

# Domain Ontologies

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# Domain Ontologies

- Domain Ontology
  - Designed to use in a specific domain or aspect.
- Type of domain ontology
  - Ontology for a specific aspect
    - ◆ Ex) Time Ontology
  - Ontology for a specific target domain
    - ◆ PROV-O: The ontology for Provenance
    - ◆ CIDOC CRM
    - ◆ Agriculture Activity Ontology (AAO)

# PROV-O: The Ontology for Provenance

- AIM
  - Represent and interchange provenance information generated in different systems and under different contexts
    - ◆ Provenance: refers to the sources of information, such as entities and processes, involved in producing or delivering an artifact.\*

\* [https://www.w3.org/2005/Incubator/prov/wiki/What\\_Is\\_Provenance](https://www.w3.org/2005/Incubator/prov/wiki/What_Is_Provenance)

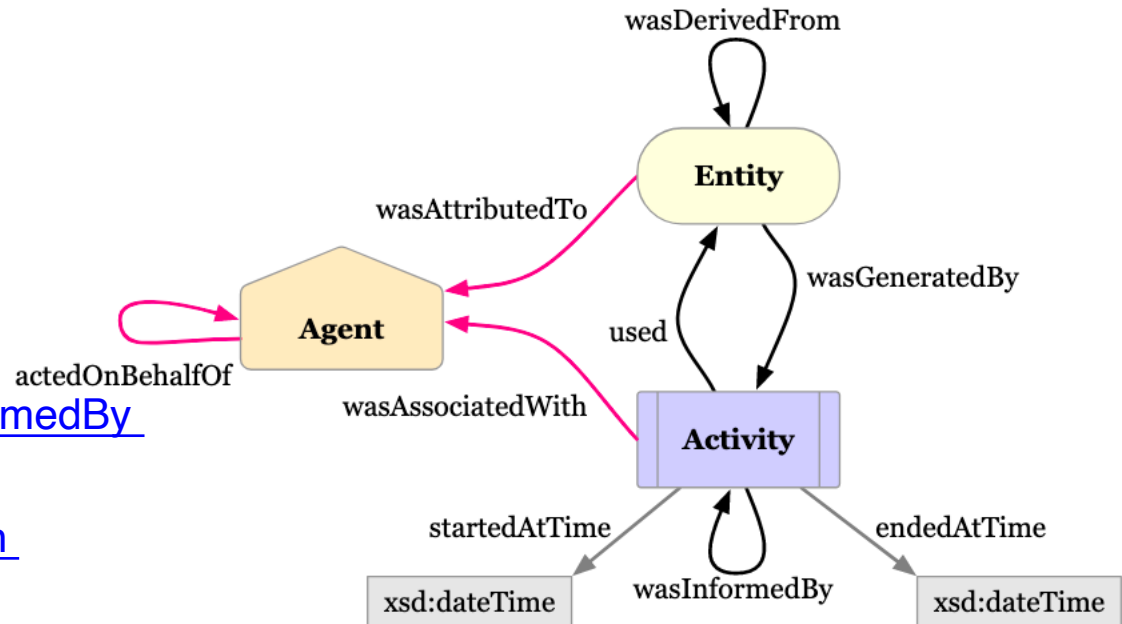
# PROV-O: Model

- Class

- An [prov:Entity](#) is a physical, digital, conceptual, or other kind of thing with some fixed aspects; entities may be real or imaginary.
- An [prov:Activity](#) is something that occurs over a period of time and acts upon or with entities; it may include consuming, processing, transforming, modifying, relocating, using, or generating entities.
- An [prov:Agent](#) is something that bears some form of responsibility for an activity taking place, for the existence of an entity, or for another agent's activity.

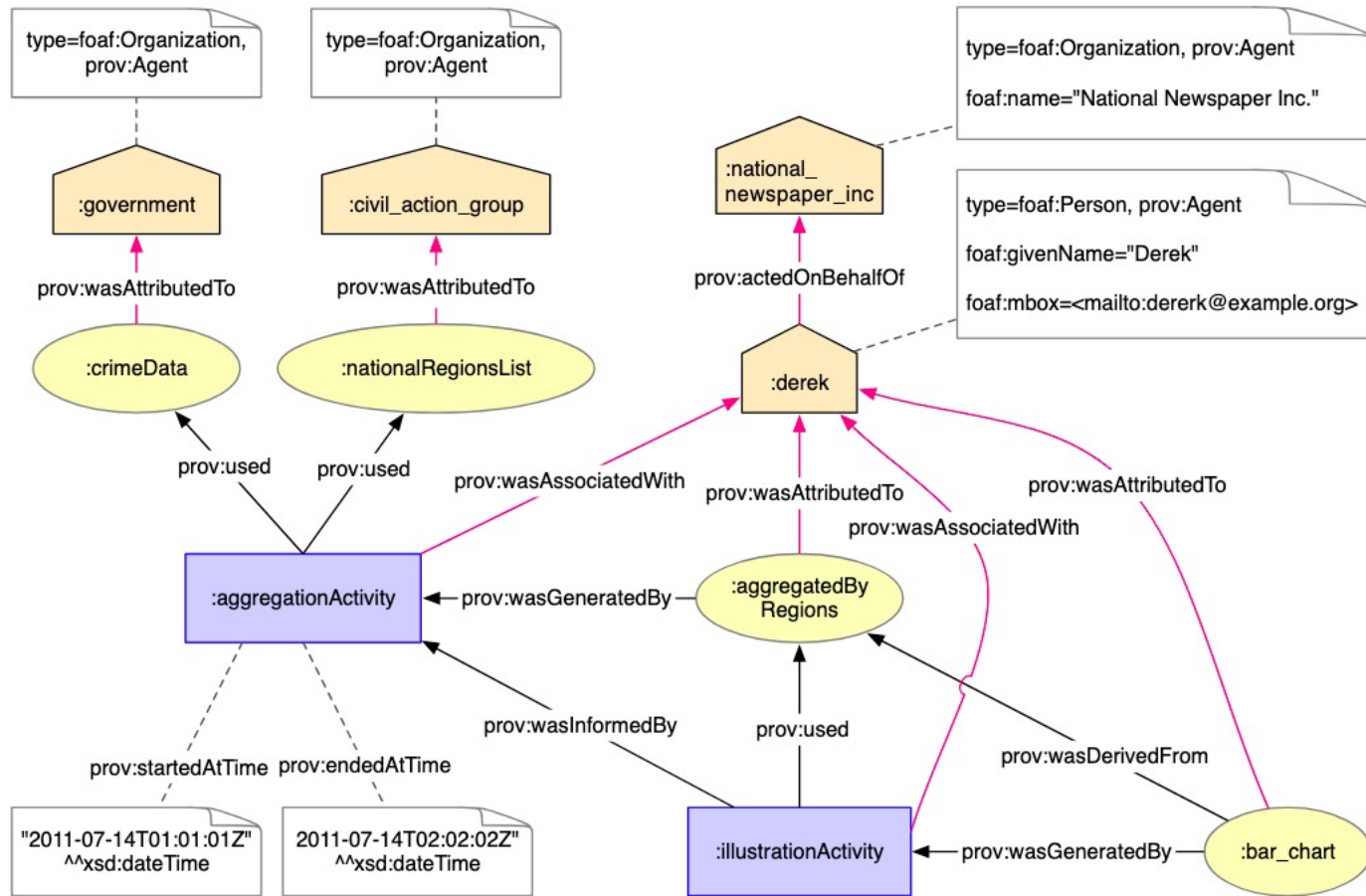
- Property

- [prov:wasGeneratedBy](#)
- [prov:wasDerivedFrom](#)
- [prov:wasAttributedTo](#)
- [prov:startedAtTime](#)
- [prov:used](#) [prov:wasInformedBy](#)
- [prov:endedAtTime](#)
- [prov:wasAssociatedWith](#)
- [prov:actedOnBehalfOf](#)





# PROV-O: Example



The diagrams in this document depict Entities as yellow ovals, Activities as blue rectangles, and Agents as orange pentagons. The responsibility properties are shown in pink.

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix prov: <http://www.w3.org/ns/prov#> .  
@prefix : <http://example.org#> .

:bar\_chart  
a prov:Entity;  
prov:wasGeneratedBy :illustrationActivity;  
prov:wasDerivedFrom :aggregatedByRegions;  
prov:wasAttributedTo :derek;

:derek  
a foaf:Person, prov:Agent;  
foaf:givenName "Derek";  
foaf:mbox <mailto:derek@example.org>;  
prov:actedOnBehalfOf :national\_newspaper\_inc;

:national\_newspaper\_inc  
a foaf:Organization, prov:Agent;  
foaf:name "National Newspaper, Inc.";

:illustrationActivity  
a prov:Activity;  
prov:used :aggregatedByRegions;  
prov:wasAssociatedWith :derek;  
prov:wasInformedBy :aggregationActivity;

:aggregatedByRegions  
a prov:Entity;  
prov:wasGeneratedBy :aggregationActivity;  
prov:wasAttributedTo :derek;

:aggregationActivity  
a prov:Activity;  
prov:startedAtTime "2011-07-14T01:01:01Z"^^xsd:dateTime;  
prov:wasAssociatedWith :derek;  
prov:used :crimeData;  
prov:used :nationalRegionsList;  
prov:endedAtTime "2011-07-14T02:02:02Z"^^xsd:dateTime;

:crimeData  
a prov:Entity;  
prov:wasAttributedTo :government;

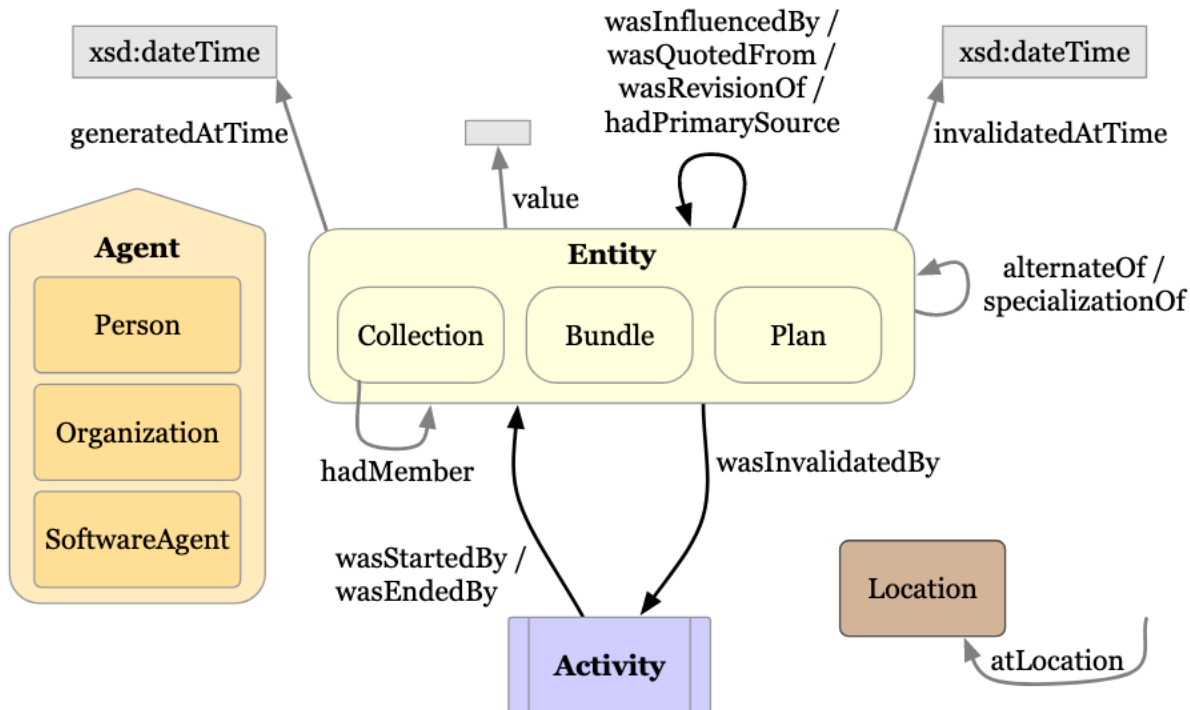
:government a foaf:Organization, prov:Agent .

:nationalRegionsList  
a prov:Entity;  
prov:wasAttributedTo :civil\_action\_group;

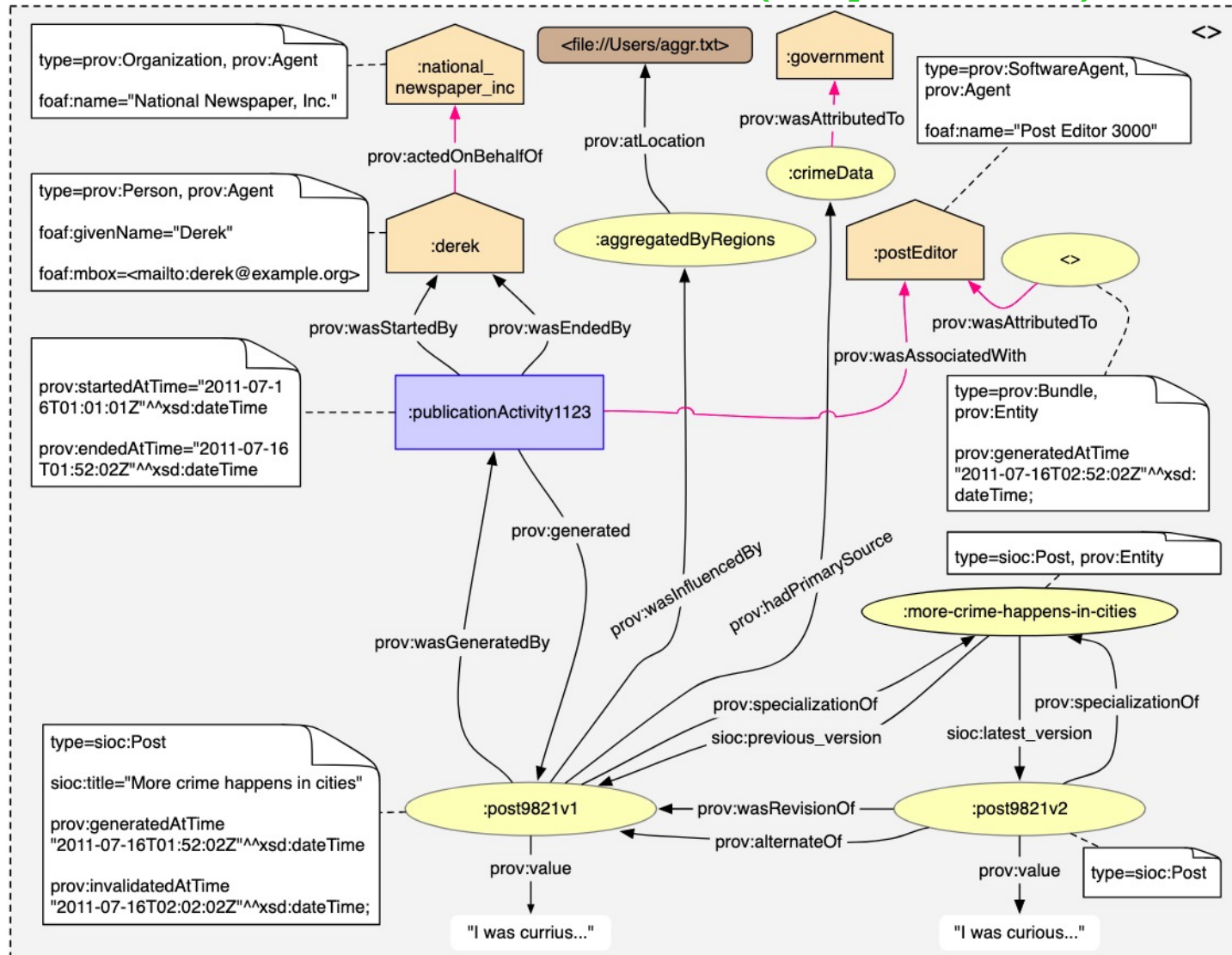
:civil\_action\_group a foaf:Organization, prov:Agent .

# PROV-O: Model (expanded)

- Extend the first model with subclass and subproperty relationship
  - Ex) Person isa Agent



# PROV-O: Model (expanded)



Derek published two versions of a blog for the National Newspaper, Inc.

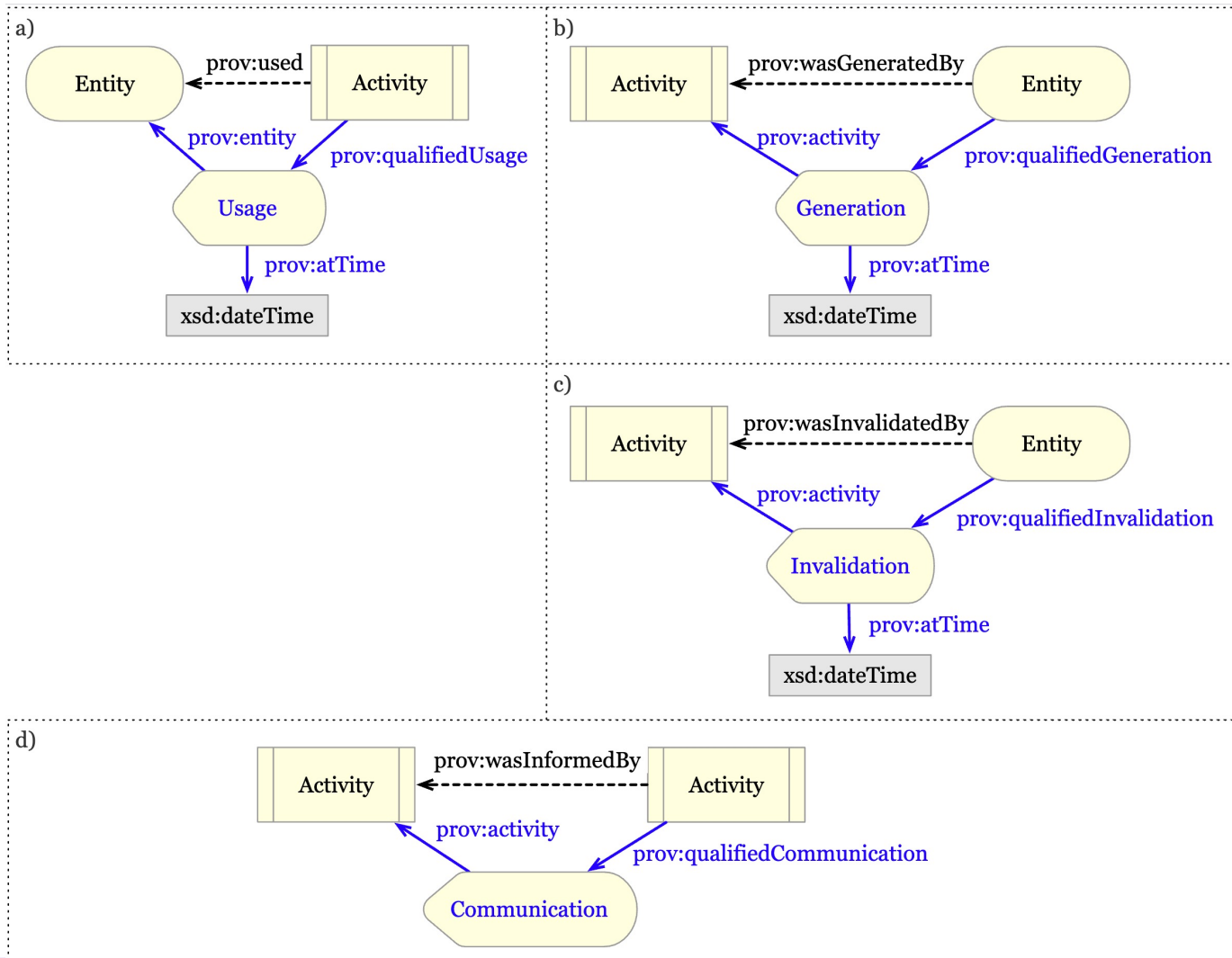
```

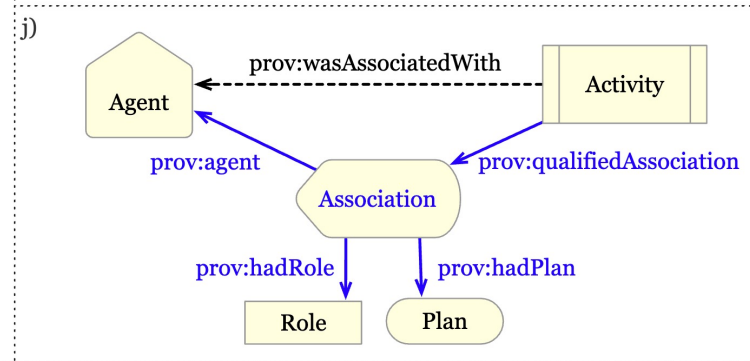
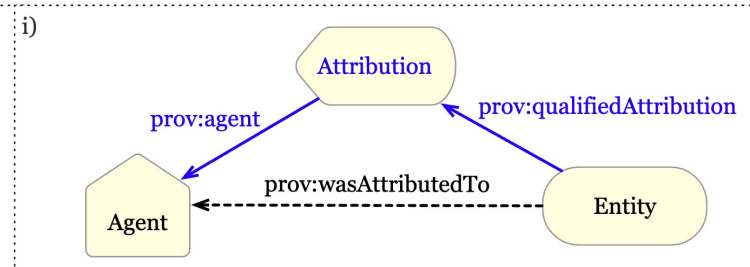
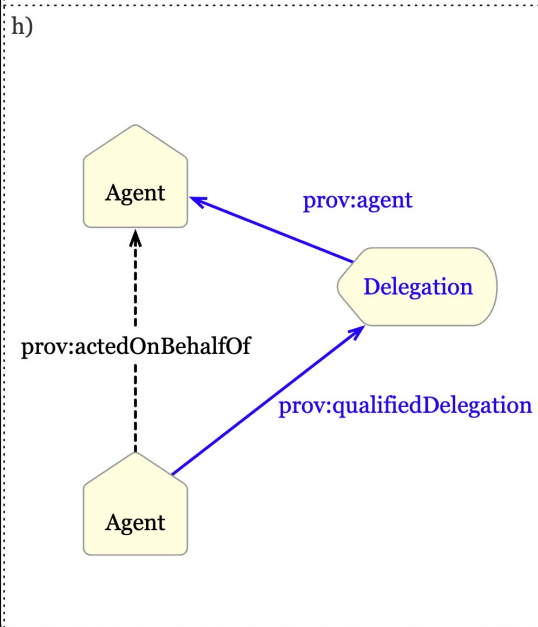
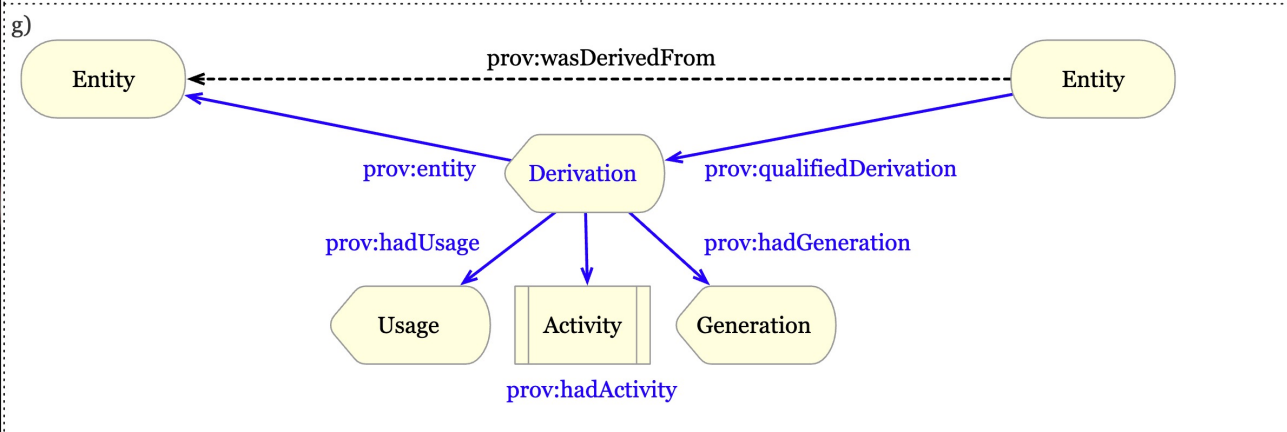
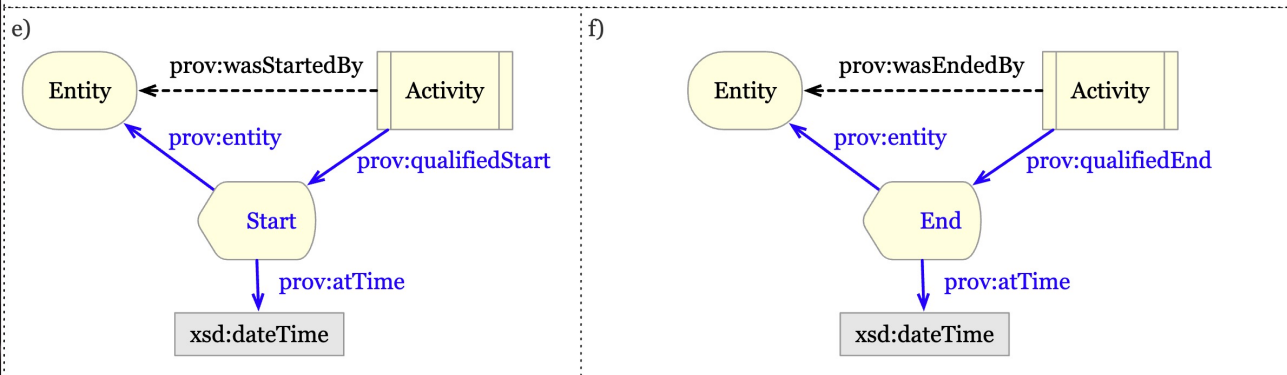
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> . ## Version 1 of the post
@prefix foaf: <http://xmlns.com/foaf/0.1/> . :post9821v1
@prefix sioc: <http://rdfs.org/sioc/ns#> . a sioc:Post, prov:Entity;
@prefix prov: <http://www.w3.org/ns/prov#> . prov:specializationOf :more-crime-happens-in-cities; ## PERMALINK to the latest revision.
@prefix my: <http://www.example.org/vocab#> . sioc:title "More crime happens in cities";
@prefix : <http://www.example.org#> . prov:value "I was currius..."; ## The text of this version (with a typo).
@base <http://www.example.com/derek-bundle.ttl> . prov:generatedAtTime "2011-07-16T01:52:02Z"^^xsd:dateTime;
<> prov:wasGeneratedBy :publicationActivity1123;
a prov:Bundle, prov:Entity; prov:wasInfluencedBy :aggregatedByRegions; ## This blog was influenced by Derek's data analysis.
prov:wasAttributedTo :postEditor; prov:hadPrimarySource :crimeData; ## Derek's blog derives from the crime data originally
prov:generatedAtTime "2011-07-16T02:52:02Z"^^xsd:dateTime; ## gathered by the government.
. prov:invalidatedAtTime "2011-07-16T02:02:02Z"^^xsd:dateTime; .
:derek :publicationActivity1123
a prov:Activity;
prov:startedAtTime "2011-07-16T01:01:01Z"^^xsd:dateTime;
prov:wasStartedBy :derek;
foaf:givenName "Derek"; prov:wasAssociatedWith :postEditor;
foaf:mbox <mailto:derek@example.org>; prov:generated :post9821v1;
prov:actedOnBehalfOf :national_newspaper_inc; prov:endedAtTime "2011-07-16T01:52:02Z"^^xsd:dateTime;
prov:wasEndedBy :derek; .
:national_newspaper_inc :aggregatedByRegions
a prov:Organization, prov:Agent; a prov:Entity;
## prov:Agent is inferred from prov:Organization prov:atLocation <file://Users/aggr.txt>; .
foaf:name "National Newspaper, Inc."; <file://Users/aggr.txt> a prov:Location .
. :crimeData
:postEditor a prov:Entity;
a prov:SoftwareAgent, prov:Agent; prov:wasAttributedTo :government; .
## prov:Agent is inferred from prov:SoftwareAgent :government
foaf:name "Post Editor 3000"; a prov:Organization, prov:Agent; .
.
:more-crime-happens-in-cities ## Version 2 of the post
a sioc:Post, prov:Entity; :post9821v2
sioc:latest_version :post9821v2; a sioc:Post, prov:Entity;
sioc:previous_version :post9821v1; prov:specializationOf :more-crime-happens-in-cities; ## PERMALINK to the latest revision.
. prov:value "I was curious..."; ## The text of this version (with fixed typo).
prov:generatedAtTime "2011-07-16T02:02:02Z"^^xsd:dateTime;
prov:wasRevisionOf :post9821v1;
prov:alternateOf :post9821v1;

```

# PROV-O: Qualified

- Enable to describe qualification information about properties







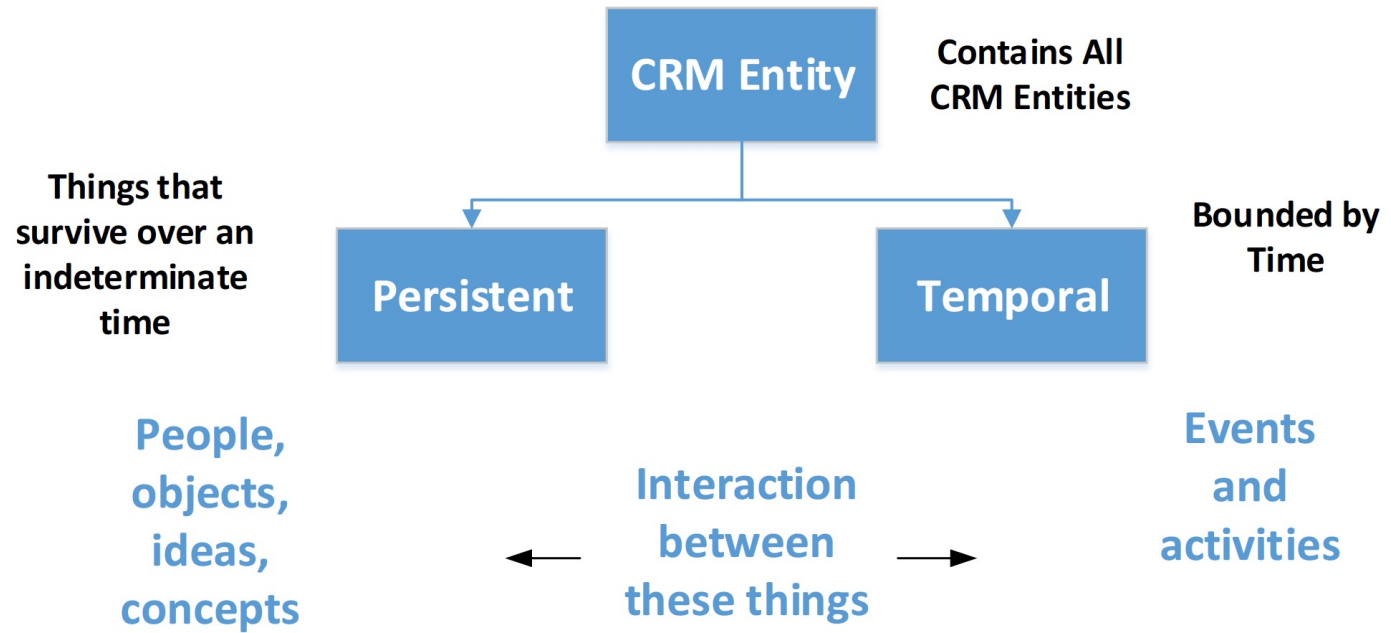
# CIDOC CRM

- The CIDOC CRM represents an 'ontology' for cultural heritage information i.e. it describes in a formal language the explicit and implicit concepts and relations relevant to the documentation of cultural heritage. The primary role of the CIDOC CRM is to serve as a basis for mediation of cultural heritage information and thereby provide the semantic 'glue' needed to transform today's disparate, localised information sources into a coherent and valuable global resource.
- The CIDOC CRM is intended to promote a shared understanding of cultural heritage information by providing a common and extensible semantic framework that any cultural heritage information can be mapped to. It is intended to be a common language for domain experts and implementers to formulate requirements for information systems and to serve as a guide for good practice of conceptual modelling. In this way, it can provide the "semantic glue" needed to mediate between different sources of cultural heritage information, such as that published by museums, libraries and archives.



# CIDOC CRM: Ontology

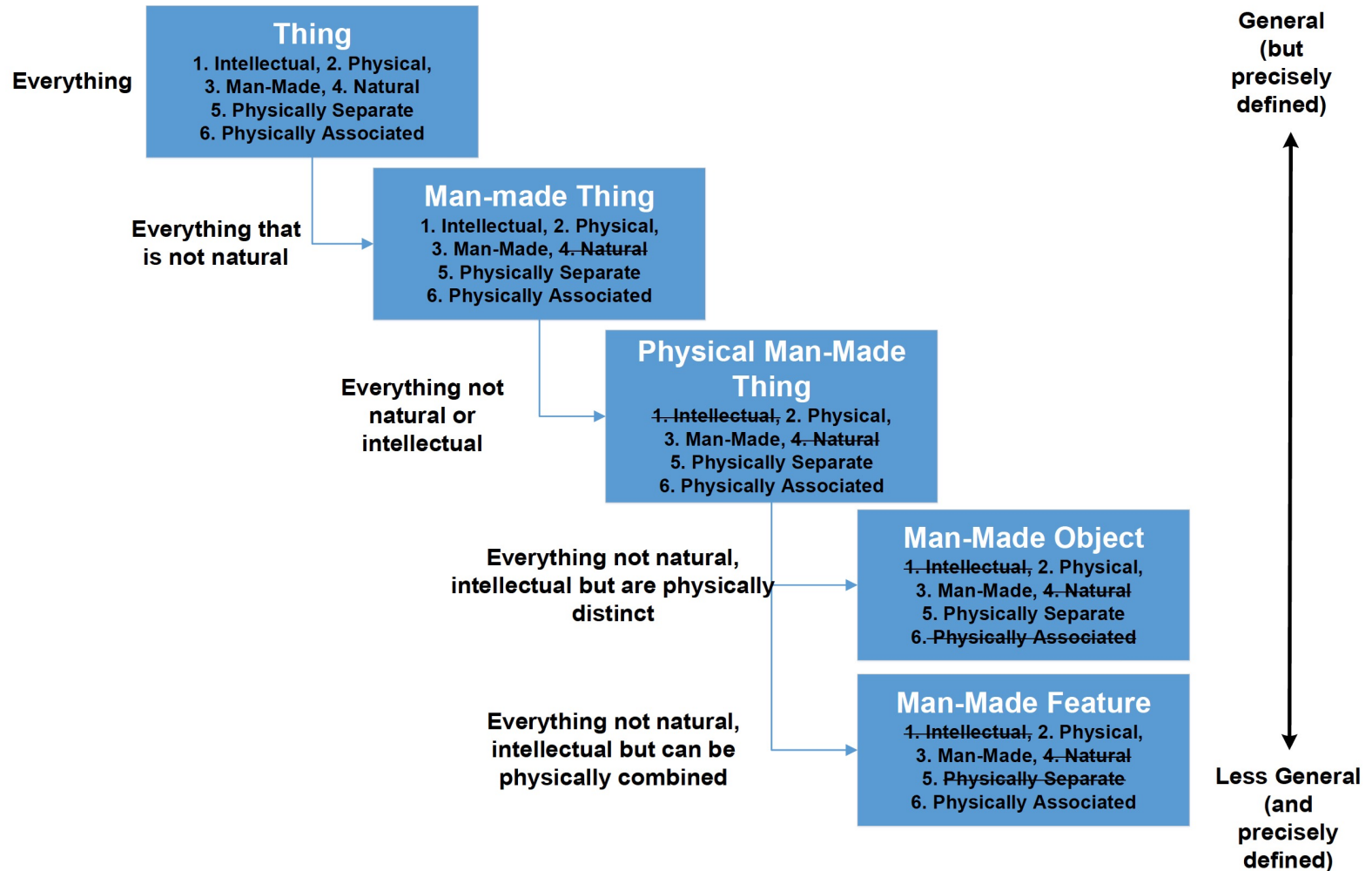
- Persistent Things and Temporary Things
  - CRM Entity
    - ◆ Persistent
    - ◆ Temporal



The CIDOC Conceptual Reference Model (CIDOC-CRM): PRIMER

Dominic Oldman<sup>1</sup> and CRM Labs<sup>2</sup>, [http://www.cidoc-crm.org/sites/default/files/CRMPrimer\\_v1.1\\_1.pdf](http://www.cidoc-crm.org/sites/default/files/CRMPrimer_v1.1_1.pdf)

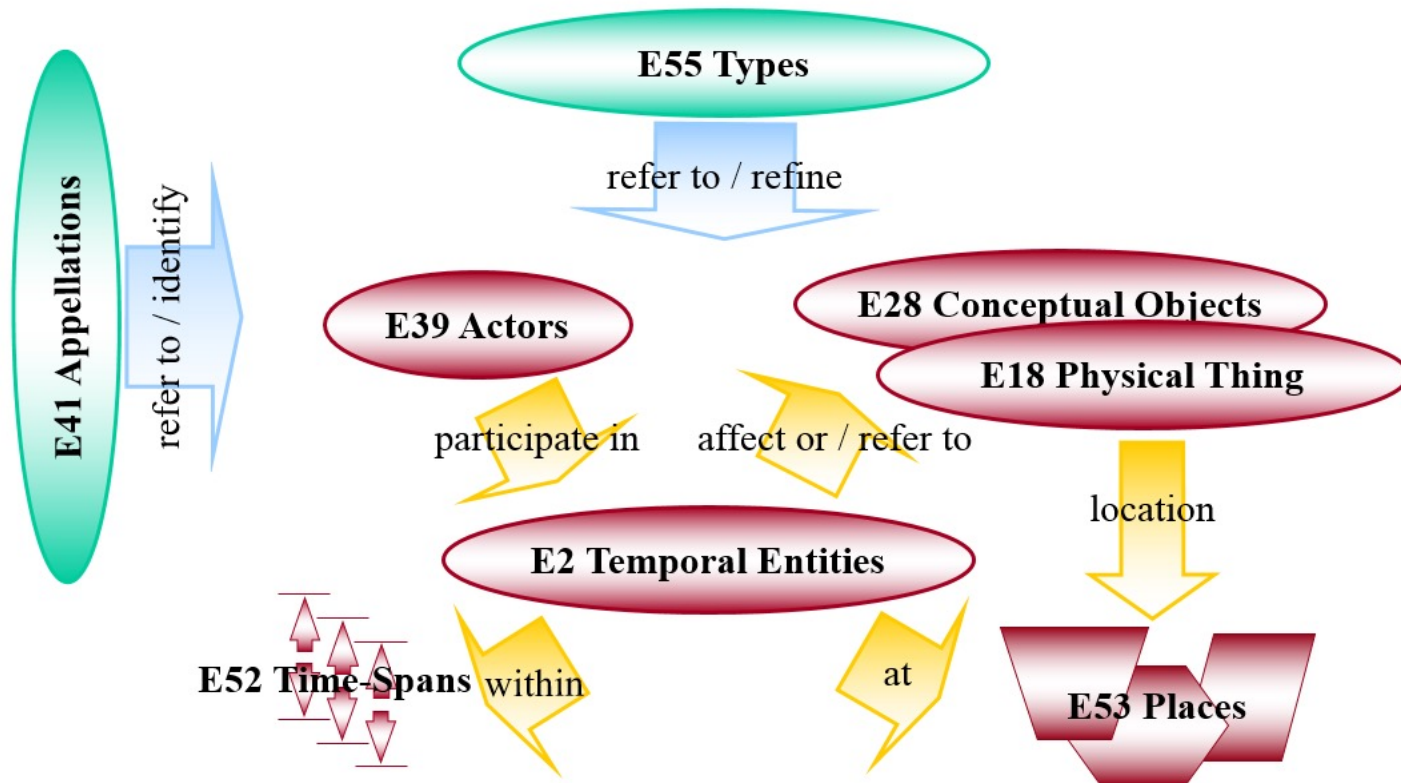
- The CRM is a Hierarchy of Entities (In fact it is poly-hierarchical)

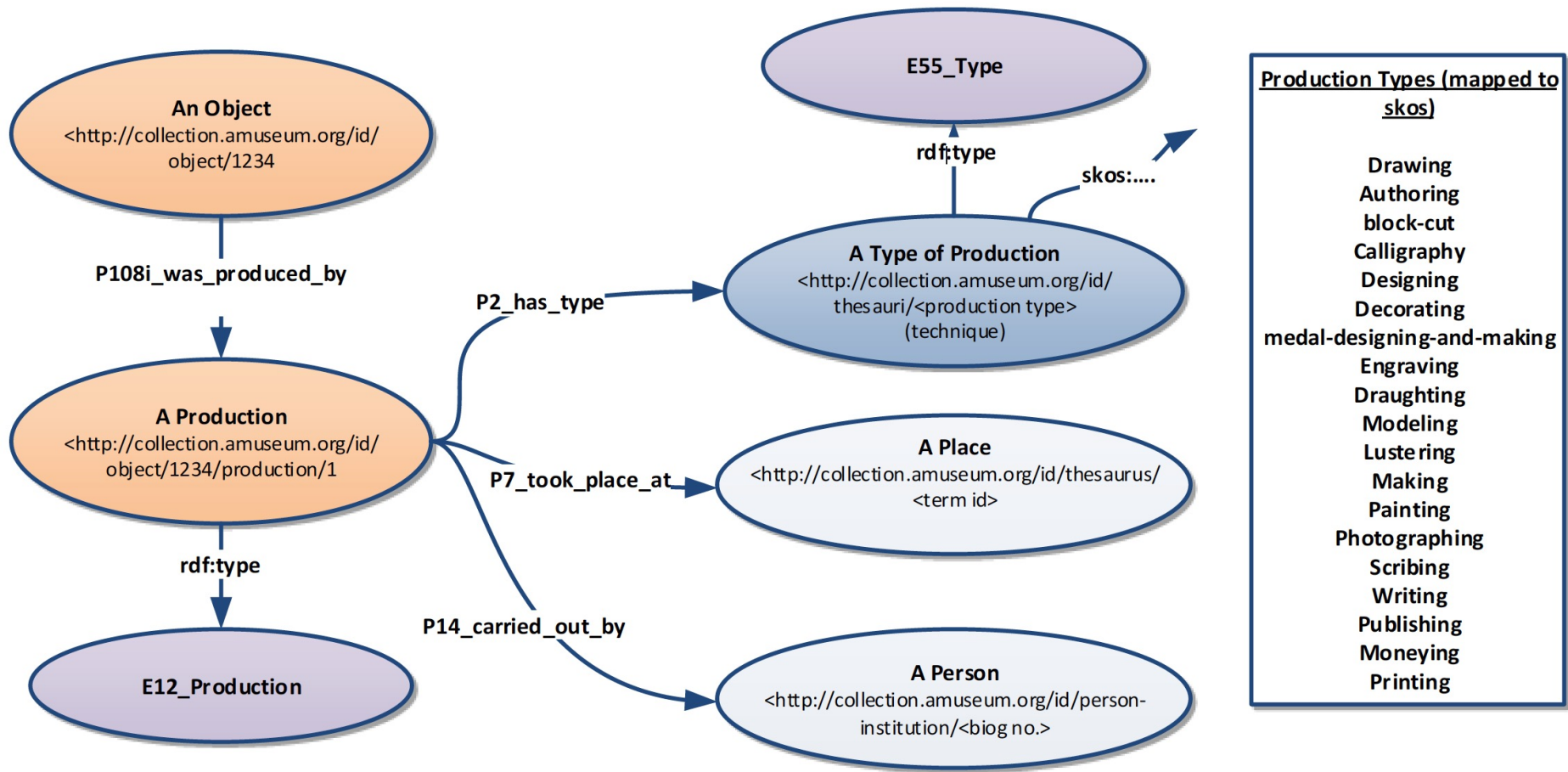


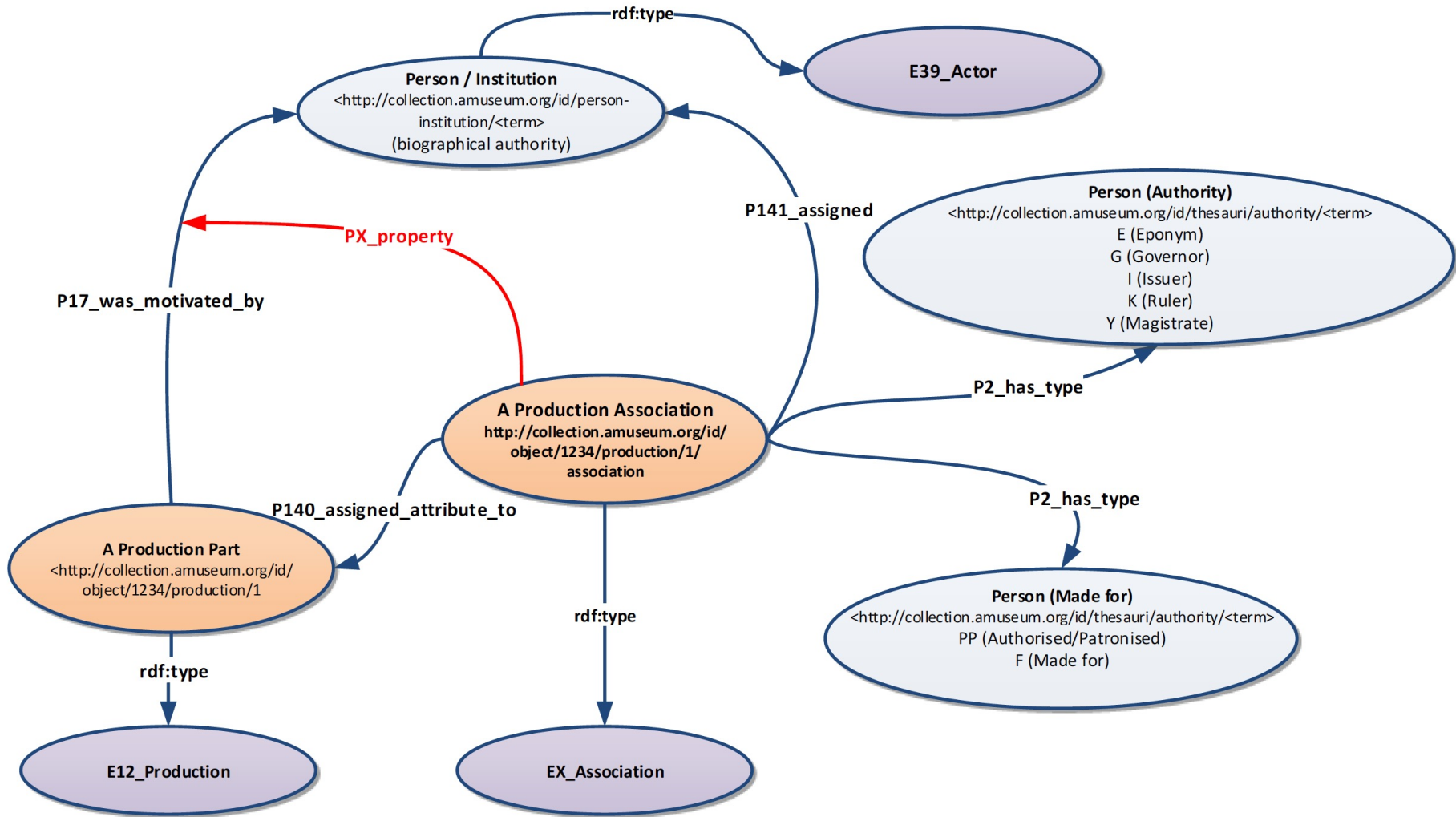
- Top Model

# The CIDOC CRM

## Top-level classes useful for integration







# Hierarchy of Class

| Entity ID | Parent Entity | Entity Name               |
|-----------|---------------|---------------------------|
| E1        |               | CRM Entity                |
| E2        | -             | Temporal Entity           |
| E3        | -             | Condition State           |
| E4        | -             | Period                    |
| E5        | -             | Event                     |
| E7        | -             | Activity                  |
| E63       | -             | Beginning of Existence    |
| E64       | -             | End of Existence          |
| E77       | -             | Persistent Item           |
| E70       | -             | Thing                     |
| E72       | -             | Legal Object              |
| E18       | -             | Physical Thing            |
| E90       | -             | Symbolic Object           |
| E71       | -             | Human-Made Thing          |
| E24       | -             | Physical Human-Made Thing |
| E28       | -             | Conceptual Object         |
| E39       |               | Actor                     |
| E74       | -             | Group                     |
| E21       | -             | Person                    |
| E52       |               | Time-Span                 |
| E53       |               | Place                     |
| E54       |               | Dimension                 |
| E97       | -             | Monetary Amount           |
| E92       | -             | Spacetime Volume          |
| E4        | -             | Period                    |
| E5        | -             | Event                     |
| E7        | -             | Activity                  |
| E63       | -             | Beginning of Existence    |
| E64       | -             | End of Existence          |
| E93       | -             | Presence                  |
| E59       | -             | Primitive Value           |
| E60       | -             | Number                    |
| E61       | -             | Time Primitive            |
| E62       | -             | String                    |
| E94       | -             | Space Primitive           |
| E95       | -             | Spacetime Primitive       |

# Hierarchy of Class

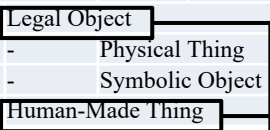
## - Temporal Entity -

|                     |   |                 |                 |       |          |                         |
|---------------------|---|-----------------|-----------------|-------|----------|-------------------------|
| <a href="#">E2</a>  | - | Temporal Entity |                 |       |          |                         |
| <a href="#">E3</a>  | - | -               | Condition State |       |          |                         |
| <a href="#">E4</a>  | - | -               | Period          |       |          |                         |
| <a href="#">E5</a>  | - | -               | -               | Event |          |                         |
| <a href="#">E7</a>  | - | -               | -               | -     | Activity |                         |
| <a href="#">E8</a>  | - | -               | -               | -     | -        | Acquisition             |
| <a href="#">E96</a> | - | -               | -               | -     | -        | - Purchase              |
| <a href="#">E9</a>  | - | -               | -               | -     | -        | Move                    |
| <a href="#">E10</a> | - | -               | -               | -     | -        | Transfer of Custody     |
| <a href="#">E11</a> | - | -               | -               | -     | -        | Modification            |
| <a href="#">E12</a> | - | -               | -               | -     | -        | - Production            |
| <a href="#">E79</a> | - | -               | -               | -     | -        | - Part Addition         |
| <a href="#">E80</a> | - | -               | -               | -     | -        | - Part Removal          |
| <a href="#">E13</a> | - | -               | -               | -     | -        | Attribute Assignment    |
| <a href="#">E14</a> | - | -               | -               | -     | -        | - Condition Assessment  |
| <a href="#">E15</a> | - | -               | -               | -     | -        | - Identifier Assignment |
| <a href="#">E16</a> | - | -               | -               | -     | -        | - Measurement           |
| <a href="#">E17</a> | - | -               | -               | -     | -        | - Type Assignment       |
| <a href="#">E65</a> | - | -               | -               | -     | -        | Creation                |
| <a href="#">E83</a> | - | -               | -               | -     | -        | - Type Creation         |
| <a href="#">E66</a> | - | -               | -               | -     | -        | Formation               |
| <a href="#">E85</a> | - | -               | -               | -     | -        | Joining                 |
| <a href="#">E86</a> | - | -               | -               | -     | -        | Leaving                 |
| <a href="#">E87</a> | - | -               | -               | -     | -        | Curation Activity       |
| <a href="#">E63</a> | - | -               | -               | -     | -        | Beginning of Existence  |
| <a href="#">E67</a> | - | -               | -               | -     | -        | Birth                   |
| <a href="#">E81</a> | - | -               | -               | -     | -        | Transformation          |
| <a href="#">E12</a> | - | -               | -               | -     | -        | Production              |
| <a href="#">E65</a> | - | -               | -               | -     | -        | Creation                |
| <a href="#">E83</a> | - | -               | -               | -     | -        | - Type Creation         |
| <a href="#">E66</a> | - | -               | -               | -     | -        | Formation               |
| <a href="#">E64</a> | - | -               | -               | -     | -        | End of Existence        |
| <a href="#">E6</a>  | - | -               | -               | -     | -        | Destruction             |
| <a href="#">E68</a> | - | -               | -               | -     | -        | Dissolution             |
| <a href="#">E69</a> | - | -               | -               | -     | -        | Death                   |
| <a href="#">E81</a> | - | -               | -               | -     | -        | Transformation          |



# Hierarchy of Class - Persistent Item -

|   |       |
|---|-------|
| - | Thing |
| - | -     |
| - | -     |
| - | -     |
| - | -     |



|                     |   |   |   |                           |
|---------------------|---|---|---|---------------------------|
| <a href="#">E72</a> | - | - | - | Legal Object              |
| <a href="#">E18</a> | - | - | - | Physical Thing            |
| <a href="#">E19</a> | - | - | - | Physical Object           |
| <a href="#">E20</a> | - | - | - | - Biological Object       |
| <a href="#">E21</a> | - | - | - | - - Person                |
| <a href="#">E22</a> | - | - | - | - Human-Made Object       |
| <a href="#">E24</a> | - | - | - | Physical Human-Made Thing |
| <a href="#">E22</a> | - | - | - | - Human-Made Object       |
| <a href="#">E25</a> | - | - | - | - Human-Made Feature      |
| <a href="#">E78</a> | - | - | - | - Curated Holding         |
| <a href="#">E26</a> | - | - | - | Physical Feature          |
| <a href="#">E27</a> | - | - | - | - Site                    |
| <a href="#">E25</a> | - | - | - | - Human-Made Feature      |
| <a href="#">E90</a> | - | - | - | Symbolic Object           |
| <a href="#">E73</a> | - | - | - | Information Object        |
| <a href="#">E29</a> | - | - | - | Design or Procedure       |
| <a href="#">E31</a> | - | - | - | Document                  |
| E32                 | - | - | - | Authority Document        |
| E33                 | - | - | - | Linguistic Object         |
| E34                 | - | - | - | Inscription               |
| E35                 | - | - | - | Title                     |
| E36                 | - | - | - | Visual Item               |
| E37                 | - | - | - | Mark                      |
| E34                 | - | - | - | Inscription               |
| E41                 | - | - | - | Appellation               |
| E42                 | - | - | - | Identifier                |
| E35                 | - | - | - | Title                     |
| E95                 | - | - | - | Spacetime Primitive       |
| E94                 | - | - | - | Space Primitive           |
| E61                 | - | - | - | Time Primitive            |

|                     |   |   |   |                           |
|---------------------|---|---|---|---------------------------|
| <a href="#">E71</a> | - | - | - | Human-Made Thing          |
| <a href="#">E24</a> | - | - | - | Physical Human-Made Thing |
| <a href="#">E22</a> | - | - | - | Human-Made Object         |
| <a href="#">E25</a> | - | - | - | Human-Made Feature        |
| <a href="#">E78</a> | - | - | - | Curated Holding           |
| E28                 | - | - | - | Conceptual Object         |
| E90                 | - | - | - | Symbolic Object           |
| E73                 | - | - | - | Information Object        |
| E29                 | - | - | - | Design or Procedure       |
| <a href="#">E31</a> | - | - | - | Document                  |
| E32                 | - | - | - | Authority Document        |
| E33                 | - | - | - | Linguistic Object         |
| E34                 | - | - | - | Inscription               |
| E35                 | - | - | - | Title                     |
| E36                 | - | - | - | Visual Item               |
| E37                 | - | - | - | Mark                      |
| E34                 | - | - | - | Inscription               |
| E41                 | - | - | - | Appellation               |
| E42                 | - | - | - | Identifier                |
| E35                 | - | - | - | Title                     |
| E95                 | - | - | - | Spacetime Primitive       |
| E94                 | - | - | - | Space Primitive           |
| E61                 | - | - | - | Time Primitive            |
| E89                 | - | - | - | Propositional Object      |
| E73                 | - | - | - | Information Object        |
| E29                 | - | - | - | Design or Procedure       |
| <a href="#">E31</a> | - | - | - | Document                  |
| E32                 | - | - | - | Authority Document        |
| E33                 | - | - | - | Linguistic Object         |
| E34                 | - | - | - | Inscription               |
| E35                 | - | - | - | Title                     |
| E36                 | - | - | - | Visual Item               |
| E37                 | - | - | - | Mark                      |
| E34                 | - | - | - | Inscription               |
| E30                 | - | - | - | Right                     |
| E55                 | - | - | - | Type                      |
| E56                 | - | - | - | Language                  |
| E57                 | - | - | - | Material                  |
| E58                 | - | - | - | Measurement Unit          |
| E98                 | - | - | - | Currency                  |
| E99                 | - | - | - | Product Type              |



# Hierarchy of Properties

| Property id  | Property Name   | Entity – Domain                    | Entity – Range                       |
|--------------|---|------------------------------------|--------------------------------------|
| <u>P1</u>    | is identified by (identifies)                               | <u>E1</u> CRM Entity               | <u>E41</u> Appellation               |
| <u>P48</u>   | - has preferred identifier (is preferred identifier of)     | <u>E1</u> CRM Entity               | <u>E42</u> Identifier                |
| <u>P102</u>  | - has title (is title of)                                   | <u>E71</u> Human-Made Thing        | <u>E35</u> Title                     |
| <u>P168i</u> | - place is defined by (defines place)                       | <u>E53</u> Place                   | <u>E94</u> Space primitive           |
| <u>P169i</u> | - spacetime volume is defined by (defines spacetime volume) | <u>E92</u> Spacetime Volume        | <u>E95</u> Spacetime Primitive       |
| <u>P170i</u> | - time is defined by (defines time)                         | <u>E52</u> Time Span               | <u>E61</u> Time Primitive            |
| <u>P2</u>    | has type (is type of)                                       | <u>E1</u> CRM Entity               | <u>E55</u> Type                      |
| <u>P137</u>  | - exemplifies (is exemplified by)                           | <u>E1</u> CRM Entity               | <u>E55</u> Type                      |
| <u>P177</u>  | - assigned property type                                    | <u>E13</u> Attribute               | <u>E55</u> Type                      |
| <u>P3</u>    | has note  | Assignment<br><u>E1</u> CRM Entity | <u>E62</u> String                    |
| <u>P79</u>   | - beginning is qualified by                                 | <u>E52</u> Time-Span               | <u>E62</u> String                    |
| <u>P80</u>   | - end is qualified by                                       | <u>E52</u> Time-Span               | <u>E62</u> String                    |
| <u>P190</u>  | - has symbolic content                                      | <u>E90</u> Symbolic Object         | <u>E62</u> String                    |
| <u>P4</u>    | has time-span (is time-span of)                             | <u>E2</u> Temporal Entity          | <u>E52</u> Time-Span                 |
| <u>P5</u>    | consists of (forms part of)                                 | <u>E3</u> Condition State          | <u>E3</u> Condition State            |
| <u>P7</u>    | took place at (witnessed)                                   | <u>E4</u> Period                   | <u>E53</u> Place                     |
| <u>P8</u>    | took place on or within (witnessed)                         | <u>E4</u> Period                   | <u>E18</u> Physical Thing            |
| <u>P12</u>   | occurred in the presence of (was present at)                | <u>E5</u> Event                    | <u>E77</u> Persistent Item           |
| <u>P111</u>  | - added (was added by)                                      | <u>E79</u> Part Addition           | <u>E18</u> Physical Thing            |
| <u>P113</u>  | - removed (was removed by)                                  | <u>E80</u> Part Removal            | <u>E18</u> Physical Thing            |
| <u>P11</u>   | - had participant (participated in)                         | <u>E5</u> Event                    | <u>E39</u> Actor                     |
| <u>P14</u>   | - - carried out by (performed)                              | <u>E7</u> Activity                 | <u>E39</u> Actor                     |
| <u>P22</u>   | - - - transferred title to (acquired title through)         | <u>E8</u> Acquisition              | <u>E39</u> Actor                     |
| <u>P23</u>   | - - - transferred title from (surrendered title through)    | <u>E8</u> Acquisition              | <u>E39</u> Actor                     |
| <u>P28</u>   | - - - custody surrendered by (surrendered custody through)  | <u>E10</u> Transfer of Custody     | <u>E39</u> Actor                     |
| <u>P29</u>   | - - - custody received by (received custody through)        | <u>E10</u> Transfer of Custody     | <u>E39</u> Actor                     |
| <u>P96</u>   | - - by mother (gave birth)                                  | <u>E67</u> Birth                   | <u>E21</u> Person                    |
| <u>P99</u>   | - - dissolved (was dissolved by)                            | <u>E68</u> Dissolution             | <u>E74</u> Group                     |
| <u>P143</u>  | - - joined (was joined by)                                  | <u>E85</u> Joining                 | <u>E39</u> Actor                     |
| <u>P144</u>  | - - joined with (gained member by)                          | <u>E85</u> Joining                 | <u>E74</u> Group                     |
| <u>P145</u>  | - - separated (left by)                                     | <u>E86</u> Leaving                 | <u>E39</u> Actor                     |
| <u>P146</u>  | - - separated from (lost member by)                         | <u>E86</u> Leaving                 | <u>E74</u> Group                     |
| <u>P151</u>  | - - was formed from (participated in)                       | <u>E66</u> Formation               | <u>E74</u> Group                     |
| <u>P16</u>   | - used specific object (was used for)                       | <u>E7</u> Activity                 | <u>E70</u> Thing                     |
| <u>P33</u>   | - - used specific technique (was used by)                   | <u>E7</u> Activity                 | <u>E29</u> Design or Procedure       |
| <u>P111</u>  | - - added (was added by)                                    | <u>E79</u> Part Addition           | <u>E18</u> Physical Thing            |
| <u>P142</u>  | - - used constituent (was used in)                          | <u>E15</u> Identifier              | <u>E90</u> Symbolic Object           |
| <u>P25</u>   | - moved (moved by)  | Assignment<br><u>E9</u> Move       | <u>E19</u> Physical Object           |
| <u>P31</u>   | - has modified (was modified by)                            | <u>E11</u> Modification            | <u>E18</u> Physical Thing            |
| <u>P108</u>  | - - has produced (was produced by)                          | <u>E12</u> Production              | <u>E24</u> Physical Human-Made Thing |
| <u>P110</u>  | - - augmented (was augmented by)                            | <u>E79</u> Part Addition           | <u>E24</u> Physical Human-Made Thing |
| <u>P112</u>  | - - diminished (was diminished by)                          | <u>E80</u> Part Removal            | <u>E24</u> Physical Human-Made Thing |
| <u>P92</u>   | - brought into existence (was brought into existence by)    | <u>E63</u> Beginning of Existence  | <u>E77</u> Persistent Item           |
| <u>P94</u>   | - - has created (was created by)                            | <u>E65</u> Creation                | <u>E28</u> Conceptual Object         |
| <u>P135</u>  | - - - created type (was created by)                         | <u>E83</u> Type Creation           | <u>E55</u> Type                      |
| <u>P95</u>   | - - has formed (was formed by)                              | <u>E66</u> Formation               | <u>E74</u> Group                     |
| <u>P98</u>   | - - brought into life (was born)                            | <u>E67</u> Birth                   | <u>E21</u> Person                    |
| <u>P108</u>  | - - has produced (was produced by)                          | <u>E12</u> Production              | <u>E24</u> Physical Human-Made Thing |

|      |   |                               |                         |       |  |                               |                          |
|------|---|-------------------------------|-------------------------|-------|--|-------------------------------|--------------------------|
| P123 | - - resulted in (resulted from)                                     | E81 Transformation            | E77 Persistent Item     | P104  | is subject to (applies to)   | E72 Legal Object              | E30 Right                |
| P93  | - took out of existence (was taken out of existence by)             | E64 End of Existence          | E77 Persistent Item     | P105  | right held by (has right on)   | E72 Legal Object              | E39 Actor                |
| P13  | - - destroyed (was destroyed by)                                    | E6 Destruction                | E18 Physical Thing      | P52   | - <i>has current owner (is current owner of)</i>                       | E18 Physical Thing            | E39 Actor                |
| P99  | - - <i>dissolved (was dissolved by)</i>                             | E68 Dissolution               | E74 Group               | P106  | is composed of (forms part of)   | E90 Symbolic Object           | E90 Symbolic Object      |
| P100 | - - was death of (died in)  | E69 Death                     | E21 Person              | P165  | - incorporates (is incorporated in)                                    | E73 Information Object        | E90 Symbolic Object      |
| P124 | - - transformed (was transformed by)                                | E81 Transformation            | E77 Persistent Item     | P107  | has current or former member (is current or former member of)          | E74 Group                     | E39 Actor                |
| P15  | was influenced by (influenced)                                      | E7 Activity                   | E1 CRM Entity           | P121  | overlaps with  | E53 Place                     | E53 Place                |
| P16  | - <i>used specific object (was used for)</i>                        | E7 Activity                   | E70 Thing               | P122  | borders with   | E53 Place                     | E53 Place                |
| P33  | - - used specific technique (was used by)                           | E11 Modification              | E29 Design or Procedure | P125  | used object of type (was type of object used in)                       | E7 Activity                   | E55 Type                 |
| P111 | - - added (was added by)  | E79 Part Addition             | E18 Physical Thing      | P32   | - used general technique (was technique of)                            | E7 Activity                   | E55 Type                 |
| P142 | - - used constituent (was used in)                                  | E15 Identifier                | E90 Symbolic Object     | P126  | employed (was employed in)   | E11 Modification              | E57 Material             |
| P17  | - was motivated by (motivated)                                      | Assignment                    |                         | P127  | has broader term (has narrower term)                                   | E55 Type                      | E55 Type                 |
| P134 | - continued (was continued by)                                      | E7 Activity                   | E1 CRM Entity           | P130  | shows features of (features are also found on)                         | E70 Thing                     | E70 Thing                |
| P136 | - was based on (supported type creation)                            | E7 Activity                   | E7 Activity             | P73i  | - is translation of  | E33 Linguistic Object         | E33 Linguistic Object    |
| P19  | was intended use of (was made for)                                  | E83 Type Creation             | E1 CRM Entity           | P128  | - carries (is carried by)  | E18 Physical Thing            | E90 Symbolic Object      |
| P20  | had specific purpose (was purpose of)                               | E7 Activity                   | E71 Human-Made Thing    | P65   | - - shows visual item (is shown by)                                    | E24 Physical Human-Made Thing | E36 Visual Item          |
| P21  | had general purpose (was purpose of)                                | E7 Activity                   | E5 Event                | P132  | spatiotemporally overlaps with   | E92 Spacetime Volume          | E92 Spacetime Volume     |
| P24  | transferred title of (changed ownership through)                    | E55 Type                      |                         | P10   | - falls within (contains)  | E92 Spacetime Volume          | E92 Spacetime Volume     |
| P26  | moved to (was destination of)                                       | E8 Acquisition                | E18 Physical Thing      | P9i   | - - forms part of  | E4 Period                     | E4 Period                |
| P27  | moved from (was origin of)  | E9 Move                       | E53 Place               | P166  | - - was a presence of (had presence)                                   | E93 Presence                  | E92 Spacetime Volume     |
| P30  | transferred custody of (custody transferred through)                | E10 Transfer of Custody       | E18 Physical Thing      | P46   | is composed of (forms part of)   | E18 Physical Thing            | E18 Physical Thing       |
| P43  | has dimension (is dimension of)                                     | E70 Thing                     | E54 Dimension           | P56   | - bears feature (is found on)  | E19 Physical Object           | E26 Physical Feature     |
| P44  | has condition (is condition of)                                     | E18 Physical Thing            | E3 Condition State      | P133  | is separated from  | E92 Spacetime Volume          | E92 Spacetime Volume     |
| P45  | consists of (is incorporated in)                                    | E18 Physical Thing            | E57 Material            | P139  | has alternative form   | E41 Appellation               | E41 Appellation          |
| P49  | has former or current keeper (is former or current keeper of)       | E18 Physical Thing            | E39 Actor               | P140  | assigned attribute to (was attributed by)                              | E13 Attribute                 | E1 CRM Entity            |
| P50  | - has current keeper (is current keeper of)                         | E18 Physical Thing            | E39 Actor               | P34   | - concerned (was assessed by)  | Assignment                    |                          |
| P109 | - has current or former curator (is current or former curator of)   | E78 Curated Holding           | E39 Actor               | P39   | - measured (was measured by)   | E14 Condition Assessment      | E18 Physical Thing       |
| P51  | has former or current owner (is former or current owner of)         | E18 Physical Thing            | E39 Actor               | P41   | - classified (was classified by)                                       | E16 Measurement               | E1 CRM Entity            |
| P52  | - has current owner (is current owner of)                           | E18 Physical Thing            | E39 Actor               | P141  | assigned (was assigned by)   | E17 Type Assignment           | E1 CRM Entity            |
| P53  | has former or current location (is former or current location of)   | E18 Physical Thing            | E53 Place               | P35   | - has identified (identified by)                                       | E13 Attribute Assignment      | E1 CRM Entity            |
| P55  | - has current location (currently holds)                            | E19 Physical Object           | E53 Place               | P37   | - assigned (was assigned by)   | E14 Condition Assessment      | E3 Condition State       |
| P156 | - occupies (is occupied by)   | E18 Physical Thing            | E53 Place               | P38   | - deassigned (was deassigned by)                                       | E15 Identifier Assignment     | E42 Identifier           |
| P54  | has current permanent location (is current permanent location of)   | E19 Physical Object           | E53 Place               | P40   | - observed dimension (was observed in)                                 | E15 Identifier Assignment     | E42 Identifier           |
| P57  | has number of parts   | E19 Physical Object           | E60 Number              | P42   | - assigned (was assigned by)   | E16 Measurement               | E54 Dimension            |
| P59  | has section (is located on or within)                               | E18 Physical Thing            | E53 Place               | P147  | curated (was curated by)   | E17 Type Assignment           | E55 Type                 |
| P62  | depicts (is depicted by)  | E24 Physical Human-Made Thing | E1 CRM Entity           | P148  | has component (is component of)  | E87 Curation Activity         | E78 Curated Holding      |
| P67  | refers to (is referred to by)                                       | E89 Propositional Object      | E1 CRM Entity           | P150  | defines typical parts of (defines typical wholes for)                  | E89 Propositional Object      | E89 Propositional Object |
| P68  | - foresees use of (use foreseen by)                                 | E29 Design or Procedure       | E57 Material            | P152  | has parent (is parent of)  | E55 Type                      | E55 Type                 |
| P70  | - documents (is documented in)                                      | E31 Document                  | E1 CRM Entity           | P157  | is at rest relative to (provides reference space for)                  | E21 Person                    | E21 Person               |
| P71  | - lists (is listed in)  | E32 Authority Document        | E1 CRM Entity           | P59i  | - is located on or within  | E53 Place                     | E18 Physical Thing       |
| P129 | - is about (is subject of)  | E89 Propositional Object      | E1 CRM Entity           | P156i | - <i>is occupied by</i>  | E53 Place                     | E18 Physical Thing       |
| P138 | - represents (has representation)                                   | E36 Visual Item               | E1 CRM Entity           | P160  | has temporal projection  | E92 Spacetime Volume          | E52 Time-Span            |
| P69  | has association with (is associated with)                           | E29 Design or Procedure       | E29 Design or Procedure | P164  | - is temporally specified by (temporally specifies)                    | E93 Presence                  | E52 Time Span            |
| P72  | has language (is language of)                                       | E33 Linguistic Object         | E56 Language            | P161  | has spatial projection   | E92 Spacetime Volume          | E53 Place                |
| P74  | has current or former residence (is current or former residence of) | E39 Actor                     | E53 Place               | P167  | was within (includes)  | E93 Presence                  | E53 Place                |
| P75  | possesses (is possessed by)   | E39 Actor                     | E30 Right               | P171  | at some place within   | E53 Place                     | E94 Space Primitive      |
| P76  | has contact point (provides access to)                              | E39 Actor                     | E41 Appellation         | P172  | contains   | E53 Place                     | E94 Space Primitive      |
| P81  | ongoing throughout  | E52 Time-Span                 | E61 Time Primitive      | P173  | starts before or with the end of (ends after or with the start of)     | E2 Temporal Entity            | E2 Temporal Entity       |
| P82  | at some time within   | E52 Time-Span                 | E61 Time Primitive      | P174  | - starts before the end of (ends after the start of)                   | E2 Temporal Entity            | E2 Temporal Entity       |
| P86  | falls within (contains)   | E52 Time-Span                 | E52 Time-Span           | P184  | - - ends before or with the end of (ends with or after the end of)     | E2 Temporal Entity            | E2 Temporal Entity       |
| P89  | falls within (contains)   | E53 Place                     | E53 Place               | P185  | - - - ends before the end of (ends after the end of)                   | E2 Temporal Entity            | E2 Temporal Entity       |
| P90  | has value   | E54 Dimension                 | E60 Number              | P182  | - - - ends before or at the start of (starts after or with the end of) | E2 Temporal Entity            | E2 Temporal Entity       |
| P91  | has unit (is unit of)   | E54 Dimension                 | E58 Measurement Unit    |       |  |                               |                          |
| P180 | - has currency  | E97 Monetary Amount           | E98 Currency            |       |  |                               |                          |
| P97  | from father (was father for)  | E67 Birth                     | E21 Person              |       |  |                               |                          |
| P101 | had as general use (was use of)                                     | E70 Thing                     | E55 Type                |       |  |                               |                          |
| P103 | was intended for (was intention of)                                 | E71 Human-Made Thing          | E55 Type                |       |  |                               |                          |



# Hierarchy of Properties

|              |   |                           |                                |
|--------------|---|---------------------------|--------------------------------|
| <u>P175</u>  | - - starts before or with the start of (starts after or with the start of)      | <u>E2</u> Temporal Entity | <u>E2</u> Temporal Entity      |
| <u>P176</u>  | - - - starts before the start of (starts after the start of)                    | <u>E2</u> Temporal Entity | <u>E2</u> Temporal Entity      |
| <u>P134i</u> | - - - - <i>was continued by</i>   | <u>E7</u> Activity        | <u>E7</u> Activity             |
| <u>P182</u>  | - - - - <i>ends before or at the start of (starts after or with the end of)</i> | <u>E2</u> Temporal Entity | <u>E2</u> Temporal Entity      |
| <u>P183</u>  | - - - - ends before the start of (starts after the end of)                      | <u>E2</u> Temporal Entity | <u>E2</u> Temporal Entity      |
| <u>P179</u>  | had sales price (was sales price of)  | <u>E96</u> Purchase       | <u>E97</u> Monetary Amount     |
| <u>P186</u>  | produced thing of product type (is produced by)                                 | <u>E12</u> Production     | <u>E99</u> Product Type        |
| <u>P187</u>  | has production plan (is production plan for)                                    | <u>E99</u> Product Type   | <u>E29</u> Design or Procedure |
| <u>P188</u>  | requires production tool (is production tool for)                               | <u>E99</u> Product Type   | <u>E19</u> Physical Object     |
| <u>P189</u>  | approximates  | <u>E53</u> Place          | <u>E53</u> Place               |
| <u>P191</u>  | had duration (was duration of)  | <u>E52</u> Time-Span      | <u>E54</u> Dimension           |
| <u>P195</u>  | was a presence of (had presence)  | <u>E93</u> Presence       | <u>E18</u> Physical Thing      |
| <u>P196</u>  | defines (is defined by)   | <u>E18</u> Physical Thing | <u>E92</u> Spacetime Volume    |
| <u>P197</u>  | covered parts of (was partially covered by)                                     | <u>E93</u> Presence       | <u>E53</u> Place               |
| <u>P198</u>  | holds or supports (is held or supported by)                                     | <u>E18</u> Physical Thing | <u>E18</u> Physical Thing      |

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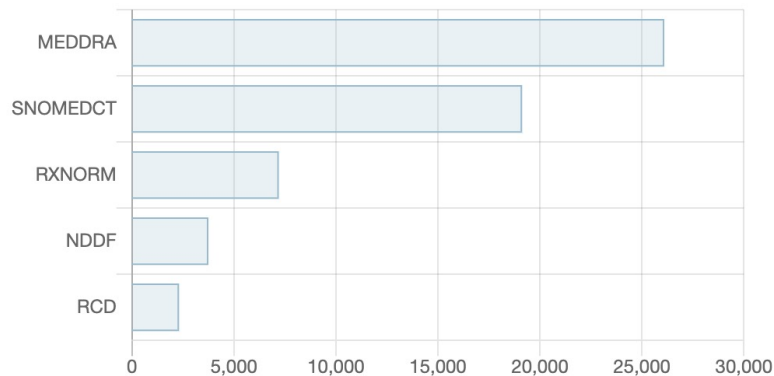
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| Ontologies | 877        |
| Classes    | 13,507,031 |
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# Gene Ontology

Last updated: May 3, 2021



- Summary**
- Classes
- Properties
- Notes
- Mappings
- Widgets

Jump to:

- biological\_process**
- behavior
- biological adhesion
- biological phase
- biological process involved in interspecies
- biological process involved in intraspecies
- biological regulation
- biomineralization
- carbohydrate utilization
- carbon utilization
- cellular process
- detoxification
- developmental process
- growth
- immune system process
- localization
- locomotion
- metabolic process
- multi-organism process
- multicellular organismal process
- nitrogen utilization
- ovulation cycle process
- phosphorus utilization
- pigmentation
- regulation of dense core granule exocytosis
- reproduction
- reproductive process
- response to stimulus
- rhythmic process
- signaling
- sulfur utilization
- viral process
- cellular\_component
- cellular anatomical entity

- Details**
- Visualization
- Notes ( 0 )
- Class Mappings ( )
- 

|                          |  |
|--------------------------|--|
| Preferred Name           | biological_process   |
| Synonyms                 | biological process<br>single-organism process<br>single organism process<br>physiological process  |
| Definitions              | A biological process represents a specific objective that the organism is genetically programmed to achieve. Biological processes are often described by their outcome or ending state, e.g., the biological process of cell division results in the creation of two daughter cells (a divided cell) from a single parent cell. A biological process is accomplished by a particular set of molecular functions carried out by specific gene products (or macromolecular complexes), often in a highly regulated manner and in a particular temporal sequence. Note that, in addition to forming the root of the biological process ontology, this term is recommended for use for the annotation of gene products whose biological process is unknown. When this term is used for annotation, it indicates that no information was available about the biological process of the gene product annotated as of the date the annotation was made; the evidence code 'no data' (ND), is used to indicate this. |
| ID                       | <a href="http://purl.obolibrary.org/obo/GO_0008150">http://purl.obolibrary.org/obo/GO_0008150</a>  |
| comment                  | Note that, in addition to forming the root of the biological process ontology, this term is recommended for use for the annotation of gene products whose biological process is unknown. When this term is used for annotation, it indicates that no information was available about the biological process of the gene product annotated as of the date the annotation was made; the evidence code 'no data' (ND), is used to indicate this.  |
| created_by               | jl   |
| creation_date            | 2012-09-19T15:05:24Z   |
| database_cross_reference | Wikipedia:Biological_process   |
|                          | A biological process represents a specific objective that the organism is genetically programmed to  |