Visual Ontology Alignment for Semantic Web Applications

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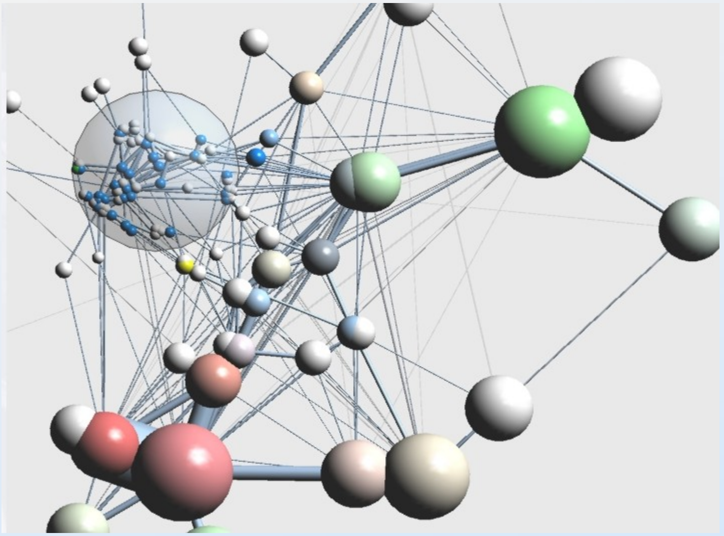


Introduction

- Motivation and research questions
- State of the Art
- Visualization for the semantic web
- AlViz – a prototype tool for visual ontology alignment
- Future research

Research Motivation

While full automation is the ultimate goal, not everything can be done automatically, user interaction is essential in order to control, approve and optimize the alignment results.

Research Questions

- Which alignment tools exist and how do they perform the necessary tasks?
- What are the main issues and shortcomings of current alignment tools?
- How can visualization support ontology alignment?

State of the Art

- Number of powerful tools, methods and techniques available for ontology management and alignment: e.g. Prompt suite, Chimæra, S-Match, FCA-Merge, OLA, ONION, Glue, IF_Map, Foam.
- Growing number of visualization tools for Protégé e.g. OntoViz, Jambalaya, Prompt-Viz, OWLViz, ezOWL, TGViz
- RDF-Gravity, OntoVista.

Visualization for supporting the Semantic Web

- Visualization techniques could support ontology experts by:
    - Direct manipulation of the classifications / concepts / instances
    - Making large, complex data accessible intuitively
    - Visual support for exploration or querying
    - Focus on structure or on the instance data
    - Visual metaphors support interpretation and understanding of multi-dimensional data.

Visualization challenges

- Graph visualization of large ontologies has posed many challenges:
  - Viewing the entire ontology at once
  - Screen resolution and layout algorithm
  - Length of time to display
  - Difficult to understand a large graph as the node size is small

Similarity between ontologies

- We extend the process of Ehrig and Sure (2004) to include validation and visualization of the alignment results.
- We adapt 23 most important rules from the Foam algorithm indicating similarity.
- We categorize relations as: equal, syntactically equal, similar-to, broader-than, narrower, different.

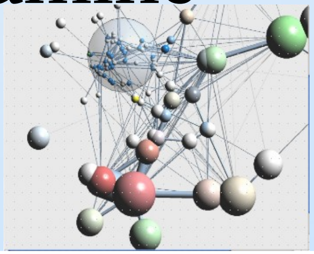
Text output

alt12FEBtest.txt

```
a.com/ontology/ISO1.owl#Class_of_responsibility_for_representation;null;
1.0;-0.3;0.0;0.0;0.0;0.0;0.0;0.9999999999999897;0.0;0.0;0.0;-0.3;-0.3;-0.3;-0.3;-0.3;-0.
3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;0
http://a.com/ontology/ISO2.owl#Class_of_responsibility_for_representation;null;http://
a.com/ontology/ISO1.owl#Class_of_specialization;null;
0.4217949471563131;-0.3;0.0;1.0;0.0;0.0;0.5307696829378887;0.9999999999999897;0.0;0.0;0.
0;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;0
http://a.com/ontology/ISO2.owl#Class_of_responsibility_for_representation;null;http://
a.com/ontology/ISO1.owl#Class_of_involvment_by_reference;null;
0.41953504380019574;-0.3;0.0;1.0;0.0;0.0;0.5172102628011847;0.9999999999999897;0.0;0.0;0
.0;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;-0.3;0
```

AlViz: A tool for visual ontology alignment

- A multiple-view tool which aims at supporting the alignment process visually.
- Is to be implemented as a tab plug-in for Protégé, using Prefuse visualization toolkit for Java.
- Linking and brushing, J-trees
- Small world graphs – allow the user to examine the structure of the ontologies.



Small World

- Small world phenomenon – six degrees of separation – Milgram's (1967) pioneering work
  - *"You are only ever six 'degrees of separation' from anybody else on the planet".*
- Many real world settings exhibit small-world properties (social, neural and peer-to-peer networks).

Small World Graphs

- Users goals:
  - Are there distinct groups of items that are strongly interconnected (i.e graph clusters)?
  - How do these split into separate clusters?
  - How do these clusters relate?

Clustering

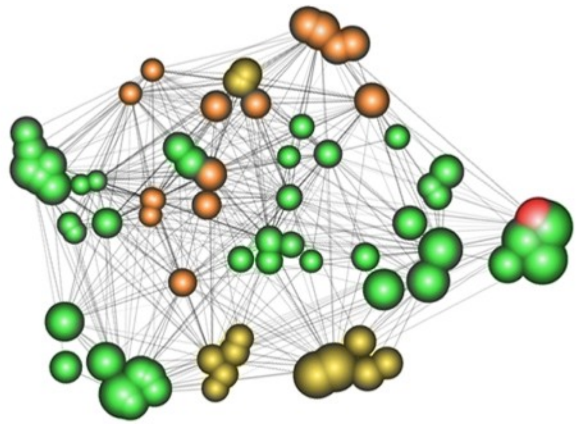


Fig A. Small world graph for a Tourism ontology

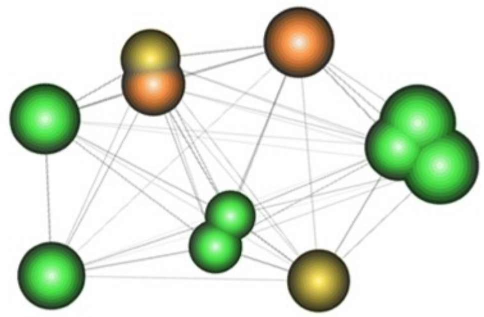
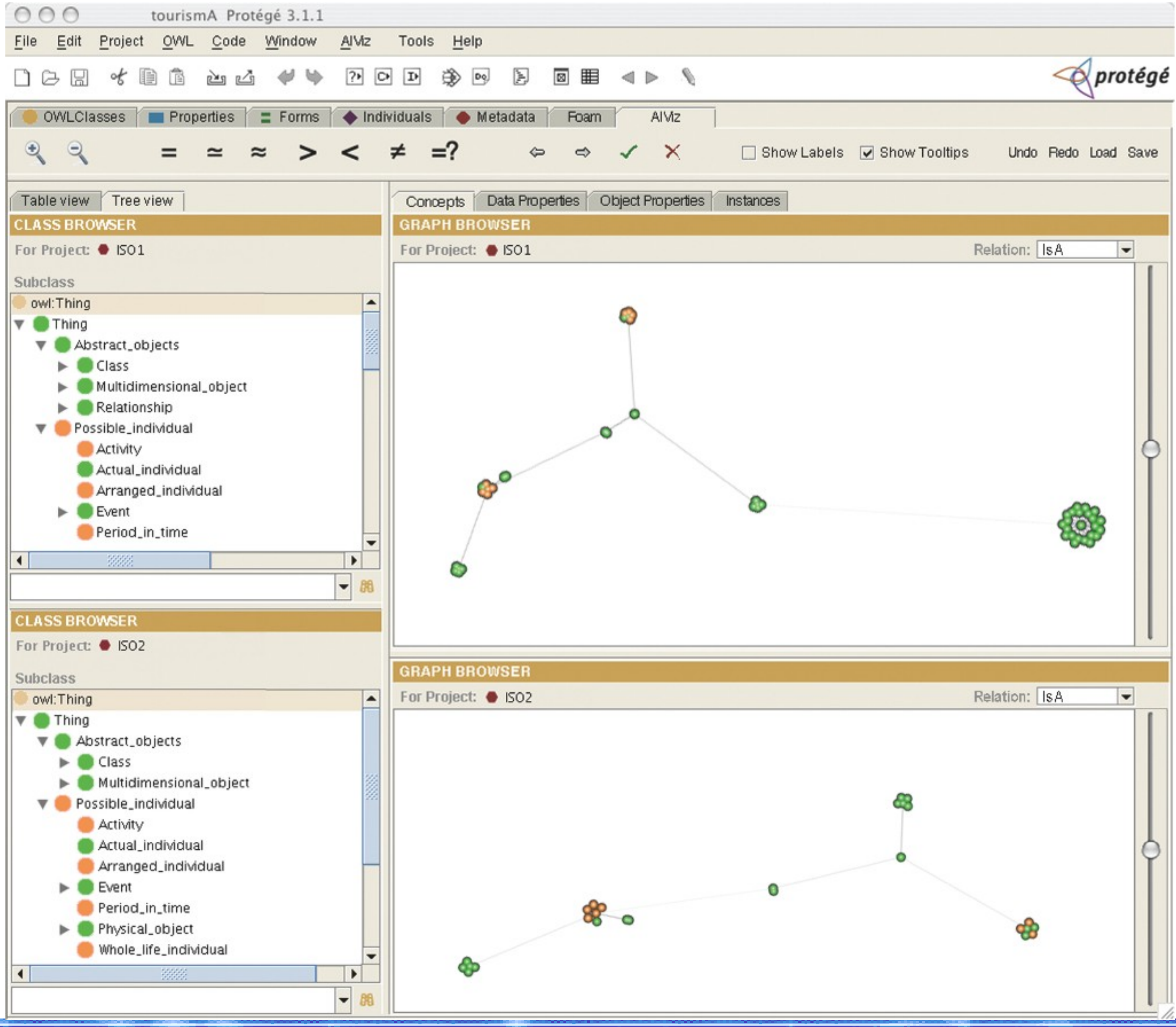


Fig B. Highly clustered small world graph of the same Tourism ontology


tourismA Protégé 3.1.1
File Edit Project OWL Code Window AIVz Tools Help
protégé
OWLClasses Properties Forms Individuals Metadata Foam AIVz
Show Labels Show Tooltips Undo Redo Load Save
Table view Tree view
CLASS BROWSER
For Project: ISO1
Subclass
owl:Thing
Thing
Abstract_objects
Class
Multidimensional_object
Relationship
Possible_individual
Activity
Actual_individual
Arranged_individual
Event
Period_in_time
Concepts Data Properties Object Properties Instances
GRAPH BROWSER
For Project: ISO1
Relation: IsA
CLASS BROWSER
For Project: ISO2
Subclass
owl:Thing
Thing
Abstract_objects
Class
Multidimensional_object
Possible_individual
Activity
Actual_individual
Arranged_individual
Event
Period_in_time
Physical_object
Whole_life_individual
GRAPH BROWSER
For Project: ISO2
Relation: IsA

Future research

- 'Real' world ontologies - scalability
- Our first experiment gave promising results. We found that our tool helps significantly with locating missing alignments.
- We need to run more experiments once the tool is fully developed.
- Applying / adapting different alignment algorithms

References

Ehrig, M. and Sure, Y. (2004): Ontology Mapping an Integrated Approach. Proc of the First European Semantic Web Symposium. Bussler, C. Davis, J Fensel, D. Studer, R. (eds)

Foam: Framework for Ontology Alignment and Mapping, url: http://www.aifb.uni-karlsruhe.de/WBS/meh/Foam

Noy, N. (2004): Ontology Management with the Prompt Plugin. Proc of the 7th International Protégé Conference.

McGuiness, D. Fikes, R. Rice, J and Wilder, S. (2000): An Environment for Merging and Testing Large Ontologies, Proc of the 7th International Conference on Principles of Knowledge Representation and Reasoning,pp. 483-493.

Ingram, S. (2005): An Interactive Small World Graph Visualization, University of British Columbia, Technical Report.

Milgram, S. (1967): The small world problem, Psychology Today, 2. pp. 60-67.

van Ham and van Wijk, J.J. (2004): Interactive Visualization of small world graphs, Proc of IEEE Symposium on Information Visualization (Image on slide 1).

Thank you!

Complexity

- Small world graphs bear the problems of high computational complexity (like all spring embedded graphs) usually $0(N^3)$
- Clustering the graph improves the programs interactivity
- Can perform at interactive speeds because on average there are *0(Log(N))* clusters visible
- Current solution manages up to about 1000 entities per ontology.
- Ongoing research to reduce the complexity of such graphs which looks promising for visualizing 10 000 nodes.

Ingram's Small World Graph Viz

- Stephen Ingram – University of British Columbia
- Implementation described in:
- “An Interactive Small World Graph Visualization”
- Available at: http://www.cs.ubc.ca/~sfingram/cs533C/
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Prefuse

Software framework for infoviz in Java2D to simplify the creation of visualizations.
Develop a pipelined series of prefuse components.
It partitions the workflow of a visualization into:

- Data – the nodes and edges and supporting data
- VisualForm – the data structures that define only the items to be drawn
- View – Frame buffer and any user controls

Software components into:

- Entities – these objects make up the data
- Filters – map the entities onto VisualItems
- VisualItem – objects that compose the VisualForm
- Layouts – determine the position/size of VisualItems on the screen
- Renderers – map the VisualItems to the Display
- Display this makes up the View.

Similarity rules

OWL Ontology Construct	Association	Description
Concept	Equal	URI's equal Data and Object properties equal
	Syntactically equal	Labels are the same
	Similar	Superclasses are the same Subclasses are the same Data properties are the same Object properties are the same Similar low/high fraction of the instances
	Broader than	Compare the subclasses of one concept with the superclasses of the other concept
	Narrower than	Compare the superclasses of one concept with the subclasses of the other concept
	Different	Two classes have no common characteristics
Data properties	Equal	URI's equal
	Syntactically equal	Labels are the same
	Similar	Data property domain is the same Data property super properties are the same Data property sub properties are the same Data property members are the same
	Different	Two data properties have no common characteristics

Similarity rules

OWL Ontology Construct	Association	Description
Object properties	Equal	URI's equal
	Syntactically equal	Labels are the same
	Similar	Object property domain is the same Object property super properties are the same Object property sub properties are the same Object property members are the same
	Different	Two object properties have no common characteristics
Instances	Equal	URI's equal
	Syntactically equal	Labels are the same
	Similar	Instances of the same concept Property members are the same Two instances linked via the same property to another instance
	Different	Two instances have no common characteristics