ERCIM Fellowship Programme: Scientific Report

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The first period of this ERCIM fellowship started on November 8^{th}, 2004 and finished on August 7^{th}, 2005. We have spent this period at CNR (Italian National Research Council) in Pisa, Italy, in the NMIS (Networked Multimedia Information Systems) group of the ISTI (Institute of Information Science and Technologies) laboratory under the supervision of Dr. Umberto Straccia.
The second period of this ERCIM fellowship started on September 1^{st}, 2005 and finished on May 31^{st}, 2006. We have spent this period at CWI (Dutch Centre for Mathematics and Computer Science) in Amsterdam, The Netherlands, in the Semantic Media Interfaces (INS2) research group under the supervision of Prof. Lynda Hardman.

1 Introduction

Internet technologies support access and sharing of knowledge in the organizations, but often with difficulty since this access is realized in a pure documentary form. However, the technologies quickly reach their limits: web site organization is expensive and full-text search inefficient. Content-based information search is becoming a necessity, all the more since this information is in a multimedia form. Content representation will enable the computer to manipulate knowledge on a more formal ground and to carry out similarity or generality search... Knowledge representation formalisms are good candidate for expressing the content. The vision of a *Semantic Web* supplies the web, as we know it (informal), with annotations expressed in a machine-processable form and linked together. In the context where web documents are formally annotated, it becomes necessary to import and manipulate the annotations according to their semantics and their use. Taking advantage of this semantic web will require the manipulation of various knowledge representation formats.

The research carried out during this period is articulated around this "Semantic Web" vision. On the one hand, our work aims at enhancing content understanding, and the interoperability of formal communicated knowledge. The semantic web idea is essentially based on the notion of ontology (that can be quickly described as conceptual schemes or knowledge bases). Even if there exists one day a standard knowledge representation language, it will be necessary to import and exchange ontologies in such a way that the semantics of their representation language is taken care of. We have investigated deeply this problem, usually named the *ontology alignment* problem. On the other hand, the need for documents to be formally annotated is even higher for multimedia contents since

it is even more difficult to process them automatically. We have thus studied how semantic web technologies (ontology-based annotations, logical rules...) can be used to improve the search and the process of audio-visual content.

We summarize briefly the main results obtained for these two activities and we give an exhaustive list of accepted publications and submissions currently under review. We report also our scientific dissemination activity, that is, the attendance and the organization of conferences and workshops, and the participation to their programme committees.

2 Research carried out and new results

2.1 Ontology alignment

Integrating heterogeneous resources of the web will require finding agreement between the underlying ontologies. A variety of methods from the literature may be used for this task, basically they perform pair-wise comparison of entities from each of the ontologies and select the most similar pairs. The underlying problem, often called the "ontology alignment" problem, can be described as follows: given two ontologies, each describing a set of discrete entities (which can be classes, properties, rules, predicates...), find the relationships (e.g., equivalence or subsumption) that hold between these entities.

We have proposed the **oMAP**[3] framework for automatically aligning OWL ontologies, a crucial step for achieving the interoperability of heterogeneous systems in the Semantic Web. This framework looks like a tool box, where different components are combined for finding the best mappings (together with their weights) between the entities defined in the OWL ontologies. We have implemented various classifiers: terminological, machine learning-based and one based on the structure and the semantics of the OWL axioms [6, 7, 13]. We have also evaluated our method on independent test sets provided by an international ontology alignment contest, and we have shown our results with respect to the other competitors [8, 9].

We have finally integrated the oMAP framework in a general methodology for performing distributed search in the Semantic Web. We have proposed to define this task as a three steps process, namely *resource selection*, *query reformulation/ontology alignment* and *rank aggregation/data fusion*. That is, an agent must know *where* to search, *how* to query, and *how* to combine the information and ranked lists provided back from querying different and heterogeneous resources. We have shown that the tasks of automated resource selection and the one of query reformulation seem to be the more problematic ones, while the data fusion and rank aggregation issue may be solved apparently by applying directly existing techniques. For the second step, namely *query reformulation and ontology alignment*, oMAP can be used as an efficient tool, whereas the first step, namely *resource selection*, will be addressed in future work [10].

[3] See the oMAP homepage at `http://www.cwi.nl/~troncy/oMAP/`.

2.2 Multimedia and the Semantic Web

Knowledge-driven audio-visual content description techniques bring promising solutions for improving the processing of multimedia documents. We have thus studied and presented an experiment based on real use cases where Semantic Web technologies are used to describe deeply the content of a corpus of TV programs. We have shown that the combination of several formal ontologies and rules allow to better describe and retrieve the audio-visual sequences [2, 3].

We have also promote the use of Semantic Web languages for describing any multimedia resources. For example, we have provided examples of the use of Semantic Web languages and tools for image annotation, based on use cases for a wide variety of domains [16]. This requires having commonly accepted, widely used vocabularies for multimedia annotation. Unfortunately, such resources are still missing, and actually, many existing approaches for multimedia metadata are not based on Semantic Web technologies. We are now working on making these approaches interoperable with the Semantic Web (see Section 3.1). A solution often mentioned for solving this problem is to develop a gold standard multimedia ontology. We have contributed to gather the basic requirements such an ontology should fulfill [14].

In parallel, various ontologies based on the MPEG-7 standard have been proposed by the community. MPEG-7 can be used to create complex and comprehensive metadata descriptions of multimedia content. Since this language is defined in terms of an XML schema, the semantics of its elements have no formal grounding. In addition, certain features can be described in multiple ways. MPEG-7 profiles are subsets of the standard that apply to specific application areas, which can be used to reduce this syntactic variability, but they still lack formal semantics. We have therefore proposed an approach for expressing semantics explicitly by formalizing the semantic constraints of a profile using ontologies and rules, thus enabling interoperability and automatic use for MPEG-7 based applications. We have demonstrated the feasibility of this approach by implementing a validation service[4] for a subset of the semantic constraints of the Detailed Audiovisual Profile (DAVP) [12].

Finally, **K-Space**[5] integrates leading European research teams to create a EU Network of Excellence in semantic inference for semi-automatic annotation and retrieval of multimedia content. The aim is to narrow the gap between content descriptors that can be computed automatically by current machines and algorithms, and the richness and subjectivity of semantics in high-level human interpretations of audiovisual media: The *Semantic Gap*. Since January 1st 2006, I'm actively participating in this EU project.

[4] `http://mpeg-7.joanneum.at/Validator/`
[5] `http://www.k-space.eu/`

3 Dissemination

3.1 Standardization body: W3C activities

I was Member of the W3C Semantic Web Best Practices and Deployment Working Group[6]. More precisely, I have been active in the Multimedia Task Force[7] and I'm one of the editors of the W3C Editors' Draft, "Image Annotation on the Semantic Web" that explains the advantages of using Semantic Web languages and technologies for the creation, storage, manipulation, interchange and processing of image metadata. Guidelines for Semantic Web-based image annotation are provided, being illustrated with use cases. Relevant RDF and OWL vocabularies are discussed, along with a short overview of publicly available tools [16].

As a follow up, I was one of the founding member of the W3C Multimedia Semantics Incubator Group[8]. Since May 1st 2006, I am co-chairing with Jeff Z. Pan this group, chartered to show how metadata interoperability can be achieved by using Semantic Web technologies to integrate existing multimedia metadata standards.

3.2 Conference and Workshop organization and attendance

I organized the following events:

- French Workshop on Knowledge and temporal documents (CDT) colocated with the 2005 AFIA platform (AFIA = French Association for Artificial Intelligence), Nice, France, June 2005 [4]. *Co-organizer with Yannick Prié.*
- French Workshop on Audiovisual Information System (SIAV) colocated with the 2nd week of the digital document (SDN 2006), Fribourg, Switzerland, September 2006 [5]. *Co-organizer with Yannick Prié.*
- First International Workshop on Semantic Web Annotations for Multimedia (SWAMM) colocated with the 15th World Wide Web Conference (WWW 2006), Edinburgh, Scotland, May 2006 [15]. *Co-organizer with Jacco van Ossenbruggen, Giorgos Stamou and Vassilis Tsouvaras.*
- Workshops and Tutorials chairs for the 1st International Conference on Semantics And digital Media Technology (SAMT 2006), Athens, Greece, December 2006.

I attended to the following conferences:

- The 16^{th} French Conference on Knowledge Engineering (Ingénierie des Connaissances), 30 May - 3 June 2005, Nice, France.
- The 4^{th} International Semantic Web Conference (ISWC), 6-10 November 2005, Galway, Ireland.
- The 6^{th} International Conference on Web Information Systems Engineering (WISE), 20-22 November 2005, New York, USA.

[6] `http://www.w3.org/2001/sw/BestPractices/`
[7] `http://www.w3.org/2001/sw/BestPractices/MM/.`
[8] `http://www.w3.org/2005/Incubator/mmsem/`

- The 2^{nd} European Workshop on the Integration of knowledge, semantic and digital Media Technologies (EWIMT), 30 November-1 December 2005, London, UK.
- The 15^{th} International World Wide Web Conference (WWW), 22-26 May 2006, Edinburgh, Scotland.
- The 3^{rd} European Semantic Web Conference (ESWC), 11-14 June 2006, Budva, Montenegro.

3.3 Conference and Workshop program committees

I was member of the programme committee for the following conferences:

- International Semantic Web Conference (ISWC): 2005, 2006.
- European Semantic Web Conference (ESWC): 2006.
- International Conference on Semantics And digital Media Technology (SAMT): 2006.
- International Conference on Artificial Intelligence: Methodology, Systems, Applications (AIMSA): 2006.
- Ingénierie des Connaissances (French Conference on Knowledge Engineering): 2005, 2006.

4 Publications

1. Jean Charlet, Bruno Bachimont, and Raphaël Troncy. Ontologies pour le Web sémantique. *Journal in Information Engineering Sciences, Revue I3*, numéro HS "Web sémantique", 2004.
2. Antoine Isaac and Raphaël Troncy. Ontologies et description du contenu de documents AV : Une expérimentation dans le domaine médical. In Prié and Troncy [4], pages 35–46. `http://liris.cnrs.fr/yannick.prie/Projets/AFIA05/`.
3. Antoine Isaac and Raphaël Troncy. Using Several Ontologies for Describing Audio-Visual Documents: A Case Study in the Medical Domain. In *Workshop on Multimedia and the Semantic Web held in conjunction with the 2^{nd} European Semantic Web Conference (ESWC'05)*, Heraklion, Crete, Greece, 29 May 2005.
4. Yannick Prié and Raphaël Troncy, editors. *Atelier Connaissance et Documents Temporels (CDT'05)*, Nice, France, 31 May 2005. `http://liris.cnrs.fr/yannick.prie/Projets/AFIA05/`.
5. Yannick Prié and Raphaël Troncy, editors. *Atelier Systèmes d'Information AudioVisuelle (SIAV'06)*, Fribourg, Switzerland, 21 September 2006. `http://liris.cnrs.fr/~siav2006/`.
6. Umberto Straccia and Raphaël Troncy. oMAP: An Implemented Framework for Automatically Aligning OWL Ontologies. In *2^{nd} Italian Workshop on Semantic Web Applications and Perspectives (SWAP'05)*, Trento, Italy, December, 15-16 2005.
7. Umberto Straccia and Raphaël Troncy. oMAP: Combining Classifiers for Aligning Automatically OWL Ontologies. In *6^{th} International Conference on Web Information Systems Engineering (WISE'05)*, pages 133–147, New York City, New York, USA, November, 20-22 2005.
8. Umberto Straccia and Raphaël Troncy. oMAP: Results of the Ontology Alignment Contest. In *Workshop on Integrating Ontologies to be held with the 3^{rd} International Conference on Knowledge Capture (K-CAP'05)*, pages 92–96, Banff, Canada, October, 2-5 2005.

9. Umberto Straccia and Raphaël Troncy. oMAP: a Tool for Automatic OWL Ontologies Alignment (**submitted**). *World Wide Web Journal*, 2006.
10. Umberto Straccia and Raphaël Troncy. Towards Distributed Information Retrieval in the Semantic Web: Query Reformulation Using the oMAP Framework. In *3rd European Semantic Web Conference (ESWC'06)*, pages 378–392, Budva, Montenegro, June, 11-14 2006.
11. Raphaël Troncy. Nouveaux outils et documents audiovisuels : les innovations du web sémantique. *Documentaliste - Sciences de l'information*, 42(6):392–404, 2005.
12. Raphaël Troncy, Werner Bailer, Michael Hausenblas, Philip Hofmair, and Rudolf Schlatte. Enabling Multimedia Metadata Interoperability by Defining Formal Semantics of MPEG-7 Profiles. In *1st International Conference on Semantics And digital Media Technology (SAMT'06)*, Athens, Greece, December, 6-8 2006.
13. Raphaël Troncy, Umberto Straccia, and Henrik Nottelmann. Alignement d'ontologies pour OWL-Lite : l'apport d'un classifieur sémantique. In *16th Journées Francophones d'Ingénierie des Connaissances (IC'05)*, pages 229–240, Nice, France, June, 1-3 2005.
14. Raphaël Troncy, Jacco van Ossenbruggen, Christian Halaschek-Wiener, Giorgos Stamou, and Vassilis Tzouvaras. Multi-Perspective Requirements for a Common Multimedia Ontology Framework. Response to call to define requirements for a multimedia ontology framework, 2006. `http://www.acemedia.org/aceMedia/reference/multimedia_ontology/`.
15. Raphaël Troncy, Jacco van Ossenbruggen, Giorgos Stamou, and Vassilis Tsouvaras, editors. *International Workshop on Semantic Web Annotations for Multimedia (SWAMM'06)*, Edinburgh, Scotland, 22 May 2006. `http://multimedia.semanticweb.org`.
16. Jacco van Ossenbruggen, Raphaël Troncy, Giorgos Stamou, and Jeff Z. Pan. Image Annotation on the Semantic Web. W3C Editors' Draft, 2006. `http://www.w3.org/2001/sw/BestPractices/MM/image_annotation.html`.

The Fellow	CNR Supervisor	CWI Supervisor
Raphaël Troncy	Umberto Straccia	Lynda Hardman