

I. Introduction:

Data integration allows access to multiple heterogeneous sources in syntax, semantics or schema. The goal of data integration is to facilitate access and reuse of source assembly. The current researches in semantic data integration are based on the concept of ontologies. An ontology is a vocabulary that describes a domain of interest and gives meaning to its terms (Gruber 1993). The ontology mapping is a morphism that consists of a collection of functions assigning symbols used in one vocabulary to the symbols in the other. There are many ways to the ontology mapping : merging, alignment,...etc. We are concentrated in the ontology alignment which is a solution to the semantic heterogeneity problem. It finds correspondences between semantically related entities of ontologies (Euzenat et al. 2007).

The most of the alignment tools detect equivalence, etymology and subsumption but no one detects synonyms. Another problem encountered is loading ontologies, however, this ontologies are well formed and are generated by ontology editor tools.

II. Tools for ontology mapping:

Our goal is to find a suitable tool to automatically update our framework. Our challenge is to know which tool to choose. Our selection criteria are:

- This tool detects **equivalence, etymology** and **synonyms**.
- It is **easy to use** (online tool, jar,...).
- It gives us **the more mappings**.
- **No difficulties when loading ontologies**.

We will test the alignment between 2 ontologies : Kofler et al. – ThinkHome[2] and Star city [2] with some alignment tools.

1- LogMap [1]:

LogMap is a highly scalable ontology matching system with 'built-in' reasoning and diagnosis capabilities. LogMap is easy to use, we can access from an interface of a website: We have to put some requestors informations, to input our ontologies and to choose the Reasoner. The result of running is fast and it's sent in emails.

The LogMap tool successfully addresses two challenges which are the insufficient scalability and the logical inconsistencies [3]. With LogMap, we don't have problems when uploading ontologies. If there are some inconsistencies, LogMap continue to run. This tool avoids errors and looks for opportunity to make mapping.

Two months ago, we tested LogMap and it made mappings only with equivalences. Thus, we decide to use other tools to have more types of mappings. Now, we come back to LogMap to verify if there's an update of versions and we get that LogMap detects equivalence and etymology and not synonyms.

```
<map>
  <Cell>
    <entity1 rdf:resource="https://www.auto.tuwien.ac.at/downloads/thinkhome/ontology/WeatherOntology.owl#Temperature"/>
    <entity2 rdf:resource="http://www.ibm.com/SCTC/ontology/WeatherOntology/WeatherOntology.owl#Temperature"/>
    <measure rdf:datatype="xsd:float">0.98</measure>
    <relation>=</relation>
  </Cell>
</map>
```

Figure 1: Equivalence with LogMap

```
<map>
  <Cell>
    <entity1 rdf:resource="https://www.auto.tuwien.ac.at/downloads/thinkhome/ontology/WeatherOntology.owl#reportsWeatherObservation"/>
    <entity2 rdf:resource="http://www.ibm.com/SCTC/ontology/CoreSpatioTemporalDataSensorOntology.owl#reportsObservation"/>
    <measure rdf:datatype="xsd:float">0.9</measure>
    <relation>=</relation>
  </Cell>
</map>
```

Figure 2: Etymology with LogMap

Despite avoiding errors and looking for opportunities to have mapping, LogMap makes less mappings than AROMA (another alignment tool that we will discuss later): 59 mappings with LogMap and 85 mappings with AROMA when testing the alignment between the 2 ontologies : Kofler et al. – ThinkHome and Star city [2].

2- Prompt [4]:

After trying LogMap, we tested the Prompt tool.

Prompt is a suite of Interactive tools for ontology merging and mapping. It is available as a plug-in for Protégé 3.4 (Protégé 4.2 don't has this plug-in).

ANCHORPROMPT is the responsible tool for mapping between ontologies. It's a graph-based tool for finding linguistic similarities. In cases where automation is not possible, user intervention is needed; possible actions are suggested. That's why we say ANCHORPROMPT is semi-automatic. We use this tool through the interface of Protégé. First, this tool only detects equivalence between concepts. Then, we

Mapping Tools

encountered some difficulties when loading ontologies-which are not in the directory of Protégé 3.4; the same ontologies are well loaded with Protégé 4.2.

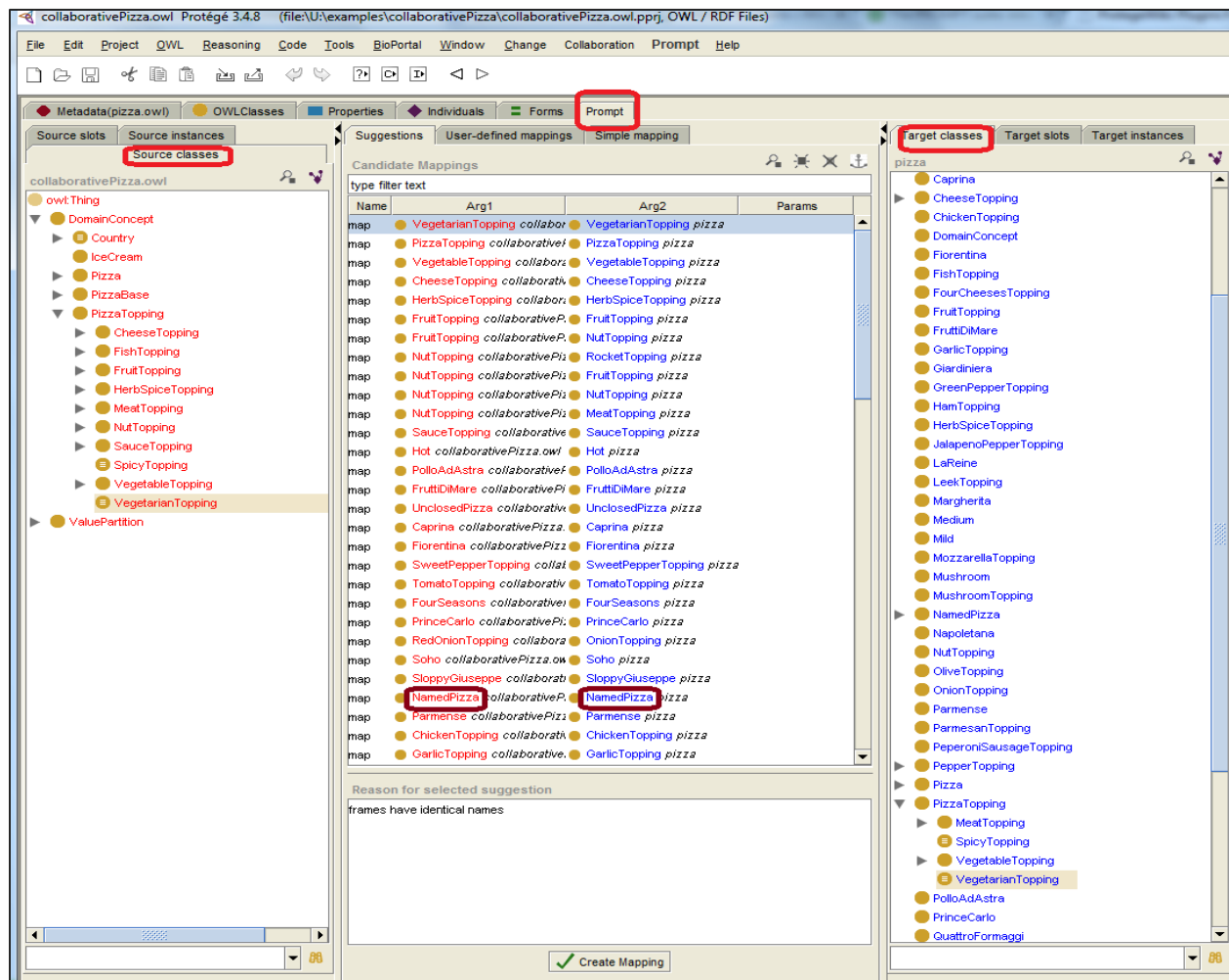


Figure 3: Equivalence with AnchorPrompt

3- AROMA [5]:

After trying Prompt and LogMap, we search another tool that can satisfy our requirements. Ontology alignment experts recommended us AROMA.

AROMA (Association Rule Ontology Matching Approach) is an alignment approach for ontologies represented in OWL. This approach allows to match not only equivalence relations but also subsumption relations between entities. AROMA relies only on the subsumption relation and on the textual data provided with the structure. This makes it

a simple and a generic approach. However, it does not exploit all the specificities of more elaborate structures such as the OWL ontologies.

AROMA is easy to use. After downloading the jar, we use the command line : “java -jar aroma.jar kofler.owl starCity.owl -o file.txt”. The output is the mapping between the 2 ontologies. First, we encountered some difficulties when loading ontologies with AROMA.

```

C:\workspace\Aroma\AROMA-1.1\lib>java -jar aroma.jar collaborativePizza.owl kofler.owl -o dddd.txt
Exception in thread "Thread-4" con.hp.hpl.jena.ontology.ConversionException: Cannot convert node http://www.w3.org/2002/07/owl#topObjectProperty to OntProperty
    at con.hp.hpl.jena.ontology.impl.OntPropertyImpl$1.wrap(OntPropertyImpl.java:69)
    at con.hp.hpl.jena.enhanced.EnhNode.convertTo(EnhNode.java:142)
    at con.hp.hpl.jena.enhanced.Polymorphic.asInternal(Polymorphic.java:65)
    at con.hp.hpl.jena.enhanced.EnhNode.wrap(EnhNode.java:99)

```

Figure 4: Difficulties when loading kofler ontology with AROMA

```

C:\workspace\Aroma\AROMA-1.1\lib>java -jar aroma.jar collaborativePizza.owl kofler.owl -o dddd.txt
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1245 column 36): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1245 column 36): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1248 column 43): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1248 column 43): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1249 column 37): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1249 column 37): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1252 column 44): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1253 column 42): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1253 column 42): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1256 column 44): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1256 column 44): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1258 column 117): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1258 column 117): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
ERROR [main] CRDFDefaultErrorHandler.java:40 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1259 column 34): <E201> Multiple chil
dren
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1260 column 55): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1260 column 55): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1261 column 61): <W136> Relative URI is
in RDF: specifically <IRI>
WARN [main] CRDFDefaultErrorHandler.java:36 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1261 column 61): <W102> Unqualified p
are not allowed. Property treated as a relative URI.
ERROR [main] CRDFDefaultErrorHandler.java:40 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1262 column 21): <E201> The attribute
element, are not permitted with any content: expecting end element tag.
ERROR [main] CRDFDefaultErrorHandler.java:40 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1262 column 55): <E201> XML element <
empty property element, whose attributes prohibit any content.
ERROR [main] CRDFDefaultErrorHandler.java:40 - file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl (line 1262 column 58): <E201> The attribut
element, are not permitted with any content: expecting end element tag.
Exception in thread "main" org.semanticweb.owl.align.AlignmentException: Cannot load file:/U:/workspace/Aroma/AROMA-1.1/lib/WeatherOntologyStarCity.owl
    at fr.inria.lapes.exmo.align.onto.jena25.JENAOntologyFactory.loadOntology(Unknown Source)
    at fr.inria.lapes.exmo.align.onto.jena25.JENAOntologyFactory.loadOntology(Unknown Source)
    at fr.inria.lapes.exmo.aroma.AROMACmdLine.main(Unknown Source)
Caused by: java.lang.NullPointerException
    at con.hp.hpl.jena.rdf.arp.impl.XMLHandler.endElement(XMLHandler.java:143)
    at org.apache.xerces.parsers.AbstractSAXParser.endElement(Unknown Source)
    at org.apache.xerces.impl.XMLNamespaceBinder.handleEndElement(Unknown Source)
    at org.apache.xerces.impl.XMLNamespaceBinder.endElement(Unknown Source)
    at org.apache.xerces.impl.dtd.XMLDTDValidator.handleEndElement(Unknown Source)
    at org.apache.xerces.impl.dtd.XMLDTDValidator.endElement(Unknown Source)
    at org.apache.xerces.impl.XMLDocumentFragmentScannerImpl.scanEndElement(Unknown Source)
    at org.apache.xerces.impl.XMLDocumentFragmentScannerImpl$FragmentContentDispatcher.dispatch(Unknown Source)
    at org.apache.xerces.impl.XMLDocumentFragmentScannerImpl.scanDocument(Unknown Source)
    at org.apache.xerces.parsers.DTDConfiguration.parse(Unknown Source)
    at org.apache.xerces.parsers.DTDConfiguration.parse(Unknown Source)
    at org.apache.xerces.parsers.XMLParser.parse(Unknown Source)
    at org.apache.xerces.parsers.AbstractSAXParser.parse(Unknown Source)
    at con.hp.hpl.jena.rdf.arp.impl.RDFXMLParser.parse(RDFXMLParser.java:106)
    at con.hp.hpl.jena.rdf.arp.JenaReader.read(JenaReader.java:215)
    at con.hp.hpl.jena.rdf.arp.JenaReader.read(JenaReader.java:202)
    at con.hp.hpl.jena.rdf.arp.JenaReader.read(JenaReader.java:272)
    at con.hp.hpl.jena.rdf.model.impl.ModeIcon.read(ModeIcon.java:225)
    at con.hp.hpl.jena.ontology.impl.OntModelImpl.read(OntModelImpl.java:2169)
    at con.hp.hpl.jena.ontology.impl.OntModelImpl.read(OntModelImpl.java:210)
    at con.hp.hpl.jena.ontology.impl.OntModelImpl.read(OntModelImpl.java:2130)
    at con.hp.hpl.jena.ontology.impl.OntModelImpl.read(OntModelImpl.java:2100)
    at con.hp.hpl.jena.ontology.impl.OntModelImpl.read(OntModelImpl.java:2061)

```

Figure 5: Difficulties when loading Star City ontology with AROMA

Second, we loaded ontologies with Protégé 4.2 and stored them in RDF/XML format. Then, this ontologies are well loaded with AROMA.

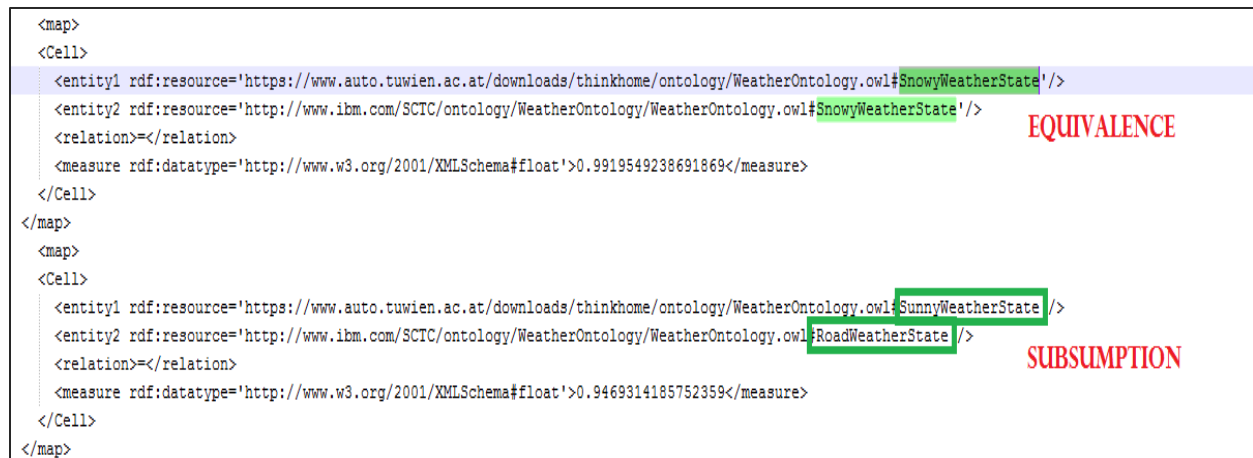


Figure 6: Equivalence and Subsumption with AROMA

Synonyms are not detected by AROMA; Integrated Wordnet in this project will help to detect them.

4. RiMOM [6]:

RiMOM (Risk Minimisation based Ontology Mapping) is a tool for ontology alignment by combining different strategies, aiming at finding the “optimal” alignment results. This tool detects only equivalence.

For working with this tool, we should have Perl environment and Wordnet. This could takes much time just to test and to be familiar with it which is not our goal.

III. Comparisons:

	Input	Output	How To use + Running	Mappings	Matching techniques	Limits
LogMap [3]	2Ontologies(Owl,RDF/XML,N3,OBO,KRSS) + Mappings	Mappings (Owl, TXT, OAEL) + Fragments of ontologies	Command line, web site, integrated In java application + semi-automatic	Equivalence And etymology	Terminological + Structural	Synonyms not detected
Prompt (Anchor-Prompt) [4]	2Ontologies (Owl)	Interface showing similarities	Plugin for Protégé 3.4 + Semi-automatic	Equivalence	Terminological + Structural	Synonyms and Subsumption not detected+ does not work well when ontologies haven't the same depth
AROMA [5]	2Ontologies (RDFS/Owl) + Preliminary alignment	File (.txt, .owl, etc ..)	Command line, integrated in java application + automatic	Equivalence and subsumption	Terminological + Extensional	Synonyms not detected

References:

[1]: <https://code.google.com/p/logmap-matcher/>

[2]: <http://www.sensormeasurement.appspot.com/?p=ontologies>

[3]: http://www.cs.ox.ac.uk/isg/projects/LogMap/papers/paper_SWAT4LS2011.pdf

[4]: The PROMPT Suite: Interactive Tools For Ontology Merging And Mapping –Natalya F. Noy and Mark A. Musen;Stanford Medical Informatics, Stanford University

[5] : Jérôme David “AROMA : une méthode pour la découverte d’alignements orientés entre ontologies à partir de règles d’association” (Phd)

[6] : <http://keg.cs.tsinghua.edu.cn/project/RiMOM/>