INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team EXMO

Computer-mediated communication of structured knowledge

Rhône-Alpes

THEME SYM

Activity Report

2004

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1. Team

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2. Overall Objectives

Keywords: *DLML*, *Transmorpher*, *WWW*, *XML*, *XSLT*, *content representation*, *knowledge representation*, *ontologies*, *property preservation*, *semantic web*, *semantics of knowledge representation*, *semiotics*, *transformations*.

We consider that, in future information systems, formalized knowledge will be massively exchanged. In this communication process, the computer can complement its medium and memory roles by formatting, filtering, classifying, consistency checking or generalizing knowledge. These manipulations can be thought of as transformations. This approach is developing with the generalized use of standardized exchange languages (XML) in network communication. Consequently, the users must ask for more guarantees from the performed transformations. *Exmo*'s goal is the development of theoretical and software tools for enabling interoperability in formalized knowledge exchange.

Our main approach is the investigation of the properties that transformations must satisfy. Among these properties are content or structure preservation, traceability, or, conversely, confidentiality. We want to contribute to a "general theory of transformations" grounded on transformation properties rather than on transformations themselves.

On the one hand, we aim at showing that this approach can be applied to various contexts depending on languages, properties and transformations. We study information preservation modelled by lattices or scenario preservation in adapted multimedia documents. On the other hand, we investigate more precisely semantic properties when transforming from one knowledge representation language to another. The main question is: are the consequences of the initial representation still consequences of the transformed one? For helping answering it, we establish relationships between several kinds of semantic properties, known or new. We also investigate more restricted cases (family of languages, patterns) that can use these relationships for establishing properties more quickly.

Our medium term objectives are (1) the opportunity to analyse transformations in terms of a set of composition operators, (2) the isolation of useful properties and the study of their behavior regarding these operators and (3) the capability to prove these properties on this kind of transformations.

On a longer term, we want to explore properties that we call semiotic, i.e., which concern the interpretation of the communicated representation by a human user. This goal should require an analysis of the extra-semantic rules that govern the choice of subsets of models.

Anticipated applications are in transformation system engineering (in which the information system is seen as a transformation flow) and semantic web infrastructure.

3. Scientific Foundations

3.1. Knowledge representation semantics

After years of empirical development, the domain of "knowledge representation" has been rationalized. In the past 15 years, the semantics of knowledge representation languages (description logics [24], conceptual graphs and object-based languages) has been investigated. It is usually defined within model theory initially developed for logics.

We consider a language L as a set of syntactically defined expressions (often inductively defined by applying constructors over other expressions). A representation (r) is a set of such expressions. An interpretation function (I) is inductively defined over the structure of the language to a set called interpretation domain (D). This expresses the construction of the "meaning" of an expression in function of its components. A formula is satisfied by an interpretation if it fulfills a condition (in general being interpreted over a particular subset of the domain). A model of a set of expressions is an interpretation satisfying all these interpretations. An expression (δ) is then a consequence of a set of expressions (r) if it is satisfied by all of its models (noted $r \models \delta$).

A computer must determine if a particular expression (taken as a query, for instance) is the consequence of a set of axioms (a knowledge base). For that purpose, it uses programs, called provers, that can be based on the processing of a set of inference rules, on the construction of models or on more classical programming. These programs are able to deduce theorems (noted $r \vdash \delta$). They are said to be sound if they only find theorems which are indeed consequences and to be complete if they find all the consequences as theorems. However, depending on the language and its semantics, the decidability (i.e., the ability to create sound and complete provers) is not warranted. And even for decidable languages, the algorithmic complexity of provers can prohibit their exploitation.

To solve this problem a trade-off between the expressivity of the language and the complexity of its provers has to be found. These considerations have led to the definition of languages with limited complexity - like conceptual graphs and object-based representations - or of modular families of languages with associated modular prover algorithms - like description logics.

Exmo mainly considers languages with well-defined semantics, and defines the semantics of some languages such as multimedia specification languages, in order to establish the properties of computer manipulations of the representations.

3.2. Transformations and properties

A transformation (τ) is an algorithmic manner to generate a representation ($\tau(r)$) from another one (r), not necessarily in the same language. We will focus on transformations made by composition of more elementary transformations for which we only know the input, output and assumed properties.

A transformation system is characterized by a set of elementary transformations and a set of composition operators. A transformation flow is the composition of elementary transformation instances whose input/output are connected by channels. A transformation flow is itself a transformation. More precisely, our work concerns syntactic transformations of XML ("eXtensible Markup Language") structures encoding knowledge representation languages. We take advantage of the XSLT transformation language ("XML Style Language Transformations" [25]) recommended by W3C, for which we put forward a compound transformation language (see §5.1).

The design of information systems as transformation flows requires the ability to express such flows and to determine their properties. A property is a boolean predicate about the transformation (e.g., "preserving information" is such a predicate - it is true or false of a transformation - and is satisfied if there exists an algorithmic means to recover r from $\tau(r)$).

We consider more closely preservation properties that can allow the preservation (or anti-preservation) of an order relation between the source representations and the target representations. For instance, one can identify:

- Syntactic properties: based on the organization of syntactic elements, like the completion ($\tau(r) \leq r$, in which $\leq$ denotes structural subsumption between representations);
- Semantic properties: based on model and consequence concepts, like consequence preservation ($\forall r \subseteq L, \forall \delta \in L, r \models_L \delta \rightarrow \tau(r) \models_{L'} \tau(\delta)$);
- Semiotic properties: based on the interpretation as signs of the manipulated objects, like interpretation preservation (let σ be the interpretation rules and $\models_{L,i}$ be the interpretation of individual i, $\forall r \subseteq L, \forall \delta \in L, \forall i, j, r, \sigma \models_{L,i} \delta \rightarrow \tau(r), \tau(\sigma) \models_{L',j} \tau(\delta)$).

Our goal is to study transformations based on transformation properties rather than on representations or transformation structures. It does not deal only with semantics but considers various properties (e.g., content or structure preservation, traceability, and confidentiality). However, we more specifically address semantic properties. We also consider properties of transformation systems (given a transformation system, is information preservation decidable and at what cost?). We try to characterize, given a particular type of property, which transformations leave them invariant and what is the action of composition operators.

4. Application Domains

Two application contexts motivate and spur our work: transformation system engineering (§4.1) and the "semantic web" infrastructure (§4.2)

4.1. Transformation system engineering

Computerization and networking lead organizations to exchange information in machine-readable form. E-commerce generates a continuous flow of such documents. As the transmitted information is neither addressed nor adapted to all the members of the organization, it is necessary to transform document structure and content. Similarly, web sites are generated from databases or primary funds and e-commerce documents are applied various transformations before goods are shipped. Additionally, the Object Management Group Model-Driven Architecture (MDA) considers the future of software development as a composition of transformations from (platform independent) domain models in function of platform description models. This is considering any implementation as adaptation.

Interoperability requirements have led to the definition of the structured document representation language XML which helps handling the syntax of documents straightforwardly. Other languages such as XSLT or Omnimark, enable the implementation of standalone transformations.

However, this view of transformations is only partial and local. It seems unavoidable that, in the future, we will have to deal with complex transformation flows automating the combination of transformations some of which coming from external sources. This will require the global understanding of the behavior of the flow of transformations. This calls for real "transformation system engineering" which should address the following issues:

- the lack of global consideration of transformations: they are processed in relation with other transformations;
- the need to consider the properties of transformations and especially their semantic properties: this will require the semantic analysis of the transformations;
- the design of transformation flows from external resources (as it is in software engineering): this will require the ability to consider the properties of imported transformations.

Transformation system engineering will require tools, methodologies and formal methods. As a matter of fact, it will be necessary to check that a particular transformation system does not export sensitive information or that the transformation process terminates. For that purpose, the transformation flow must be expressed in a parsable way and the expected properties of the flow must be expressed (see §3.2). *Exmo* is concerned by tools and formal methods and aims at combining them in solutions for transformation flow design environments (see §5.1).

4.2. Semantic web technologies

Web technologies support access and sharing of knowledge, often difficult to access in a documentary form, in the organizations. 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. Content representation will enable computers to manipulate knowledge on a more formal ground and to carry out similarity or generality search... Knowledge representation formalisms are good candidates for expressing the content.

The vision of a "semantic web" [26] supplies the web, as we know it (informal) with annotations expressed in a machine-processible 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. *Exmo* concerns are thus central to the semantic web implementation.

Our work aims at enhancing content understanding. This concerns the intelligibility of communicated knowledge and formal knowledge transformations. 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 a standard knowledge representation language emerges, it will still be necessary to import and exchange ontologies in such a way that the semantics of their representation language is taken care of. We work on finding the correspondences between various knowledge representation languages and ontologies (see §6.2) in order to take advantage of them in ontology merging and bridging or message translation. Bringing solutions to this problem is part of the ambition of *Exmo*.

5. Software

Exmo's work can be used in software. We have proposed an API for expressing ontology alignment. We have designed and developed a system for expressing and processing relatively complex transformation flows.

5.1. Alignment API : manipulating ontology alignments

Participants: Euzenat Jérôme [Correspondent], Pierson Jérôme.

We have designed a format for expressing alignments in a uniform way [15]. The goal of this format is to be able to share on the web the available alignments. It should help systems using alignments (e.g., mergers, translators) to take advantage of any alignment algorithm and it will help alignment algorithms to be used in many different tasks. This format is expressed in RDF, so it is freely extensible, and has been defined by a DTD (for RDF/XML), an OWL ontology and an RDF Schema. Aligned entities are identified by their URIs.

The API itself is a *Java* description of tools for accessing the common format. It defines four main interfaces (Alignment, Cell, Relation and Evaluator) and proposes the following services:

- Storing, finding, and sharing alignments;
- Piping alignment algorithms (improving an existing alignment);
- Manipulating (thresholding and hardening);
- Generating processing output (transformations, axioms, rules);
- Comparing alignments.

The API can be used for producing transformations, rules or bridge axioms independently from the algorithm which produced the alignment. The proposed API implementation is based on the OWL-API and offers floating point measures between 0 and 1. It features:

- a base implementation of the interfaces with all useful facilities;
- a library of sample aligners;

- a library of renderers (XSLT, SWRL, OWL, C-OWL);
- a couple of evaluators (Precision/Recall and weighted Hamming distance);
- a parser for the format.

To instanciate the API, it is thus sufficient to refine the base implementation by implementing the `align()` method. Doing so, the new implementation will benefit from all the services already implemented in the base implementation.

The *Alignment API* has been used for the processing of the EON Ontology Alignment Contest. It is used in the people's portal alignment tool at DERI Innsbruck and used or output by a number of alignment tools (among which OLA that we develop jointly with the University of Montréal).

The *Alignment API* is freely available since december 2003 under the LGPL licence at http://co4.inrialpes.fr/align

5.2. Transmorpher : expression and processing of XML transformation flows

Participant: Euzenat Jérôme [Correspondent].

In order to prove or check the properties of transformations, it is necessary to have a representation of these transformations. The XSLT language enables the expression of a transformation in XML but is relatively difficult to analyse. In order to overcome this problem, we have designed and developed in collaboration with the *Fluxmedia* company, the *Transmorpher* environment. *Transmorpher* is a layer on top of XSLT allowing the expression of complex transformation flows.

Transmorpher enables the definition and processing of generic transformations of XML documents. It aims at providing XSLT extensions in order to:

- Describe straightforwardly simple transformations (e.g., removing elements, replacing attribute names, merging documents, applying regular expression substitution);
- Composing transformations by connecting their (multiple) input and output;
- Applying transformations until closure;
- Calling external transformation engines.

Transmorpher describes the transformation flows in XML. Input/output channels carry the information, mainly XML, from one transformation to another. Transformations can be other transformation flows or elementary transformations. *Transmorpher* provides a set of abstract elementary transformations (including their execution model) and one default instantiation. Such elementary transformations include external call (e.g. XSLT), dispatcher, serializer, query engine, iterator, merger, generator and rule sets.

Rule sets describe transformations in a language simpler than XSLT. It is currently processed by transformation to XSLT (extended by regular expression substitution).

Transmorpher provides a set of documented *Java* classes (which can be refined or integrated into another software) and a transformation flow processing engine. A transformation flow can be described by programming in *Java* or providing an XML description. *Transmorpher* has been registered by the "Agence de Protection des Programmes" (APP) under the IDDN.FR.001.430009.000.R.P.2003.000.30620. It is freely available, under the GPL licence, since June 2001 at http://transmorpher.inrialpes.fr. It works correctly but is still subject to improvements.

An extension of *Transmorpher* towards safer transformations consists in attaching assertions to the transformations in a transformation flow in order to tell if a property is assumed, proved or to be checked. This will allow experiments on proving properties of compound transformations.

6. New Results

The results in 2004 are very narrowly focussed around ontology alignment (§6.3 and 6.4). Other trends of research such as semantic adaptation of multimedia documents (§6.1) and graph-based knowledge representation languages (§6.2) have also been active.

6.1. Semantic adaptation of multimedia documents

Participants: Laborie Sébastien [Correspondent], Euzenat Jérôme, Layaïda Nabil [WAM team].

When a multimedia document is executed on platforms with limited resources (e.g., a mobile phone that can only display one image at once or an interactive display without keyboard), it is necessary to adapt the document to the target device. We want to describe properties that must be preserved by that adaptation. For that purpose, we use the semantic approach [3], which considers a model of a multimedia document as one of its potential execution (an execution satisfying its specification). We define classes of models (e.g., considering that all models with the same scheduling are the same). In a first approximation, adaptation reduces the set of models of a specification by selecting those satisfying the adaptation constraints.

This approach has been applied to the temporal and spatial dimensions based on Allen and RCC algebras respectively. But this year we have applied our framework to the temporal and spatial dimensions of the SMIL 2.0 language.

A SMIL document cannot be directly adapted so we introduced bijective translations from SMIL to Allen and RCC algebra. The adaptation can then take place within the algebra. However, after adaptation, the converse transformation does not necessarily yield a coherent document. So we produced a retrofitting procedure that we have proved to yield a coherent document and preserving the neutrality and minimality requirements that characterize the adaptation [23].

Moreover, we found that the generic distance we used in our initial proposal was not necessarily the best for all situations of transgressive adaptation. We have thus provided a case analysis of SMIL objects which finds the best distance in all cases.

6.2. Algorithms for graph-based knowledge representation languages

Participant: Baget Jean-François [Correspondent].

Our work on graph-based knowledge representation languages, such as conceptual graphs and RDF, has led to identify similarities, not only between the algorithms used to compute logical consequence (different kinds of graph homomorphisms), but also in the way their semantics are expressed. In order to identify the logics that can benefit from this property, we obtained the following results:

- For any logic, the logical consequence relation is a preorder;
- For any preorder R, we can build a logic L whose logical consequence relation is R, and where the interpretations are formulas of the language (we call such a logic a self-interpreted logic).
- Any preorder on a countable set of objects is a suborder of graph homomorphism.

So assuming that we can effectively map the preorder R into graph homomorphism (this is not possible in the general case, the existence result in the third item being non constructive), we can automatically obtain a sound and complete algorithm (as in [10]), based upon graph homomorphism, for the logical consequence relation of any logic (or more precisely of the equivalent self-interpreted logic).

Our first goal has been to find restrictions on the logics studied such that the third result can be proven in a constructive way. This is the case, for instance, when deciding whether or not an interpretation is a model for a formula belongs to NP (because the existing sequence of problem reductions provides the homomorphism).

It is now possible to develop a meta-language for describing such a self-interpreted logic (and only these logics). This language will be used to describe the syntax and semantics for any such logics. It will then be possible to automatically generate an algorithm that is sound and complete w.r.t. logical consequence. Two related works are the optimization of the generated algorithm, and the search of a wider class of logics that can benefit from this framework (mainly using graph homomorphism-based rules [11]).

This work has interesting consequences w.r.t. *Exmo* objectives. Let us suppose two ontologies O and O' in logics expressed in our meta-language and a set of equivalences (the result of an alignment) between terms of O and O'. A merge of O and O' is an ontology O'' that contains both formulas of O and O', that preserves logical consequence in O and O', and where equivalent terms in O and O' are interpreted as the same object in each model. If we can generate this logic, and if the obtained O'' is self-interpreted, then we can generate the logical consequence algorithm for O''. We have developed a set of transformations ensuring that the obtained logic is self-interpreted, but two questions remain: 1) are these transformations sufficient to handle all cases, and 2) can we automatically compose these transformations to obtain O'' ?

6.3. Ontology alignment: framework, surveying and benchmarking

Participants: Euzenat Jérôme [Correspondent], Pierson Jérôme, Zimmermann Antoine.

Semantic interoperability can be grounded in ontology reconciliation. Integrating heterogeneous resources of the web requires finding agreement between the underlying ontologies. The underlying problem, which we call 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, etc.), find the relationships (e.g., equivalence or subsumption) that hold between these entities. 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.

In the context of the Knowledge web network of excellence, we are developing activities for structuring the research on ontology alignment at the European level. This has led to numerous activities and results:

- The definition of a general framework [19] characterizing the alignment process and the semantics of its output,
- A survey of existing alignment techniques and systems [20],
- The design and organization of an Ontology alignment contest for assessing the degree of achievement of actual ontology alignment algorithms [16] [17] [5].

These activities have helped shaping the European research community on the topics of ontology alignment and matching. Some of them have benefited from the development of the *Alignment API* (see §5.1) [15] which provides a common ground for implementing and comparing alignment algorithms.

6.4. Similarity for ontology alignment

Participant: Euzenat Jérôme [Correspondent].

In order to be able to align ontologies written in OWL-Lite, we developed an algorithm (OLA), adapted from a method for measuring object-based similarity [13]. OLA relies on a universal measure for comparing the entities of two ontologies that combines in a homogeneous way all the knowledge used in entity descriptions: it deals successfully with external data types, internal structure of classes as given by their properties and constraints, external structure of classes as given by their relationships to other classes and the availability of individuals. This is an improvement over other methods that usually take advantage of only a subpart of the language features.

The proposed method does not only compose linearly individual methods for assessing the similarity between entities, it uses an integrated similarity definition that makes them interact.

One-to-many relationships and circularity in entity descriptions constitute the key difficulties in this context: These are respectively dealt with through local matching of entity sets and iterative computation of recursively dependent similarities which produces subsequent approximations of the target solution.

The algorithms has now been fully implemented as an instanciation of the *Alignment API* and tested in the Ontology Alignment Contest (see §6.3). This has led to a number of original developments (instantiation of the aggregation function to missing features or term-based comparison of labels [14]).

This work is developed in collaboration with the University of Montréal.

7. Contracts and Grants with Industry

7.1. France Telecom R&D

Participants: Pierson Jérôme, Euzenat Jérôme.

The work of Jérôme Pierson is developed in collaboration with the Centre Norbert Segard of France Telecom R&D. Jérôme Pierson's thesis is jointly supervised by Fano Ramparany and Jérôme Euzenat in the framework of a CIFRE contract. The topic of this thesis is to investigate the notion of context in ambiant computing and the ability to match ontologies when shifting context.

7.2. INA

Participants: Troncy Raphaël, Euzenat Jérôme.

The work of Raphaël Troncy has been developed in close cooperation with the research and experimentation department of the National Institute for Audiovisual (Institut National de l'Audiovisuel, INA). Raphaël Troncy's thesis [6] has been jointly supervised by Bruno Bachimont and Jérôme Euzenat in the framework of a CIFRE contract.

8. Other Grants and Activities

8.1. European initiatives

8.1.1. Knowledge web network of excellence: realising the semantic web

Participants: Euzenat Jérôme [correspondant], Baget Jean-François, Zimmermann Antoine.

Exmo, as part of INRIA is a founding and active member of the Knowledge web Network of Excellence. The INRIA node comprises the *Acacia*, *Exmo* and *Orpailleur* teams. *Exmo* is in charge of the work package 2.2 on "Heterogeneity". Jérôme Euzenat is vice-scientific director of Knowledge web and represents INRIA in the executive management board.

More information on *Knowledge web* can be found at http://knowledgeweb.semanticweb.org.

8.1.2. Collaboration with University of Trento

Participant: Euzenat Jérôme [correspondant].

In the context of the T-Rex programme of Knowledge web, Pavel Shvaiko of the university of Trento visited *Exmo* during the month of October. We worked with Pavel on characterizing alignment algorithms and considering C-OWL as an output language for the *Alignment API*. We also have close cooperation with other members of the University of Trento through the Knowledge web network of excellence.

8.2. International Initiatives

8.2.1. W3C WebOnt Working group

Participants: Euzenat Jérôme [correspondant], Baget Jean-François.

Jean-François Baget and Jérôme Euzenat have been the INRIA representatives to the Web Ontology working group (for short WebOnt).

WebOnt has designed the OWL language: a description logics based language (in the continuity of DAML+OIL), built on top of the other language designed in W3C semantic web activity: RDF. OWL is now a recommendation of W3C. We have more specifically worked on the OWL/XML presentation language and its translation to the OWL/RDF interchange format.

More information on WebOnt can be found at http://www.w3.org/2001/sw/WebOnt/. We have provided a number of presentations of this language [9] [12] [8].

8.2.2. W3C Data Access Working group

Participant: Baget Jean-François [correspondant].

The Data Access Working Group is one of the two new working groups (along with the Best practice group) that form the "Semantic Web Activity" of the World Wide Web Consortium (W3C). It is chartered to develop a query language (named SPARQL) and protocol for querying RDF and OWL data. Jean-François Baget represents INRIA in this working group.

More information on RDFDAG can be found at http://www.w3.org/2001/sw/DataAccess/.

8.2.3. Collaboration with University of Montréal

Participant: Euzenat Jérôme [correspondant].

Exmo collaborates with the team of Petko Valtchev (David Loup, Mohamed Touzani) at the university of Montréal (DIRO) on the topic of "Ontology alignment" (see §6.4).

9. Dissemination

9.1. Leadership within scientific community

- Jérôme Euzenat is elected member of the board of the French artificial intelligence society (AFIA).
- Jérôme Euzenat is founding member of the "Semantic web science association" (steering committee for the ISWC conference series), member of the steering committee of the LMO conference series and member of the steering committee for the RFIA 2004 conference.
- Jérôme Euzenat is vice-scientific director and coordinator of "Heterogeneity" work package of the Knowledge web network of excellence (see §8.1) (2001-2004).

9.2. Editorial boards, conference and workshop committees

- Jérôme Euzenat has been the program chair of the "Langages et modèles à objets (LMO)" conference (Lille), March 15-17th, 2004.
- Editorial board of the journal "L'objet", "Journal électronique d'intelligence artificielle (JEDAI)", "Journal of Web Semantics" and "Journal of Data Semantics" (Jérôme Euzenat).
- Program committee for the 2004 issues of the conferences "European Conference on Artificial Intelligence (ECAI)", "International Semantic Web Conference (ISWC)", "World-wide web conference (WWW)", "ACM Conf. on Formal Ontologies in Information Systems (FOIS)", "European Semantic Web Symposium (ESWS)", "International Conference on Knowledge Engineering and Management (EKAW)", "Langages et modèles à objets (LMO)", "Ingénierie des connaissances (IC)", and "ODBase" (Jérôme Euzenat)
- Program committee member of the 2^{nd} "International Workshop on Regulatory Ontologies" (Jérôme Euzenat).

9.3. Conferences, meetings and tutorial organization

- Organizer of the Ontology Alignment Contest at the EON workshop at ISWC 2004, Hiroshima (JP), november 2004. 40 people (Jérôme Euzenat).
- Organizer for the workshop on "Semantic intelligent middleware for the web and the grid" at ECAI 2004, Valencia (SP), (Jérôme Euzenat).

9.4. Invited conferences and other talks

- Web sémantique et partage de connaissance: journées de l'Internet (panel), Autrans (FR), January, 9th (Jérôme Euzenat)
- Heterogeneity Knowledge web work package: Knowledge web kick off meeting, Madrid (SP), February 3rd and SDK cluster meeting, Karlsruhe (DE), April 6th (Jérôme Euzenat)
- Échanges de connaissance structurée médiatisés par ordinateur, Présentation France Telecom R&D, Meylan (FR), March 11th (Jérôme Euzenat)
- Chouette alors! Un langage d'ontologies pour le web: conférence invité "ingénierie des connaissances", Lyon (FR), May 7th (Jérôme Euzenat)
- Alignment: evaluation, benchmarking, challenges: Dagsthul seminar, Wadern (DE), September 23rd (Jérôme Euzenat)
- RDF(S) Querying: Knowledge web plenary meeting, Manchester (UK), September 28th (Jean-François Baget)
- RDF Semantics: a graph-based approach: Presentation for the Information Management Group, University of Manchester, Manchester (UK), September 29th (Jean-François Baget)
- Introduction to the EON Ontology Alignment Contest: EON workshop, Hiroshima (JP), November 8th (Jérôme Euzenat)
- Ontology alignment for the semantic web and agents: Seminar NII, Tokyo (JP), November 15th (Jérôme Euzenat)
- Adaptation sémantique de documents multimédia: Réunion du Groupe de travail "Documents multimédia", Grenoble (FR), December 10th (Sébastien Laborie)

9.5. Teaching

- Web sémantique et pratique documentaire: Séminaire "publier sur Internet", Aix-les-Bains (FR), September 28-29th (Jérôme Euzenat and Raphaël Troncy)
- Web, Connaissance, Sémantique: Lecture (24h), Master "Mathématiques et informatique" research option, "Intelligence, interaction, information" track, Université Joseph-Fourier-INP Grenoble (Jean-François Baget and Jérôme Euzenat)

9.6. Miscellaneous

- Development and maintainance of the web site (http://jedai.afia-france.org) for the Journal électronique d'intelligence artificielle (JEDAI).
- Jérôme Euzenat is redactor-in-chief (with Philippe Morignot) of the Bulletin de l'AFIA.
- Jérôme Euzenat has been evalutor for the Explorary workshop applications of the European Science Foundation.

10. Bibliography

Major publications by the team in recent years

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