Open Data Heterogeneity, Quality and Scale

Presentation of the Open Data Research Group

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Outline

1. The Big Picture
2. Ontology Matching
3. Data Linking
4. Dataset Recommendation
5. Warehousing and Datamining

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The Big Picture

What is Open Data?

Any piece of data that is available free of cost to any individual or organization for use and re-use:

– *processing, mining, knowledge extraction, reasoning, statistical inference, etc.*

Testimonies of growing importance

- Release of the Open Data Charter by the G8
- EU digital agenda
- Open Data France
- Etalab (data.gouv.fr)

The Big Picture

The Semantic Web Context

The evolving vision of the World Wide Web:

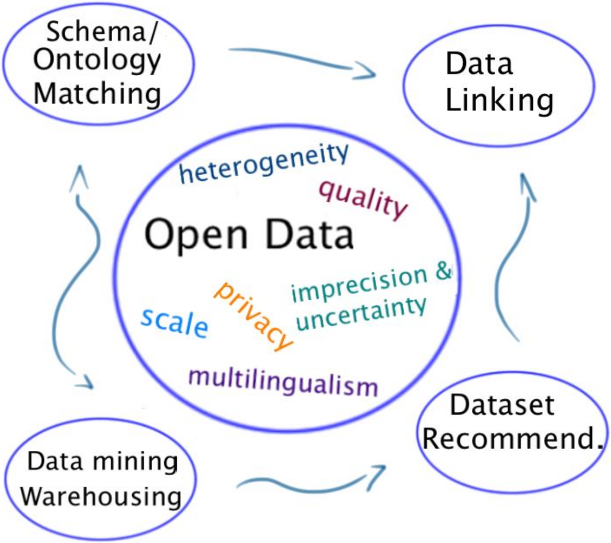
Web of Documents –> Semantic Web –> Web of Data

Linked data principles: [Bizer, Heath, Bernes-Lee. IJWS 2009]

1. Use URIs as names for things.
2. Use HTTP URIs so that people can look up those names.
3. When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL).
4. Include links to other URIs, so that they can discover more things

The Big Picture

The Open Data Research Group



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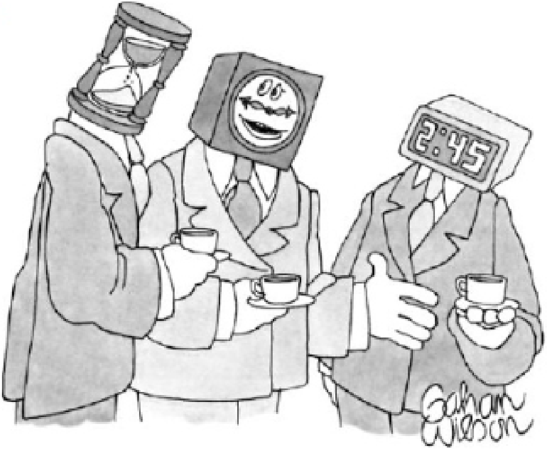
Ontology Matching



"Basically, we're all trying to say the same thing."

Borrowed from a tutorial by S. Staab and A. Hotho.

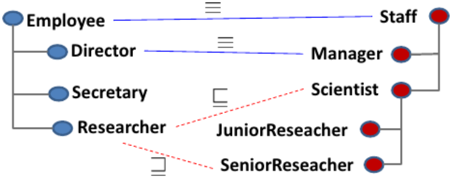
Ontology Matching

A Generic Framework for Ontology Matching and Evaluation

Ontologies are created in a **decentralized**, strongly **human biased** manner. Many ontologies describing the same domain of interest

=> **ontology heterogeneity:**

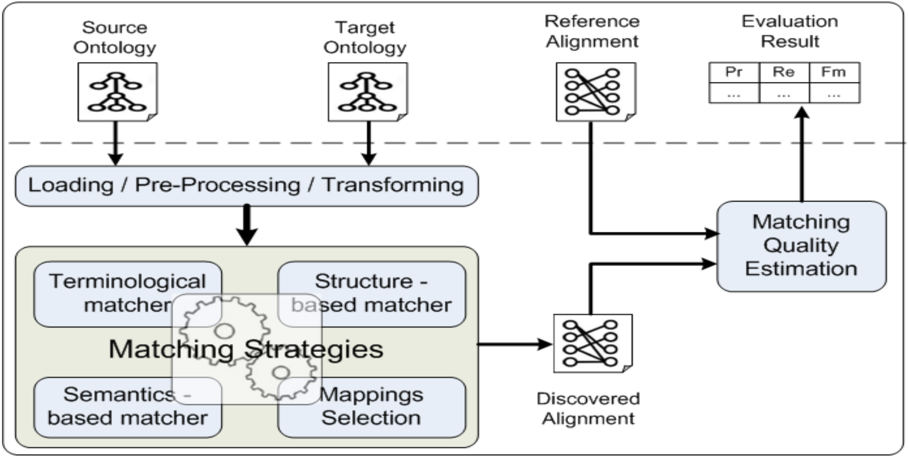
- syntactic
- terminological
- conceptual / structural



=> **Ontology Matching:** detect the semantic correspondences between the elements of two ontologies.

Ontology Matching

A Generic Framework for Ontology Matching and Evaluation



[Ngo, Bellahsene, Todorov. ESWC 2013]

Ontology Matching

Previous and Ongoing Work

Previous and ongoing work

- Schema matching / The system YAM
- The system YAM++
- Multimedia ontology matching for semantic information retrieval
- Fuzzy ontology matching with background knowledge
- Matching cross-lingual ontologies
- Large-scale matching (large ontologies vs. large number of ontologies)

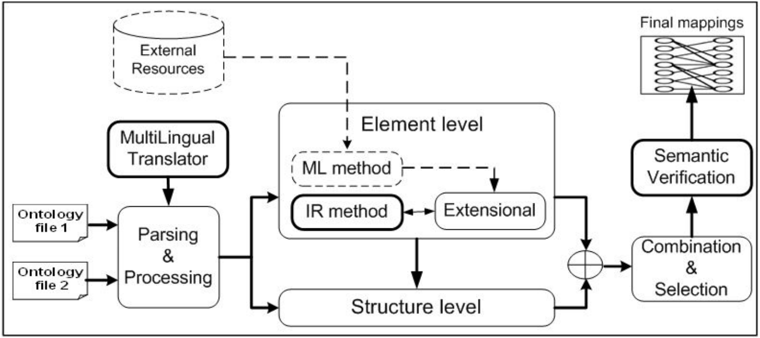
Ontology Matching

YAM++ (not) Yet Another Matcher

Many matching systems are out there. Here are some of the pluses of YAM++:

- Automatic configuration: similarity measures selection, tuning, and combination
- A novel terminological measure based on Tversky's similarity
- Able to deal with large ontologies

Among the best performing systems in the current state-of-the-art (cf. OAEI reports)



[Ngo, Bellahsene, EKAW 2012], [http://oaei.ontologymatching.org]

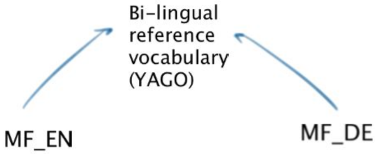
Ontology Matching

Cross-lingual Ontology Matching

Motivation

- No one-to-one correspondence between the majority of terms across different languages
- Machine translation still tolerates low precision levels
- No large training corpora with OM data

Use of background knowledge



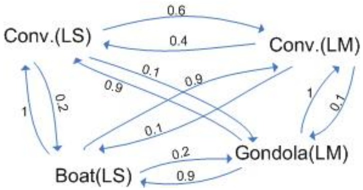
- Implicit alignment of cross-lingual ontologies (mediated by a YAGO/Wordnet taxonomy with French/German WordNet labels)
- No use of automatic translation
- Allows to capture various aspects of the similarity of concepts given in different languages

Ontology Matching

A Fuzzy Framework for Ontology Matching

Consider the (inherently) vague nature of concepts and their alignemnts

- Provide the missing implicit background knowledge
- Most matching procedures produce 1:1 mappings: often we will not be interested in the best (exact) match, but would like to find related yet not equivalent concepts
- A fuzzy set representation of the concepts, construction of a fuzzy common ontology
- Infer (fuzzy) relations between cross-ontology concepts



[Todorov, Hudelot, Popescu, Geibel. IJUFKS 2014 (in print)]

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Data Linking

The fourth principle of linked data:

–> Include links to other URIs, so that they can discover more things

- Data Linking: The processes of finding equivalent resources on the web of data, or, more generally, connecting things that are somehow related
- Take two datasets as input -> produce a set of links between entities of these collections
- Establishing typed links (classes, properties, instances)
- Key-entity: a measure of similarity between instances distributed among heterogeneous data sources.

...but

- The Linked Data resources: over 31 billions of triples
- Yet only 5 percent of these are links between knowledge bases

Data Linking

Data linking, link discovery...

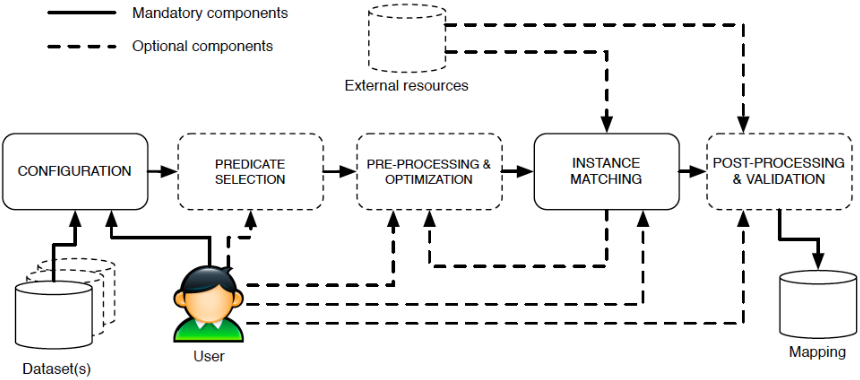
- An interdisciplinary topic on the frontiers of NLP, graph theory, statistics, RDB
- Related to the OM field, yet a separate problem
- Frameworks: RDF-AI, LIMES, SILK, zhishi.links, etc.
- Evaluation: Instance Matching track at the OAEI

Among the challenges:

- Complexity
- Link specification: choice and combination of similarity measures, which properties of the resources to take into account?
- The limitations of *owl:sameAs*: towards a more flexible definition of the relation of identity
- Multilingualism

Data Linking

A General Framework



[Ferrara, Nikolov, Scharffe. IJSW 2011]

Data Linking

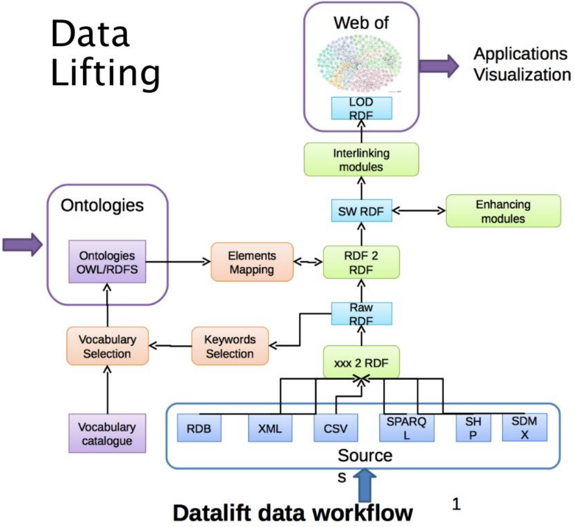
Datalift

The Datalift Project: a platform for "lifting" of data

- Different input formats are converted to RDF
- Ontologies are selected to describe the data
- Provide infrastructure for dataset publishing
- Handling licenses and access rights
- Data linking

Data Linking

Datalift



[Scharffe et al. 2012, http://datalift.org]

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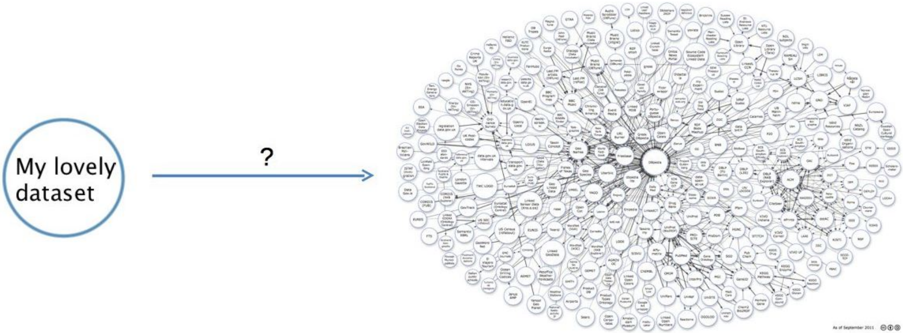
Dataset Recommendation for Linking

...Any candidates?



Towards an automatic ***discovery*** *and* ***recommendation*** *of candidate datasets for linking*

Dataset Recommendation for Linking

Given a dataset *d*, return a (possibly) ranked set of WoD datasets with respect to their relevance to the dataset *d* in view of the linking task.

Towards dataset profiling: definition of a collection of characteristics that allow to

- describe in the best possible way a dataset
- separate this dataset in the best possible way from other datasets
- many (statistical) characteristics of interest (scale, coverage, data values range, degree of connectedness, attribute entropy, etc...)

Two main approaches already proposed in the literature:

- Collect simple characteristics coming from vocabularies and meta-data [Luger. MSc Thesis 2012]
- A key-word search over an existing semantic web index [Nikolov et al. JIST 2011]

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Warehousing and Datamining

Opening data requires to build data warehouses from sources that are selected and integrated.

Application of data mining techniques for selecting relevant views

Key questions:

- which cost functions are relevant in the particular context of open and linked data;
- how data mining algorithms can be used to automatically build relevant views;
- how such (multidimensional) views can be published to end-users; and
- how logical operators can be adapted to fit the web of data framework.

[A. Laurent, MJ Lesot. 2009], [Laurent et al. IJUFKS 2012]

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[Todorov, Hudelot, Popescu, Geibel. IJUFKS 2014 (in print)] Konstantin Todorov, Celine Hudelot, Adrian Popescu, Peter Geibel. Fuzzy Ontology Alignment Using Background Knowledge. Intl. Journal on Uncertainty, Fuzziness and Knowledge-Based Systems. To appear 2014.

Thank you for listening!