Activity Report 2013

Project-Team GRAPHIK

GRAPHs for Inferences and Knowledge representation

Table of contents

Project-Team GRAPHIK

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

Creation of the Project-Team: 2010 January 01.

1. Members

Research Scientists
Jean-François Baget [Inria, Researcher]
Rallou Thomopoulos [INRA, Researcher, HdR]

Faculty Members
Marie-Laure Mugnier [Team leader, Univ. Montpellier II, Professor, HdR]
Michel Chein [Univ. Montpellier II, Professor, HdR]
Madalina Croitoru [Univ. Montpellier II, Associate Professor]
Jérôme Fortin [Univ. Montpellier II, Associate Professor]
Souhila Kaci [Univ. Montpellier II, Professor, HdR]
Michel Leclère [Univ. Montpellier II, Associate Professor]

External Collaborators
Patrice Buche [Research Engineer, INRA, HdR]
Patricio Mosse [INRA]

Engineers
Alain Gutierrez [Engineer, CNRS, 50% member of GraphIK]
Luc Menut [Engineer, INRA, 50% member of GraphIK]

PhD Students
Fabien Garreau [Univ. Angers, from Nov. 2012]
Léa Guizol [CNRS, from Oct. 2011]
Mélanie König [Univ. Montpellier II, from Oct. 2011]
Bruno Paiva Lima Da Silva [Univ. Montpellier II, from Oct. 2010]
Namrata Patel [Univ. Montpellier II, from Oct. 2013]
Tjitze Rienstra [Univ. of Luxembourg and Univ. Montpellier II, from Sept. 2011]
Swan Rocher [Inria, from Sept. 2013]
Michaël Thomazo [Univ. Montpellier II, until Aug. 2013]
Abdallah Arioua [INRA, from Nov. 2013]
Yoann Bonavero [CNRS, co-supervison with MAREL, from Oct. 2012]

Post-Doctoral Fellow
Nouredine Tamani [Inria, from Nov. 2013]

Administrative Assistant
Annie Aliaga [Inria]

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 of this domain: 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 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 of languages and the 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 axis) 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.

2.5. Highlights of the Year

- Rallou Thomopoulos defended her HDR, entitled *Aide à la décision dans les filières agroalimentaires*, on Dec. 2013.
- Three papers from the team were accepted at IJCAI 2013 (International Joint Conference in Artificial Intelligence), the major conference in Artificial Intelligence [41], [37], [42].

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 *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 special 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 reasonings 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 is a central problem in knowledge representation and in database theory. 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 ontogical languages, typically description logics, were not designed for efficient querying. On the other hand, database languages were 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 can be seen as an abstraction of ontological knowledge expressed in the main languages used in the context of KB querying. See Section 6.1 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 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 will 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 6.2).

4. Application Domains

4.1. Introduction

We currently focus on two application domains: *agronomy*, where knowledge representation is applied to the quality in agri-food chains, and *bibliographic databases*, in particular management of bibliographic metadata.

The choice of the agronomy domain is motivated both by the strong expertise of GraphIK (UMR IATE) and by its adequation to our research themes. Indeed, the agri-food domain seems to be particularly well-adapted to artificial intelligence techniques: there are no mathematical models available to solve the problems related to the quality of agrifood chains, which need to be stated at a more conceptual level; solving these problems requires an integrated approach that takes into account expert knowledge, which is typically symbolic, as well as numeric data, vague or uncertain information, multi-granularity knowledge, multiple and potentially conflicting viewpoints and actors.

The second area, metadata management, is not strictly speaking an application domain, but rather a cross-cutting axis. Indeed, metadata can be used to describe data in various areas (including for instance scientific publications in agronomy). We have a long experience in this domain, and we currently focus on document metadata.

4.2. Agronomy

Within this field we have investigated two different agronomy scenarios: (1) choosing between two different kinds of flour in function of their nutritional, economic, health and other factors and (2) packaging conception. 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 properly model the knowledge using facts, rules and negative constraints. Then, in a second step, in the possibly inconsistent knowledge base thus obtained, 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).

4.3. Document Metadata

Semantic metadata, in particular semantic annotations for multimedia documents, are at the core of the applications we are working on for several years. In our current project ANR Qualinca with ABES and INA (see Section 8.1), the semantic metadata considered consists of information present in bibliographic databases and authority notices (which respectively describe documents and so-called authorities, such as authors typically). The challenge is not to build these metadata, which have been built by human specialists and already exist, but to check their validity, to link or to merge different metadata bases.

5. 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+/-. This year, the following features have been developed:

- we have introduced the concept of scripted rule which associates more fluidly the editable graphical objects with scripts that perform operations on knowledge graphs. These features have been tested and improved in various projects this year (see *e.g.* Qualinca in Section 8.1 or CTFC in Section 7.2).

- we have implemented an interface for quick and assisted creation of graphs. It is based upon Datalog+/- language and provides tools for automatic completion.

- finally, default conceptual graphs rules were implemented in Cogui. An editing interface is available as well as the operation to find all extensions of a rule set. This feature is required by the CTFC project (see Section 7.2).

5.2. Cogui/Capex

Participants: Alain Gutierrez, Patrice Buche, Awa Diattara, Jérôme Fortin.

Cogui/Capex is a platform for expert knowledge management. It has been developed in order to propose a simple and useful interface to applicative domain experts. This will allow us to validate the integration of our theoretical tools into a real-world application and strengthen GraphIK's involvement in agronomy applications (see the projects with CTFC in Section 7.2 and Panzani in Section 7.3).

5.3. Alaska

Participants: Bruno Paiva Lima Da Silva, Jean-François Baget, Madalina Croitoru.

Alaska (http://alaska.bplsilva.com/) is a java library dedicated to the storage and querying of large knowledge bases. It intends to be the foundation layer of our OBDA (Ontology Based Data Access) software developments. It has been built, first as part of a master thesis, and now of Bruno Paiva Lima da Silva' PhD (that will be defended in Jan. 2014).

In Alaska, facts and queries are defined via a generic interface that favors a logical view of these objects. Implementations of this interface allow for the storage of facts w.r.t. different storage paradigms and systems (e.g., relational databases *MySQL* and *Sqlite*; triple stores *Sesame* and graph databases *Neo4J*, *DEX*, *Hyper-GraphDB* and *OrientDB*). For the time being, we can store 10^7 to 10^8 atoms. In the same way, logical queries can be evaluated through different methods, be it the native querying mechanism of the considered database (*e.g. SPARQL* or *SQL*), or specifically designed algorithms (from a simple backtrack to a full constraint solver based upon *Choco* http://www.emn.fr/z-info/choco-solver/ for hard problem instances). Note that all these methods provide the same answer set to queries.

This library already allows for testing our OBDA algorithms on large instances. The ADT Quasar (that will start in March 2014) will involve the integration of Alaska with other tools developed in the team (see also Section 5.4), and its improvement from a research library to a distributable tool.

5.4. Tools for Rule-Based Reasoning

Participants: Mélanie König, Michel Leclère, Marie-Laure Mugnier, Swan Rocher, Michaël Thomazo.

Kiabora has been designed to analyze an existential rule base (see Section 6.1) and determine if it allows for finite query answering, i.e., if any conjunctive query evaluated over any fact base while taking this set of rules into account will be answered in a finite time. This year, we fixed some bugs and added some specific options. In addition, a presentation and a demo of Kiabora were made at RR 2013 [38].

Besides, the algorithms presented in [38], [37], [41] were implemented and let to experiments. These algorithms are still under development since new improvements have to be integrated.

6. New Results

6.1. Ontology-Based Query Answering with Existential Rules

Participants: Jean-François Baget, Fabien Garreau, Mélanie König, Michel Leclère, Marie-Laure Mugnier, Swan Rocher, Michaël Thomazo.

Note that for this section, as well as all sections in New Results, participants are given in alphabetical order.

This year we continued to work on the existential rule framework in the context of Ontology-Based Query Answering (a.k.a. Ontology-Based Data Access, OBDA). See the 2011-2012 activity reports for details on this framework (a.k.a. Tuple-Generating Dependencies or Datalog+/-). The ontology-based query answering issue consists in querying data while taking into account inferences enabled by an ontology. This ontology is here described by existential rules, a very expressive formalism which generalizes the lightweight description logics used for OBDA (e.g. the tractable fragments of the Semantic Web language OWL 2).

From 2009 to 2011, we mainly investigated decidability and complexity issues. In 2012, we tackled the next step, which consists in developing algorithms with good theoretical properties (they should at least run in the "right" worst-case complexity class) and with good performance in practice. There are two main ways of processing rules, namely forward chaining and backward chaining, which are also known as "materialization" and "query rewriting". In forward chaining, rules are applied to enrich the initial data and query answering can then be solved solved by evaluating the query against the "saturated" database (as in a classical database system, i.e., forgetting the rules). 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).

In 2013, on the one hand we focussed on the improvement of query rewriting algorithms, on the other hand we began to investigate extensions of our framework.

6.1.1. Improvement of Query Rewriting Algorithms

The advantage of the query rewriting approach is that the data are not modified (hence no write access permission is required and the data do not grow; moreover, there is no materialization that would need to be updated when data change). However, the practicability of this approach is questionable due to (1) the weak expressivity of classes for which efficient rewriters have been implemented, and (2) the large size of rewritings using UCQ.

With respect to the first point, we improved the algorithm designed in 2012. This algorithm accepts as input any set of existential rules and stops if this set of rules fulfills so-called finite unification set (fus) property, meaning that the set of rules allows to rewrite any query as a first-order query, e.g. a UCQ (this property is not true in general, where no finite rewriting may exist). We also studied properties of rewriting operators that ensure the correctness and the termination of a generic breadth-first rewriting algorithm and analyzed some operators with respect to these properties.

- *Work published in IJCAI 2013 [37] and RR 2013 (Rules and Web Reasoning) [36]*

With respect to the second point, we defined semi-conjunctive queries (SCQs), which are a syntactical extension of conjunctive queries. We designed and implemented an algorithm called Compact, which computes sound and complete rewritings of a conjunctive query in the form of a union of SCQs (USCQs). As in the above work, any kind of existntial rules can be considered, however the algorithm is ensured to stop only for fus rules. First experiments show that USCQs are both very efficiently computable and more efficiently evaluable than their equivalent UCQs.

- *Work published in IJCAI 2013 [41]*

6.1.2. Ongoing Work: Extensions of the Framework

Inconsistent-tolerant query answering. It may be the case that the data are inconsistent with the ontology, specially when there are several data sources. The classic logical framework becomes inappropriate since an inconsistent logical theory entails everything. Therefore, inconsistency-tolerant semantics have been defined to get meaningful answers. These semantics are based on the notion of repairs, which are maximal subsets of the data consistent with the ontology. In the most natural semantics, a tuple is an answer to the query if it is an answer in each repair. This issue is relevant to Pagoda and Qualinca, two ANR projects respectively started in 2013 and 2012 (see Section 8.1). Swan Rocher's master thesis was devoted to a query answering algorithm in this framework, where the ontology is described by existential rules and negative constraints.

Existential Rules with non-monotonic negation. Non-monotonic negation is very useful for modeling purposes. We added non-monotonic negation to existential rules, under stable model semantics. This brought us close to logic programs considered in the area called Answer Set Programming. First results were obtained on the semantics and decidability of query answering with these rules. This work is part of ASPIQ project started in 2013 (see Section 8.1).

- *Paper curently submitted to an international conference.*

6.1.3. Others

Michael Thomazo defended his PhD thesis entitled "Conjunctive Query Answering Under Existential Rules —Decidability, Complexity, and Algorithms" (Oct. 2013). The main contributions of this thesis are the following: first, a unified view of the currently known existential rule classes ensuring decidability of query answering, together with a complexity analysis and a worst-case optimal algorithm for a new generic class, which generalizes a family of very expressive decidable classes (see the gbts class in 2012 activity report); second, a generic algorithm for query rewriting, which overcomes some causes of combinatorial explosion that make classical approaches inapplicable.

- *See the PhD thesis [15] and the extended abstract published in IJCAI 2013 [42].*

The journal version extending the papers at IJCAI 2011 and KR 2012, in collaboration with Sebastian Rudolph (TU Dresden), is still in preparation but almost finished (postponement due to the addition of complementary results).

6.2. Reasoning with Imperfect Information and Priorities

Participants: Madalina Croitoru, Jérôme Fortin, Souhila Kaci, Tjitze Rienstra, Rallou Thomopoulos.

6.2.1. Monotonic and Non-monotonic Inference for Abstract Argumentation

An argumentation framework (or framework, for short) consists of a set of arguments, whose content may be left unspecified, together with an attack relation encoding conflict between arguments. Given a framework, a semantics specifies which sets of arguments (called extensions) are rationally acceptable. This formalism captures many different types of reasoning considered in the area of AI. In many applications, a framework somehow represents (part of) an agent's belief state. Beliefs are then formed on the basis of acceptable sets of arguments. For example, a 'grounded reasoner' forms beliefs on the basis of the framework's grounded extension, a 'preferred reasoner' on the basis of the preferred extensions, and so on. There is a problem with this account, however. Two different argumentation frameworks may be considered equivalent as soon as they lead to the same extensions. A more appropriate notion of equivalence is strong equivalence. Given a semantics, two frameworks are said to be strongly equivalent if their extensions are the same given every possible addition of new arguments and attacks. But still, it leaves open the question of how to form beliefs on the basis of a framework, so that different frameworks can be meaningfully distinguished, even if their extensions are the same. We addressed this problem and presented a new approach to reasoning about the outcome of an argumentation framework, where an agent's reasoning with a framework and semantics is represented by an inference relation defined over a logical labeling language. We first studied a monotonic type of inference which is, in a sense, more general than an acceptance function, but equally expressive. In order to overcome the limitations of this expressiveness, we studied a non-monotonic type of inference which allows counterfactual inferences. We precisely characterized the classes of frameworks distinguishable by the non-monotonic inference relation for the admissible semantics.

- *Joint work with R. Booth and L. van der Torre (Univ. of Luxembourg), published in FLAIRS 2013 [27]*

6.2.2. Dynamics in Abstract Argumentation

Recent years have seen a considerable work on dynamics in argumentation framework (AF). We addressed dynamics in abstract argumentation using a logical theory where an agent's belief state consists of an argumentation framework and a constraint that encodes the outcome the agent believes the argumentation framework should have. Dynamics enters in two ways: (1) the constraint is strengthened upon learning that the AF should have a certain outcome and (2) the argumentation framework is expanded upon learning about new arguments/attacks. A problem faced in this setting is that a constraint may be inconsistent with the AF's outcome. We discussed two ways to address this problem: First, it is still possible to form consistent fallback beliefs, i.e., beliefs that are most plausible given the agent's argumentation framework and constraint. Second, we showed that it is always possible to find argumentation framework expansions to restore consistency. Our work combines various individual approaches in the literature on argumentation dynamics in a general setting.

- *Joint work with R. Booth and L. van der Torre (Univ. of Luxembourg), published in SUM 2013. [26]*

Preferences have been intensively studied in argumentation framework. Preference-based argumentation frameworks are instantiation of Dung's framework in which the defeat relation (in the sense of Dung) is computed from an attack relation and a preference relation over the set of arguments. We distinguish between different ways to derive preferences over arguments, e.g., from their relative specificity, relative strength or from values promoted by the arguments. However an underexposed aspect in these models is change of preferences. We proposed a dynamic model of preferences in argumentation, centering on what we call property-based AFs. It is based on Dietrich and List's model of property-based preference and it provides an account of how and why preferences in argumentation may change. The idea is that preferences over arguments are derived from preferences over properties of arguments, and change as the result of moving to different motivational states. We also provided a dialogical proof theory that establishes whether there exists some motivational state in which an argument is accepted.

- *Joint work with R. Booth (Univ. of Luxembourg), published in ADT 2013.*

6.2.3. Representing Synergy Among Arguments with Choquet Integral

Preference-based argumentation frameworks are instantiation of Dung's framework in which the defeat relation (in the sense of Dung) is computed from an attack relation and a preference relation over the set of arguments. Value-based argumentation framework is a preference-based argumentation framework where the preference relation over arguments is derived from a preference relation over values they promote. We extended value-based argumentation framework with collective defeats and arguments promoting values with various strengths. In the extended framework, we defined a function which computes the strength of a collective defeat. We also defined desired properties for the proposed function. Surprisingly, we showed that this function obeying the corresponding properties is Choquet integral, a well-known aggregation function at work in multiple criteria decision.

- *Joint work with C. Labreuche (Thales), published in EC-SQARU 2013 [35]*

6.2.4. Compiling Preference Queries in Qualitative Constraint Problems

Comparative preference statements are the basic ingredients of conditional logics for representing users' preferences in a compact way. These statements may be strict or not and obey different semantics. Algorithms have been developed in the literature to compute a preference relation over outcomes given a set of comparative preference statements and one or several semantics. These algorithms are based on insights from non-monotonic reasoning (more specifically, minimal and maximal specificity principles) enforcing the preference relations to be a complete preorder. The main limitation of these logics however relies in preference queries when comparing two outcomes. Indeed given two outcomes having the same preference w.r.t. the preference relation, there is no indication whether this equality results from an equality between two preference statements or the outcomes are in fact incomparable and equality has been enforced by specificity principles. On the other hand, comparative preference statements and their associated semantics can be translated into qualitative constraint satisfaction problems in which one can have a precise ordering over two outcomes. We investigated this bridge and provided a compilation of conditional logics-based preference queries in qualitative constraint problems.

- *Joint work with J.-F. Condotta (CRIL), published in FLAIRS 2013 [31]*

6.2.5. Argumentation for Reasoning with Inconsistencies

We investigate the use of argumentation when reasoning over an inconsistent knowledge base. We use argumentation in this context given the explanation power that it may bring (and that is currently under investigation).

We have investigated logical based argumentation following two methods. First, we have defined our own argument and attack notion (given the logical language at hand) and showed that such instantiation respects desirable properties of consistency and maximality (called rationality postulates in the field). This work has showed that the ICR, AR, IAR semantics investigated by inconsistent query answering (see Pagoda, Section 8.1) are the same as skeptically preferred or stable semantics, grounded and universally stable or preferred. Such result is encouraging as it bridges the two communities (argumentation and inconsistent query

answering) allowing to use results from one field in order to enrich the other. We have also investigated the practical applicability of such argument definition and approach in the selection of flour for bread.

- *Joint work with Srdjan Vesic (Univ. of Luxembourg), published in RIA 2013 [23] and SUM 2013 [32]*

.

On the other hand we have also looked at using a generic logical argumentation framework (ASPIC) in order to instantiate it with a simple logic in the EcoBioCap project (see Section 8.2). We have extended previous results to enrich bipolar queries. A software tool is under construction.

- *Work published in RIA 2013 [21]*

6.3. Semantic Data Integration

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

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. Since the seminal paper [59], this issue has been been studied under various names: "record linking", "entity resolution", "reference resolution", "de-duplication", "object identification", "data reconciliation", etc., mostly in databases (cf. the bibliography by William E. Winckler [60]). 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.

Past years, 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 catalogue from the ABES agency). The prototype providing this service has been implemented on top of Cogui and experiments have been led in the context of the SudocAd project (jointly conducted by ABES and GraphIK).

Our proposed method can be stated as follows: first, enrich authority records with knowledge extracted from bibliographic records in which the authority is mentioned ; then, use logical rules which conclude on different levels of reconciliation, to compare the authors of a new bibliographic record with the enriched authority records ; finally, for each author of the new bibliographic record, order the authority identifiers by level of reconciliation.

- *Work published in [30].*

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. This year, this work has been pursued along three different axis:

1. We have built a formal framework allowing to evaluate the quality of links in a documents database. We propose two different "quality" notions, based upon an identification predicate 'id and a differentiation predicate di between pairs of authority notices identifiers (these predicates can be either given by an expert or computed using rules). We have first introduced the notion of a *well-founded* database, when id is an equivalence relation and di its complement. This property can be checked using logical inferences and combinatorial techniques. In the general case where a database

is not necessarily well-founded, we have proposed different distances to a well-founded one. We have also introduced a more complex quality criterion that corresponds to *stability by substitution* (a fundamental property of logical equality that is not necessarily satisfied by *id*).

– *A research report should lead to a publication in 2014.*

2. We developed a methodology for detecting linkage errors and fixing them, based upon a clustering method of authors in bibliographic records. Last year, the general schema of the methodology was defined. It is based upon a set of criteria which allows us to cluster "similar" authors together. Each criterion represents a point of view on the author: name, publication time span, publication domain, etc... This year, two aggregation semantics for such criteria have been developed, implemented and evaluated.

– *Work published in AI-SGAI 2013 [34].*

3. We have studied methods allowing to automatically extract similarity criteria between named entities. This problem is very similar to the automatic discovery of composite key constraints in RDF data sources that conform to a given ontology. We have studied the different existing methods allowing to discover such keys, and have proposed logical semantics for these different keys. These semantics allow to understand and compare the results produced by these different methods. These methods have been evaluated against the documentary databases provided by our partners ABES and INA.

– *Work described in a research report [48], at the moment, two papers are submitted.*

7. Bilateral Contracts and Grants with Industry

7.1. ABES

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

Collaboration with ABES. Funding of half a PhD grant (Léa Guizol, started in October 2011). See Section 6.3.

7.2. CTFC

Participants: Patrice Buche, Jérôme Fortin, Awa Diattara.

We have initiated a national collaboration with the technical center of Comptois' cheese (CTFC : Centre Technique des Fromages Comtois). The objective of this collaboration is to design and test a platform for expert knowledge management. This will allow 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.

This collaboration should be strengthened in 2014 in a enlarged project involving different traditional food chains (CNAOL, Conseil National des Appelations d'Origine Laitière).

7.3. 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 and thus ensure that our developments and software 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, Jérôme Fortin, Marie-Laure Mugnier, Michel Leclère.

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

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 6.1 for this year results (Extensions of the Framework).*

8.1.1.2. Pagoda

Participants: Jean-François Baget, Marie-Laure Mugnier, Mélanie König, 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.

The primary aim of this project is to help 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 6.1 for this year results.*

8.1.1.3. Qualinca

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

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.

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 6.3 for this year results.*

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 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 aboratory). 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". GraphIK is involved in this project via its common members with IATE team. The budget is managed by IATE team.

- *See Section 6.2 for this year 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 and Michaël Thomazo collaborate 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-supervise a PhD student (Tjitze Rienstra).

Sebastian Rudolph: TU Dresden (Germany)

Jean-François Baget, Marie-Laure Mugnier and Michaël Thomazo collaborate with Sebastian Rudolph on existential rules. Michaël Thomazo started a postdoc in Sebastian Rudolph's team. Madalina Croitoru collaborates with Sebastian Rudolph (also with Sarah Gaggl) on approximation algorithms for argumentation semantics, as well as on multi agent knowledge allocation.

Srdjan Vesic: University of Luxmbourg, Individual and Collective Reasoning research group (Luxembourg)

Madalina Croitoru collaborates with Srdjan Vesic on logical argumentation in the positive existential fragment of first-order logic with and without preferences.

Nir Oren: University of Aberdeen, Department of Computing Science (United Kingdom)

Madalina Croitoru collaborates with Nir Oren on graphical norm representation and reasoning, as well as on arguing about preferences using a structured argumentation framework.

Ioannis A. Vetsikas: University of Athens, IIT (Greece)

Madalina Croitoru collaborates with Ioannis A. Vetsikas on information selling mechanism design.

Talal Rahwan: University of Southampton, School of Electronics and Computer Science (United Kingdom)

Tomasz Michalak: University of Oxford, Department of Computer Science (United Kingdom)

Madalina Croitoru collaborates with Talal Rahwan and Tomasz Michalak on coalition formation using graphs structures.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- March 2013: Richard Booth (Univ. of Luxembourg). LIRMM AI seminar on *Quantifying disagreement in argument-based reasoning*.

- March 2013: Wojtek Jamroga (Univ. of Luxembourg). LIRMM AI seminar on *Some Funny Complexity Results for Judgment Aggregation*.

- April 2013: Pierre Bourhis (Univ. of Oxford). GraphIK seminar on *The Impact of Disjunction on Query Answering Under Guarded-based Existential Rules*.

- May 2013: Georg Gottlob (Univ. of Oxford). GraphIK seminar on *The Hypergraph Transversal Problem: Applications, Complexity, and Tractable Cases*.

- October 2013: Carsten Lutz (Univ. of Bremen). GraphIK seminar on *Ontology-Based Data Access: A Study Through Disjunctive Datalog, CSP, and MMSNP*, in the context of Michaël Thomazo's PhD's defense.

- October 2013: Georg Gottlob (Univ. of Oxford). GraphIK seminar on *Robust Constraint Satisfaction and Local Hidden Variables in Quantum Mechanics*, in the context of Michaël Thomazo's PhD's defense.

- November 2013: Roman Kontchakov and Michael Zakharyaschev (Birkbeck College, Londres). GraphIK seminar on *Theory and practice of ontology-based data access with OWL 2 QL*.

8.3.2. *Visits to International Teams*

Patrice Buche visited Wageningen UR Food and Biobased Research (Nederlands) two days in May 2013 (scientific exchanges on quantity and units ontologies).

9. Dissemination

9.1. Scientific Animation

9.1.1. *Habilitations à Diriger les Recherches (HDR)*

Rallou Thomopoulos defended her HDR on December, entitled *Aide à la décision dans les filières agroalimentaires* in front of the following jury:

- Christine FROIDEVAUX , Pr., Univ. Paris Sud, Orsay, Reviewer
- Bernard MOULIN, Pr., Univ. Laval, Québec, Canada, Reviewer
- Henri PRADE, DR CNRS, IRIT, Toulouse , Reviewer
- Joël ABECASSIS, IR (HDR), INRA, Montpellier
- Fabien GANDON, CR (HDR), Inria, Sophia-Antipolis
- Marie-Laure MUGNIER, Pr., Univ. Montpellier 2, Président of Jury

9.1.2. *Organization of Conferences/Workshops*

- Souhila Kaci co-organized the "Uncertain reasoning" track at FLAIRS'13. She also co-organized the 7th Multidisciplinary Workshop on Preferences (MPREF'13) in conjunction with IJCAI'13.

- Patrice Buche co-organized the IN-OVIVE workshop dedicated to heterogeneous data sources integration in life sciences during IC'2013 in Lille http://umr-iate.cirad.fr/actualites/atelier-in-ovive-a-la-conference-ic-2013-le-2-juillet.

- Madalina Croitoru was chair of GKR 2013 (3rd IJCAI international workshop on graph structures for knowledge representation and reasoning), in conjunction with IJCAI'13; and is general chair of ICCS 2014 (International Conference on Conceptual Structures).

9.1.3. *Editorial Boards*

ICCS (International Conference on Conceptual Structures)

RIA (Revue Francophone d'Intelligence Artificielle)

9.1.4. Program Committees

- **International conferences and workshops:**
    - ECAI 2014 (European Conference on Artificial Intelligence) [senior PC; PC]; RR 2014 (8th International Conference on Web Reasoning and Rule Systems) [co-presidency of program committee]; IPMU 2014 (15th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based System) [initiative committee of special session on "Decision Support and uncertainty management in Agri-Environment"]; ICCS 2014 (International Conference on Conceptual Structures) [general chair; steering committee]; ESWC 2014 (European Semantic Web Conference), IJCAI'13 (International Joint Conference on Artificial Intelligence)[senior PC; PC]; AAMAS'13 (Autonomous Agents and Multiagent Systems); EUSFLAT 2013 (8th conference of the European Society for Fuzzy Logic and Technology); RR 2013 (7th International Conference on Web Reasoning and Rule Systems).
    - NMR 2014 (Non-monotonic reasoning workshop); MPREF'14 (Workshop on Advances in Preference Handling); GKR 2013 (3rd IJCAI international workshop on graph structures for knowledge representation and reasoning)[chair].
- **National conferences and workshops:** JIAF 2013 and 2014 (Journées d'Intelligence Artificielle Fondamentale); IC 2013 (Ingénierie des Connaissances); LFA 2013 (22e rencontres francophones sur la logique floue et ses applications)

9.1.5. Invited Talks

- Jean-François Baget gave an invited talk at the "Artificial Intelligence meets the Web of Data" workshop associated to ESWC'13 (European Semantic Web Conference). Title : *"Ontologies and large databases: querying algorithms for the Web of Data"*.
- Marie-Laure Mugnier gave an invited talk at the workshop CrEDIBLE (fédération de données et de connaissances distribuées en imagerie biomédicale, CNRS - défi MASTODONS). Title: *"Ontological Query Answering with Existential Rules"*.
- Madalina Croitoru gave a seminar at the Univ. of Dresden. Title: *"What can argumentation do for inconsistent query answering?"*
- Madalina Croitoru gave 15h of lectures at the Computer Science winter school of the Univ. of Buenos Aires (ECI winter school, http://www.dc.uba.ar/events/eci/2013/cursos/). Title: *"Graph-based representation and reasoning in artificial intelligence"*

9.1.6. Scientific Advisory Boards

- ABES (National Bibliographic Agency for Universities) Scientific Advisory Board, Michel Chein (since its creation in 2010).
- Advisory Board of the Center of Excellence in Semantic Technologies (MIMOS, Malaysia), Marie-Laure Mugnier (since its creation in 2008).
- Scientific board of INRA-CEPIA department (Caractérisation et Elaboration des Produits Issus de l'Agriculture – Agricultural Products Engineering), Marie-Laure Mugnier (since Septembre 2011).

9.1.7. Local Collective Tasks

Souhila Kaci is co-responsible of "Artificial Intelligence" axis at LIRMM.

Souhila Kaci and Namrata Patel are members of the LIRMM Laboratory Council.

Jean-François Baget is member of the LIRMM Scientific Council.

9.1.8. Participation to the W3C RDF Working Group

(Jean-François Baget) The mission of the RDF Working Group, part of the Semantic Web Activity, is to update the 2004 version of the Resource Description Framework (RDF) Recommendation. The scope of work is to extend RDF to include some of the features that the community has identified as both desirable and important for interoperability based on experience with the 2004 version of the standard, but without having a negative effect on existing deployment efforts. http://www.w3.org/2011/01/rdf-wg-charter.

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	2012/13	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.	96	L and M (UM2)	2
M. -L. Mugnier	Professor	192	L and M (UM2)	3
R. Thomopoulos	Research Scientist	0		no
L. Guizol	PhD	64	L	no
M. König	PhD	64	L	no
B. Paiva Lima	PhD	64	L (UM2)	no
M. Thomazo	PhD	64	L and M1 (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)

Globally, the team ensures the courses in logics (propositional logic and first-order logic in L, logics for Artificial Intelligence in M2) at the Montpellier 2 University, as well as the Master courses in Artificial Intelligence, Decision Support, Knowledge Representation and Knowledge Engineering. 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 20 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).

9.2.2. Supervision

9.2.2.1. PhDs

Michaël Thomazo defended his PhD on October *Conjunctive Query Answering Under Existential Rules - Decidability, Complexity, and Algorithms* [15]. The jury was:

- Georg GOTTLOB (PR), Univ. of Oxford, Reviewer
- Carsten LUTZ (PR), Univ. of Bremen, Reviewer
- Marie-Christine ROUSSET (PR), Univ. de Grenoble, Reviewer

- Christophe PAUL (DR), CNRS, Examiner
- Jean-François BAGET (CR), Inria, Co-advisor
- Marie-Laure MUGNIER (PR), Univ. Montpellier 2, Advisor

The PhDs in progress are:

PhD in progress : Bruno Paiva Lima da Silva (ministry grant), Comparing Storage Systems for Large knowledge bases, Oct. 2010, supervised by Jean-François Baget and Madalina Croitoru. Defence in Jan. 2014.

PhD in progress : Tjitze Rienstra, Dynamic argumentation systems, Oct. 2010, supervised by Souhila Kaci and Leon van der Torre (University of Luxembourg)

PhD in progress : Mélanie König (ministry grant), Algorithms for querying large knowledge bases, Oct. 2011, supervised by Michel Leclère and Marie-Laure Mugnier

PhD in progress : Léa Guizol (ABES grant), Entity identification in metadata bases, Oct. 2011, supervised by Madalina Croitoru

PhD in Progress: 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

PhD in Progress: 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

PhD in Progress: Namrata Patel (Univ. Montpellier II grant), Preference Handling in Decision Problems (bourse ministerielle), Sept. 2013, supervised by Souhila Kaci

9.2.3. Juries

9.2.3.1. PhDs

- Patrice Buche was reviewer for *Semantic support for quantitative research* , Hajo Rijgersberg, VU University Amsterdam, May 2013
- Patrice Buche was reviewer for *Validation, synthèse et paramétrage des cartes cognitives* , Aymeric Le Dorze , LERIA/Angers University, Nov. 2013
- Patrice Buche was reviewer for *Evolution cohérente des ressources termino-ontologiques et des annotations sémantiques* , Anis Tissaoui, IRIT/Toulouse 3 University, Dec. 2013
- Patrice Buche was jury member for *D'un langage de haut niveau à des requêtes graphes permettant d'interroger le web sémantique*, Camille Pradel, IRIT/Toulouse 3 University, Dec. 2013
- Marie-Laure Mugnier and Jean-François Baget were jury members (and co-directors) for *Conjunctive Query Answering Under Existential Rules - Decidability, Complexity, and Algorithms*, Univ. Montpellier II, Oct. 2013.

9.2.3.2. HDRs

- Marie-Laure Mugnier was jury president for *Aide à la décision dans les filières agroalimentaires*, Rallou Thomopoulos, Univ. Montpellier II, Dec. 2013
- Marie-Laure Mugnier was jury president for *Contribution des modèles de connaissances à l'amélioration continue des processus industriels*, Bernard Kamsu, ENI Tarbes, Apr. 2013

9.2.3.3. Other juries

- Marie-Laure Mugnier was president of a recruitement committee for a professor position at UM2-IUT Béziers
- Marie-Laure Mugnier was member of 3 recruitement committees for associate professor positions at UM2-IUT Montpellier, UPMF-Grenoble and SupAgro Montpellier
- Madalina Croitoru was member of a recruitment committee for an associate professor position at UM2-IUT Montpellier.

9.3. Popularization

Patrice Buche was invited to give a talk about Packaging Decision support system involving flexible querying and argumentation at ANR Ribenut final meeting in November, 14 2013 (Avignon)

10. Bibliography

Major publications by the team in recent years

[1] F. ALKHATEEB, J.-F. BAGET, J. EUZENAT. *Extending SPARQL with regular expression patterns (for querying RDF)*, in "Journal of Web Semantics", 2009, vol. 7, n⁰ 2, pp. 57-73

[2] J.-F. BAGET, J. FORTIN. *Default conceptual graph rules, atomic negation and Tic-Tac-Toe*, in "ICCS'10: 18th International Conference on Conceptual Structures - Conceptual Structures: From Information to Intelligence", Malaisie, M. CROITORU, S. FERRÉ, D. LUKOSE (editors), LNAI, Springer, July 2010, pp. 42-55, ICCS'10 Best Paper Award, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00537338/en/

[3] J.-F. BAGET, M. LECLÈRE, M.-L. MUGNIER, E. SALVAT. *On Rules with Existential Variables: Walking the Decidability Line*, in "Artificial Intelligence", March 2011, vol. 175, n⁰ 9-10, pp. 1620-1654 [*DOI : 10.1016/J.ARTINT.2011.03.002*], http://hal.inria.fr/lirmm-00587012/en

[4] J.-F. BAGET, M.-L. MUGNIER, S. RUDOLPH, M. THOMAZO. *Walking the Complexity Lines for Generalized Guarded Existential Rules*, in "IJCAI'11: International Joint Conference on Artificial Intelligence", Barcelona, Spain, T. WALSH (editor), AAAI Press, July 2011, pp. 712-717, http://hal.inria.fr/lirmm-00618081/en

[5] M. CHEIN, M.-L. MUGNIER. , *Graph-based Knowledge Representation and Reasoning—Computational Foundations of Conceptual Graphs*, Advanced Information and Knowledge Processing, Springer, 2009

[6] S. DESTERCKE, P. BUCHE, B. CHARNOMORDIC. *Evaluating Data Reliability: an Evidential Answer with Application to a Web-Enabled data Warehouse*, in "IEEE Transactions on Knowledge and Data Engineering", January 2013, vol. 25, n⁰ 1, pp. 92-105, http://hal.inria.fr/lirmm-00611954

[7] S. DESTERCKE, P. BUCHE, V. GUILLARD. *A Flexible Bipolar Querying Approach with Imprecise Data and Guaranteed Results*, in "Fuzzy Sets and Systems", April 2011, vol. 169, n⁰ 1, pp. 51-54 [*DOI : 10.1016/J.FSS.2010.12.014*], http://hal-lirmm.ccsd.cnrs.fr/lirmm-00611940/en/

[8] J. FORTIN, A. KASPERSKI, P. ZIELINSKI. *Some methods for evaluating the optimality of elements in matroids with ill-known weights*, in "Fuzzy Sets and Systems", 2009, vol. 160, n⁰ 10, pp. 1341-1354

[9] S. KACI. , *Working with Preferences: Less Is More*, Cognitive Technologies, Springer, 2011, pp. 11-193

[10] S. KACI. *Characterization of Positive and Negative Information in Comparative Preference*, in "ECAI'12: 20th European Conference on Artificial Intelligence", France, I. PRESS (editor), August 2012, pp. 450-455, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00762956

[11] M. KÖNIG, M. LECLÈRE, M.-L. MUGNIER, M. THOMAZO. *A Sound and Complete Backward Chaining Algorithm for Existential Rules*, in "RR'2012: International Conference on Web Reasoning and Rule Systems", Australie, Springer, 2012, pp. 122-138, RR'2012 Best Paper Award, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00764341

[12] M.-L. MUGNIER, G. SIMONET, M. THOMAZO. *On the Complexity of Entailment in Existential Conjunctive First Order Logic with Atomic Negation*, in "Information and Computation", March 2012, vol. 215, pp. 8-31 [*DOI : 10.1016/J.IC.2012.03.001*], http://hal.inria.fr/lirmm-00681914

[13] M. THOMAZO, J.-F. BAGET, M.-L. MUGNIER, S. RUDOLPH. *A Generic Querying Algorithm for Greedy Sets of Existential Rules*, in "KR'12: International Conference on Principles of Knowledge Representation and Reasoning", Italie, 2012, pp. 096-106, http://hal-lirmm.ccsd.cnrs.fr/lirmm-00763518

[14] M. THOMAZO. *Compact Rewriting for Existential Rules*, in "IJCAI'2013: 23rd International Joint Conference on Artificial Intelligence", Beijing, China, 2013, http://hal.inria.fr/lirmm-00839422

Publications of the year

Doctoral Dissertations and Habilitation Theses

[15] M. THOMAZO. , *Conjunctive Query Answering Under Existential Rules - Decidability, Complexity, and Algorithms*, Université Montpellier II - Sciences et Techniques du Languedoc, October 2013, http://hal.inria.fr/tel-00925722

[16] R. THOMOPOULOS. , *Aide à la décision dans les filières agroalimentaires*, Université Montpellier II - Sciences et Techniques du Languedoc, December 2013, Habilitation à Diriger des Recherches, http://hal.inria.fr/tel-00933376

Articles in International Peer-Reviewed Journals

[17] J.-R. BOURGUET, R. THOMOPOULOS, M.-L. MUGNIER, J. ABÉCASSIS. *An artificial intelligence-based approach to deal with argumentation applied to food quality in a public health policy*, in "Expert Systems with Applications", 2013, vol. 40, n° 11, pp. 4539-4546, http://hal.inria.fr/lirmm-00835177

[18] M. CHEIN, M.-L. MUGNIER, M. CROITORU. *Visual reasoning with graph-based mechanisms: the good, the better and the best*, in "The Knowledge Engineering Review", 2013, vol. 28, n[o] Special Issue 3, pp. 249-271 [*DOI :* 10.1017/S0269888913000234], http://hal.inria.fr/lirmm-00856811

[19] S. DESTERCKE, P. BUCHE, B. CHARNOMORDIC. *Evaluating Data Reliability: an Evidential Answer with Application to a Web-Enabled data Warehouse*, in "IEEE Transactions on Knowledge and Data Engineering", January 2013, vol. 25, n° 1, pp. 92-105, http://hal.inria.fr/lirmm-00611954

[20] R. THOMOPOULOS, S. DESTERCKE, B. CHARNOMORDIC, J. IYAN, J. ABÉCASSIS. *An iterative approach to build relevant ontology-aware data-driven models*, in "Information Sciences", February 2013, vol. 221, pp. 452-472 [*DOI :* 10.1016/J.INS.2012.09.015], http://hal.inria.fr/hal-00753335

Articles in National Peer-Reviewed Journals

[21] P. BUCHE, M. CROITORU, J. FORTIN, P. MOSSE, N. TAMANI, R. THOMOPOULOS. *Argumentation et négociation pour le choix d'emballages alimentaires biodégradables*, in "Revue d'Intelligence Artificielle", 2013, vol. 27, In Press, http://hal.inria.fr/lirmm-00830429

[22] P. BUCHE, S. DERVAUX, J. DIBIE-BARTHÉLÉMY, L. SOLER, L. IBANESCU, R. TOUHAMI. *Intégration de données hétérogènes et imprécises guidée par une ressource termino-ontologique*, in "Revue d'Intelligence Artificielle", September 2013, vol. 27, n° 4-5, pp. 539-568 [*DOI :* 10.3166/RIA27.539-568], http://hal.inria.fr/lirmm-00903768

[23] R. THOMOPOULOS, M. CROITORU. *Aide à la décision en ingénierie inverse : une approche s'appuyant sur l'argumentation*, in "Revue d'Intelligence Artificielle", 2013, vol. 27, nᵒ 4-5, pp. 493-513, http://hal.inria.fr/lirmm-00835197

International Conferences with Proceedings

[24] J.-F. BAGET, M. CROITORU, B. PAIVA LIMA DA SILVA. *ALASKA for Ontology Based Data Access*, in "The Semantic Web: ESWC 2013 Satellite Events", France, July 2013, http://hal.inria.fr/lirmm-00936487

[25] S. L. BERRAHOU, P. BUCHE, J. DIBIE-BARTHÉLÉMY, M. ROCHE. *How to extract unit of measure in scientific documents?*, in "KDIR'2013: 5th International Conference on Knowledge Discovery and Information Retrieval", Vilamoura, Portugal, September 2013, http://hal.inria.fr/lirmm-00903771

[26] R. BOOTH, S. KACI, T. RIENSTRA, L. VAN DER TORRE. *A Logical Theory about Dynamics in Abstract Argumentation*, in "SUM'2013: 7th International Conference on Scalable Uncertainty Management", Washington, DC, United States, LNCS, September 2013, vol. 8078, pp. 148-161 [*DOI : 10.1007/978-3-642-40381-1_12*], http://hal.inria.fr/lirmm-00863487

[27] R. BOOTH, S. KACI, T. RIENSTRA, L. VAN DER TORRE. *Monotonic and Nonmonotonic Inference for Abstract Argumentation*, in "FLAIRS'2013: 26th International Florida Artificial Intelligence Research Society Conference", United States, A. PRESS (editor), May 2013, pp. 1-8, http://hal.inria.fr/lirmm-00857793

[28] P. BUCHE, V. CUCHEVAL, A. DIATTARA, J. FORTIN, A. GUTIERREZ. *Implementation of a knowledge representation and reasoning tool using default rules for a decision support system in agronomy applications*, in "GKR@IJCAI'2013: 3rd International Workshop on Graph Structures for Knowledge Representation and Reasoning", Beijing, China, November 2013, http://hal.inria.fr/lirmm-00830437

[29] P. BUCHE, S. DERVAUX, J. DIBIE-BARTHÉLÉMY, L. IBANESCU, T. HECHT, L. SOLER. *Semi-automatic loading of a microbial risk in food database thanks to an ontology in the context of Linked Data*, in "ICPMF'13: 8th International conference on predictive modeling in food", Paris, France, September 2013, http://hal.inria.fr/lirmm-00903772

[30] M. CHEIN, M. LECLÈRE, Y. NICOLAS. *SudocAD: A Knowledge-Based System for the Author Linkage Problem*, in "KSE'13: 5th International Conference on Knowledge and Systems Engineering", Viet Nam, Advances in Intelligent Systems and Computing, Springer, 2014, vol. I (Part II), pp. 65-83 [*DOI : 10.1007/978-3-319-02741-8_8*], http://hal.inria.fr/lirmm-00933702

[31] J.-F. CONDOTTA, S. KACI. *Compiling Preference Queries in Qualitative Constraint Problems*, in "FLAIRS'2013: 26th International Florida Artificial Intelligence Research Society Conference", United States, A. PRESS (editor), May 2013, 8 p. , http://hal.inria.fr/lirmm-00857798

[32] M. CROITORU, S. VESIC. *What Can Argumentation Do for Inconsistent Ontology Query Answering?*, in "SUM'2013: 7th International Conference on Scalable Uncertainty Management", Washington, DC, United States, LNCS, Springer, September 2013, vol. 8078, pp. 15-29 [*DOI : 10.1007/978-3-642-40381-1_2*], http://hal.inria.fr/lirmm-00936486

[33] S. DESTERCKE, P. BUCHE, B. CHARNOMORDIC. *Decision support system using flexible query and reliability assessment - Application to biodegradable and biosourced packaging design*, in "FUZZ-IEEE 2013: International Conference on Fuzzy Systems", Hyderabad, India, June 2013, http://hal.inria.fr/lirmm-00830426

[34] L. GUIZOL, M. CROITORU, M. LECLÈRE. *Aggregation Semantics for Link Validity*, in "AI-2013: 33rd International Conference of the British Computer Society's Specialist Group on Artificial Intelligence (SGAI)", Cambridge, United Kingdom, M. BRAMER, M. PETRIDIS (editors), 2013, pp. 359-372, http://hal.inria.fr/lirmm-00921018

[35] S. KACI, C. LABREUCHE. *Representing Synergy among Arguments with Choquet Integral*, in "EC-SQARU'2013: 12th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty", Utrecht, Netherlands, LNCS, July 2013, pp. 302-314 [*DOI : 10.1007/978-3-642-39091-3_26*], http://hal.inria.fr/lirmm-00857796

[36] M. KÖNIG, M. LECLÈRE, M.-L. MUGNIER, M. THOMAZO. *On the Exploration of the Query Rewriting Space with Existential Rules*, in "RR'2013: International Conference on Web Reasoning and Rule Systems", Mannheim, Germany, LNCS, Springer, 2013, pp. 123-137 [*DOI : 10.1007/978-3-642-39666-3_10*], http://hal.inria.fr/lirmm-00838806

[37] M. KÖNIG, M. LECLÈRE, M.-L. MUGNIER, M. THOMAZO. *Sound, Complete, and Minimal Query Rewriting for Existential Rules*, in "IJCAI'2013: 23rd International Joint Conference on Artificial Intelligence", Beijing, China, September 2013, http://hal.inria.fr/lirmm-00838791

[38] M. LECLÈRE, M.-L. MUGNIER, S. ROCHER. *Kiabora: An Analyzer of Existential Rule Bases*, in "RR'2013: Web Reasoning and Rule Systems", Mannheim, Germany, W. FABER, D. LEMBO (editors), LNCS, Springer Verlag, July 2013, vol. 7994, pp. 241-246 [*DOI : 10.1007/978-3-642-39666-3_22*], http://hal.inria.fr/lirmm-00934018

[39] T. RAHWAN, T. MICHALAK, T.-D. NGUYEN, M. POLUKAROV, M. CROITORU, N. R. JENNINGS. *Coalitional Games via Network Flows*, in "IJCAI'2013: 23rd International Joint Conference on Artificial Intelligence", Beijing, China, August 2013, pp. 324-331, http://hal.inria.fr/lirmm-00936484

[40] N. TAMANI, M. CROITORU, P. BUCHE. *A Viewpoint Approach to Structured Argumentation*, in "AI'2013: 33rd SGAI Conference on Innovative Techniques and Applications of Artificial Intelligence", Cambridge, United Kingdom, Research and Development in Intelligent Systems XXX, Springer, December 2013, pp. 265-271 [*DOI : 10.1007/978-3-319-02621-3_19*], http://hal.inria.fr/lirmm-00936485

[41] M. THOMAZO. *Compact Rewriting for Existential Rules*, in "IJCAI'2013: 23rd International Joint Conference on Artificial Intelligence", Beijing, China, 2013, http://hal.inria.fr/lirmm-00839422

[42] M. THOMAZO. *Ontology Based Query Answering with Existential Rules*, in "IJCAI'2013: 23rd International Joint Conference on Artifcial Intelligence", Beijing, China, 2013, pp. 3017-3021, http://hal.inria.fr/lirmm-00925730

National Conferences with Proceedings

[43] T. HECHT, P. BUCHE, J. DIBIE-BARTHÉLÉMY, L. IBANESCU, C. TROJAHN. *Exploitation des ontologies liées sur le Web de données pour aligner une nouvelle ontologie*, in "EGC'2014: 14èmes Journées Francophones "Extraction et Gestion des Connaissances"", IRISA, Rennes, France, January 2014, http://hal.inria.fr/lirmm-00915265

[44] L. LEBRAS, P. BUCHE, J. DIBIE-BARTHÉLÉMY, M. ROCHE. *Enrichissement d'une RTO par l'ajout de termes spécialisés*, in "EGC'2013: 13e Conférence Francophone sur l'Extraction et la Gestion des Connaissances", Toulouse, France, January 2013, http://hal.inria.fr/lirmm-00764373

[45] R. TOUHAMI, P. BUCHE, J. DIBIE-BARTHÉLÉMY, L. IBANESCU. *Evolution d'une RTO dédiée à la représentation de relations n-aires*, in "EGC'2013: 13e Conférence Francophone sur l'Extraction et la Gestion des Connaissances", Toulouse, France, C. VRAIN, A. PÉNINOU, F. SÉDES (editors), Hermann Editions, January 2013, vol. RNTI-E-24, pp. 413-418, http://hal.inria.fr/lirmm-00764984

Conferences without Proceedings

[46] I. VETSIKAS, M. CROITORU. *How Much Should You Pay for Information?*, in "ICEBE'2013: 10th International Conference on e-Business Engineering", United Kingdom, September 2013, http://hal.inria.fr/lirmm-00936483

Scientific Books (or Scientific Book chapters)

[47] P. BUCHE, S. DESTERCKE, V. GUILLARD, O. HAEMMERLÉ, R. THOMOPOULOS. *Flexible bipolar querying of uncertain data using an ontology*, in "Springer Series " Studies in Computational intelligence "", Springer, June 2013, 25 p. , http://hal.inria.fr/lirmm-00764985

Research Reports

[48] M. CHEIN, M. CROITORU, M. LECLÈRE, N. PERNELLE, F. SAIS, D. SYMEONIDOU. , *Defining Key Semantics for the Semantic Web : a Theoretical View*, December 2013, http://hal.inria.fr/hal-00915798

[49] M. CROITORU, R. THOMOPOULOS, N. TAMANI. , *Using Argumentation in a French Agrifood Chain Application: Technical Report*, December 2013, http://hal.inria.fr/lirmm-00915839

[50] M. CROITORU, S. VESIC. , *What Can Argumentation Do for Inconsistent Ontology Query Answering?*, April 2013, 17 p. , http://hal.inria.fr/lirmm-00812630

[51] L. GUIZOL, M. CROITORU, M. LECLÈRE. , *Aggregation Semantics for Link Validity: Technical Report*, April 2013, http://hal.inria.fr/lirmm-00936246

[52] M. KÖNIG, M. LECLÈRE, M.-L. MUGNIER, M. THOMAZO. , *On the Exploration of the Query Rewriting Space with Existential Rules*, April 2013, http://hal.inria.fr/lirmm-00825634

[53] M. KÖNIG, M. LECLÈRE, M.-L. MUGNIER, M. THOMAZO. , *Sound, Complete and Minimal UCQ-Rewriting for Existential Rules*, November 2013, 29 p. , http://hal.inria.fr/lirmm-00903375

[54] F. SAÏS, R. THOMOPOULOS. , *A Hybrid, Case-Based Related Approach to Generate Predictions from Rules*, 2013, http://hal.inria.fr/lirmm-00835217

[55] N. TAMANI, M. CROITORU. , *Argumentation for conflicting viewpoint relational database querying*, December 2013, Technical Report, http://hal.inria.fr/lirmm-00915967

[56] R. THOMOPOULOS, M. CROITORU, N. TAMANI. , *Backward chaining argumentation in agrifood chains: a practical use case*, 2013, http://hal.inria.fr/lirmm-00835250

[57] R. THOMOPOULOS, D. PATUREL, S. QUÉRÉ. , *Un système d'argumentation avec contextes et indicateurs pour analyser un dispositif d'approvisionnement en circuit court*, 2013, http://hal.inria.fr/lirmm-00835205

[58] I. VETSIKAS, M. CROITORU. , *How Much Should You Pay for Information?: Technical Report*, June 2013, 16 p. , http://hal.inria.fr/lirmm-00830805

References in notes

[59] H. B. NEWCOMBE, J. M. KENNEDY, S. AXFORD, A. JAMES. *Automatic Linkage of Vital Records*, in "Science", October 1959, vol. 130, n⁰ 3381, pp. 954–959

[60] W. E. WINKLER. *Overview of record linkage and current research directions*, in "Bureau of the Census", Citeseer, 2006