Event that is part of it. As a consequence, the former event occurred in a spatio-temporal region that is contained in the spatio-temporal region of the latter event.
Maps to: Equivalent to crm:P9_consists_of

5.31 has_period

Domain: AO_Temporal_Region
Range: AO_Concept (from PeriodO)
Subproperty of:
Superproperty of:
Inverse: is_period_of
Obligation: Desirable
Scope Note: This property associates a AO_Temporal_Region with a temporal period defined in periodO, so it ranges over web resources.
Maps to: crm:P2_has_type->E55_Type->P2_has_type->E55_Type["PeriodO"]

5.32 has_native_period

Domain: AO_Temporal_Region
Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse: is_native_period_of
Obligation: Mandatory
Scope Note: This property associates a AO_Temporal_Region with a concept representing a period in some local vocabulary of the provider. Its range is therefore AO_Concept.
Examples:
Maps to: crm:P2_has_type->E55_Type->P2_has_type->E55_Type["Native Period"]

5.33 has_spatial_coverage

Domain: AO_Data_Resource
Range: AO_Spatial_Region

Subproperty of:
Superproperty of:
Inverse: is_spatial_coverage_of
Obligation: Mandatory
Scope Note: This property associates a data resource with the spatial region covered by the content of the resource.
Maps to: Equivalent to crm:P129_is_about with a restricted range E53_Place
Hints: This is a sub-property of dc:spatial

5.34 has_spatial_precision

Domain: AO_Data_Resource
Range: AO_Dimension
Subproperty of:
Superproperty of:
Inverse: is_spatial_precision_of
Obligation: Optional
Scope Note: This property associates a data resource with the approximation with which the spatial region covered by the content of the resource is specified.
Maps to: Sub-property of crm:P43_has_dimension

5.35 has_value

Domain: AO_Dimension
Range: xsd:decimal
Subproperty of:
Superproperty of:
Inverse:
Obligation: Optional
Scope Note: This property associates a numeric value with a dimension.
Maps to: Sub-property of crm:P90_has_value

5.36 has_unit

Domain: AO_Dimension
Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse:
Obligation: Optional
Scope Note: This property associates a unit of measure with a dimension.
Maps to: Sub-property of crm:P2_has_note

5.37 is_accessible_at

Domain: AO_Service
Range: rdfs:Resource
Subproperty of:
Superproperty of:
Inverse: is_access_point_of
Obligation: Mandatory
Scope Note: This property is used to associate a service with an IRI where the service is accessible. If the service is a web service, this IRI is the technical access point of the service. Otherwise, it is the IRI of a resource describing how the service can be accessed.
Examples: The ARIADNE Visual service is accessible at http://visual.ariadne-infrastructure.eu/
Maps to: Equivalent to crmpe:PP28_has_designated_access_point

5.38 has_functionality

Domain: AO_Service
Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse: is_functionality_of
Obligation: Mandatory
Scope Note: This property associates a service with its functionality, expressed in some vocabulary.
Examples: The ARIADNE visual service has functionality "3D visualization"
Maps to: This property is equivalent to crmpe:PP45_has_competency

5.39 has_consumed_media

Domain: AO_Service
Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse: is_consumed_media_of
Obligation: Mandatory
Scope Note: This property associates a service with the media type(s) handled by the service. The list of possible mediaType is open.
Examples: The ARIADNE visual service has consumed media "image", "2D model"
Maps to: Equivalent to crm:P125_used_object_of_type

5.40 has_produced_media

Domain: AO_Service

Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse: is_produced_media_of
Obligation: Mandatory
Scope Note: This property specifies the media types of the objects created by the service. The list of possible mediaType is open.
Scope Note: This property associates a service with the media type(s) produced by the service. The list of possible mediaType is open.
Examples: "image", "audio", "video", "text", "3D model", "2D model"
Maps to: This property is a shortcut of the fully developed path
                   crmdig:L11_had_output->crmdig:D1_Digital_Object->crm:P2_has_type->crm:E55_Type->crm:P2_has_type->crm:E55_Type["media"]

5.41 has_consumed_format

Domain: AO_Service
Range: AO_Concept (the IRI of a MIME type)
Subproperty of:
Superproperty of:
Inverse: is_the_format_consumed_by
Obligation: Mandatory
Scope Note: This property specifies the MIME type of the objects handled by the service.
Examples: "iana:image/jpeg"
Maps to: This property is a shortcut of the fully developed path
                   crmdig:L10_had_input->crmdig:D1_Digital_Object->crm:P2_has_type->crm:E55_Type->crm:P2_has_type->crm:E55_Type["format"]

5.42 has_produced_format

Domain: AO_Service
Range: AO_Concept (the IRI of a MIME type)
Subproperty of:
Superproperty of:
Inverse: is_the_format_produced_by
Obligation: Mandatory
Scope Note: This property specifies the MIME type of the objects created by the service.
Examples: "iana:image/jpeg"
Maps to: This property is a shortcut of the fully developed path
                   crmdig:L11_had_output->crmdig:D1_Digital_Object->crm:P2_has_type->crm:E55_Type->crm:P2_has_type->crm:E55_Type["format"]

5.43 has_supported_language

Domain: AO_Service
Range: AO_Concept (linked to lexvo.org)
Subproperty of:
Superproperty of:
Obligation: Desirable
Scope Note: This property specifies the languages supported by the service, encoded according with ISO 639 standard (ISO 639-1:2002).
Examples: The Pisa Meteo service has supported language "it"
Maps to: Equivalent to crm:P72_has_language
Hints: This property is a sub-property of dc:language

5.44 has_technical_support

Domain: AO_Service
Range: AO_Agent
Subproperty of:
Superproperty of:
Inverse: is_technical_support_of
Obligation: Mandatory
Scope Note: This property specifies the agent offering technical support on the service, if any.
Examples: AO_Service C has_technical_support https://www.isti.cnr.it/
Maps to: Subproperty of crmpe:PP2_provided_by

5.45 has_time_interval

Domain: AO_Object
Range: AO_Temporal_Region
Subproperty of:
Superproperty of:
Inverse: is_time_interval_of
Obligation: Optional
Scope Note: This property connects an object to a temporal region relevant for that object
Examples:
Maps to: This property is a shortcut of the fully developed path crm:P140i_was_attributed_by-> crm:E13_Attribute_Assignment->crm:P141_assigned-> crm:E52_Time-Span

5.46 has_space_region

Domain: AO_Object
Range: AO_Spatial_Region
Subproperty of:
Superproperty of:
Inverse: is_space_region_of
Obligation: Optional
Scope Note: This property connects an object to a spatial region relevant for that object
Examples:
Maps to: This property is a subproperty of crm:P53_has_former_or_current_location

5.47 was_present_at

Domain: AO_Object
Range: AO_Event
Subproperty of:
Superproperty of:
Inverse: occurred_in_the_presence_of
Obligation: Optional
Scope Note: This property connects an object to an event in which the object plays a relevant role
Examples:
Maps to: This property is a subproperty of crm:P12i_was_present_at

5.48 has_name

Domain: AO_Agent
Range: xsd:string
Subproperty of:
Superproperty of:
Obligation: Mandatory
Scope Note: This property is used to specify the name of the person, institution or organisation related with an AO_Resource
Examples: Julian Richards has name "Julian Richards"
Maps to: This property is a shortcut of the fully developed path
                 →   P1_is_identified_by→   E41_Appellation→   P2_has_type   →   E55_Type['Name']
Hints: This property is a sub-property of foaf:name

5.49 has_agent_identifier

Domain: AO_Agent

Range:	xsd:string
Subproperty of:	
Superproperty of:	
Obligation:	Desirable
Scope Note:	This property is used to specify the identifier of the person, institution or organisation related with an AO_Resource. The identifier also specifies the authority that provides it.
Examples:	M. Theodoridou has ORCID "http://orcid.org/0000-0002-4623-9186"
Maps to:	This property is a shortcut of the fully developed path → P1_is_identified_by→ E41_Appellation→ P2_has_type → E55_Type[Authority]
Hints:	This property is a sub-property of foaf:name

5.50 has_email

Domain:	AO_Agent
Range:	xsd:string
Subproperty of:	
Superproperty of:	
Obligation:	Desirable
Scope Note:	This property is used to specify the mail address of the person, institution or organisation related with an AO_Resource
Examples:	name@institution.org
Maps to:	This property is a shortcut of the fully developed path crm:P76_has_contact_point->E51_Contact_Point->P2_has_type->E55_Type["Email"]
Hints:	This property is a sub-property of foaf:mbox

5.51 has_homepage

Domain:	AO_Agent
Range:	rdfs:Resource
Subproperty of:	
Superproperty of:	
Inverse:	is_homepage_of
Obligation:	Optional
Scope Note:	This property is used to specify the website home page of the person, institution or organisation related with an AO_Resource
Examples:	http://www.vast-lab.org
Maps to:	This property is a shortcut of the fully developed path crm:P76_has_contact_point->E51_Contact_Point->P2_has_type->E55_Type["homepage"]
Hints:	This property is a sub-property of foaf:homepage

5.52 from

Domain: AO_Temporal_Region
Range: xsd:gYear
Subproperty of:
Superproperty of:
Obligation: Desirable
Scope Note: This property is used to indicate the starting date of a AO_Temporal_Region in ISO 8601 format.
Examples: Temporal region X starts from 312
Maps to: This property is equivalent to crm:P79_beginning_is_qualified_by

5.53 until

Domain: AO_Temporal_Region
Range: xsd:gYear
Subproperty of:
Superproperty of:
Obligation: Desirable
Scope Note: This property is used to indicate the ending date of a AO_Temporal_Region in ISO 8601 format.
Examples: Temporal region X lasts until 1491
Maps to: This property is equivalent to crm:P80_end_is_qualified_by

5.54 has_place_name

Domain: AO_Spatial_Region
Range: xsd:string
Subproperty of:
Superproperty of:
Obligation: Mandatory
Scope Note: This property is used to identify a SpatialRegion with its place name.
Examples: Spatial region Z has place name "Florence"
Maps to: This property is a sub-property of P87_is_identified_by

5.55 has_coordinate_system

Domain: AO_Spatial_Region
Range: xsd:string
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property indicates the coordinate system used to encode coordinates.
Examples: Spatial region W has coordinate system "EPSG 2763"

Maps to: This property is a shortcut of the fully developed path
→ P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type
→ E55_Type[*coordinate-system-name*]

5.56 has_country_code

Domain:	AO_Spatial_Region
Range:	rdfs:Resource, the Wikipedia IRI corresponding to the 3-letter alphabetic code set by ISO 3166
Subproperty of:	
Superproperty of:	
Obligation:	Mandatory
Scope Note:	This property indicates code of the country where a spatial region belongs.
Examples:	Spatial region W belonging to Afghanistan has code https://en.wikipedia.org/wiki/ISO_3166-1_alpha-3#AFG
Maps to:	This property is a subproperty of P3 has note

5.57 has_latitude

Domain:	AO_Spatial_Region_Point
Range:	xsd:decimal
Subproperty of:	
Superproperty of:	
Obligation:	Desirable
Scope Note:	This property indicates the latitude value of the coordinates of a AO_Spatial_Region.
Examples:	Spatial region W has latitude 54.540575
Maps to:	This property is a shortcut of the fully developed path → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type → E55_Type["latitude"]
Hints:	This is a sub-property of geo:lat

5.58 has_longitude

Domain:	AO_Spatial_Region_Point
Range:	xsd:decimal
Subproperty of:	
Superproperty of:	
Obligation:	Desirable
Scope Note:	This property indicates the minimum longitude value of the coordinates of a AO_Spatial_Region.
Examples:	Spatial region W has longitude -3.293877
Maps to:	This property is a shortcut of the fully developed path → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type → E55_Type["longitude"]

Hints: This is a sub-property of geo:lon

5.59 has_bounding_box_min_lat

Domain: AO_Spatial_Region_BBox
Range: xsd:decimal
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property indicates the minimum latitude value of the bounding box area defining a AO_Spatial_Region.
Examples: Spatial region W has bounding box min lat 49.85215377807617
Maps to: This property is a shortcut of the fully developed path
                   → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type → E55_Type["boundingBoxMinLat"]

5.60 has_bounding_box_min_lon

Domain: AO_Spatial_Region_BBox
Range: xsd:decimal
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property indicates the minimum longitude value of the bounding box area defining a AO_Spatial_Region.
Examples: Spatial region W has bounding box min lon -6.0230712890625
Maps to: This property is a shortcut of the fully developed path
                   → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type → E55_Type["boundingBoxMinLon"]
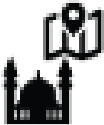
5.61 has_bounding_box_max_lat

Domain: AO_Spatial_Region_BBox
Range: xsd:decimal
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property indicates the maximum latitude value of the bounding box area defining a AO_Spatial_Region.
Examples: Spatial region W has bounding box max lat 55.7147331237793
Maps to: This property is a shortcut of the fully developed path
                   → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type → E55_Type["boundingBoxMaxLat"]

5.62 has_bounding_box_max_lon

Domain: AO_Spatial_Region_BBox
Range: xsd:decimal
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property indicates the maximum longitude value of the bounding box
                     area defining a AO_Spatial_Region.
Examples: Spatial region W has bounding box max lon 2.0408935546875
Maps to: This property is a shortcut of the fully developed path
                     → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type
                     → E55_Type["boundingBoxMaxLon"]

5.63 has_place_IRI

Domain: AO_Spatial_Region_StdName
Range: AO_Concept
Subproperty of:
Superproperty of:
Inverse: is_place_IRI_of
Obligation: Desirable (the gazetteer should be specified too)
Scope Note: This property associates a spatial region with a URI/IRI or other unique
                     identifier from a standard gazetteer (e.g. Geonames for modern places,
                     Pleiades for ancient places) used to refer a place or a spatialRegion.
Examples: Spatial region W has place IRI http://www.geonames.org/3176959
Maps to: This property is a shortcut of the fully developed path
                     → P87_is_identified_by → E44_Place_Appellation → P2_has_type →
                     E55_Type["gazetteer name"]

5.64 has_polygonal_representation

Domain: AO_Spatial_Region_Polygon
Range: XMLLiteral
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property associates a spatial region with an XML representation of
                     the polygon, typically handled by a GIS.
Examples:
Maps to: This property is a shortcut of the fully developed path
                     → P87_is_identified_by → E47_Spatial_Coordinates → P2_has_type
                     → E55_Type["polygon"]

5.65 has_institution

Domain: AO_Person
Range: AO_Concept
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property specifies the institution where an agent belongs.
Examples: Agent Carlo has institution "ISTI"
Maps to:
Hints: This property is a sub-property of the inverse of foaf:member

5.66 is_mirror_of

Domain: AO_Digital_Image
Range: AO_Concept
Subproperty of:
Superproperty of:
Obligation: Optional
Scope Note: This property associates a digital image with the image it is a mirror of. The latter image is supposed to be on some provider's site, identified by an IRI.
Examples: (example given in 3.10 Digital images)
Maps to: Maria please help with the co-reference assignment path
Hints: this property is a sub-property of owl:sameAs

6 Appendix 3: ARIADNEplus subjects

In the first phase of the ARIADNE project there were nine top level ARIADNE subjects. With the increased number of archaeological sub-domains represented In ARIADNEplus this was expanded to thirteen, reflecting the range of datasets provided. Where data are aggregated at item level, the same ARIADNE subject is applied to the collection record.

	ARIADNEplus subject type	ARIADNE plus icon	Existing Getty AAT thesaurus URI
1	**Site/monument** Aggregated at item level (generally with one record per monument or site May have specific categories below e.g. maritime; Building In these cases more than one ARIADNE subject type may be applied		Sites: http://vocab.getty.edu/page/aat/300000809 Monuments: http://vocab.getty.edu/page/aat/300006958 Archaeological sites http://vocab.getty.edu/page/aat/300000810 Underwater archaeological sites http://vocab.getty.edu/page/aat/300387535 Burial sites http://vocab.getty.edu/page/aat/300387004
2	**Fieldwork** These are item level records for individual archaeological investigations or, to use the UK terminology, archaeological events. The majority with be excavations but there may be specific sub-types, such as maritime or building. This is used where there is just a record which describes the fieldwork, ands no link to additional text reports or data sets		Excavations http://vocab.getty.edu/page/aat/300053702 Underwater archaeology http://vocab.getty.edu/page/aat/300054339 Environmental archaeology http://vocab.getty.edu/page/aat/300379406 Field archaeology http://vocab.getty.edu/page/aat/300379558 See also: https://heritagedata.org/live/schemes/agl_et.html

3	**Fieldwork report** Archaeological fieldwork records as above but with links to online fieldwork reports i.e. "grey literature"		See above
4	**Fieldwork archive** Archaeological fieldwork records as above but with links to online fieldwork archives, including digital objects such as images, databases and spreadsheets etc.		See above
5	**Scientific analysis** This is a broad category including all kinds of material and structure characterisations (e.g. XRF, XRD, X-ray tomography) , as well as Ancient DNA and stable isotopes, and environmental records		http://vocab.getty.edu/page/aat/300010357 See also https://heritagedata.org/live/schemes/560.html
6	**Date** Aggregated at item level, so each record is a single archaeological date e.g. C14, dendrochronology, thermoluminescence/OSL The category has been separated from Scientific analysis as a specific class due to the large number of dating databases aggregated		Presented as "Dating" in the portal

7	**Artefact** Aggregated at item level, so each record is a description of a single artefact. Due to the large number of numismatic databases aggregated coins have been made a separate class		
8	**Coin** Aggregated at item level, so each record is a description of a single coin - can be regarded as a special type on Artefact, with its own subject type where the collection can be separated		
9	**Building survey** Specific category of fieldwork report or archive for standing building survey		
10	**Maritime** Specific category of site/monument for wrecks, or sub-type of fieldwork for underwater archeology		
11	**Inscription** This is a brosd category of monument/ artefact, including milestones, Roman tombstones, grafiitti, pottery stamp - to be aggregated at item level. Defined as objects that bear graphical manifestations of a human thought, either as letters, symbols, geometric shapes or images.		http://vocab.getty.edu/page/aat/300028702 Use EAGLE thesaurus below top level category https://www.eagle-network.eu/resources/vocabularies/typeins/

12	**Rock Art** This has been distinguished from Inscription as it is a specific research area with several large datasets aggregated.		Rock Art: http://vocab.getty.edu/page/aat/300184090
13	**Burial** Aggregated at item level, with a single record per burial.		http://vocab.getty.edu/page/aat/300387004