Ontology mediation, merging and aligning

Ontologies are shared specifications and can be used for the annotation of multiple data sources (web pages, XML documents, relational databases).

However, it cannot be expected that all individuals and organizations will ever agree on using one common terminology or ontology.

Ontology mediation enables reuse of data across applications on Semantic Web, and sharing of data between heterogeneous knowledge bases.

Principle kinds of mediation:
- Mapping
- Merging

Ontology mapping:
Correspondences are used to, for example, transforming data between different representations. Correspondences between ontologies are stored separately – are not part of the ontologies themselves.

The (semi-)automated discovery of such correspondences is called **ontology alignment**.

(mapping: slides 11-15, alignment: 16-22)

Ontology merging:
A new ontology is created which is the union of the source ontologies – it captures all the knowledge from the original ones.

The challenge – all correspondences and differences are reflected in the merged ontology.

(Also slide 23)
ontology mediation
ontology mismatches

two types of mismatches:
- conceptualization mismatches
- explication mismatches

ontology mismatches: conceptualization

scope mismatch:
occurs when two classes have some overlap in their sets of instances, but the sets are not exactly the same

model coverage and granularity mismatches:
- differences in the part of the domain that is covered by both ontologies
- differences in the level of details

ontology mismatches: explication

style of modeling mismatch:
the paradigm used to specify a certain concept (for example time) is different
the way concepts are describe differs (subclasses vs. attributes)

terminological mismatch:
concepts are equivalent but represented using different names

ontology mismatches: explication

encoding mismatch:
ontologies are encoded in a different way (using km vs miles for a distance)

ontology mapping

a specification of the semantic overlap between two ontologies
the correspondences between different entities of the two ontologies are expressed using some axioms formulated in a specific mapping language

ontology mapping

three phases:
- mapping discovery
- mapping representation
- mapping exploitation/execution
ontology mediation
ontology mapping

MAFRA (Mapping FRAmework)
- lift and normalization (lifting the content of the ontologies to RDFS and normalization of their vocabularies)
- similarity (computation of similarities between ontology entities)
- semantic bridging (establishing correspondences between similar entities, in the form of so-called semantic bridges)
- execution (exploiting the bridges/mappings for individual transformation)
- post-processing (revisiting the mapping specification for improvements)

ontology mediation
ontology mapping

semantic bridge (five aspects):
- entity aspect (entities related by a bridge – may be concepts, relations, attributes)
- cardinality aspect (a number of ontology entities at both sides of the bridge – 1:n or m:1)
- structural aspect (a single bridge may be combined into a more complex bridge)
- transformation aspect (how individuals are transformed by associated transformation functions)
- constraint aspect (conditions upon whose fulfillment the bridge evaluation depends)

ontology mediation
ontology mapping

a common tendency is the existence of an ontology of mappings that contains the vocabulary for the representation of mappings

semantic bridges are captured in the Semantic Bridging Ontology (SBO)

ontology mediation
ontology mapping

it is a process of discovering similarities between two source ontologies

input: a number of ontologies
output: a specification of the correspondences between ontologies

ontology mediation
ontology alignment

algorithms that perform matching can be divided based on:
- a schema-based matching
- an individual-based (instant-based) matching
or
- an element-level matching
- a structure-level matching

ontology mediation
ontology alignment

a schema-based matching

takes different aspects of the concepts and relations in the ontologies and uses some similarity measure to determine correspondence
ontology mediation
ontology alignment

an individual-based matching
takes the individuals which belong to the concepts in different ontologies and compares them to discover similarity between the concepts

ontology mediation
ontology alignment

an element-level matching
compares properties of the particular concept or relation, such as a name, and uses those to find similarities

ontology mediation
ontology alignment

a structure-level matching
compares the structure of ontologies to find similarities

ontology mediation
ontology merging

is a process of creation of one ontology from two or more source ontologies – it will unify and in general replace the original ontologies

approaches:
- creating of a new, merged ontology (next slide)
- creating a “view” – so called a bridge ontology – it specifies correspondences between entities (slide 13)