



IN PARTNERSHIP WITH:
CNRS

**Institut polytechnique de
Grenoble**

**Université Pierre Mendès-France
(Grenoble)**

**Université Joseph Fourier
(Grenoble)**

Activity Report 2014

Project-Team EXMO

Computer mediated exchange of structured knowledge

IN COLLABORATION WITH: Laboratoire d'Informatique de Grenoble (LIG)

RESEARCH CENTER
Grenoble - Rhône-Alpes

THEME
**Data and Knowledge Representation
and Processing**

Table of contents

1. Members	1
2. Overall Objectives	1
3. Research Program	2
3.1. Knowledge representation semantics	2
3.2. Ontology matching and alignments	2
3.3. Data interlinking	3
4. Application Domains	3
5. New Software and Platforms	4
5.1. Alignment API	4
5.2. The OntoSim library	5
6. New Results	5
6.1. Highlights of the Year	5
6.2. Ontology matching and alignments	5
6.2.1. Evaluation	5
6.2.2. Algebras of alignment relations	5
6.3. Data interlinking	6
6.3.1. Interlinking cross-lingual RDF data sets	6
6.3.2. Interactive learning of interlinking patterns	6
6.3.3. An iterative import-by-query approach to data interlinking	6
6.3.4. Link key extraction	7
6.4. Dynamic aspects of networks of ontologies	7
6.4.1. Evolution of ontology networks and linked data	7
6.4.2. Cultural alignment repair	7
7. Partnerships and Cooperations	8
7.1. National Initiatives	8
7.1.1. ANR Datalift	8
7.1.2. ANR Lindicle	8
7.2. European Initiatives	8
7.3. International Research Visitors	9
8. Dissemination	9
8.1. Promoting Scientific Activities	9
8.1.1. Scientific events organisation	9
8.1.1.1. general chair, scientific chair	9
8.1.1.2. member of the organizing committee	9
8.1.2. Scientific events selection	10
8.1.2.1. member of the conference program committee	10
8.1.2.2. reviewer	10
8.1.3. Journal	10
8.1.3.1. member of the editorial board	10
8.1.3.2. reviewer	10
8.1.4. Seminars	10
8.2. Teaching - Supervision - Juries	11
8.2.1. Teaching	11
8.2.2. Supervision	11
8.2.3. Juries	11
8.3. Popularization	11
9. Bibliography	12

Project-Team EXMO

Keywords: Ontology Matching, Data Interlinking, Semantic Web, Knowledge Representation, Artificial Intelligence

Creation of the Project-Team: 2003 July 01.

1. Members

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2. Overall Objectives

2.1. General Objectives

The semantic web blends the communication capabilities of the web with knowledge representation. Expressing formalised knowledge on a computer is useful, not exclusively for the need of the computer, but for communication. The goal of EXMO is the development of theoretical, experimental and software tools for communicating formalised knowledge.

There is no reason why knowledge expressed on the web should be in a single format or by reference to a single vocabulary (or ontology). In order to interoperate, the representations have to be matched and transformed. We currently build on our experience of alignments as representing the relationships between ontologies. Such alignments may be used for generating knowledge transformations (or any other kind of mediators) used for interoperating or interlinking data. We focus on the design of an alignment infrastructure and on the investigation of alignment properties when they are used for reconciling ontologies or interlinking data.

On a longer term, we study how a semantic web made of interrelated ontologies and datasets evolves and structures itself depending on its use. In particular, we aim at understanding how it influences and is influenced by its use in interpersonal communication.

EXMO's work is naturally applied in all contexts in which ontologies are used for expressing knowledge that has to be communicated. It is more directly focussed on the infrastructure of the semantic web and the web of data.

3. Research Program

3.1. Knowledge representation semantics

We usually work with semantically defined knowledge representation languages (like description logics, conceptual graphs and object-based languages) [16]. Their semantics is usually defined within model theory initially developed for logics. The languages dedicated to the semantic web (RDF and OWL) follow that approach. RDF is a knowledge representation language dedicated to the description of resources; OWL is designed for expressing ontologies: it describes concepts and relations that can be used within RDF.

We consider a language L as a set of syntactically defined expressions (often inductively defined by applying constructors over other expressions). A representation ($o \subseteq L$) is a set of such expressions. It is also called an ontology. An interpretation function (I) is inductively defined over the structure of the language to a structure 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 expressions. An expression (δ) is then a consequence of a set of expressions (o) if it is satisfied by all of their models (noted $o \models \delta$).

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 procedural programming. These programs are able to deduce theorems (noted $o \vdash \delta$). 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. Even for decidable languages, the algorithmic complexity of provers may 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 (such as RDF and OWL that we contributed to define), and defines the semantics of some languages such as the SPARQL query language and alignment languages, in order to establish the properties of computer manipulations of the representations.

3.2. Ontology matching and alignments

When different representations are used, it is necessary to identify their correspondences. This task is called ontology matching and its result is an alignment [3]. It 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, if any, holding between these entities.

An alignment between two ontologies o and o' is a set of correspondences $\langle e, e', r \rangle$ such that:

- e and e' are the entities between which a relation is asserted by the correspondence, e.g., formulas, terms, classes, individuals;
- r is the relation asserted to hold between e and e' . This relation can be any relation applying to these entities, e.g., equivalence, subsumption.

In addition, a correspondence may support various types of metadata, in particular measures of the confidence in a correspondence.

Given the semantics of the two ontologies provided by their consequence relation, we define an interpretation of two aligned ontologies as a pair of interpretations $\langle m, m' \rangle$, one for each ontology. Such a pair of interpretations is a model of the aligned ontologies o and o' if and only if each respective interpretation is a model of the ontology and they satisfy all correspondences of the alignment.

This definition is extended to networks of ontologies: a collection of ontologies and associated alignments. A model of such an ontology network is a tuple of local models such that each alignment is valid for the models involved in the tuple. In such a system, alignments play the role of model filters which select the local models that are compatible with all alignments. So, given an ontology network, it is possible to interpret it.

However, given a set of ontologies, it is necessary to find the alignments between them and the semantics does not tell which ones they are. Ontology matching aims at finding these alignments. A variety of methods is used for this task. They perform pairwise comparisons of entities from each of the ontologies and select the most similar pairs. Most matching algorithms provide correspondences between named entities, more rarely between compound terms. The relationships are generally equivalence between these entities. Some systems are able to provide subsumption relations as well as other relations in the support language (like incompatibility or instantiation). Confidence measures are usually given a value between 0 and 1 and are used for expressing preferences between two correspondences.

3.3. Data interlinking

Links are important for the publication of RDF data on the web. We call data interlinking the process of generating links identifying same resource described in two data sets. Data interlinking parallels ontology matching: from two datasets (d and d') it generates a set of links (also called a linkset, L).

We have extended the notion of database keys in a way which is more adapted to the context of description logics and the openness of the semantic web [11]¹. Like alignments, link keys [3] are assertions across ontologies and are not part of a single ontology. We have introduced the notion of a link key which is a combination of such keys with alignments. More precisely, a link key is an expression $\langle K^{eq}, K^{in}, C \rangle$ such that:

- K^{eq} is a set of pairs of property expressions;
- K^{in} is a set of pairs of property expressions;
- C is a correspondence between classes.

Such a link key holds if and only if for any pair of resources belonging to the classes in correspondence such that the values of their property in K^{eq} are pairwise equal and the values of those in K^{in} pairwise intersect, the resources are the same.

As can be seen, link key validity is only relying on pairs of objects in two different data sets. We further qualify link keys as weak, plain and strong depending on them satisfying further constraints: a weak link key is only valid on pairs of individuals of different data sets, a plain link key has to apply in addition to pairs of individuals of the same data set as soon as one of them is identified with another individual of the other data set, a strong link key is a link key which is also a key for each data set, it can be thought of as a link key which is made of two keys.

Link keys can then be used for finding equal individuals across the two data sets and generating the corresponding owl:sameAs links.

4. Application Domains

4.1. Semantic web technologies

The main application context motivating our work is the “semantic web” infrastructure [18].

¹Time did not permit to input properly all publications in HAL v3. We understand well that these are thus not Inria publications. However, we put them as footnotes in case they may interest the reader. They are all directly available from our team web site.

Internet technologies support organisations and people in accessing and sharing knowledge, often difficult to access in a documentary form. However, these technologies quickly reach their limits: web site organisation is expensive and full-text search inefficient. Content-based information search is becoming a necessity. Content representation enables 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 content.

The vision of a “semantic web” [14] complements the web, with formal knowledge representation spanning across sites. Taking advantage of this semantic web requires the manipulation of various knowledge representation formats. EXMO concerns are thus central to the semantic web implementation. Our work aims at enhancing content understanding, including the intelligibility of communicated knowledge and formal knowledge transformations.

In addition, EXMO also considers more specific uses of semantic web technologies in wider context (typically in the smart city context, §7.2.1.1).

5. New Software and Platforms

5.1. Alignment API

Participants: Jérôme Euzenat [Correspondent], Jérôme David, Nicolas Guillouet, Armen Inants, Luz Maria Priego-Roche.

We have designed a format for expressing alignments in a uniform way [1]. The goal of this format is to share available alignments on the web. It should help systems using alignments, e.g., mediators, translators, to take advantage of any matching algorithm and it will help matching algorithms to be used in many different tasks. This format is expressed in RDF, so it is freely extensible.

The API itself [1] is a JAVA description of tools for accessing the common format. It defines five main interfaces (OntologyNetwork, Alignment, Cell, Relation and Evaluator).

We provide an implementation for this API which can be used for producing transformations, rules or bridge axioms independently from the algorithm which produced the alignment. The proposed implementation features:

- a base implementation of the interfaces with all useful facilities;
- a library of sample matchers;
- a library of renderers (XSLT, RDF, SKOS, SWRL, OWL, C-OWL, SPARQL);
- a library of evaluators (various generalisation of precision/recall, precision/recall graphs);
- a flexible test generation framework which allows for generating evaluation datasets;
- a library of wrappers for several ontology API;
- a parser for the format.

To instantiate the API, it is 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.

In 2014, the Alignment API integrated an implementation of link keys (§6.3.4) and transformations of these into SPARQL queries.

We have developed, on top of the Alignment API, an Alignment server that can be used by remote clients for matching ontologies and for storing and sharing alignments. It is developed as an extensible platform which allows to plug-in new interfaces. The Alignment server can be accessed through HTML, web service (SOAP and REST) and agent communication interfaces. It has been used this year in the Ready4SmartCities project (§7.2.1.1).

The Alignment API is used in the Ontology Alignment Evaluation Initiative data and result processing (§6.2.1). It is also used by more than 50 other teams worldwide.

The Alignment API is freely available since december 2003, under the LGPL licence, at <http://alignapi.gforge.inria.fr>.

5.2. The OntoSim library

Participants: Jérôme David [Correspondent], Jérôme Euzenat.

OntoSim is a library offering similarity and distance measures between ontology entities as well as between ontologies themselves. It materialises our work towards better ontology proximity measures.

There are many reasons for measuring a distance between ontologies. For example, in semantic social networks, when a peer looks for particular information, it could be more appropriate to send queries to peers having closer ontologies because it will be easier to translate them and it is more likely that such a peer has the information of interest. OntoSim provides a framework for designing various kinds of similarities. In particular, we distinguish similarities in the ontology space from those in the alignment space. The latter ones use available alignments in an ontology network while the former only rely on ontology data. OntoSim is provided with 4 entity measures which can be combined using various aggregation schemes (average linkage, Hausdorff, maximum weight coupling, etc.), 2 kinds of vector space measures (boolean and TFIDF), and 4 alignment space measures. It also features original comparison methods such as agreement/disagreement measures. In addition, the framework embeds external similarity libraries which can be combined to our own.

OntoSim is based on an ontology interface allowing for using ontology parsed with different APIs. It is written in JAVA and is available, under the LGPL licence, at <http://ontosim.gforge.inria.fr>.

6. New Results

6.1. Highlights of the Year

- Our work on link key extraction and evaluation (§6.3.4) has been published at ECAI 2014.
- Jérôme Euzenat has been elected fellow of the European Coordination Committee for Artificial Intelligence (ECCAI).

6.2. Ontology matching and alignments

We pursue our work on ontology matching and alignment support [8] [10] with contributions to evaluation and alignment semantics.

6.2.1. Evaluation

Participant: Jérôme Euzenat.

Since 2004, we run the Ontology Alignment Evaluation Initiative (OAEI) which organises evaluation campaigns for assessing the degree of achievement of actual ontology matching algorithms [2].

This year, we ran the OAEI 2014 evaluation campaign [15]. We used again our generator for generating new version of benchmarks. The Alignment API was used for manipulating alignments and evaluating results.

A novelty of this year was that data interlinking evaluation was using the SEALS platform and a new query-based evaluation track was created.

The participating systems and evaluation results were presented in the 9th Ontology Matching workshop, held in Riva de Garda, Italy. More information on OAEI can be found at <http://oaei.ontologymatching.org/>.

6.2.2. Algebras of alignment relations

Participants: Armen Inants [Correspondent], Jérôme Euzenat.

Qualitative calculus is the central concept in qualitative binary constraint satisfaction problems. All formalisms developed so far are homogeneous – they assume a single universe. We had previously shown the advantages of using a homogeneous qualitative calculus for expressing ontology alignment relations between concepts. We tackle the problem of combining two or more calculi over disjoint universes into a single calculus. The problem is important, because in the ontology matching domain we deal with various kinds of ontological entities: concepts, individuals, properties. We define a new formalism called a heterogeneous qualitative calculus, based on an algebraic construct called Schröder category. A Schröder category is to binary relations over heterogeneous universes what a relation algebra is to homogeneous ones. We establish the connection between homogeneous and heterogeneous qualitative calculi by defining two mutually inverse transition operators. We provide an algorithm for combining two homogeneous calculi with different universes into a single calculus.

This work has vocation to support developments of the Alignment API towards relation algebras. It is part of the PhD of Armen Inants.

6.3. Data interlinking

The web of data uses semantic web technologies to publish data on the web in such a way that they can be interpreted and connected together. It is thus important to be able to establish links between these data, both for the web of data and for the semantic web that it contributes to feed. We consider this problem from different perspectives.

6.3.1. Interlinking cross-lingual RDF data sets

Participants: Tatiana Lesnikova [Correspondent], Jérôme David, Jérôme Euzenat.

RDF data sets are being published with labels that may be expressed in different languages. Even systems based on graph structure, ultimately rely on anchors based on language fragments. In this context, data interlinking requires specific approaches in order to tackle cross-lingualism. We proposed a general framework for interlinking RDF data in different languages and implemented two approaches: one approach is based on machine translation, the other one is based taking advantage of multilingual references, such as BabelNet. We evaluated variation of these two settings on English (DBPedia) and Chinese (XLore) datasets. Both approaches demonstrated promising results [20]. We will conduct more experiments including other language pairs and larger corpus.

This work is part of the PhD of Tatiana Lesnikova developed in the LINDICLE project (§7.1.2).

6.3.2. Interactive learning of interlinking patterns

Participants: Zhengjie Fan [Correspondent], Jérôme Euzenat.

We proposed an interlinking method which, from class correspondences between data source ontologies, uses k -means or k -medoids clustering to produce property correspondences. It then generates a first interlinking pattern which is a combination of a link key and similarity measures. Such patterns can be transformed into a SILK script for generating an initial link set. A sample of these links are assessed by users as either correct or incorrect. These are taken as positive and negative example by an extension of the disjunctive version space method to find an interlinking pattern, that can justify correct links and incorrect links. Experiments show that, with only 1% of sample links, this method reaches a F-measure over 96%. The F-measure quickly converges, being improved by nearly 10% than other comparable approaches [19].

This work is part of the PhD of Zhengjie Fan [4], co-supervised with François Scharffe (LIRMM), and developed in the DATALIFT project (§7.1.1).

6.3.3. An iterative import-by-query approach to data interlinking

Participants: Manuel Atencia Arcas [Correspondent], Mustafa Al-Bakri, Steffen Lalande, Marie-Christine Rousset.

We modelled the problem of data interlinking as a reasoning problem on possibly decentralised data. We described an import-by-query algorithm that alternates steps of sub-query rewriting and of tailored querying of data sources. It only imports data as specific as possible for inferring or contradicting target sameAs assertions. Experiments conducted on a real-world dataset have demonstrated in practice the feasibility and usefulness of this approach for data interlinking and disambiguation purposes.

This work is part of the PhD thesis of Mustafa Al-Bakri, co-supervised by Manuel Atencia and Marie-Christine Rousset, developed in the QUALINCA project.

6.3.4. *Link key extraction*

Participants: Jérôme David [Correspondent], Manuel Atencia Arcas, Jérôme Euzenat.

Ontologies do not necessarily come with key descriptions, and never with link key assertions. Keys can be extracted from data by assuming that keys holding for specific data sets, may hold universally. We have extended such a classical key extraction technique for extracting weak link keys. We designed an algorithm to generate first a small set of candidate link keys and described this approach in the framework of formal context analysis [13]. Depending on whether some of the, valid or invalid, links are known, we defined supervised and non supervised measures for selecting the appropriate link keys. The supervised measures approximate precision and recall on a sample, while the non supervised measures are the ratio of pairs of entities a link key covers (coverage), and the ratio of entities from the same data set it identifies (discrimination). We have experimented these techniques, showing the accuracy and robustness of both approaches [12].

This work has been developed partly in the LINDICLE project (§7.1.2).

6.4. Dynamic aspects of networks of ontologies

Huge quantities of data described by ontologies and linked together are made available. These are generated in an independent manner by autonomous providers such as individuals or companies. They are heterogeneous and their joint exploitation requires connecting them, ending up as a mesh of reticulated knowledge.

However, data and knowledge have to evolve facing changes in what they represent, changes in the context in which they are used and connections to new data and knowledge sources. As their production and exchange are growing larger and more connected, their evolution is not anymore compatible with manual curation and maintenance. We work towards their continuous evolution as it is critical to their sustainability.

Two different approaches are currently explored.

6.4.1. *Evolution of ontology networks and linked data*

Participants: Adam Sanchez Ayte [Correspondent], Jérôme David, Jérôme Euzenat.

As link keys are obtained by statistical analysis of datasets (§6.3.4), they are both data-dependent and computation-intensive. Therefore, their recalculation should be avoided if possible. We are developing methods to analyse if changes performed in the data, necessarily require link key recomputation.

To reach this goal, we are developing an approach considering datasets as logical theories. In this context, changes that affect a link key are meta-logical operations. We adopt the framework of belief revision to define postulates that evolution operators must satisfy.

This work is part of the PhD thesis of Adam Sanchez Ayte developed in the LINDICLE project (§7.1.2).

6.4.2. *Cultural alignment repair*

Participant: Jérôme Euzenat [Correspondent].

Alignments between ontologies may be established through agents holding such ontologies attempting at communicating and taking appropriate action when communication fails. This approach, that we call cultural repair, has the advantage of not assuming that everything should be set correctly before trying to communicate and of being able to overcome failures. We tested this approach on alignment repair, i.e., the improvement of incorrect alignments. For that purpose, we performed a series of experiments in which agents react to mistakes in alignments. Agents only know about their ontologies and alignments with others and they act in a fully decentralised way. We showed that cultural repair is able to converge towards successful communication through improving the objective correctness of alignments. The obtained results are on par with a baseline of state-of-the-art alignment repair algorithms [7] [17]

The benchmarks, results and software are available at <http://lazylav.gforge.inria.fr>.

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Datalift

Program: ANR-ContInt

Project acronym: Datalift

Project title: DATALIFT

Instrument: platform

Duration: September 2010 - March 2014

Coordinator: Inria EXMO/François Scharffe

Participants: Jérôme Euzenat, Zhengjie Fan, Jérôme David

See also: <http://www.datalift.org>

Abstract: EXMO coordinates with LIRMM the DATALIFT project whose goal is to produce a platform for publishing governmental data as linked data. EXMO is particularly involved in the generation of links between datasets (see §6.3).

7.1.2. ANR Lindicle

Program: ANR-Blanc international 2

Project acronym: LINDICLE

Project title: Linking data in cross-lingual environment

Duration: January 2013 - December 2016

Coordinator: Inria EXMO/Jérôme David

Participants: Jérôme Euzenat, Manuel Atencia Arcas, Jérôme David, Tatiana Lesnikova, Adam Sanchez Ayte

Other partners: Tsinghua university (CN)

See also: <http://lindicle.inrialpes.fr>

Abstract: The LINDICLE project investigates multilingual data interlinking between French, English and Chinese data sources (see §6.3).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. Ready4SmartCities

Type: CAPACITIES

Defi: ICT-2013.6.4 - Optimising Energy Systems in Smart Cities

Instrument: Coordination and Support Action

Project acronym: Ready4SmartCities

Project title: ICT Roadmap and Data Interoperability for Energy Systems in Smart Cities

Objectif: Optimising Energy Systems in Smart Cities

Duration: October 2013 - September 2015

Coordinator: D'appolonia Spa (Italy)

Other partners: D'appolonia (Italy) Universidad Politecnica de Madrid (Spain) CSTB (France), CERTH (Grèce), VTT (Finland), AIT (Austria), AEC3 (UK), Politecnico di Torino (Italy), Empirica (Germany)

Inria contact: Jérôme Euzenat

Participants: Jérôme Euzenat, Luz Maria Priego-Roche, Jérôme David, Adam Sanchez Ayte

See also: <http://www.ready4smartcities.eu>

Abstract: The Ready4SmartCities project aims at increasing awareness and interoperability for the adoption of OCT and semantic technologies in energy system to obtain a reduction of energy consumption and CO₂ emission at smart cities community level through innovative relying on RTF and innovation outcomes and ICT-based solutions.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

- Giuseppe Pirrò (Free University of Bozen-Bolzano) visited EXMO in February 2014 working on web query languages.
- Juanzi Li and Zhigang Wang (Tsinghua university) visited EXMO in October 2014, working on multilingual data interlinking.
- Kate Revoredo and Frenanda Baião (Federal University of the State of Rio de Janeiro) visited EXMO in October, 2014, working on learning alignments.

8. Dissemination

8.1. Promoting Scientific Activities

8.1.1. Scientific events organisation

8.1.1.1. general chair, scientific chair

- Jérôme Euzenat was organiser of the Ontology matching workshop of the 13th ISWC, Riva del Garda (IT), 2014 (with Pavel Shvaiko, Ming Mao, Ernesto Jiménez-Ruiz, Juanzi Li and Axel Cyrille Ngonga-Ngomo),
- Jérôme Euzenat was co-chair with Maria Keet of the “ontologies” area of the programme committee of the “European Semantic Web Conference (ESWC)”, 2014

8.1.1.2. member of the organizing committee

- Jérôme Euzenat is founding member of the “Semantic Web Science Association” (steering committee for the ISWC conference series).
- Jérôme David has been member of the organisation committee of the “Web of data summer school”, Saint-Étienne (FR).

8.1.2. Scientific events selection

8.1.2.1. member of the conference program committee

- Manuel Atencia and Jérôme Euzenat were programme committee members of the 21st “European conference on artificial intelligence (ECAI)” 2014.
- Jérôme Euzenat was programme committee member of the “International conference on Knowledge Representation and Reasoning (KR)” 2014.
- Manuel Atencia and Jérôme Euzenat were programme committee members of the 13th “International semantic web conference (ISWC)” 2014.
- Jérôme Euzenat was programme committee member of the “International Conference on Formal Ontologies for Information Systems (FOIS)” 2014.
- Jérôme Euzenat was programme committee member of the “International Conference on Conceptual Structures (ICES)” 2014.
- Jérôme Euzenat was programme committee member of the conference «Reconnaissance des Formes et Intelligence Artificielle (RFIA)» 2014.
- Manuel Atencia, Jérôme David and Jérôme Euzenat were programme committee members of the “knowledge engineering (ingénierie des connaissances)” conference 2014.
- Jérôme Euzenat was programme committee member of the conference “French fundamental artificial intelligence days” (JIAF) 2014.
- Jérôme David and Tatiana Lesnikova have been programme committee members of the 9th “Ontology matching workshop (OM)”, 2014.
- Jérôme David has been programme committee member of the IC workshop “Des sources ouvertes au web des données (SoWeDo)”, 2014.

8.1.2.2. reviewer

- Manuel Atencia has been reviewer for the 17th “International Conference on Database Theory” (ICDT) 2014.
- Jérôme David has been reviewer for the 21st “European conference on artificial intelligence (ECAI)” 2014.
- Jérôme David has been reviewer for the 11th “European Semantic Web Conference (ESWC)”, 2014.
- Jérôme David has been reviewer for the 21st International Conference on Conceptual Structures (ICES), 2014.

8.1.3. Journal

8.1.3.1. member of the editorial board

- Jérôme Euzenat is editorial board member of *Journal of Web Semantics*, *Journal on Data Semantics* and *Semantic web journal*.

8.1.3.2. reviewer

- Jérôme Euzenat has been reviewer for the Journal of Artificial Intelligence Research.
- Jérôme Euzenat has been reviewer for the Semantic web journal.
- Jérôme Euzenat has been reviewer for the Journal of the Association for Information Science and Technology.

8.1.4. Seminars

- Seminar on “Data integration with ontologies through alignments”, Semanco VoCamp, Barcelona (ES), 13/02/2014 (Jérôme Euzenat).
- Invited talk on “Foundations for revising networks of ontologies”, WoDOOM workshop, Hersounis-sos (GR), 26/05/2014 (Jérôme Euzenat).

- Invited talk on “Raisonnement avec des réseaux d’ontologies”, Journées d’intelligence artificielle fondamentale, Angers (FR), 12/06/2014 (Jérôme Euzenat).
- Invited talk on “Représenter, communiquer, échouer”, Journée ARIA de promotion de l’intelligence artificielle, Paris (FR), 2/10/2014 (Jérôme Euzenat).

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

- Licence: Jérôme David, Inff3 Algorithmique et programmation par objets, 70, L2 MASS, UPMF, France
- Licence: Manuel Atencia, Introduction aux technologies du Web, L3 MASS, UPMF, France
- Master: Jérôme David, Documents XML, 30, M1, UPMF, France
- Master: Manuel Atencia, Langages et technologies du Web 1, M1 IC2A, UPMF, France
- Master: Manuel Atencia, Langages et technologies du Web 2, M1 IC2A, UPMF, France
- Master: Jérôme David, Développement Web Mobile, 30, M2, UPMF, France
- Master: Manuel Atencia, Web Sémantique, M2 IC2A, UPMF, France
- Master: Jérôme Euzenat, Semantic web: from XML to OWL, 22heqTD, M2R, Université Joseph Fourier & INPG, France
- Post-graduate level: Jérôme Euzenat and Pavel Shvaiko, Ontology matching, 3h, Tutorial ISWC, Riva del Garda, Italy

8.2.2. Supervision

- PhD: Zhengjie Fan, Concise Pattern Learning for RDF Data Sets Interlinking, Université de Grenoble, 4/4/2014, supervisors: Jérôme Euzenat and François Scharffe
- PhD in progress: Tatiana Lesnikova, Multilingual data interlinking, 1/10/2012, supervisors: Jérôme Euzenat and Jérôme David
- PhD in progress: Armen Inants, Ontology alignment algebra, 1/12/2012, supervisor: Jérôme Euzenat
- PhD in progress: Adam Sanchez Ayte, Ontology alignment and data interlinking evolution on the web of data, 1/12/2013, supervisor: Jérôme Euzenat and Jérôme David

8.2.3. Juries

- Jérôme Euzenat has reviewed the PhD dissertation of Sébastien Harispe, Knowledge-based semantic measures: from theory to application, Université de Montpellier 2, 25/04/2014, supervisors: Jacky Montmain and Sylvie Ranwez
- Jérôme Euzenat was member of the HDR committee of Fabian Suchanek, Contribution à l’avancement des grandes bases de connaissances, Université Pierre et Marie Curie, 10/09/2014
- Jérôme Euzenat chaired the PhD committee of Mustafa Al-Bakri, Uncertainty-sensitive reasoning over the web of data, Université de Grenoble, 15/12/2014, supervisors: Marie-Christine Rousset and Manuel Atencia

8.3. Popularization

- Jérôme Euzenat gave a talk to the Canopé network conference cycle on “Communication et adaptation: la fabrique de la communication flexible (communication and adaptation: the making of flexible communication), CROP, Grenoble (FR), 2/04/2014.
- Jérôme Euzenat gave a talk to the 7es journées de l’interopérabilité des applications d’entreprise (JIAE) on “Aligner les ontologies pour communiquer (matching ontologies to communicate)”, Saint-Étienne (FR), 16/05/2014.

- Jérôme David participates to the working group “Créer et maintenir une interconnexion sémantique des grands référentiels culturels: le "Graphe Culture"” of the ministry of Culture. <http://cblog.culture.fr/projet/2013/11/07/groupe-de-travail-metadonnees-culturelles/>

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- [4] Z. FAN. *Concise Pattern Learning for RDF Data Sets Interlinking*, Université de Grenoble, April 2014, <https://tel.archives-ouvertes.fr/tel-00986104>

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- [5] F. ALKHATEEB, J. EUZENAT. *Constrained regular expressions for answering RDF-path queries modulo RDFS*, in "International Journal of web information systems", 2014, vol. 10, n^o 1, pp. 24-50, alkhateeb2014a [DOI : 10.1108/IJWIS-05-2013-0013], <https://hal.inria.fr/hal-00975283>
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- [7] J. EUZENAT. *First experiments in cultural alignment repair*, in "Proc. 3rd ESWC workshop on Debugging ontologies and ontology mappings (WoDOOM)", Hersounisos, Greece, No commercial editor., May 2014, pp. 3-14, euzenat2014b, <https://hal.inria.fr/hal-01006344>

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