



# Towards an Annotation Data Model for a Scholarly Semantic Annotation Platform in Visual Heritage: A Case Study Using the Murten Panorama

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**EPFL**

Experimental  
Museology  
+

4th International Workshop on Semantic Web and Ontology Design for Cultural Heritage  
Maison des Sciences de l'Homme, Tours, France

30 October 2024

# Structure of the Presentation

1. **Project background and motivation**
2. **Methodology**
3. **Result**
4. **Future work**



# DIAGRAM: Digitising and Augmenting the Panorama of the Battle of Murten

## Details of the digital twin:

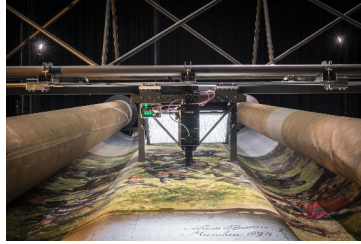
Done during:  
August-September 2023

Physical size of the panorama:  
~10m × 100m

Resolution of the digital twin:  
3,805,340 × 425,000 @ 1,000dpi or  
1.6 Terapixels

File size of the digital twin:  
4.8 TB @ RGB8  
9.6 TB @ RGB16

Stitched from:  
27,000 shots



Digitization



Recognition: Nomination to UNESCO  
Memory of the World Programme



Augmentation: reinvention, education,  
access

# Historical Sources Linked to the Murten Panorama

Visual Place



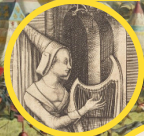
Event Visual



Event Visual



Visual



Event Visual



Concept



Visual



Textual

ganz entgegengesetzt und im Grunde sich eben für bewährte in gar uns so gli-  
chen (nach S. 13 ff.)  
Was Recht, den 29. Juni 1476.  
Der englische Kaiser  
HENRICH VI. KÖNIG VON  
FRANKREICH.  
(Nr. 476.) **Versicherung an den Herzog von Savoyen.** (Cop. nach 1522.)  
Zweckmäßigkeit und notwendigste Sache!  
[Die haben Ihre Versicherung erhalten, daß bei dem von Savoyen, der Reichthum bei  
Ihrer Kammerlei von Savoyen, bei der Heiratzeit geordnet wurde, nämlich es  
25,000 Schweizer Söldner, die es wohl begreifen lassen, Savoyen hat sie  
aufkommen bei dem Herzog von Savoyen.] Ich, Herzog, habe bei Savoyen, \*) bei  
Savoyen von Savoyen, das 2. 1476 und von der Zeit Savoyen von Savoyen.  
Ich habe mich von Savoyen gemacht, weil ich Savoyen bei Savoyen  
der Savoyen und, wie ich Savoyen, Savoyen Savoyen Savoyen. \*)  
Savoyen (Savoyen), den 29. Juni 1476.

Actor



Object

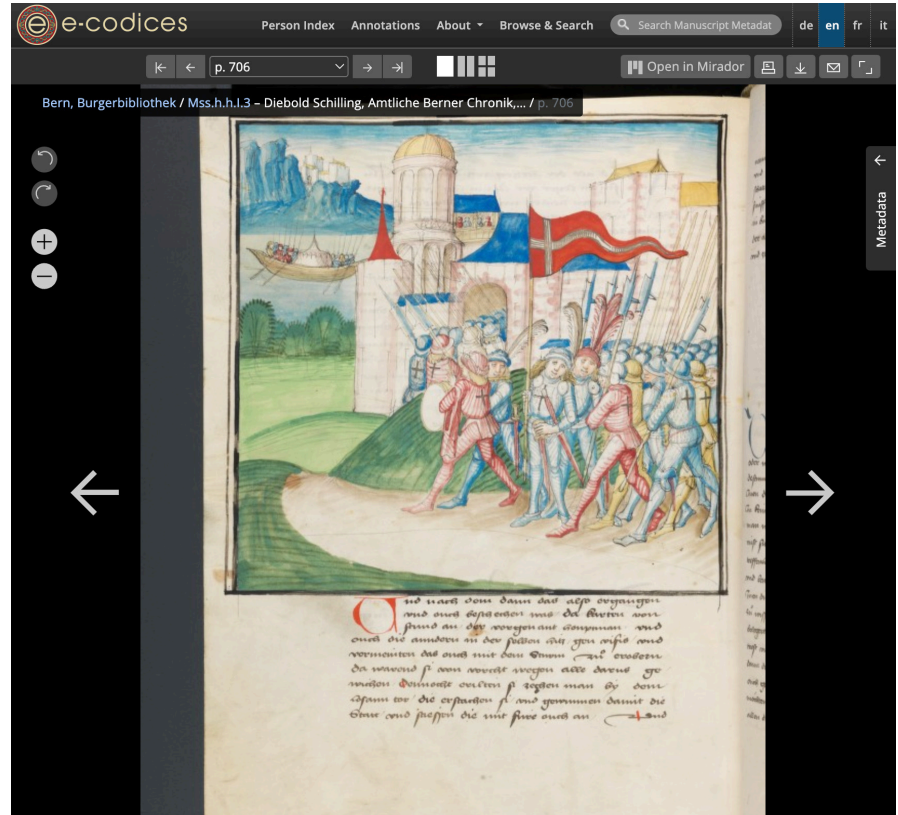


Object



# Concept of the Scholarly Semantic Annotation Platform

- Collate digitized historical source into the platform
- Make connection down to local feature level (a.k.a. points of interest)
- Document scholarly process with formal ontology
- "Linked Annotation"



frame-bbc64696-9bad-4858-a306-f270d0dfb10a

Change Layout Full Screen

ilif murten




Image annotations

- frame-bbc64696-... 00 I
- frame-bbc64696-... 00 I

frame-d94578b7-fa72-449f-b06a-15e072b5fd5a

Change Layout Full Screen


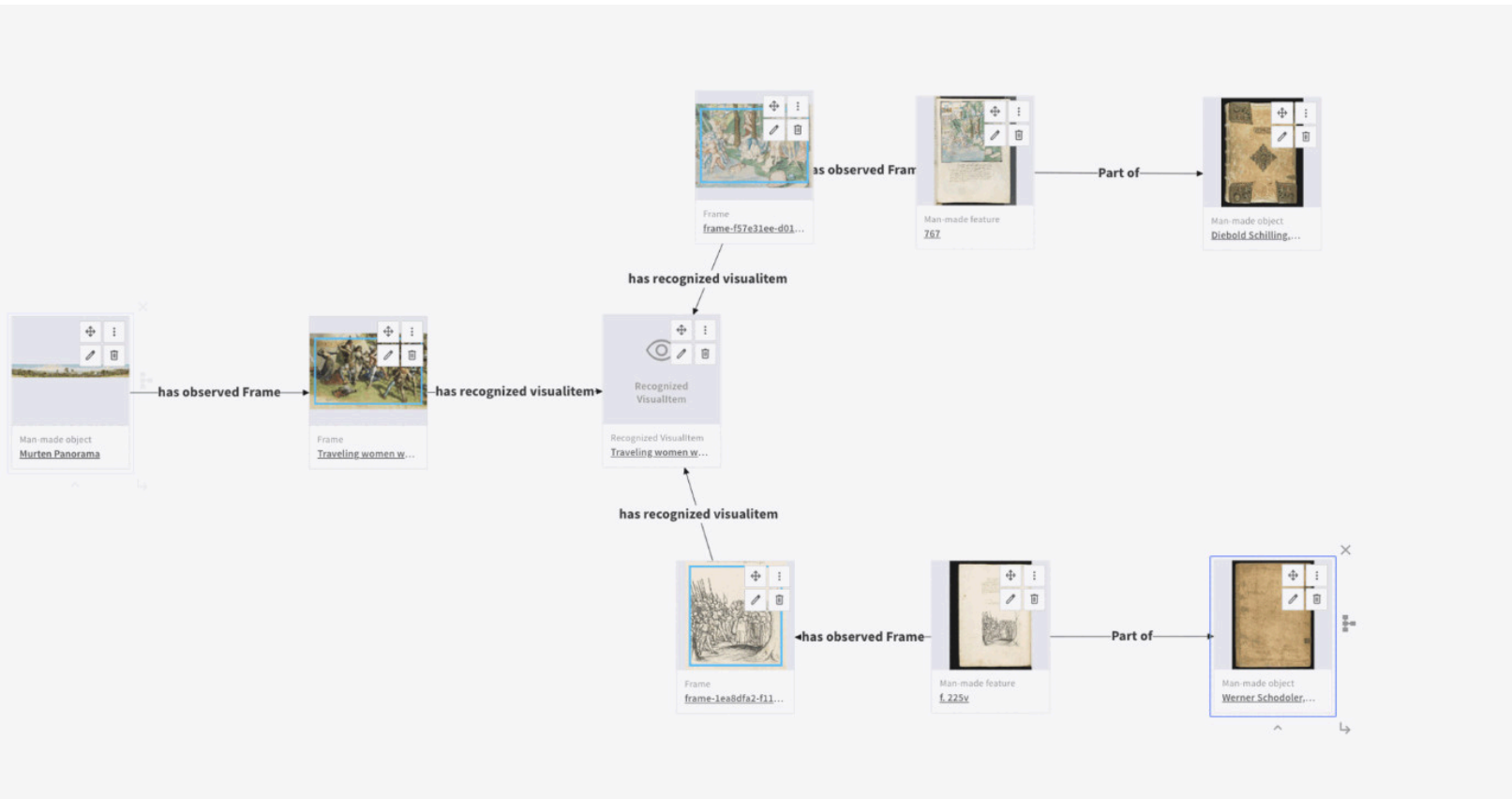


Image annotations

- frame-d94578b7-... 00 I
- frame-d94578b7-... 00 I
- frame-d94578b7-... 00 I



# Development of the Annotation Data Model: Goal and Challenges

**Goal: To develop a CIDOC-CRM based scholarly annotation data model for visual material**

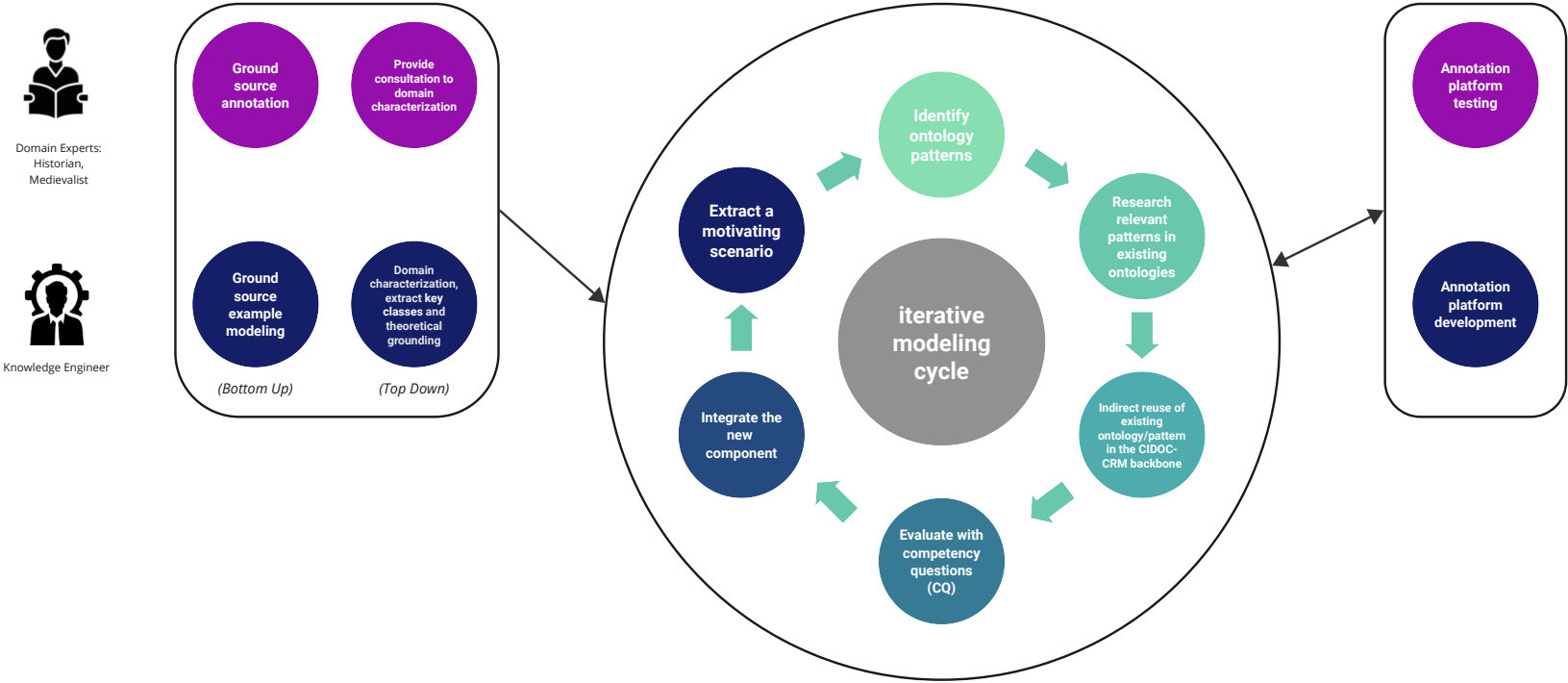
## **Challenges:**

- **Domain "bias" of the expert**
- **Modeling scholarly annotation is tricky**





# Development of the Annotation Data Model: Methodology



Adapted SAMOD Methodology

# Development of the Annotation Data Model: Groundsource Study

Motivating scenario	Description	Example
Image-Image Comparative Annotation Image-Text Historical Event Annotation	Describes visual connections between related historical images or image segments. Contextualizes and compares the annotation subject with a real historical event based on historical documents.	See 4.4.1. An example of this pattern is the death of John of Luxembourg (1437-1476) described by Panigarola's letter. The case was discussed in a previous presentation [23].
Image-Object Comparative Annotation	Describes visual relationships between related images or image segments and a museum collection item.	A pavise depicted in the panorama, with its equivalent item (KZ-386) found at the Swiss National Museum.
Image-Image Similarity Assessment	Evaluates the type and degree of similarity between related images or image segments.	Evaluate the similarity of the coat of arms representation in the panorama versus the historical sources.
Image-Real-World Entity and Concept Linking	Most common annotation task that identify and classify images or image segments to the represented person, concept, or place.	Identify Charles the Bold (1433-1477) by attributes, such as the collar of Order of the Golden Fleece.

Description	Upon receiving an image that appears visually connected to the annotation subject, the first step is to perform source criticism. This involves evaluating the image's temporal extent, creator, provenance, and other relevant details. Afterward, describe the visual relationship between the image and the annotation subject. Even if direct evidence of an influence cannot be found, we assume these images are linked through a visual transmission process, similar to what is seen in manuscript transmission, where prototypes or representations are transmitted through both tangible and intangible pathways. Our goal is to capture and describe the deep visual relationships between images in our system, enabling future analysis of how the prototype evolves over time.
Competency questions (CQ)	What are the changes over time for a particular representation?

Motivating scenario and an example

# Development of the Annotation Data Model: Image-image Annotation

## Description

Upon receiving an image that appears visually connected to the annotation subject, the first step is to perform source criticism. This involves evaluating the image's temporal extent, creator, provenance, and other relevant details. Afterward, describe the visual relationship between the image and the annotation subject. Even if direct evidence of an influence cannot be found, we assume these images are linked through a visual transmission process, similar to what is seen in manuscript transmission, where prototypes or representations are transmitted through both tangible and intangible pathways. Our goal is to capture and describe the deep visual relationships between images in our system, enabling future analysis of how the prototype evolves over time.

## Competency questions (CQ)

What are the changes over time for a particular representation?



Werner Schodoler Chronicle (16th c., ZF 18, Aargauer Kantonsbibliothek)

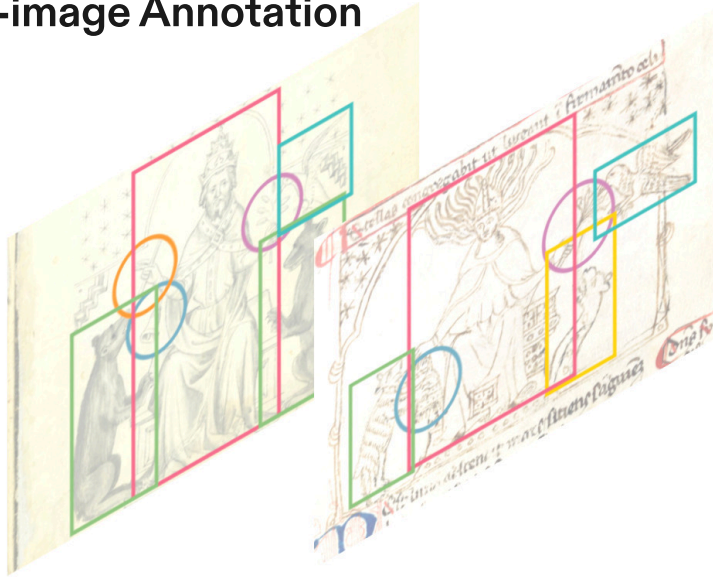


Murten Panorama (19th c.)



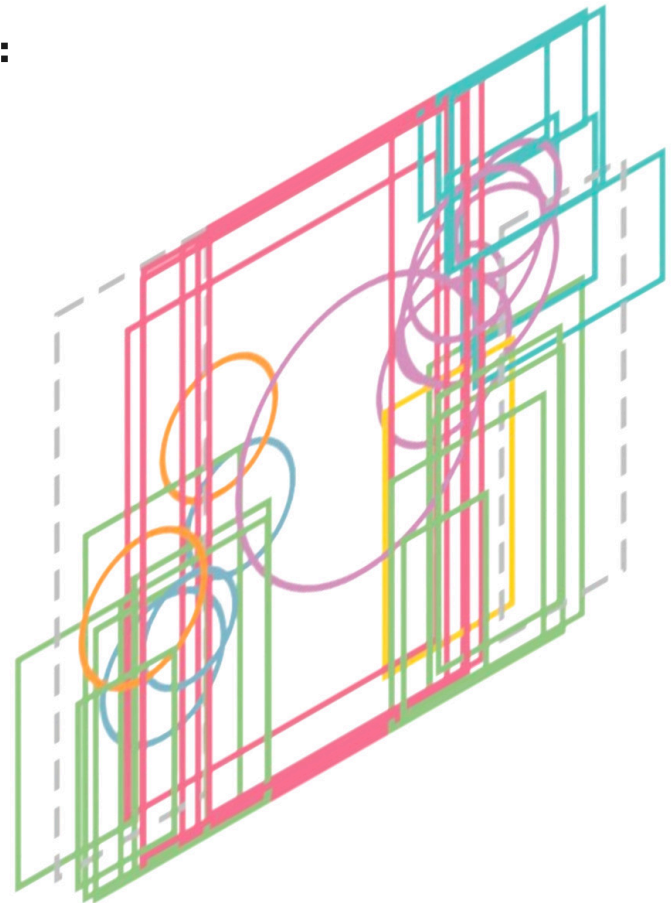
Berner Schilling Chronicle (15th c., Mss.h.h.I.3, Burgerbibliothek Bern)

# Development of the Annotation Data Model: Image-image Annotation

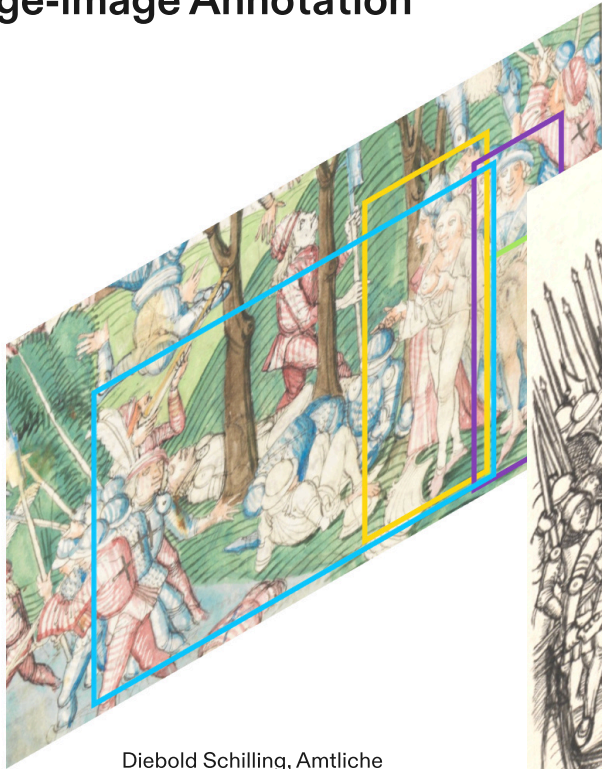


Vaticinium I from the Ascende calve prophecies with highlighted (corresponding and diverging) elements; from VadSig Ms. 342, Kantonsbibliothek, Vadianische Sammlung, St. Gallen, f. 1, <<http://www.e-codices.ch/de/vad/0342/1/>>

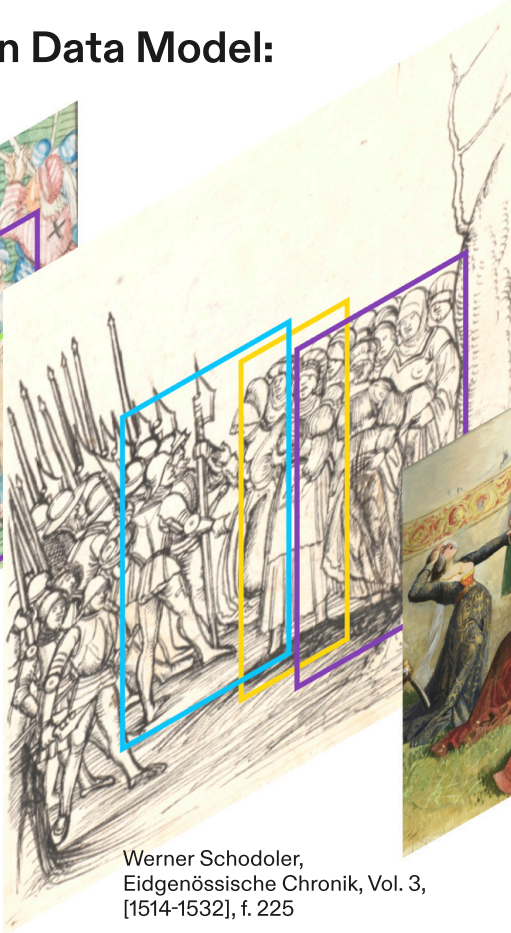
Ms. 68, Bibliothèque municipale, Châlons-en-Champagne, f. 61v, <<https://portail.bibliissima.fr/ark:/43093/ffdta75fb810cd375c252b0869f32d1f3be0794c60446>> (CC BY-NC 3.0).



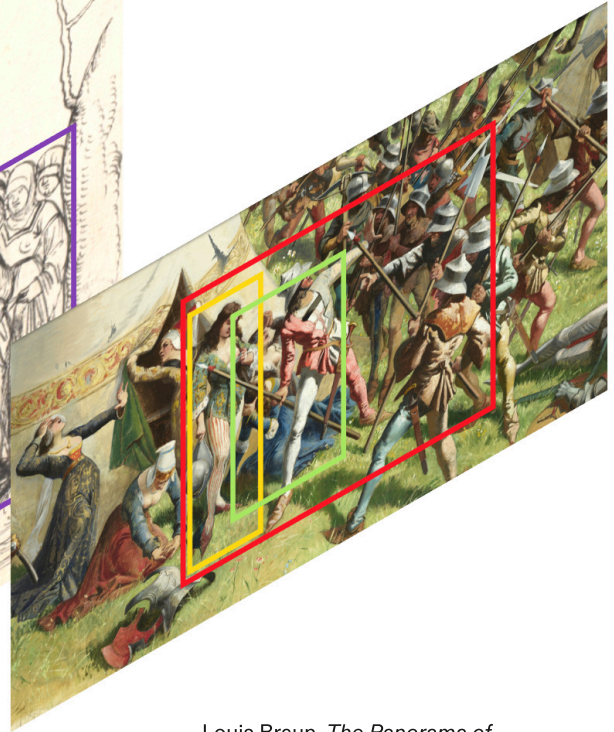
# Development of the Annotation Data Model: Image-image Annotation



Diebold Schilling, *Amtliche Berner Chronik*, vol. 3, 1478-83, p. 763



Werner Schodoler, *Eidgenössische Chronik*, Vol. 3, [1514-1532], f. 225

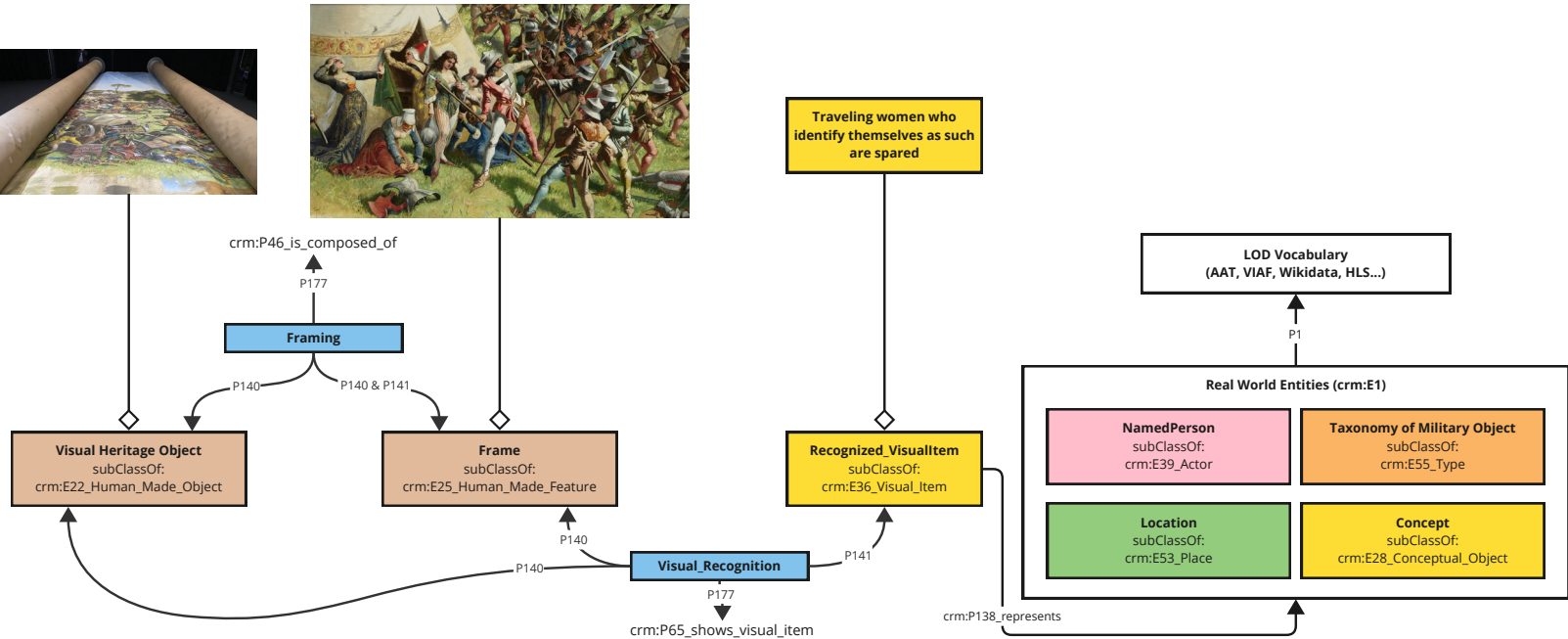


Louis Braun, *The Panorama of the Battle of Murten*, 1893

# Development of the Annotation Data Model: Result from the first iteration: visual recognition module



# Development of the Annotation Data Model: Result from the first iteration: visual recognition module



Conceptual reuse: VIR (Carboni, N., & de Luca, L. (2019). *An Ontological Approach to the Description of Visual and Iconographical Representations*. *Heritage*, 2(2), Article 2. <https://doi.org/10.3390/heritage2020078>)

# Development of the Annotation Data Model: Result from the first iteration: visual recognition module

Root E25

Frame of Root E25

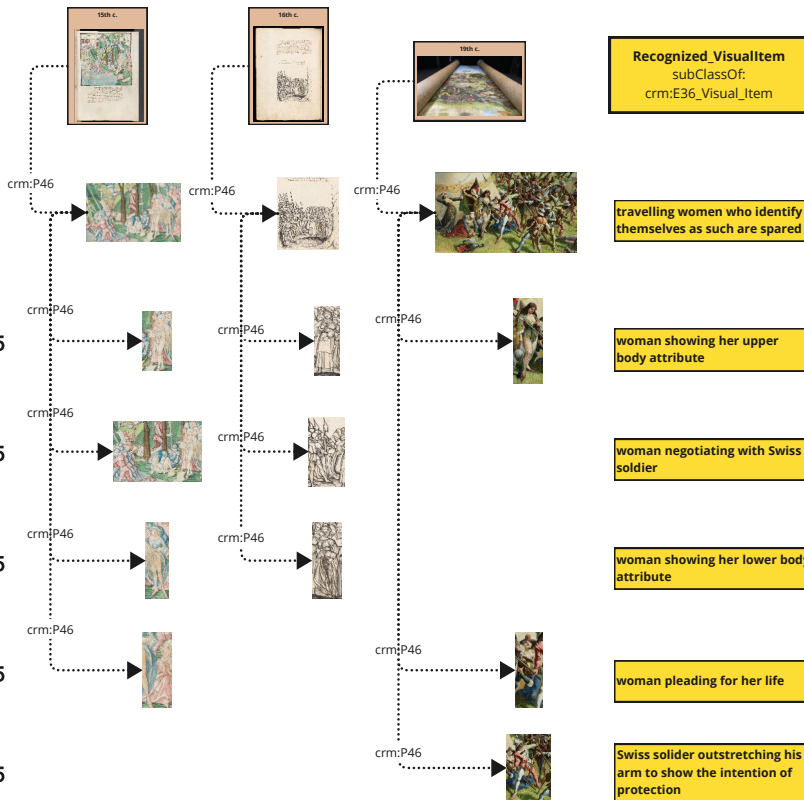
Frame of Frame of Root E25

Frame of Frame of Root E25

Frame of Frame of Root E25

Frame of Frame of Root E25

Frame of Frame of Root E25





# Competency Questions (CQ) example:

## What are the changes over time for a recognized visual item (novel attributes)?

```
1 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
2 PREFIX owl: <http://www.w3.org/2002/07/owl#>
3 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
4 PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
5 PREFIX crm: <http://www.cidoc-crm.org/cidoc-crm/>
6 PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
7
8 SELECT DISTINCT (?q2_sub_rvi AS ?recognized_visual_item) (MIN(?q1_ling_appl_content) AS ?unique_content)
9 (COUNT(?q1_frame_or_object) AS ?count) #count the occurrence of query attributes in all frames or objects that showed the query recognized visualitem, 1 : attribute unique to the query frame, > 1 : common attribute
10 WHERE {
11   BIND (<http://www.researchspace.org/resource/recognized_visual_item/adc8e1a7-aea3-4542-ad36-36bc80449320> AS ?q1_rvi) #query recognized visualitem i.e. "Traveling women who identify themselves as such are spared."
12   ?q1_vr crm:P141_assigned ?q1_rvi .
13   ?q1_vr crm:P140_assigned_attribute_to ?q1_frame .
14   ?q1_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
15
16   ?q1_framing crm:P141_assigned ?q1_frame .
17   ?q1_framing crm:P140_assigned_attribute_to ?q1_frame_or_object .
18   ?q1_framing a <http://murtenannotation.local/ver1/Framing> .
19
20   ?q1_sub_framing crm:P141_assigned ?q1_sub_feature .
21   ?q1_sub_framing crm:P140_assigned_attribute_to ?q1_frame .
22   ?q1_sub_framing a <http://murtenannotation.local/ver1/Framing> .
23
24   ?q1_sub_vr crm:P141_assigned ?q2_sub_rvi .
25   ?q1_sub_vr crm:P140_assigned_attribute_to ?q1_sub_feature .
26   ?q1_sub_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
27
28   ?q1_appl_assg crm:P140_assigned_attribute_to ?q2_sub_rvi .
29   ?q1_appl_assg crm:P141_assigned ?q1_ling_appl .
30   ?q1_ling_appl crm:P72_has_language/skos:prefLabel "eng" .
31   ?q1_ling_appl crm:P190_has_symbolic_content ?q1_ling_appl_content .
32   ?q1_appl_assg a <http://murtenannotation.local/ver1/Appellation_Assignment> .
33 }
34 {
35   SELECT DISTINCT ?q2_sub_rvi
36   WHERE {
37     BIND (<http://www.researchspace.org/resource/recognized_visual_item/adc8e1a7-aea3-4542-ad36-36bc80449320> AS ?q2_rvi)
38     BIND (<http://www.researchspace.org/resource/man_made_object/79530dbc-f4fd-462e-b4bc-50f5b813010c/frame/c86bbc29-3995-4829-b248-91d805ae70b6> AS ?q2_frame) #select all the sub frame recognized visualitem (attributes) from the query frame => query
39     attributes #query recognized visualitem i.e. "Traveling women who identify themselves as such are spared." #query frame (Murten Panorama)
40     ?q2_sub_framing crm:P141_assigned ?q2_sub_frame .
41     ?q2_sub_framing crm:P140_assigned_attribute_to ?q2_frame .
42     ?q2_sub_framing a <http://murtenannotation.local/ver1/Framing> .
43
44     ?q2_sub_vr crm:P141_assigned ?q2_sub_rvi .
45     ?q2_sub_vr crm:P140_assigned_attribute_to ?q2_sub_frame .
46     ?q2_sub_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
47   }
48 }
49 GROUP BY ?q2_sub_rvi
50 HAVING (?count = 1)
```

Swiss soldier outstretching his arm to show the intention of protection



# Competency Questions (CQ) example:

## What are the changes over time for a recognized visual item (absent attributes)?

```
1 PREFIX : <http://murtenannotation.local/ver1/>
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX owl: <http://www.w3.org/2002/07/owl#>
4 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
5 PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
6 PREFIX crm: <http://www.cidoc-crm.org/cidoc-crm/>
7 PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
8
9 SELECT DISTINCT ?q2_sub_rvi (?q1_ling_appl_content AS ?removed_content)
10 WHERE {
11   BIND (<http://www.researchspace.org/resource/man_made_object/79530dbc-f4fd-462e-b4bc-50f5b813010c/frame/c06bbc29-3995-4829-b248-91d805ae70b6> AS ?murten_frame)
12   FILTER NOT EXISTS { #find all query attributes that are not recognized on the sub frames of the Murten Panorama
13     ?q1_sub_framing crm:P140_assigned_attribute_to ?murten_frame .
14     ?q1_sub_framing crm:P141_assigned ?q1_sub_frame .
15     ?q1_sub_framing a <http://murtenannotation.local/ver1/Framing> .
16
17     ?q1_sub_vr crm:P140_assigned_attribute_to ?q1_sub_frame .
18     ?q1_sub_vr crm:P141_assigned ?q2_sub_rvi .
19     ?q1_sub_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
20   }
21   ?q1_appl_assg crm:P140_assigned_attribute_to ?q2_sub_rvi .
22   ?q1_appl_assg crm:P141_assigned ?q1_ling_appl .
23   ?q1_ling_appl crm:P172_has_language/skos:prefLabel "eng" .
24   ?q1_ling_appl crm:P190_has_symbolic_content ?q1_ling_appl_content .
25   ?q1_appl_assg a <http://murtenannotation.local/ver1/Appellation_Assignment> .
26 }
27
28 SELECT DISTINCT ?q2_sub_rvi
29 WHERE {
30   BIND (<http://www.researchspace.org/resource/recognized_visual_item/ad38e1a7-aea3-4542-ad36-36bc80449320> AS ?q2_rvi)
31   BIND (<http://www.researchspace.org/resource/man_made_object/79530dbc-f4fd-462e-b4bc-50f5b813010c/frame/c06bbc29-3995-4829-b248-91d805ae70b6> AS ?murten_frame) #select all the sub frame recognized visualitem (attributes) from the query frames =>
32   query attributes #query recognized visualitem i.e. "Traveling women who identify themselves as such are spared."
33   ?q2_vr crm:P141_assigned ?q2_rvi .
34   ?q2_vr crm:P140_assigned_attribute_to ?q2_frame .
35   ?q2_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
36
37   ?q2_sub_framing crm:P140_assigned_attribute_to ?q2_frame .
38   ?q2_sub_framing crm:P141_assigned ?q2_sub_frame .
39   ?q2_sub_framing a <http://murtenannotation.local/ver1/Framing> .
40
41   ?q2_sub_vr crm:P140_assigned_attribute_to ?q2_sub_frame .
42   ?q2_sub_vr crm:P141_assigned ?q2_sub_rvi .
43   ?q2_sub_vr a <http://murtenannotation.local/ver1/Visual_Recognition> .
44   FILTER (?q2_frame != ?murten_frame) #exclude the frame from the Murten Panorama from query frames
45 }
46 }
```

woman negotiating with Swiss soldier

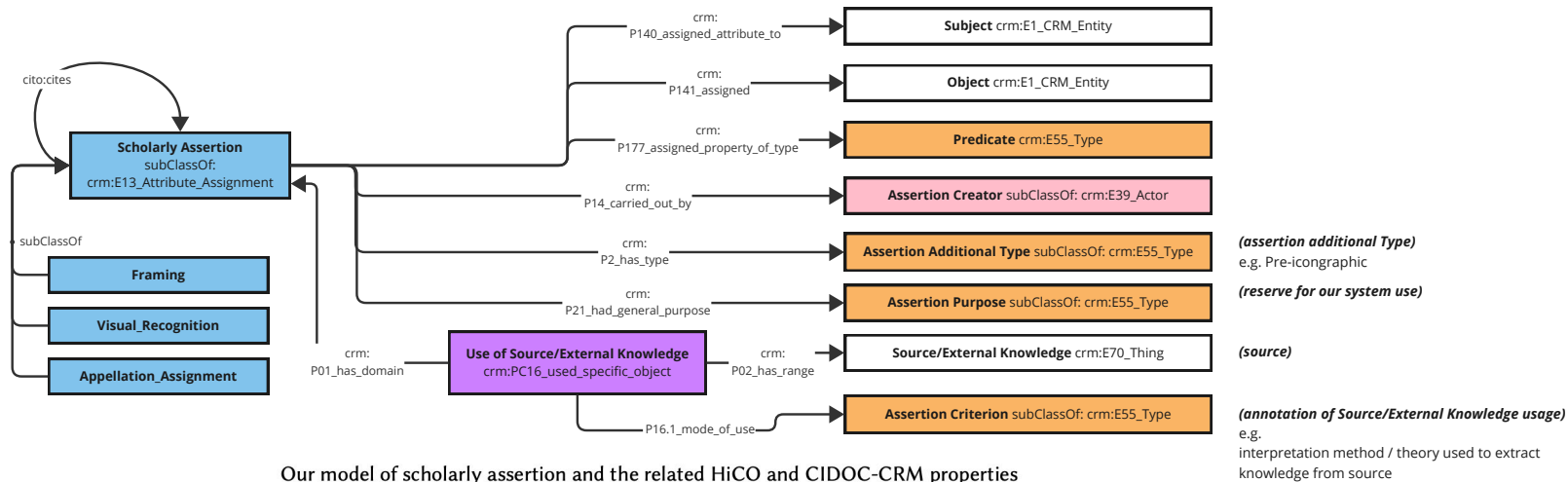


woman showing her lower body attribute



query attributes #query recognized visualitem i.e. "Traveling women who identify themselves as such are spared."

# Development of the Annotation Data Model: Result from the first iteration: scholarly assertion module



Our model of scholarly assertion and the related HiCO and CIDOC-CRM properties

Data element	HiCO properties	Our selection of CIDOC-CRM property (path)
Assertion Creator	prov:wasAssociatedWith	crm:P14_carried_out_by
Additional Type	hico:hasInterpretationType	crm:P2_has_type
Source/External Knowledge	cito:cites	crm:P01←crm:PC16_used_specific_object→crm:P02_has_range
Assertion Criterion	hico:hasInterpretationCriterion	crm:P01←crm:PC16_used_specific_object→crm:P16.1_mode_of_use
Relation to Other Assertion	sub-properties of cito:cites	sub-properties of cito:cites

Conceptual Reuse: *Daquino, M., & Tomasi, F. (2015). Historical Context Ontology (HiCO): A Conceptual Model for Describing Context Information of Cultural Heritage Objects. [https://doi.org/10.1007/978-3-319-24129-6\\_37](https://doi.org/10.1007/978-3-319-24129-6_37)*

# Limitation and discussion

- Possible abuse of E36 as a common aggregator node
- To be addressed in to next iteration

## E73 Information Object in version 7.1.1

**Subclass of :** [E89 Propositional Object](#), [E90 Symbolic Object](#)

**Superclass of:** [E29 Design or Procedure](#), [E31 Document](#), [E33 Linguistic Object](#), [E36 Visual Item](#)

**Scope Note:**

This class comprises identifiable immaterial items, such as poems, jokes, data sets, images, texts, multimedia objects, procedural prescriptions, computer program code, algorithm or mathematical formulae, that have an objectively recognizable structure and are documented as single units. The encoding structure known as a named graph also falls under this class, so that each named graph is an instance of E73 Information Object.

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

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

**Examples:**

- image BM00038850.JPG from the Clayton Herbarium in London (E31) (Natural History Museum, 2021)
- E. A. Poe's *The Raven* (Poe, 1869)
- the movie *The Seven Samurai* by Akira Kurosawa (Mellen, 2002)
- the text of Huray describing the Maxwell Equations (Huray, 2010)
- the Getty AAT as published as Linked Open Data, accessed 1/10/2014

## F2 Expression

SubClass Of:

[E73 Information Object](#)

SuperClass Of:

–

Scope Note:

This class comprises the intellectual or artistic realisations of Works in the form of identifiable immaterial objects, such as texts, poems, jokes, musical or choreographic notations, movement pattern, sound pattern, images, multimedia objects, or any combination of such forms. The substance of F2 Expression is signs.

An Expression is the outcome of the intellectual or creative process of realizing a Work. Subsequent expressions conveying the same work may be created over time.

Expressions do not depend on a specific physical carrier and can exist on one or more carriers simultaneously. As far as bibliographic practice is concerned, only instances of F2 Expression that are externalised on physical carriers other than both the creator's brain and an auditor's brain are taken into account.

The form of F2 Expression is an inherent characteristic of the F2 Expression. Differences in form imply different Expressions (e.g., from text to spoken word, a transcript of a recording). Similarly, differences in language or means of performance imply different Expressions (e.g., translations or arrangements for different instruments). Thus, if a text is revised or modified, the result is considered to be a new F2 Expression. While theoretically any change in signs will result in a new Expression, conventionally the context and use will determine the rules for distinguishing among expressions.

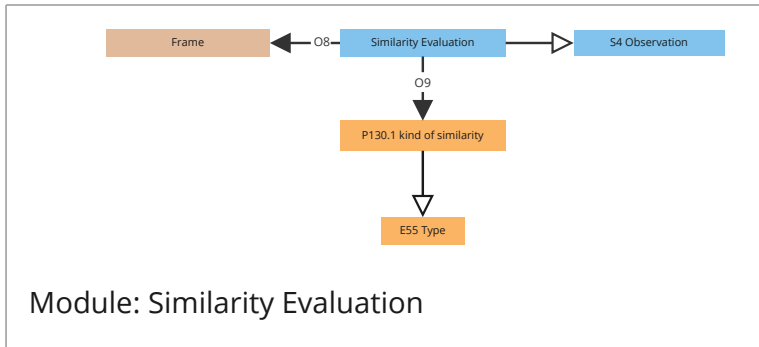
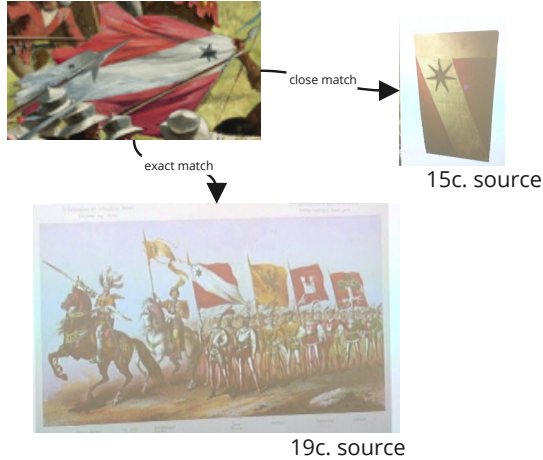
An instance of F2 Expression which includes spoken or written text may be multiply instantiated as an instance of E33 Linguistic Object. This allows for the association of the E56 Language of the text with the instance of F2 Expression by using the property P72 has language (is language of).

# Future work

- **Second iteration: a flexible multiple layer model multiple layer model**
- **not aiming to be exhaustive but representative**
- **modularized and incremental development**

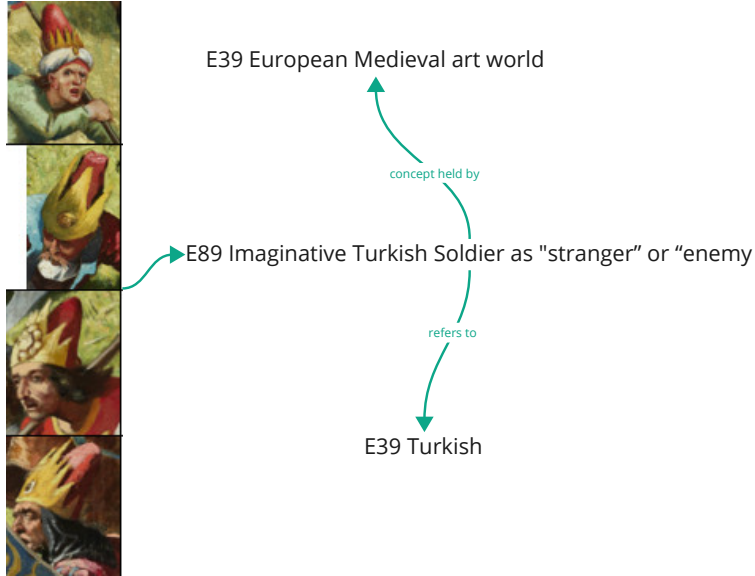
- Layer 0: World of Digitization
  - Key notion: digital representations
  - Key ontologies: CRMdig, CRM base
- Layer 1: World of Collation
  - Key notion: **Factual statement**
  - Key ontologies: CRMtex, CRM base, LRMoo
- Layer 2: World of Hermeneutics
  - Key notion: **hermeneutic decoding process**
  - Key ontologies: CRMSci, CRMtex
- Layer 3: World of Scholarly Provenance
  - Key notion: **Inheriting hermeneutic objects as scholarly assertion objects**
  - Key ontologies: HiCO
- Layer 4: World of Scholarly Argumentation
  - Key notion: **Inheriting scholarly assertion objects as argumentation objects.**
  - Key ontologies: CRMInf
- Layer 5: World of Critical Scholarly Reading
  - Key notion: **Inheriting real world entities as social representation objects** Key ontologies: CRMaaa, SDHSS
- Wrapper layer: World of Annotation
  - Key notion: **Wrapping scholarly object as annotation objects,**
  - Key ontologies: CRMdig, Web Annotation Ontology

# Future work



- Layer 0: World of Digitization
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# Future work



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  - Key ontologies: CRMtex, CRM base, LRMoo
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  - Key notion: **Inheriting hermeneutic objects as scholarly assertion objects**
  - Key ontologies: HiCO
- Layer 4: World of Scholarly Argumentation
  - Key notion: **Inheriting scholarly assertion objects as argumentation objects.**
  - Key ontologies: CRMInf
- Layer 5: World of Critical Scholarly Reading
  - Key notion: **Inheriting real world entities as social representation objects** Key ontologies: CRMaaa, SDHSS
- Wrapper layer: World of Annotation
  - Key notion: **Wrapping scholarly object as annotation objects,**
  - Key ontologies: CRMdig, Web Annotation Ontology

# Future work

- **Coming soon:**
  - **PURL with <https://w3id.org> and prefix!**
  - **Ontology and Documentation on Github repository**





- **Thanks you very much for your attention!**

- **Project websites:**

- <https://www.epfl.ch/labs/emplus/projects/diagram/>
- <https://www.epfl.ch/labs/emplus/projects/murten-panorama-digital-twin-scanning-project-the-making-of/>

