



IN PARTNERSHIP WITH:  
**CNRS**

**INRA**

**Université des sciences et  
techniques du Languedoc  
(Montpellier 2)**

# Activity Report 2014

## **Project-Team GRAPHIK**

### GRAPHS for Inferences and Knowledge representation

IN COLLABORATION WITH: Laboratoire d'informatique, de robotique et de microélectronique de Montpellier (LIRMM)

RESEARCH CENTER  
**Sophia Antipolis - Méditerranée**

THEME  
**Data and Knowledge Representation  
and Processing**



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# Project-Team GRAPHIK

**Keywords:** Artificial Intelligence, Knowledge Representation, Reasoning, Data Management, Rule-based Languages

*Creation of the Project-Team:* 2010 January 01.

## 1. Members

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## 2. Overall Objectives

### 2.1. Logic and Graph-based KRR

The main research domain of GraphIK is Knowledge Representation and Reasoning (KRR), which studies paradigms and formalisms for representing knowledge and reasoning on these representations. We follow a logic-oriented approach: the different kinds of knowledge have a logical semantics and reasoning mechanisms correspond to inferences in this logic. However, in the field of logic-based KRR, we distinguish ourselves by also using graphs and hypergraphs (in the graph-theoretic sense) as basic objects. Indeed, we view labelled graphs as an *abstract representation* of knowledge that can be expressed in many KRR languages: different kinds of conceptual graphs —historically our main focus—, the Semantic Web language RDFS, expressive rules equivalent to the so-called tuple-generating-dependencies in databases, some description logics dedicated to query answering, etc. For these languages, reasoning can be based on the structure of objects (thus on graph-theoretic notions), with homomorphism as a core notion, while being sound and complete with respect to entailment in the associated logical fragments. An important issue is to study *trade-offs* between the expressivity and computational tractability of (sound and complete) reasoning in these languages.

### 2.2. From Theory to Applications, and Vice-versa

We study logic- and graph-based KRR formalisms from three perspectives:

- theoretical (structural properties, expressiveness, translations between languages, problem complexity, algorithm design),
- software (developing tools to implement theoretical results),
- applications (which also feed back into theoretical work).

### 2.3. Main Challenges

GraphIK focuses on some of the main challenges in KRR:

- ontological query answering, *i.e.*, query answering taking an ontology into account, and able to process large datasets;
- reasoning with rule-based languages;
- dealing with heterogeneous and hybrid knowledge bases (*i.e.*, composed of several modules that have their own formalism and reasoning mechanisms);
- reasoning with “imperfect knowledge” (*i.e.*, vague, uncertain, partially inconsistent, multi-viewpoints and/or with multi-granularity).

### 2.4. Scientific Directions

GraphIK has three main scientific directions:

1. **decidability, complexity and algorithms** for problems in languages corresponding to first-order logic fragments;
2. the addition of expressive and **non-classical features** (to the first-order logic languages studied in the first direction) with a good expressivity/efficiency trade-off;
3. the integration of theoretical tools to **real knowledge-based systems**.

From an applicative viewpoint, two themes are privileged for the next years:

- knowledge representation for agronomy, the final objective being a knowledge-based system to aid decision-making for the quality control in food processing.
- data integration and quality improvement, specifically for document metadata.

## 3. Research Program

### 3.1. Logic-based Knowledge Representation and Reasoning

We follow the mainstream *logic-based* approach to the KRR domain. First-order logic (FOL) is the reference logic in KRR and most formalisms in this area can be translated into fragments (i.e., particular subsets) of FOL. A large part of research in this domain can be seen as studying the *trade-off* between the expressivity of languages and the complexity of (sound and complete) reasoning in these languages. The fundamental problem in KRR languages is entailment checking: is a given piece of knowledge entailed by other pieces of knowledge, for instance from a knowledge base (KB)? Another important problem is *consistency* checking: is a set of knowledge pieces (for instance the knowledge base itself) consistent, i.e., is it sure that nothing absurd can be entailed from it? The *ontological query answering* problem is a topical problem (see Section 3.3). It asks for the set of answers to a query in the KB. In the case of Boolean queries (i.e., queries with a yes/no answer), it can be recast as entailment checking.

### 3.2. Graph-based Knowledge Representation and Reasoning

Besides logical foundations, we are interested in KRR formalisms that comply, or aim at complying with the following requirements: to have good *computational* properties and to allow users of knowledge-based systems to have a maximal *understanding and control* over each step of the knowledge base building process and use.

These two requirements are the core motivations for our specific approach to KRR, which is based on labelled *graphs*. Indeed, we view labelled graphs as an *abstract representation* of knowledge that can be expressed in many KRR languages (different kinds of conceptual graphs —historically our main focus—, the Semantic Web language RDF (Resource Description Framework), its extension RDFS (RDF Schema), expressive rules equivalent to the so-called tuple-generating-dependencies in databases, some description logics dedicated to query answering, etc.). For these languages, reasoning can be based on the structure of objects, thus based on graph-theoretic notions, while staying logically founded.

More precisely, our basic objects are labelled graphs (or hypergraphs) representing entities and relationships between these entities. These graphs have a natural translation in first-order logic. Our basic reasoning tool is graph homomorphism. The fundamental property is that graph homomorphism is sound and complete with respect to logical entailment *i.e.*, given two (labelled) graphs  $G$  and  $H$ , there is a homomorphism from  $G$  to  $H$  if and only if the formula assigned to  $G$  is entailed by the formula assigned to  $H$ . In other words, logical reasoning on these graphs can be performed by graph mechanisms. These knowledge constructs and the associated reasoning mechanisms can be extended (to represent rules for instance) while keeping this fundamental correspondence between graphs and logics.

### 3.3. Ontological Query Answering

Querying knowledge bases has become a central problem in knowledge representation and in databases. A knowledge base (KB) is classically composed of a terminological part (metadata, ontology) and an assertional part (facts, data). Queries are supposed to be at least as expressive as the basic queries in databases, i.e., conjunctive queries, which can be seen as existentially closed conjunctions of atoms or as labelled graphs. The challenge is to define good trade-offs between the expressivity of the ontological language and the complexity of querying data in presence of ontological knowledge. Classical ontological languages, typically description logics, were not designed for efficient querying. On the other hand, database languages are able to process complex queries on huge databases, but without taking the ontology into account. There is thus a need for new languages and mechanisms, able to cope with the ever growing size of knowledge bases in the Semantic Web or in scientific domains.

This problem is related to two other problems identified as fundamental in KRR:

- *Query-answering with incomplete information.* Incomplete information means that it might be unknown whether a given assertion is true or false. Databases classically make the so-called closed-world assumption: every fact that cannot be retrieved or inferred from the base is assumed to be false. Knowledge bases classically make the open-world assumption: if something cannot be inferred from the base, and neither can its negation, then its truth status is unknown. The need of coping with incomplete information is a distinctive feature of querying knowledge bases with respect to querying classical databases (however, as explained above, this distinction tends to disappear). The presence of incomplete information makes the query answering task much more difficult.
- *Reasoning with rules.* Researching types of rules and adequate manners to process them is a mainstream topic in the Semantic Web, and, more generally a crucial issue for knowledge-based systems. For several years, we have been studying some rules, both in their logical and their graph form, which are syntactically very simple but also very expressive. These rules, known as existential rules or Datalog<sup>+</sup>, can be seen as an abstraction of ontological knowledge expressed in the main languages used in the context of KB querying. See Section 6.2 for details on the results obtained.

A problem generalizing the above described problems, and particularly relevant in the context of multiple data/metadata sources, is *querying hybrid knowledge bases*. In a hybrid knowledge base, each component may have its own formalism and its own reasoning mechanisms. There may be a common ontology shared by all components, or each component may have its own ontology, with mappings being defined among the ontologies. The question is what kind of interactions between these components and/or what limitations on the languages preserve the decidability of basic problems and if so, a “reasonable” complexity. Note that there are strong connections with the issue of data integration in databases.

### 3.4. Imperfect Information and Priorities

While classical FOL is the kernel of many KRR languages, to solve real-world problems we often need to consider features that cannot be expressed purely (or not naturally) in classical logic. The logic- and graph-based formalisms used for previous points have thus to be extended with such features. The following requirements have been identified from scenarios in decision making in the agronomy domain (see Section 4.2):

1. to cope with vague and uncertain information and preferences in queries;
2. to cope with multi-granularity knowledge;
3. to take into account different and potentially conflicting viewpoints ;
4. to integrate decision notions (priorities, gravity, risk, benefit);
5. to integrate argumentation-based reasoning.

Although the solutions we develop need to be validated on the applications that motivated them, we also want them to be sufficiently generic to be applied in other contexts. One angle of attack (but not the only possible one) consists in increasing the expressivity of our core languages, while trying to preserve their essential combinatorial properties, so that algorithmic optimizations can be transferred to these extensions. To achieve that goal, our main research directions are: non-monotonic reasoning (see ANR project ASPIQ in Section 8.1), as well as argumentation and preferences (see Section 6.3).

## 4. Application Domains

### 4.1. Semantic Metadata

Semantic metadata are at the core of the applications we have been working on for several years. These three last years, we have switched from semantic annotations of documents to interlinking problems between individual references in annotations of documents. The main linkage problem in our current ANR project Qualinca (see Section 8.1) consists of identifying an authority (*i.e.*, an element of a referential described by



metadata) in a bibliographic notice (*i.e.*, metadata describing a document). This problem is an instance of the intensively studied reference resolution problem. In the Semantic Web, it can be recast as the computation of `OWL:sameAs` links between two metadata bases, clearly a fundamental problem for the Linked Open Data. We use a knowledge-based approach to solve this problem, and this year we have especially studied key notions for building rules that conclude on coreference or difference links between entities.

## 4.2. Agronomy

Within this field, we investigate two different agronomy scenarios: (1) in the context of a public health controversy about bread making, choosing between different kinds of flour in function of nutritional, economic, health and other criteria and (2) designing ecoefficient and biodegradable packaging. The second scenario is part of a larger decision support system implemented within the EU FP7 project EcoBioCap (see Section 8.2).

Both scenarios rely upon different criteria which bring conflicting information for decision making. The aim is then twofold. First to properly model the knowledge using facts, rules and negative constraints. Then, in a second step, in the possibly inconsistent knowledge base thus obtained, to select maximally consistent subsets that will be used for decision making. We have chosen to use argumentation in this context (of reasoning in the presence of inconsistency) due to the fact that we aim to investigate, in the future, the explanation power of argumentation approaches (very useful in this context where the domain experts are not computer scientists).

# 5. New Software and Platforms

## 5.1. Cogui

**Participants:** Alain Gutierrez, Michel Leclère, Marie-Laure Mugnier, Michel Chein, Madalina Croitoru.

*Cogui* (<http://www.lirmm.fr/cogui>) is a tool for building and verifying knowledge bases. It is a freeware written in Java (version 1.6). Currently, it supports Conceptual Graphs and import/export in RDFS and Datalog<sup>+</sup>.

This year, we have particularly improved scripts, which are interpreted pieces of code allowing to freely manipulate objects of the KB. The main improvements are the following:

- script management with better bug tracking and error reporting;
- interoperability between scripts and objects of the knowledge base;
- embedding of a Java library, which allows to import java classes into scripts (a feature required in the application developed for Qualinca).

## 5.2. Graal

**Participants:** Clément Sipieter, Jean-François Baget, Marie-Laure Mugnier, Swan Rocher.

Graal is a new software platform written in java, built since March 2014 from the Alaska platform developed during Bruno Paiva Lima Da Silva's PhD thesis. It also integrates algorithms developed by various members of the team. It is developed by Clément Sipieter thanks to the Inria ADT QUASAR.

Graal is intended to be a generic platform for ontological query answering with existential rules. It will implement and allow to compare various paradigms that fall into that framework.

In its current state, Graal allows storage of data via a generic interface in different storage paradigms and systems. Currently, the relational database management systems MySQL, PostgreSQL, Sqlite, and InMemory graph and LinkedList structures are implemented. The triple store Jena TDB and the graph database system Sparksee are coming soon. Graal also allows us to query this database taking into account an ontology represented by a set of existential rules. It provides forward chaining and backward chaining algorithms (building up on the work of Mélanie König) and a tool for the analysis of the properties of a set of rules which is an integration of Swan Rocher's tool Kiabora <http://www2.lirmm.fr/~mugnier/graphik/kiabora/>. The input and output of this software can be expressed in our Datalog-inspired format DLGP or in the Semantic Web language OWL. This software is designed in a modular way, hence it is possible to use only a subpart of Graal without embedding it all or to easily replace an implementation of a module by another.

## 6. New Results

### 6.1. Highlights of the Year

- *Michael Thomazo was awarded the AFIA Prize 2014 (French Association for Artificial Intelligence) for his PhD entitled "Conjunctive Query Answering Under Existential Rules - Decidability, Complexity, and Algorithms" defended in October 2013. He was also awarded the first accessit of Gilles Kahn Prize 2014 by the SIF (French Society for Computer Science) [14].*
- *Madalina Croitoru and Alain Gutierrez were awarded the Best Technical Paper of SGAI-2014 for "On Ontological Expressivity and Modelling Argumentation Schemes using COGUI", in collaboration with Wael Hamdan, Rady Khazem and Ghaida Rebdawi .*
- *Abdallah Arioua was awarded the Best Student Paper Award of SGAI-2014 for "Query Failure Explanation in Inconsistent Knowledge Bases: A Dialogical Approach" in collaboration with Nouredine Tamani, Madalina Croitoru and Patrice Buche .*

BEST PAPERS AWARDS :

[36] **On Ontological Expressivity and Modelling Argumentation Schemes Using COGUI in AI'2014: Thirty-fourth SGAI International Conference on Artificial Intelligence.** W. HAMDAN, R. KHAZEM, G. REBDAWI, M. CROITORU, A. GUTIERREZ, P. BUCHE.

[28] **Query Failure Explanation in Inconsistent Knowledge Bases: A Dialogical Approach in AI'2014: 34th SGAI International Conference on Innovative Techniques and Applications of Artificial Intelligence.** A. ARIOUA, N. TAMANI, M. CROITORU, P. BUCHE.

### 6.2. Ontology-Based Query Answering with Existential Rules

**Participants:** Jean-François Baget, Fabien Garreau, Mélanie König, Michel Leclère, Marie-Laure Mugnier, Swan Rocher, Federico Ulliana.

Ontology-based query answering (and more generally *Ontology-Based Data Access, OBDA*) is a new paradigm in data management, which takes into account inferences enabled by an ontology when querying data. In other words, the notion of a database is replaced by that of a knowledge base, composed of data (also called facts) and of an ontology. In this context, *existential rules* (also called Datalog+) have been proposed to represent the ontological component [59], [58]. This expressive formalism generalizes both description logics used in OBDA (such as  $\mathcal{EL}$  and DL-Lite), which form the cores of so-called tractable profiles of the Semantic Web ontological language OWL2) and Datalog, the language of deductive databases. Since about five years, we have been studying the theoretical foundations of this framework (mainly concerning decidability and complexity) and developing associated algorithmic techniques. We have started the development of a platform dedicated to OBDA with existential rules (see section 5.2).

Before presenting this year's results, we recall the two classical ways of processing rules, namely forward chaining and backward chaining, also known as "materialization" and "query rewriting" in the OBDA setting. In forward chaining, the rules are applied to enrich the initial data and query answering can then be solved by evaluating the query against the "saturate" database (as in a classical database system *i.e.*, with forgetting the rules). The backward chaining process can be divided into two steps: first, the initial query is rewritten using the rules into a first-order query (typically a union of conjunctive queries, UCQ); then the rewritten query is evaluated against the initial database (again, as in a classical database system). Since entailment is not decidable with general existential rules, both forward and backwards processes may not halt.

#### 6.2.1. Improvement of Query Rewriting Algorithms

These last two years, we designed and implemented a query rewriting algorithm that takes as input a set of existential rules and a UCQ  $q$  and outputs a UCQ, which is a sound and complete rewriting of  $q$ , whenever such a rewriting exists [60], [61], [62]. This year's main improvement to this algorithm is the implementation of a unifier able to process rules without decomposing their head into single atoms. This improvement appeared to have a very high impact on the efficiency of query rewriting (up to 274 quicker on an ontology where

32% of the rules have a head composed of two atoms instead of a single one). Beside, much effort has been devoted to experiments: to find appropriate benchmarks, to build a translator from the Semantic Web format OWL/OWL2 to our existential rule format dlgp (since most existing ontologies are available in OWL/OWL2 format), to select existing tools to compare with, run them, finally compare tools on several criteria.

- *Results partially published in the Semantic Web Journal [22].*

Query rewriting techniques have the interest of being independent from the data. However, a main bottleneck is that the size of the rewritten query can be exponential in the size of the original query, hence the produced rewriting maybe not usable in practice. A well-known source of combinatorial explosion are some very simple rules, which form the core of any ontology, typically expressing concept and relation hierarchies, concept properties and relation signatures. We have proposed a rewriting technique, which consists in compiling these rules into a preorder on atoms and embedding this preorder into the rewriting process. This allows to compute compact rewritings that can be considered as “pivotal” representations, in the sense that they can be easily translated into different kinds of queries that can be evaluated by different kinds of database systems. The provided algorithm computes a sound, complete and minimal UCQ rewriting, if one exists. Experiments show that this technique leads to substantial gains in the query rewriting process, in terms of size and runtime, and scales on very large ontologies (several ten thousands of rules).

- *Results not published yet. Reported in Mélanie König’s PhD thesis [17].*

### 6.2.2. A Better Approximation of Chase Termination for Existential Rules and their Extension to Non-monotonic Negation

Forward chaining with existential rules is known as the *chase* in databases. Various acyclicity notions ensuring chase termination have been proposed in the knowledge representation and databases. Acyclicity conditions found in the literature can be classified into two main families: the first one constrains the way existential variables are propagated during the chase and the second one constrains dependencies between rules *i.e.*, the fact that a rule may lead to trigger another rule. These conditions are based on different graphs, but all of them can be seen as forbidding “dangerous” cycles in the considered graph. We defined a new family of graphs that allows to unify and strictly generalize these acyclicity notions without increasing worst-case complexity.

Second, we considered the extension to existential rules with nonmonotonic negation under stable model semantics and further extended acyclicity results obtained in the positive case by exploiting negative information.

- *This work is part of Fabien Garreau and Swan Rocher’s PhD theses. Results published at the European Conference on Artificial Intelligence (ECAI 2014)[30](long version as an arXiv report) and at the Workshop on Non-monotonic Reasoning (NMR 2014) [31].*

### 6.2.3. Detailed Results and Complements on Query Answering under Greedy Bounded-Treewidth Sets of Existential Rules

The family of greedy bounded-treewidth sets of existential rules (gbts) is an expressive class of rules for which entailment is decidable. This decidability property relies on a structural property of the saturation by the chase (*i.e.*, the set of inferred facts): for any initial set of facts, the saturation of these facts has a bounded treewidth (where the treewidth is computed on a graph associated with a set of atoms). Moreover, a tree decomposition of bounded width can be incrementally built during the chase. This family generalizes the important family of guarded existential rules, which itself generalizes Horn description logics used in OBDA.

In papers published at IJCAI 2011 and KR 2012, we studied the complexity of entailment under gbts rules as well as under known subclasses of gbts (with respect to data, combined and query complexity) and provided a generic algorithm with optimal worst-case complexity. This year, we finally completed a long report (75 pages) containing the detailed proofs of the results, some of them being very technical; in this report, we also clarified and reformulated the description of the generic algorithm, according to Michael Thomazo’s PhD thesis (defended in October 2013); finally, we complemented the landscape of gbts classes by studying the complexity of all subclasses obtained by combining the syntactic criteria which define already known classes.

- *Results available as an arXiv report [56]. Submitted to a major journal in Artificial Intelligence. In collaboration with Sebastian Rudolph (TU Dresden) and Michael Thomazo (now postdoctoral student in Sebastian Rudolph’s group).*

#### 6.2.4. Extracting Bounded-level Modules from Deductive RDF Triplestores

The Semantic Web is consolidating a legacy of well-established knowledge bases spanning from life sciences, to geographic data and encyclopedical repositories. Today, reusing knowledge and data available online is vital to ensure a coherent development of the Semantic Web, thereby capitalizing on the efforts made in the last years by many institutions and domain experts to publish quality information.

In this paper we studied how to extract modules from RDF knowledge bases equipped with Datalog inference rules, we called Deductive RDF Triplestores. A module is a Deductive RDF Triplestore entailed from the reference system, which is defined upon a restricted vocabulary (or signature). We proposed a new semantics for bounded-level modules allowing to control their size, and then presented extraction algorithms compliant with the novel semantics. This feature is helpful since many ontologies are extremely large, while users often need to reuse only a small part of resources in their work.

This work was partially carried out before the arrival of Federico Ulliana at GraphIK. For the future, we plan to study module extraction for knowledge bases equipped with existential rules, which extend the rules considered here.

- *Results published at the Twenty-Ninth AAAI Conference on Artificial Intelligence (AAAI 15) [44]. In collaboration with Marie-Christine Rousset from LIG (University of Grenoble).*

#### 6.2.5. Axiomatisation of Consistent Query Answering via Belief Revision

This work takes place in the OBQA setting where a query is being asked over a set of knowledge bases defined over a common ontology. When the union of knowledge bases along with the ontology is inconsistent, several semantics have been defined which are tolerant to inconsistency. These semantics all rely on computing repairs, *i.e.*, maximal (in terms of set inclusion) consistent subsets of the data set. They have been studied from a productivity point of view and a complexity point of view. We take a new point of view to define axiomatic characterisations of two such semantics, namely IAR (Intersection of All Repairs) and ICR ((Intersection of Closed Repairs)). We argue that such characterisation can provide an alternative way of comparing the semantics and new insights into their properties. Furthermore such axiomatisation can be used when proposing a generalisation of inconsistency tolerant semantics. In order to provide the axiomatic characterisations we define belief revision operators that correspond to IAR and ICR.

- *Work published at [43]. In collaboration with Ricardo Rodriguez from University of Buenos Aires.*

### 6.3. Reasoning with Imperfect Information and Priorities

**Participants:** Abdallah Arioua, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Souhila Kaci, Namrata Patel, Tjitze Rienstra, Nouredine Tamani, Rallou Thomopoulos.

This work focuses on two main notions, namely *argumentation systems*, which allow to represent and deal with conflicting information, and formalisms to represent *preferences*, which allow to compare possible outcomes in decision making and recommender systems.

#### 6.3.1. Fundamental Aspects of Argumentation

A Dung-style argumentation framework aims at representing conflicts among elements called arguments. The basic ingredients of this framework is a set of arguments and a Boolean abstract (*i.e.*, its origin is not known) binary defeat relation on these arguments. This abstract framework can be instantiated in different ways, by representing arguments in a given knowledge representation formalism, which allows to take the semantics of arguments into account in the computation of the defeat relation.

Preference-based argumentation frameworks are instantiations of Dung's framework in which the defeat relation is derived from an attack relation and a preference relation over the arguments. Recently, Dung's framework has been extended in order to consider the strength of the defeat relation *i.e.*, to quantify the degree to which an argument defeats another argument. In this work, we instantiated this extended framework by a preference-based argumentation framework with a valued preference relation. As particular cases, the latter can be derived from a weight function over the arguments or a Boolean preference relation. We showed under

some reasonable conditions that there are “less situations” in which a defense between arguments holds with a valued preference relation compared to a Boolean preference relation. Finally, we provided some conditions that the valued preference relation shall satisfy when it is derived from a weight function.

- *This is a joint work with Christophe Labreuche from Thales and published in [20]*

We also considered an extension to argumentative frameworks based on fuzzy set theory. The knowledge base is fuzzified to allow agents expressing their expertise (facts and rules) attached with grades of importance in the unit interval. Arguments are then attached with a strength score aggregating the importance expressed on their facts and rules. Extensions, corresponding to subsets of consistent arguments, are also attached with forces computed based on their strong arguments. The forces are used then to rank extensions from the strongest to the weakest one, upon which decisions can be made. We have also shown that the strength preference relation defined over arguments is reasonable according to classical rationality postulates and our fuzzy logical argumentation system can be seen as a computationally efficient instantiation of the generic model of structured argumentation framework. We furthered our theoretical research and demonstrate the added value of our approach in the practical setting of the European project EcoBioCap (see Sect.8.2).

- *Work published in IPMU 2014 [47] and Fuzz IEEE 2014 [46].*

One instantiation, among many others, of Dung’s framework consists in constructing the arguments from a set of propositional logic formulas. Thus an argument is seen as a reason for or against the truth of a particular statement. Despite its advantages, the argumentation approach for inconsistency handling also has important shortcomings. More precisely, in some applications what one is interested in are not so much only the conclusions supported by the arguments but also the precise explanations of such conclusions. We showed that argumentation framework applied to classical logic formulas is not suitable to deal with this problem. On the other hand, intuitionistic logic appears to be a natural alternative candidate logic (instead of classical logic) to instantiate Dung’s framework. We developed *constructive argumentation framework*. We showed that intuitionistic logic offers nice and desirable properties of the arguments. We also provided a characterization of the arguments in this setting in terms of minimal inconsistent subsets when intuitionistic logic is embedded in the modal logic S4.

- *This is a joint work with Yakoub Salhi from CRIL and published in [39]*

Lastly, we developed a model of abduction in abstract argumentation, where changes to an argumentation framework act as hypotheses to explain the support of an observation. We presented dialogical proof theories for the main decision problems (*i.e.*, finding hypotheses that explain skeptical/credulous support) and we showed that our model can be instantiated on the basis of abductive logic programs.

- *This work has been done in Tjitze Rienstra’s thesis and published in [32].*

### 6.3.2. Use of Argumentation in Explanation, Querying and Decision Making

Besides work on the foundations of argumentation frameworks, we have studied the use of argumentation techniques in various tasks: explanation of query failure, reverse engineering, and decision making. These studies are mainly motivated by agri-food scenarios: bread conception, packaging conception, and durum wheat conception.

We have proposed an argumentation-based explanation for *query failure explanation* under the inconsistency tolerant semantics ICR in an Ontology-Based Data Access setting with existential rules. We used a rule-based language and we base our work on the equivalence between ICR-based query answering in inconsistent knowledge bases and sceptical acceptance of arguments. We proposed a multilevel explanation that exploits both the inference power of the logical language as well as arguments of dialectical nature. We also investigated an interactive argumentative approach where the process of explanation takes the form of a dialogue between the user and the reasoner.

- *Work published in COMMA 2014 [27] and SGAI 2014 [28] where it received the best student paper award.*

Within the framework of the European project EcoBioCap <http://www.ecobiocap.eu> about the design of next generation packagings using advanced composite structures based on constituents derived from the food industry, we have been developing a Decision Support System (DSS) for packaging material selection. [40], [49]. The DSS consists of two steps: (1) aggregating possibly conflicting needs expressed by several parties involved in the considered field and (2) querying a database of packagings with the resulting aggregation obtained at point (1). We instantiate for each need, called viewpoint or aspect, an argumentation system to reason about arguments solely expressed on it [45]. This will then be used to generate the query on the packaging database. To this aim we show how to instantiate ASPIC with the DLR-Lite logic modeling expert ontologies in this real world scenario [47].

- *Work published in AAMAS 2014 [45], IPMU 2014 [47], ICCS 2014 [40], and COMMA 2014 [49].*

Evaluating food quality is a complex process since it relies on numerous criteria historically grouped into four main types: nutritional, sensorial, practical and hygienic qualities. They may be completed by other emerging preoccupations such as the environmental impact, economic phenomena, etc. However, all these aspects of quality and their various components are not always compatible and their simultaneous improvement is a problem that sometimes has no obvious solution, which corresponds to a real issue for decision making. We propose a decision support method guided by the objectives defined for the end products of an agrifood chain. It is materialized by a backward chaining approach based on argumentation [47]. An extended version of this paper reporting on experimental results and expert evaluation has been published in Ecological Informatics [24].

- *Work published in IPMU 2014 [47], and Ecological Informatics 2014 [24].*

Knowledge elicitation, representation and reasoning explanation by / to non-computing experts has always been considered as a crafty task due to difficulty of expressing logical statements by non-logicians. We use the COGUI editor in order to elicit and represent argumentation schemes expressed using existential rules within an inconsistent knowledge base. COGUI is a visual, graph based knowledge representation editor compatible with main Semantic Web languages (see Section 5.1). COGUI allows for default reasoning on top of ontologies. We investigate its use for modelling and reasoning using argumentation schemes and discuss the advantages of such representation. We show how this approach can be useful in the practical setting of EcoBioCap where the different argumentation schemes can be used to lead reasoning.

- *Work published in SGA1 2014 [36] where it received the best technical paper award. In collaboration with Wael Hamdan, Rady Khazem and Ghaisa Rebdawi from the Higher Institute of Applied Science and Technology (HIAS), Syria.*

### 6.3.3. Preferences

Qualitative and comparative preference statements of the form “prefer  $\alpha$  to  $\beta$ ” are useful components of many applications. This statement leads to the comparison of two sets of alternatives: the set of alternatives in which  $\alpha$  is true and the set of alternatives in which  $\beta$  is true. Different ways are possible to compare two sets of objects leading to what is commonly known as preference semantics. The choice of the semantics to employ is important as they differently rank-order alternatives. Existing semantics are based on philosophical and non-monotonic reasoning grounds. In the meanwhile, they have been widely and mainly investigated by AI researchers from algorithmic point of view. We came to this problem from a new angle and completed existing theoretical investigations of the semantics. In particular, we provided a comparison of the semantics on the basis of their psychological plausibility by evaluating their closeness to human behavior.

- *This is a joint work with Eric Raufaste from CLLE and published in [38]*

There has been a growing interest in the study of preferences for their utility in solving problems related with decision making. Most of the preference representation languages developed in the literature are based on comparative preference statements since they offer a simple and intuitive way for expressing preferences. They can be further interpreted following different semantics, imparting a greater flexibility on how outcomes can be compared. So far the main objective has been to rank-order the set of outcomes given a set of comparative preference statements and one or several semantics. Tackling this problem from a different angle, we looked into the behavioral aspects of the preference semantics and statements by attempting to formalise the intuition

behind them using postulates studied in preference logics and non-monotonic reasoning. We selected the postulates w.r.t. three criteria: coherence, syntax independence and inference. Thus, our analysis provided a means to determine those properties that are satisfied for a given preference semantics.

- *This work has been done in Namrata Patel's thesis and published in [21]*

Intelligent ‘services’ are increasingly used on e-commerce platforms to provide assistance to customers. Numerous preference elicitation methods developed in the literature are now employed for this purpose. However, it is commonly known that there is a real bottleneck in preference handling as concerns the elicitation of preferences because it does not cater to the wide range of preference representation languages available. Thus, as a first step in developing a decision-support tool using an AI based on such languages, this paper describes a preliminary study conducted to address this issue. We proposed a method of eliciting real-time user preferences expressed in natural language (NL) which can be formally represented using comparative preference statements complying with different semantics, and provided a proof of concept to demonstrate its feasibility. Since we developed NL resources to detect preference semantics, we also made a comparative study with existing resources to underline the peculiarities of our model.

- *This work has been done in Namrata Patel's thesis and published in [37]*

## 6.4. Semantic Data Integration

**Participants:** Michel Chein, Madalina Croitoru, Léa Guizol, Michel Leclère, Rallou Thomopoulos.

It often happens that different references (*i.e.*, data descriptions), possibly coming from heterogeneous data sources, concern the same real world entity. In such cases, it is necessary: (i) to detect whether different data descriptions really refer to the same real world entity and (ii) to fuse them into a unique representation. This issue has been studied under various names: “record linking”, “entity resolution”, “reference resolution”, “de-duplication”, “object identification”, “data reconciliation”, etc., mostly in databases. It has become one of the major challenges in the Web of Data, where the objective is to link data published on the web and to process them as a single distributed database.

We investigate this problem in the specific context of bibliographic databases. Indeed, people working in bibliographical information systems have a lasting tradition of using norms and have integrated, along collections of documents notices (e.g. bibliographic records), collections of authority notices that categorize the different named entities used to describe documents (people, organizations, places, ...). In current databases, documents notices do not use directly the names of named entities to fill a particular field (author, editor, ...), but the unique identifier of the authority notice representing that named entity.

A few years ago, we began a collaboration with ABES (National Bibliographic Agency for Universities) to develop a method and a prototype to perform entity resolution between on one hand the authors of a new bibliographic record, and, on the other the authority references of an authority catalog (and namely the Sudoc catalog from the ABES agency). A problem with this approach is that it relies upon pre-established links between bibliographic records and authority notices. However, our experimentation and evaluation have shown that many existing links were erroneous, and thus led to the propagation of new linkage errors. We have thus began to work on methods and tools to repair linkage errors in bibliographical databases. The first step of our approach was to build a knowledge-base over an ontology (based on the international standards FRBR and CIDOC-CRM) aiming at representing bibliographic data (an RDFS base) as well as librarian knowledge.

From that, we developed a methodological framework allowing to design rules concluding on the coreference or the difference between entities of the bibliographic knowledge base. This framework was implemented in Cogui.

### 6.4.1. An Original Methodology to Compute Coreference and Difference Links

Our methodology can be briefly summarized as follows. The first step consists in computing “sure” links. In the second step, authority notices are enriched by information that comes from bibliographic notices to which they are linked by sure links. In the third step, Datalog rules that conclude on coreference or difference are triggered. The results are used to compute new sure links. These steps are iterated until stability *i.e.*, no

new sure link is discovered. More specifically, the Datalog rules are the following form. The body of a rule is a conjunction of similarity criteria on attributes and its head states the coreference or the difference of two individual entities with a specific confidence level (represented as a symbolic value). We are currently instantiating this methodology for the Sudoc catalog, jointly with the ABES librarians, which will allow them to evaluate it.

#### **6.4.2. Partitioning Semantics for Link Discovery in Bibliographic Knowledge Bases**

With the aim of evaluating and improving the quality of links in bibliographical knowledge bases, we have developed a decision support system based on partitioning semantics. The novelty of our approach consists in using symbolic values criteria for partitioning and suitable partitioning semantics. We have investigated the limits of those partitioning semantics: how the characteristics of the input (objects and criteria) influences characteristics of the result, namely correctness of the result and execution time. We have also evaluated and compared the above mentioned semantics on a real qualitative sample. This sample is issued from the catalogue of French university libraries (SUDOC) maintained by ABES.

- *This work is part of Lea Guizol's PhD thesis [16]. Work published in Fuzz IEEE 2014 [46].*

#### **6.4.3. Key Discovery on the Semantic Web**

Many techniques were recently proposed to automate the linkage of RDF datasets. Predicate selection is the step of the linkage process that consists in selecting the smallest set of relevant predicates needed to enable instance comparison. We call keys this set of predicates that is analogous to the notion of keys in relational databases. We have formally explained the different assumptions behind two existing key semantics (IC), and have evaluated experimentally these keys semantics by studying how discovered keys could help dataset interlinking or cleaning.

- *Work published in IC 2014 [50] and ICCS 2014 [29] in collaboration with Manuel Atencia and Jerome David from LIG, and Nathalie Pernelle, Fatiha Sais and Danai Symeonidou from LRI. See also the reconciliation-based approach in[23].*

#### **6.4.4. Fusion of Linked Data**

The problem of data fusion starts from reconciled datasets, whose objects are linked with semantic sameAs relations, as described above. We attempt to merge the often conflicting information of these reconciled objects in order to obtain unified representations that only contain the best quality information. We are studying an approach to determine the most appropriate value(s). Our method combines different quality criteria based on the value and its data source, and exploits, whenever possible, the ontology semantics, constraints and relations. Moreover we create a mechanism to provide explanations about the quality of each value, as estimated by our system. To achieve this, we generate annotations used for traceability and explanation purposes.

- *Work described in the Qualinca deliverable 4.2 research report, and accepted for publication in EGC'2015 : "Linked Data Annotation and Fusion driven by Data Quality Evaluation" (authors: Ioanna Giannopoulou, Fatiha Sais from LRI, and Rallou Thomopoulos)*

## **7. Bilateral Contracts and Grants with Industry**

### **7.1. Bilateral Contracts with Industry**

#### **7.1.1. CTFC**

**Participants:** Patrice Buche, Jérôme Fortin.



We collaborate since 2012 with the technical center of Comtois' cheese (CTFC : Centre Technique des Fromages Comtois). The objective of this collaboration is to design and test a platform for expert knowledge management. This allows us to validate the integration of our theoretical tools into a real-world application and strengthen GraphIK's involvement in agronomy applications. A master degree internship in collaboration with CTFC was done by Awa Diattara (University Gaston Berger of Saint-Louis, Sénégal) in 2012. Awa Diattara came back as engineer to complete her work for a six month period in 2013. In order to evaluate our approach on different agri-food chains, we have initiated a work with Panzani (6 months internship of Laureline Estival 2013-2014) and established fruitful contacts with other partners.

This collaboration will be strengthened in 2015 in a enlarged project involving different traditional food chains (CNAOL, Conseil National des Appellations d'Origine Laitière). The new project called « OcamEx : Outil de capitalisation et de mobilisation du savoir-faire et de l'expérience fromagers en filière valorisant leur terroir. » is presented as a collaboration with technical partners (Ceraq, CTFC (Centre Technique des Fromages Comtois), Pôle fromager AOP Massif Central, Institut de l'Élevage, Actalia, Typ-Tech), CNAOL (Conseil national des appellations d'origines laitières) scientific partners (INRA Aurillac, INRA URTAL Poligny, UMR IATE (équipe Ingénierie des connaissances), UMR LIRMM/Inria (équipe GraphiK), UMR HEUDIASYC (équipe Décision), Agrosup Dijon UR DPF, INRA UMR I2M Bordeaux, ENSC Bordeaux training partners : Enils from Aurillac, Mamirolle-Poligny and la Roche sur Foron Cheese partners : Comté (CIGC), Reblochon (SIR), Emmental (Savoicime), Cantal et Salers (CIF)

The aim of this collaboration is to develop a platform that will be used in traditional cheese processing for expert knowledge management.

### 7.1.2. ABES

**Participants:** Michel Leclère, Michel Chein, Madalina Croitoru, Léa Guizol.

Collaboration with ABES. Funding of half a PhD grant (Léa Guizol, 2011-2014). See Section 6.4.

### 7.1.3. Panzani

**Participants:** Patrice Buche, Jérôme Fortin, Laureline Estival, Bernard Cuq.

We have initiated a national collaboration with Panzani. The objective of this collaboration is to test and get new feedbacks about the platform for expert knowledge management. A master degree internship in collaboration with Panzani was done by an agronomy student, Laureline Estival (Agrosup Dijon), in 2013. This internship enabled us to validate the interest of our tool for Panzani by showing that our techniques could deal with several types of applications while being usable by non computer sciences experts.

Laureline Estival has continued her work, financed by Panzani, as an engineer to complete the knowledge base for a six month period in 2013-14.

## 8. Partnerships and Cooperations

### 8.1. National Initiatives

#### 8.1.1. ANR

##### 8.1.1.1. ASPIQ

**Participants:** Jean-François Baget, Fabien Garreau, Marie-Laure Mugnier, Jérôme Fortin, Michel Leclère.

ASPIQ (ASP technologies for Querying large scale multisource heterogeneous web information), is an ANR white project (duration: 4 years) that started in Oct. 2012. It involves partners from CRIL, LERIA and LSIS. The project coordinator is Odile Papini (LSIS). <http://aspiq.lsis.org/>

The main objective of this project is to propose:

- extensions of standard ASP for representing OWL2 tractable sublanguages;
- new operations for merging conflicting information in this extended ASP;
- the identification of subclasses of this extended ASP allowing for efficient query answering mechanisms;
- an implementation of a prototype reasoning system.
- *See Section 6.2 for this year's results (Extensions of the Framework).*

#### 8.1.1.2. Pagoda

**Participants:** Jean-François Baget, Marie-Laure Mugnier, Mélanie König, Swan Rocher, Michaël Thomazo.

Pagoda (Practical Algorithms for Ontology-based Data Access) is an ANR JCJC (young researchers) project that started in Jan. 2013 (duration: 4 years). The project coordinator is Meghyn Bienvenu (LRI). It involves partners from the EPI LEO, the LIG, and the Anatomy Laboratory of Grenoble. <http://pagoda.lri.fr/>

The primary aim of this project is to address challenges brought by scalability and the handling of data inconsistencies by developing novel OBDA (Ontology Based Data Access) query answering algorithms and practical methods for handling inconsistent data.

- *See Section 6.2 for this year's results.*

#### 8.1.1.3. Qualinca

**Participants:** Michel Leclère, Michel Chein, Madalina Croitoru, Léa Guizol, Rallou Thomopoulos, Alain Gutierrez, Swan Rocher, Marie-Laure Mugnier.

Qualinca is an ANR Contint project that started in Apr. 2012 (duration: 4 years). The project coordinator is Michel Leclère (GraphIK). It involves partners from LRI, LIG, ABES and INA. <http://www.lirmm.fr/qualinca/index8ece.html?q=en/en/home>

The main objective is to elaborate mechanisms allowing to:

- evaluate the quality of an existing document base;
- maintain a given level of quality by controlling updating operations;
- increase the quality of a given base;
- develop generic methods that take into account the quality of a given base (for instance for searching documents or interconnecting bases).
- *See Section 6.4 for this year's results.*

#### 8.1.1.4. Dur-Dur

**Participants:** Abdallah Arioua, Patrice Buche, Madalina Croitoru, Jérôme Fortin, Rallou Thomopoulos.

Dur-Dur (Innovations agronomiques, techniques et organisationnelles pour accroître la DURabilité de la filière blé DUR) is an ANR project that started in 2014 (duration: 3 years). It is led by IATE Laboratory. <http://umr-iate.cirad.fr/projets/dur-dur>

The Dur-Dur project develops a systematic approach to investigate the questions related to the management of the nitrogen, energy and contaminants, to guarantee a global quality of products throughout the production and the processing chain. The knowledge representation task of Dur-Dur proposes to map the stakeholders' objectives into a multicriteria cartography, as well as possible means to reach them, and computes the compatibility / incompatibility of these objectives on the basis of argumentation methods. The research methods used are qualitative and based both on argumentation theory and on Social Multi- Criteria Evaluation (SMCE) theory. They will be extended and adapted to the needs of the project to provide a formal framework of assessment of the various orientations considered for the durum wheat chain.

### 8.1.2. Competitivity Clusters

We are taking part in the Laboratory of Excellence (“labex”) *NUMEV* (Digital and Hardware Solutions, Modelling for the Environment and Life Sciences), led by University of Montpellier 2 in partnership with CNRS, University of Montpellier 1 and Inria. This project aims at developing information and communication technologies for environmental and life sciences. We are participating to one of the four axis, namely “Scientific Data: processing, integration and security”.

## 8.2. European Initiatives

### 8.2.1. FP7 & H2020 Projects

#### 8.2.1.1. EcoBioCap

**Participants:** Patrice Buche, Madalina Croitoru, Jérôme Fortin, Patricio Mosse.

EcoBioCap is a FP7-KBEE project that started in March 2011 (duration: 4 years). It is led by INRA (and scientifically managed by Montpellier IATE laboratory). It involves sixteen partners among which Cork University (Ireland), CSIC (Spain), Roma University La Sapienza (Italy), SIK (Sweden). The objective of EcoBioCAP is to “provide the EU food industry with customizable, ecoefficient, biodegradable packaging solutions with direct benefits both for the environment and EU consumers in terms of food quality and safety”. The budget is managed by IATE team.

- See Section 6.3 for this year’s results.

### 8.2.2. Collaborations with Major European Organizations

*Richard Booth:* University of Luxembourg, Interdisciplinary Centre for Security, Reliability and Trust (Luxembourg)

Souhila Kaci collaborates with Richard Booth on abstract argumentation. Madalina Croitoru collaborates with Richard Booth on argumentation labelling distances.

*Leon van der Torre:* University of Luxembourg, Computer Science and Communications Research Unit (Luxembourg)

Souhila Kaci collaborates with Leon van der Torre on argumentation aspects. They co-supervised a PhD student (Tjitze Rienstra) from 2010 to 2014.

*Sebastian Rudolph and Michaël Thomazo:* TU Dresden (Germany)

Jean-François Baget and Marie-Laure Mugnier collaborate with Sebastian Rudolph and Michaël Thomazo on existential rules.

*Markus Krötzsch:* TU Dresden (Germany)

Jean-François Baget, Marie-Laure Mugnier and Clément Sipieter collaborate with Markus Krötzsch who is associated with the ADT QUASAR (Section 5.2), as an expert in the Semantic Web.

*Ricardo Rodriguez:* University of Buenos-Aires(Argentina)

Madalina Croitoru collaborates with Ricardo Rodriguez on axiomatization of consistent query answering semantics inspired from axiomatization of belief revision operators.

*Milos Stoiakovitch:* University of Novi Sad (Serbia)

Madalina Croitoru collaborates with Milos Stoiakovitch on properties of positional games in argumentation.

## 8.3. International Research Visitors

### 8.3.1. Visits to the GraphIK team

- January 2014: Camille Pradel, IRIT. He gave a talk presenting his PhD results *D’un langage de haut niveau à des requêtes graphes permettant d’interroger le web sémantique*. <http://thesesups.ups-tlse.fr/2237/1/2013TOU30261.pdf>

- January 2014: Florent Domenach, Nicosia University, Chypre. He gave a talk *Analyse formelle de concepts, application à l'analyse d'annotations sémantiques*.
- February 2014: Aymeric Ledorze, LERIA Aymeric Ledorze (LERIA). He gave a talk presenting his PhD results *Validation, synthèse et paramétrage des cartes cognitives*. <https://tel.archives-ouvertes.fr/tel-00956983/document>
- February 2014: Pierre Bisquert, IRIT. He gave a talk presenting his PhD results on *Étude du changement en argumentation*. <http://thesesups.ups-tlse.fr/2272/1/2013TOU30302.pdf>
- February 2014: Lakhdar Saïs, CRIL. He gave a talk on *Approches déclaratives pour la fouille de données*. <http://www.cril.univ-artois.fr/decMining/pdf/slidesSeminaireLirmm.pdf>
- April 2014: Meghyn Bienvenu, LRI, One week work on query rewriting as part of the Pagoda project (see 8.1).
- April 2014: Federico Ulliana, Inria Grenoble. He gave a talk on *Deductive RDF Triplestores : domain-specific applications and bounded-size module extraction*.
- June 2014: Slawek Staworko, Inria Lille. He gave a talk on *Prioritized Repairing and Consistent Query Answering in Relational Database*. <http://researchers.lille.inria.fr/~staworko/research/talk-montpellier14.pdf>
- September 2014: Jérôme Lang, LAMSADE. He gave a talk on *Introduction au choix social computationnel*. [http://www.afia.asso.fr/tiki-download\\_wiki\\_attachment.php?attId=83](http://www.afia.asso.fr/tiki-download_wiki_attachment.php?attId=83)
- October 2014: Bernardo Cuenca Grau, Department of Computer Science, Oxford. Work on algorithms for reasoning with existential rules.
- October 2014: Meghyn Bienvenu, LRI, One week work on query rewriting as part of the Pagoda project (see 8.1).

### 8.3.2. Visits to International Teams

- January 2014: Madalina Croitoru was invited by the Universitat Autònoma de Barcelona (UAB). Work with Lluís Godo Lacasa (Artificial Intelligence Research Institute, IIIA) and Ricardo Rodríguez (University of Buenos Aires) on the axiomatisation of consistent query answering via belief revision (see 6.2).

## 9. Dissemination

### 9.1. Promoting Scientific Activities

#### 9.1.1. Scientific events organisation

##### 9.1.1.1. General chair, scientific chair

- Madalina Croitoru was general chair of ICCS 2014 (21st International Conference on Conceptual Structures) <http://iccs2014.info.uaic.ro/index.php>.

##### 9.1.1.2. Member of the organizing committee

- Fabien Garreau was member of the organizing committee of JIAF 2014 (Journées d'Intelligence Artificielle Fondamentale) <http://jiaf2014.univ-angers.fr/index.php?accueil>.
- Jérôme Fortin was member of the local organizing committee of IPMU 2014 (15th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based System) <http://www.ipmu2014.univ-montp2.fr/>.
- Patrice Buche was member of the initiative committee for a special session in IPMU'2014 (Decision Support and uncertainty management in Agri-Environment) <http://www.ipmu2014.univ-montp2.fr/SpecialSessions.php>.

- Patrice Buche was member of the initiative committee for a special session in MTSR'2014 (Metadata and Semantics for Agriculture, Food & Environment) <http://www.mtsr-conf.org/>.
- Patrice Buche was member of the initiative committee for a special session in IC'2014 (IN-OVIVE 2014) [https://colloque6.inra.fr/in\\_ovive\\_2014](https://colloque6.inra.fr/in_ovive_2014).

### 9.1.2. Scientific events selection

#### 9.1.2.1. Responsible of the conference program committee

- Marie-Laure Mugnier (along with Roman Kontchakov, London) was Program Chair of the 8th International Conference on Web Reasoning and Rule Systems (RR'2014), Athens, 2014 <http://rr2014.di.uoa.gr/>.

#### 9.1.2.2. Member of the conference program committee

- Marie-Laure Mugnier was senior PC member of AAAI 2015 (AAAI Conference on Artificial Intelligence).
- Federico Ulliana was PC member of AAAI 2015 (AAAI Conference on Artificial Intelligence).
- Marie-Laure Mugnier and Souhila Kaci were PC members of ECAI 2014 (European Conference on Artificial Intelligence).
- Jean-François Baget was PC member of RR 2014 (International Conference on Web Reasoning and Rule Systems).
- Jean-François Baget and Michel Leclère were PC members of ESWC 2014 (European Semantic Web Conference).
- Jérôme Fortin was PC member of ICCS 2014 (International Conference on Conceptual Structures).
- Marie-Laure Mugnier was PC member of NMR 2014 (Non Monotonic Reasoning Workshop).
- Souhila Kaci was PC member of MPREF'14 (Workshop on Advances in Preference Handling).
- Madalina Croitoru was PC member of the special session on "Decision Support and uncertainty management in Agri-Environment" of IPMU 2014 (15th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based System).
- Madalina Croitoru was PC member of COMMA 2014 (5th International Conference on Computational Models of Argument).
- Madalina Croitoru was PC member of AGI-14 (7th Conference on Artificial General Intelligence).
- Madalina Croitoru was PC member of AIMSA 2014 (16th International Conference on Artificial Intelligence: Methodology, Systems, Applications).
- Madalina Croitoru was PC member of IBERAMANIA 2014 (Ibero-American Conference on Artificial Intelligence).
- Rallou Thomopoulos was PC member of IPMU 2014 (Information Processing and Management of Uncertainty in Knowledge-Based Systems).
- Patrice Buche was PC member of CARI 2014 (Colloque africain sur la recherche en informatique et mathématiques appliquées)
- Marie-Laure Mugnier was PC member of JIAF 2014 (Journées d'Intelligence Artificielle Fondamentale).
- Rallou Thomopoulos was PC member of GeCSO (Gestion des Connaissances dans la Société et les Organisations).
- Patrice Buche was PC member of IC 2014 (Journées francophones d'Ingénierie des Connaissances).
- Patrice Buche was PC member of RFIA 2014 (Congrès national sur la Reconnaissance de Formes et l'Intelligence Artificielle).

### 9.1.3. Journal

#### 9.1.3.1. Member of the editorial board

- Madalina Croitoru is member of the editorial board of the International Journal of Conceptual Structures and Smart Applications (IJCSSA).
- Marie-Laure Mugnier is member of the editorial committee of the journal Revue d'Intelligence Artificielle (RIA).

#### 9.1.3.2. Reviewer

- Transactions on Database Systems (TODS)
- Journal of Artificial Intelligence (JAIR)

#### 9.1.4. Scientific Animation

- Patrice Buche animates the national network INRA IN-OVIVE <http://www6.inra.fr/reseau-in-ovive>.
- Patrice Buche animates the regional seminar MIA <http://umr-iate.cirad.fr/seminaires/aide-a-la-decision>.
- Souhila Kaci animates the LIRMM seminar on Artificial Intelligence <https://www.lirmm.fr/recherche/departements/info/poles-de-recherche/ia>.

#### 9.1.5. Invited Talks

- Marie-Laure Mugnier gave an invited talk at the 10th Reasoning Web Summer school (RW'2014), Athens, Sept. 2014. <http://rw2014.di.uoa.gr/>. Title : “*Ontology-Based Query Answering with Existential Rules*” [http://rw2014.di.uoa.gr/sites/default/files/slides/Ontology-Based\\_Query\\_Answering\\_with\\_Existential\\_Rules.pdf](http://rw2014.di.uoa.gr/sites/default/files/slides/Ontology-Based_Query_Answering_with_Existential_Rules.pdf).
- Madalina Croitoru gave an invited talk at the MIA-INRA seminar, Lyon, March 2014. [https://colloque6.inra.fr/math\\_info/Programme-Actes](https://colloque6.inra.fr/math_info/Programme-Actes). Title: “*Ingénierie de la connaissance et argumentation*”. [https://colloque.inra.fr/math\\_info/content/download/318/3534/version/1/file/Madalina\\_Croitoru.pdf](https://colloque.inra.fr/math_info/content/download/318/3534/version/1/file/Madalina_Croitoru.pdf)
- Madalina Croitoru gave an invited talk at the INCOM-INRA seminar, Paris, April 2014. Title: “*Argumentation based Explanation in Agronomy*”.
- Marie-Laure Mugnier gave an invited talk at 25èmes journées francophones d'ingénierie des connaissances (IC'2014), Clermont Ferrand, May 2014. <http://www.irit.fr/IC2014>. Title: “*Un nouveau cadre pour l'interrogation de données basée sur une ontologie : les règles existentielles*” <http://www.irit.fr/CMS-DRUPAL7/IC2014/>.
- Marie-Laure Mugnier gave an invited talk at the INRA Open Data seminar, Montpellier, Dec. 2014. <http://www6.inra.fr/reseau-in-ovive/Actions-du-reseau/Seminaires/Seminaire-Open-Data-du-17-19-Decembre-2014>. Title: “*L'approche OBDA*”.
- Federico Ulliana gave an invited talk at the INRA Open Data seminar, Montpellier, Dec. 2014. Title: “*My Corporis Fabrica*”. <http://www6.inra.fr/reseau-in-ovive/Media/Fichier/seminaires/Seminaire-Open-Data-du-17-19-Decembre-2014/My-Corporis-Fabrica>
- Michel Chein gave an invited talk at the ISIMA-LIMOS Seminar, Clermont-Ferrand, Dec. 2014. Title: “*Un problème d'identification d'entités nommées dans les bases bibliographiques.*”

## 9.2. Teaching - Supervision - Juries

### 9.2.1. Teaching

The next table details the number of lecture hours as well as the number of module responsibilities for each team member.

Name	Position	2013/14	Cursus (*)	Module Resp. (per year)
J.-F. Baget	Research Scientist	40	M (UM2)	1
M. Croitoru	Assistant Prof.	198	L2	2
M. Chein	Emeritus Prof.	0		
J. Fortin	Assistant Prof	230	Polytech	2
S. Kaci	Professor	198	L and M(UM2)	3
M. Leclère	Assistant Prof.	196	L and M (UM2)	2
M. -L. Mugnier	Professor	192	L and M (UM2)	3
L. Guizol	PhD	64	L (UM2)	no
M. König	PhD	64	L (UM2)	no
A. Arioua	PhD	12	L (UM2)	no

(\*) L =Licence, M = Master (M1 = first year, M2 = second year), UM2 = Univ. Montpellier 2 (Sciences), IUT = Institute of Technology of UM2 (Licence Cursus), Polytech = Engineering School of UM2, UM3 = Univ. Montpellier 3 (Art and Humanities)

The courses taught by team members are mainly in Logics (in Licence), Artificial Intelligence, Knowledge Representation, Knowledge Engineering, and Decision Support (in Master). We are also responsible of modules in Web Technologies (Professional L at IUT) and Databases (L).

We have some specific responsibilities in the Computer Science Licence and Master:

- Michel Leclère is co-responsible of the master speciality DECOL (about 30 students) started in September 2011.
- Marie-Laure Mugnier is co-responsible of the Computer Science Master started in September 2011 (about 250 students), which gathers six specialties. She is also leading the Master project for the next four years (LMD4).
- Souhila Kaci is leading the Licence project for the next four years (LMD4).
- Madalina Croitoru is responsible of the special year teaching formation at IUT Montpellier II (25 students).

### 9.2.2. Supervision

Madalina Croitoru defended her HDR in November *Reasoning about Knowledge as Graphs: Practical Artificial Intelligence Applications* [15]. The jury was:

- Leila Amgoud, Directeur de Recherche, IRIT, Toulouse, France (reviewer)
- Ollivier Haemmerle, Professeur, IRIT, Toulouse, France (reviewer)
- Jan Top, Professeur, Vrije, Universiteit, Netherlands (reviewer)
- Jérôme Lang, Directeur de Recherche, Paris Dauphine, France (examiner)
- Marie-Laure Mugnier, Professeur, Univ. Montpellier 2, France (examiner)

Bruno Paiva Lima da Silva defended his PhD in January *Data Access over Large Semi-Structured Databases* [18]. The jury was:

- Ollivier Haemmerlé, Professeur, IRIT (reviewer)
- Fabien Gandon Dr. & HDR, Inria Sophia-Antipolis (reviewer)
- Odile Papini, Professeur, Université Aix-Marseille II (examiner)
- Marie-Laure Mugnier, Professeur, Université Montpellier II (advisor)
- Jean-François Baget, Chargé de Recherche, Inria (co-advisor)
- Madalina Croitoru, Maître de Conférences, Université Montpellier II (co-advisor)

*Mélanie König* defended her PhD in October *Interrogation de grandes bases de connaissances : algorithmes de réécriture de requêtes conjonctives en présence de règles existentielles* [17]. The jury was:

- Bernardo Cuenca Grau Tenure, Associate Professor, Univ. Oxford (reviewer)
- Igor Stephan, Maître de conférence HDR, Univ. Angers (reviewer)
- Marianne Huchard, Professeur, Univ. Montpellier II (examiner)
- Lhouari Nourine, Professeur, Univ. Blaise Pascal (examiner)
- Meghyn Bienvenu, Chargé de recherche CNRS, Univ. Paris Sud (examiner)
- Remi Coletta, Maître de conférence, Univ. Montpellier II (examiner)
- Marie-Laure Mugnier, Professeur, Univ. Montpellier II (advisor)
- Michel Leclère, Maître de conférence, Univ. Montpellier II (co-advisor)

*Tjitze Rienstra* defended his PhD in October *Argumentation in Flux – Modelling change in the theory of argumentation*. The jury was:

- Lluís Godo, professor, Institut d'Investigació en Intel·ligència Artificial, Bellaterra, Spain (chairman)
- Pietro Baroni, professor, Università degli Studi di Brescia, Italy (vice-chairman)
- Beishui Liao, professor, Zhejiang University, China (member)
- Richard Booth, researcher, Université du Luxembourg (member)
- Leon van der Torre, professor, Université du Luxembourg (co-supervisor)
- Souhila Kaci, professor, Université de Montpellier, France (co-supervisor)

*Léa Guizol* defended her PhD in November *Partitioning semantics for entity resolution and link repairs in bibliographic knowledge bases* [16]. The jury was:

- Nathalie Aussenac, Directeur de recherches, CNRS, IRIT, Toulouse (reviewer)
- Englebert Mephu Nguifo, Professeur, Université Clermont-Ferrand (reviewer)
- Mathieu Roche, Directeur de recherches, Université Montpellier II (examiner)
- Marie-Laure Mugnier, Professeur Université Montpellier II (advisor)
- Madalina Croitoru, Maître de conférences, Univ. Montpellier II (co-advisor)

The PhDs in progress are:

*Fabien Garreau* (ANR ASPIQ grant), Algorithms for stable model semantics and existential rules (ANR ASPIQ, with Univ. of Angers), Sept. 2012, supervised by Igor Stephan, Jean-François Baget and Laurent Garcia

*Swan Rocher* (ANR Qualinca grant), Reasoning with inconsistent knowledge bases in presence of existential rules (ANR Qualinca), Sept. 2013, supervised by Marie-Laure Mugnier and Jean-François Baget

*Namrata Patel* (Univ. Montpellier II grant), Preference Handling in Decision Problems (ministry grant), Sept. 2013, supervised by Souhila Kaci

*Abdallah Arioua* (ANR Dur-Dur& INRA Grant), Argumentation Theory and its Application to Knowledge-based Systems, started Nov. 2013, supervised by Patrice Buche, Madalina Croitoru and Jérôme Fortin.

### 9.2.3. Juries

Jury member - Mustafa AL BAKRI - Uncertainty-Sensitive Reasoning over the Web of Data - December 15, 2014 - Université de Grenoble, LIG (Marie-Laure Mugnier)

Jury member - Rim TOUHAMI - Construction et évolution d'une ressource termino-ontologique dédiée à la représentation de relations n-aires, application à l'évaluation du risque microbiologique dans des aliments emballés - Université Montpellier 2, UMR IATE, MIA & AgroParisTech, September 5, 2014 (Marie-Laure Mugnier)



Reviewer - Maxime LEFRANCOIS - "Représentation des connaissances sémantiques lexicales de la Théorie Sens-Texte : Conceptualisation ; représentation ; et opérationnalisation des définitions lexicographiques" - Université de Nice, Inria & I3S, June 24, 2014 (Marie-Laure Mugnier)

Recruitment committee member: Assistant Professor position at Université d'Orsay (Marie-Laure Mugnier)  
Assistant Professor position at Université Montpellier 2 (Madalina Croitoru, Marie-Laure Mugnier)

## 10. Bibliography

### Major publications by the team in recent years

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A. ARIOUA, N. TAMANI, M. CROITORU, P. BUCHE. *Query Failure Explanation in Inconsistent Knowledge Bases: A Dialogical Approach*, in "AI'2014: 34th SGAI International Conference on Innovative Techniques and Applications of Artificial Intelligence", Cambridge, United Kingdom, Research and Development in Intelligent Systems XXXI, December 2014, pp. 119-133 [DOI : 10.1007/978-3-319-12069-0\_8], <http://hal-lirmm.ccsd.cnrs.fr/lirmm-01091082>.

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