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# Accessing Cultural Heritage Collections Using Semantic Web Techniques

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# (Some) Needs for managing CH Digital Collections

- Representation of artefacts and knowledge about them
  - Pointing at collection objects
  - Describing them (creating metadata) according to specific structures and vocabularies
    - Metadata schemes
    - Controlled vocabularies, e.g. thesauri
- Accessing them using metadata and viewpoint information
  - Data commonly searched/presented via the MD schemes and the vocabularies
  - Sometimes 'advanced' features such as search using the information contained in thesauri

**Results 1-5 of 1000 for: ICONCLASS codes:**(49l171)

**1.**
**The Hague, KB, KA 20**

Philip II of Macedon enthroned

Fol. 38r: hist. in.

65x60

iconclass:
31A25551(+932)
44B1212
44B191
45C13(SWORD)
49L12(N)
49L171
98B(PHILIP)5

**2.**
**The Hague, KB, KA 20**

Julius Caesar enthroned, with soldiers

Fol. 49v: hist. in.

65x60

iconclass:
31A25551(+932)
44B1212
44B125
44B191
45B
45C13(SWORD)
49L12(N)
49L171
98B(CAESAR)5

**3.**
**The Hague, KB, KA 20**

The Emperor Anastasius I enthroned, with soldiers

Fol. 155r: hist. in.

65x55

iconclass:
31A25551(+932)
44B112
44B1212
44B125
44B191
45B
45C13(SWORD)
49L12(S)
49L171
61B2(ANASTASIUS I)21
61D(BYZANTINE EMPIRE)
61D(EASTERN ROMAN EMPIRE)

**4.**
**The Hague, KB, KA 20**

The Emperor Mauritius enthroned, with a soldier

Fol. 171r: hist. in.

70x55

iconclass:
31A25551(+932)
44B112
44B1212
44B125
44B191
45B
49L12(T)
49L171
61B2(MAURITIUS TIBERIUS)21
61D(BYZANTINE EMPIRE)
61D(EASTERN ROMAN EMPIRE)

**5.**
**The Hague, KB, KA 20**

The Emperor Heraclius I enthroned

Fol. 184v: hist. in.

60x55

iconclass:
31A25552
44B112
44B1212
44B191
49L12(E)
49L171
61B2(HERACLIUS I)21
61D(BYZANTINE EMPIRE)
61D(EASTERN ROMAN EMPIRE)

# Semantic Web Main Features

*Knowledge representation mechanisms to create machine-readable metadata, allowing systems and users to deal with the growing number of accessible documents on the web*

- Pointing at documents/knowledge objects (URIs)
- Enabling structured assertions
  *RDF*: factual knowledge in the form of subject-property-object triples
- Building those assertions on top of shared and structured views
  *Ontologies*: declarative specifications of concepts and roles/property (building blocks of assertions) in a given domain
- Controlling existing facts and producing new ones
  *RDFS/OWL* encoding of ontologies, used by inference engines
  Hierarchical knowledge, domains/ranges of relations, etc.
  *Using reasoning knowledge amounts to delegate part of the exploitation tasks from the user to the system*

# Fundamental Common Features

- Need to categorize/classify things
  - Both ontologies and thesauri bring concept hierarchies giving the intended meaning of a vocabulary through definition and use links between its items
- Need to structure representations
  - Resorting to MD schemes is similar to using relations

*The representations/description of CH artefacts can be encoded by SW facts*

- Turning to 'Ontological'commitments to allow for an intelligent (i.e. proper) way to exploit the information

*SW formal control and inference mechanisms can be considered as a realization of the information management vision that grounded the introduction of controlled descriptions*

# Sesame Query Example

**Evaluate a SeRQL-select query**

Your query: Clear

```
select Xid, Xtitle
from {X} rdf:type {ims:Record}, {X} rdf:type {ic:not_49_L_17_1}, {X} rdf:type {ic:not_34},
{X} ims:record-id {Xid}, {X} ims:title {Xtitle}
using namespace
        ims = <http://www.cs.vu.nl/STITCH/pp/im-schema#>,
        ic = <http://www.cs.vu.nl/STITCH/pp/ic#>
```

Response format: HTML Append namespaces Evaluate

RDF SESAME copyright © 2001-2005 Aduna BV

**Query results:**

| Xid | Xtitle |
|---|---|
| "11356" | "St. George on horseback fighting the dragon; the princess nearby with a dog (?); the king and queen watching the scene from the city-walls" |

1 results found in 10 ms.

1.
**The Hague, MMW, 10 F 1**

Suffrage

St. George on horseback fighting the dragon; the princess nearby with a dog (?); the king and queen watching the scene from the city-walls

Master of the Dresden Prayer Book, Willem Vrelant, follower (illuminator)

Fol. 210v: hist. in.

33x36

iconclass:
11H(GEORGE)41
25I146
34B11
44B113
44B1511
49L12(G)
49L171
49L72

# Differences

- CH documentary systems do not use explicit formal meaning
  - Controlled vocabularies are not ontologies
  - Qualitative gap regarding ‘meaningful exploitation’enabled
- SW techniques bring more freedom regarding structure expression
  - Semi-structured data vs. structured data
- Consequence: dealing with SW formal knowledge is more complex for machines and designers, but also for users
  - How can we transpose existing information sources (databases and vocabularies)
  - How may formal reasoning knowledge benefits exceed the price of turning to SW solutions?



# Main Research Problems

- Ontological representation of vocabularies and collection data
  - Vocabularies: relevant encoding ontologies (cf. W3C SKOS)
  - MD structures: ontologies providing proper collection-related properties/relations
- Reasoning to help exploitation
  - Transposition of hierarchical/associational knowledge encoded in CH resources
  - Design of application-related reasoning knowledge

- Projects
  - UvA/VU: annotation, transposition of thesauri and MD schemes
  - *MuseumFinland*: browsing/recommendation system, central repository for various collections

# CH Interoperability Problems

- Current CH trend: portals that build on heterogeneous collections
  - Different databases/vocabularies/MD schemes
- Syntactic interoperability problem being solved?
  - Access can be granted
- The semantic interoperability problem is still to be addressed

  *Collections usually come with a point of view/commitment which is lost during the aggregation of descriptions*
  - Structure: imposed common MD schemes for storage and/or search
  - Content: full-text storage and search, ignoring the semantics of initial vocabularies
- It requires solving difficult problems
  - Representation of different points of view in the same system
  - Creation of new alignment knowledge that would enable the system to work in a seamless way

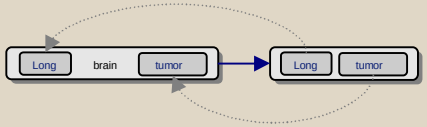
# SW and Interoperability

SW propose solutions to the CH world regarding semantic interoperability:

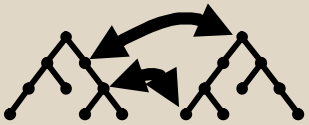
- « Meta-Language » standardization
  - For metadata (using RDF triples)
  - For metadata scheme/vocabulary (using ontologies in RDFS/OWL)
- Alignment of description languages/points of view
  - Some (often controversial) upper-level and reference ontologies
  - Growing interest for tools matching ontologies without enforcing standardization

# Automatic Ontology Matching Techniques

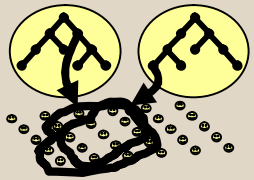
*Recognizing equivalence or subsumption links between ontology elements*



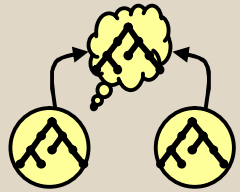

- Lexical
  Labels of entities and textual definitions



- Structural
  Structure of the formal definitions of entities, position in the hierarchy



- Statistical
  Objects, instantiation of the concepts



- Shared background knowledge
  Using a conceptual reference to deduce correspondences

Indeed, most of the mapping tools use a mix of such approaches
  E.g. lexical string matching can ignite a structural alignment process

# Applying Ontology Mapping for CH (1)

- Concepts come from thesauri, not from full-fledged formal ontologies
  - Only BT/RT, limits semantic/structure-based matching?
- Difficulty to obtain objects indexed against two points of view
  - Disqualifies instance-based matching?
- Several problems in a single one
  - Metadata scheme mapping
  - Content vocabulary mapping
  - Alignment between MD elements and vocabulary elements
- We need useful situated mappings, rather than 'strictly ontological' mappings
  - Focusing on associative RT links rather than definitional ones

# Applying Ontology Mapping for CH (2)

Different possible solutions, taking into account the different cases

- MD scheme mapping and thesaurus mapping can use structural techniques
  - BT/NT
  - MD organization
- MD scheme mapping can use background knowledge
  - Existing alignments between MD schemes
  - Dedicated SW-flavored initiatives (CIDOC-CRM)
- Thesaurus/content vocabulary mapping can use lexical techniques
  - Language information found in thesauri (synonymy/UF)

All reasonable combinations have to be tested

*How automatic can be the matching between two CH collections?*

## Conclusion

- Applying SW techniques to CH collections is feasible
  - Representation and exploitation
  - Special case of semantic integration
- A research agenda well filled!
- There is room for cross-domain collaboration
- STITCH/CATCH

# Links

- SW at W3C
  - http://www.w3.org/2001/sw/
- SW at VU
  - http://www.cs.vu.nl/ai/kr/
  - http://www.cs.vu.nl/bi/
- DE talk by Lynda Hardman
  - http://homepages.cwi.nl/~lynda/talks/
- Sesame RDF/S repository
  - http://www.openrdf.org
- Medieval Illuminated Manuscripts
  - http://www.kb.nl/kb/manuscripts/
- Other projects
  - SKOS, http://www.w3.org/2004/02/skos/
  - MuseumFinland, to follow!