1 Team proposal: Wimmics

Name: Wimmics

Meaning: Web-Instrumented Man-Machine Interactions, Communities, and Semantics.

Challenge: bridging formal semantics and social semantics on the web

Status: joint research team between INRIA Sophia Antipolis - Méditerranée and I3S (CNRS and Université Nice Sophia Antipolis).

Main research area: graph-oriented knowledge representation, reasoning and operationalization to model and support actors, actions and interactions in web-based epistemic communities.

Main application area: supporting and fostering interactions in online communities and management of their resources

INRIA Field: Perception, Cognition, Interaction

INRIA Theme: Knowledge and Data Representation and Management

I3S division: GLC Software and Knowledge Engineering

CNRS institute: INS2I

Web site: http://wimmics.inria.fr

2 Research proposal

2.1 Context: semantic frictions on the web

The Web is no longer perceived as a documentary system. Among its many evolutions, it became a virtual place where persons and software interact in mixed communities i.e. a hybrid space where humans and web robots interact and form new kinds of collectives. These large scale interactions create many problems in particular the one of reconciling formal semantics of computer science (e.g. logics, ontologies, typing systems, etc.) on which the Web architecture is built, with soft semantics of people (e.g. posts, tags, status, etc.) on which the Web content is built.

Let us take a concrete and very common example. Many Web sites include forums, blogs, status feeds, wikis, etc. In other words, many Web sites include content management systems and rapidly build huge collections of information resources. As these collections grow, several tasks become harder to automate: search, notification, restructuring, navigation assistance, recommendation, trend analysis, etc. One of the main problems is the gap between the fairly informal way content is generated (e.g. plain text, short messages, free keywords) and the need for structured data and formal semantics to automate these functionalities (e.g. efficient indexes, domain thesauri). Mixed structures are starting to appear (e.g. structured folksonomies, hash tags, machine tags, etc.) but automating support in such collaboration spaces requires efficient and complete methods to fully bridge that gap.

As the Web becomes a ubiquitous infrastructure bathing all the objects of our world, this is just one example of the many frictions it will create between formal semantics and social semantics. This trend is also amplified by the growing number of dataset published and interlinked online by initiatives like Linking Open Data. This expending web of data together with the schemas, ontologies and vocabularies used to structure and link it forms a formal semantic web with which we have to design new interaction means to support the next generation of web applications.

This is why the Wimmics team proposes to study methods, models and algorithms to bridge formal semantics and social semantics on the Web.

2.2 Research topic: bridging formal semantics and social semantics

From a formal modeling point of view one of the consequences of the evolutions of the Web is that the initial graph of linked pages has been joined by a growing number of other graphs. This initial graph is now mixed with sociograms capturing the social network structure, workflows specifying the decision paths to be followed, browsing logs capturing the trails of our navigation, service compositions specifying distributed processing, open data linking distant datasets, etc.

Moreover, these graphs are not available in a single central repository but distributed over many different sources and some sub-graphs are public (e.g. dbpedia) while other are private (e.g. corporate data). Some sub-graphs are small and local (e.g. a users' profile on a device), some are huge and hosted on clusters (e.g. Wikipedia), some are largely stable (e.g. thesaurus of Latin), some change several times per second (e.g. social network statuses), etc.

And each type of network of the Web is not an isolated island. Networks interact with each other: the networks of communities influence the message flows, their subjects and types, the semantic links between terms interact with the links between sites and vice-versa, etc.

Not only do we need means to represent and analyze each kind of graphs, we also need the means to combine them and to perform multi-criteria analysis on their combination.

Wimmics proposes to address this problem focusing on the characterization of (a) typed graphs formalisms to model and capture these different pieces of knowledge and (b) hybrid operators to process them jointly. We will especially consider the problems that occur in such structures when we blend formal stable semantic models and socially emergent and evolving semantics.

In the two next sections we detail this research program according to two main research directions combining two complementary types of contributions we target:

(1) First research direction (section 2.3): to propose multidisciplinary approach to analyze and model the many aspects of these intertwined information systems, their communities of users and their interactions;
(2) Second research direction (section 2.4): to propose formalizations of the previous models and reasoning algorithms on these models providing new analysis tools and indicators, and supporting new functionalities and better management.

In a nutshell, the first research direction looks at models of systems, users, communities and interactions while the second research direction considers formalisms and algorithms to represent them and reason on their representations.

In the short term we intend to survey, extend, formalize and provide reasoning means over models representing systems, resources, users and social links in the context of social semantic web applications.

In the longer term we intend to extend these models (e.g. dynamic aspects), unify their formalisms (dynamic typed graphs) and propose mixed operations (e.g. metrical and logical reasoning) and algorithms to scale them (e.g. random walks) to support the analysis of epistemic communities structures, resources and dynamics.

Ultimately our goal is to provide better collective applications on the web of data and the semantic web with two sides to the problem: (1) improve access and use of the linked data for epistemic communities and at the same time (2) use typed graph formalisms to represent the web resources, users and communities and reason on them to support their management.

2.3 First problem: analyzing and modeling users, communities and their interactions in a Social Semantic Web context

2.3.1 Examples of research questions for modeling intertwined information systems, their communities of users and their interactions

Examples of questions addressed in this first research direction include:

How do we improve our interactions with an information system that keeps getting more and more complex?

How do we reconcile and integrate the formalized stable semantics of computer science and the negotiable social interactions?

How to facilitate communication between systems and system developers using formal representations and users and usage analysts using corresponding less formal or non-formal representations?

How do we reconcile local contexts of users and global characteristics of the world-wide system?

2.3.2 Overall approach to modeling intertwined information systems, their communities of users and their interactions

The main goal of this first research direction is to improve the understanding the systems have of the communities of their users. To provide better collective applications on the web of data and the semantic web we need to adapt classical models to the specificities and variety of web systems (requirements, functionalities, specifications), users (profiles and context: location, devices, activities, etc.), and groups (communities ad networks of interest, communities and networks of practice, social constructs, etc.). These models will be designed integrated and published according to web standards to support functionalities of web applications providing access and use of the linked data to epistemic communities.

We defend that such models necessarily call for multidisciplinary approaches to analyze and model the many aspects of the information systems intertwined on the web, their communities of users and their interactions.

Our proposal relies on extending requirement modeling to build models of the systems; on cognitive studies and user modeling results to build models of the users; on ergonomic studies and interaction design methods to model the interactions between users through the system and with the system, in order to support and improve these interactions;

2.3.3 Short term objectives for modeling intertwined information systems, their communities of users and their interactions

We had several experiences in past projects with a user modeling technique known as Personas [46]. We are interested in these user models that are represented as specific, individual humans and we apply them to capture models of the members of web-based communities. Personas are derived from significant behavior patterns (i.e., sets of behavioral variables) elicited from interviews with and observations of users (and sometimes customers) of the future product. The main merit of the Personas method is to engage design team members more effectively in not only taking users into account but also having constantly in mind that they are designing for people. This effectiveness comes from several aspects, in particular: (1) by integrating concrete elements in the description of a user-type (name, photo, etc.)., it prevents the user remains an abstraction for the designer (this abstraction leading the designer to lose sight of the user); (2) by connecting more strongly scenarios to the actors of these scenarios (i.e., the users), the Personas method avoids the problem often encountered in conventional methods of scenario-based design, namely to ignore users in the development of scenarios and thus "dehumanizing" these scenarios. In the Personas method, the link between scenarios and users is established with the most important characteristic of personas: their goals; these goals form the basis for scenario development. Our user models will specialize "Personas" approaches to include aspects

appropriate to Web applications. The formalization of these models will rely on ontology-based modeling of users and communities starting with generalist schemas (e.g. FOAF).

Beyond the individual user models we propose to rely on social studies to build models of the communities, their vocabularies, activities and protocols in order to identify where and when formal semantics is useful. We already proposed an extension of the Persona approach to Collective Personas [17] and will further develop our method to encompass web-based communities. We intend to compare this approach to the related "collaboration personas" method [56][57] and to the group modeling methods [58] which are extensions to groups of the classical user modeling techniques dedicated to individuals. Both methods having been developed independently from one another, they differ along several dimensions, for example: whereas the Collaboration Personas method (CnP) focuses on forms of collaboration within a group, the Collective Personas method (CeP) focuses on the nature of the collective; whereas, CeP refers to models or theories of collectives to define types of collectives, CnP uses pragmatic classifications; whereas CnP describes scenarios as stories, CeP describes them in a more structured way. Today, except Wimmics, there is only one research team explicitly working on this kind of method, the team from IBM Research (Almaden, San Jose, California, USA: Tara Matthews, Steve Whittaker, Thomas Moran) who developed the Collaboration Personas method. We also propose to rely on and adapt participatory sketching and prototyping to support the design of interfaces for visualizing and manipulating representations of collectives.

We have a background in requirement models and, in the short term, we want to consider their extension and specialization to web applications (in particular semantic web and linked data applications) and their representation in web-based formalisms in order to support mutual understanding and interoperability between requirements, resources and specifications of interconnected web applications and web datasets. (e.g. [28])

For all the models we identified here we will rely on and evaluate knowledge representation methodologies and theories, in particular ontology-based modeling.

2.3.4 Long term modeling objectives for modeling intertwined information systems, their communities of users and their interactions

In addition to the persona models identified in the previous section, in a longer term we will consider a number of additional features to be captured in the user models.

First we want to add contexts, devices, processes and mediums descriptions that will then be be formalized and used to support adaptation, proof and explanation and foster acceptation and trust from the users. We specifically target a unified formalization of these contextual aspects [42] to be able to integrate them at any stage of the processing.

We will extend current descriptions of relational and emotional aspects in existing variants of the personas technique. In particular we will exploit Olsen's characterization of a user's relationship to a product [48] since this characterization was made by analogy to human relationships. The elaboration of the characteristics to be included in a "relational-user" model will rely on work dealing with "relational agency" ("as a capacity to recognize others as resources, to elicit their interpretations and to negotiate aligned actions" [47]), and on "relational agents" (as "computational artifacts designed to build long-term social-emotional relationships with users" [45]). The elaboration of relational characteristics will be informed by empirical studies of relationship characterization, and of personality definition by users on the Web. These directions are a natural extension of our work on the use of affective ontologies in semantic web applications [16] and algebraic modeling of emotional states [37].

For each of these extensions we will systematically consider additional extensions of the corresponding schemas to capture additional aspects and publish them as public ontologies on the semantic web.

Concerning the social dimension we will then to focus on studying and modeling mixed representations containing social semantic representations (e.g. folksonomies) and formal

semantic representations (e.g. ontologies) and propose operations that allow us to couple them and exchange knowledge between them. The very long term objective is obtained a uniformed and integrated representation of social aspects (e.g., groups, networks, communities), social objects (web resources e.g. pictures, posts), social informal semantics (e.g. tags, folksonomies) and social formal semantics (e.g. ontologies, schemas).

To take into account social dynamics, we believe that argumentation theory can provide models (e.g. [62]) that must be adapted to open web constraints. Argumentation theory can be combined to requirement engineering to improve participant awareness and support decision-making (e.g. [27]). On the methodological side, we propose to adapt to the design of such systems the incremental formalization approach originally introduced in the context of CSCW and HCI communities [59][60]. In incremental formalization users first express information informally and then the system helps them formalize it. The goal of such an approach or of similar approaches is to get users to interact at least partially with formal representations, to make them contribute to a formalization closer to their needs [43]. Argumentation theory can also be combined with semantic web models and social web approaches to provide explicit formal representation of some social dynamics (e.g. opinions, agreements, debates, disagreements) more and more useful to understand the state and status of a resource and, for instance, decide on whether to trust it or not. This kind of understanding and models would allow scaling-up some very time-consuming tasks on the social web (e.g. management of Wikipedia).

Finally, on a very long term a much needed evolution of all our models is the temporal and dynamic dimension. We need to study and survey current emerging initiatives on dynamic graph representation and analysis and merge them with typed graph models of the web of data to natively and uniformly support the time dimension in our representations.

2.4 Second problem: formalizing and reasoning on heterogeneous semantic graphs

2.4.1 Examples of research questions for modeling intertwined information systems, their communities of users and their interactions

Examples of questions addressed in this second research direction include:

What kind of formalism is the best suited for the models of the previous section

How do we analyze these typed graph structures and their interactions?

How do we support different graph life-cycles, calculations and characteristics in a coherent and understandable way?

2.4.2 Overall approach to formalizing and reasoning on typed graph oriented models

In this second research direction we propose to focus on formalizing as typed graphs the models identified in the previous section in order for software to exploit them in their processing. The challenge is two-sided:

1. To propose models and formalisms to capture and merge representations of both kinds of semantics (e.g. formal ontologies and social folksonomies). The important point is to allow us to capture those structures precisely and flexibly and yet create as many links as possible between these different objects.
2. To propose algorithms (in particular graph-based reasoning) and approaches (e.g. human-computing methods) to process these mixed representations. In particular we are interested in allowing cross-enrichment between them and in exploiting the life cycle and specificities of each one to foster the life-cycles of the others.

While some of these problems are known, for instance in the field of knowledge representation and acquisition (e.g. disambiguation, fuzzy representations, argumentation theory), the Web

reopens them with exacerbated difficulties of scale, speed, heterogeneity, and an open-world assumption by default.

Many approaches emphasize the logical aspect of the problem especially because logics are close to computer languages. We defend that the graph nature of linked data on the Web and the large variety of types of links that compose them call for typed graphs models. We believe the relational dimension is of paramount importance in these representations and we propose to consider all these representations as fragments of a typed graph formalism directly built above the semantic Web formalisms. Our choice of a graph based programming approach for the semantic and social web and of a focus on one graph based formalism is also an efficient way to support interoperability, genericity, uniformity and reuse.

2.4.3 Short term objectives for formalizing and reasoning on typed graph oriented models

We will first target an abstract graph model close to the GRIWES model [1] and we will evaluate it in merging social graphs (e.g. sociograms, folksonomies) and semantic Web graphs (e.g. RDF, schemas, linked data) in a unified typed graph formalism. This work on abstracting the knowledge representation models will follow our experience with conceptual graphs and semantic networks approaches. An example of such abstract structure is the ERGraph [1] defined relatively to a set of labels L as a 4-tuple $G=(E_G, R_G, n_G, l_G)$ where:

- E_G and R_G are two disjoint finite sets respectively, of nodes called entities and of hyperarcs called relations.
- $n_G : R_G \rightarrow E_G^*$ associates to each relation a finite tuple of entities called the arguments of the relation.
- $l_G : E_G \cup R_G \rightarrow L$ is a labelling function of entities and relations.

New knowledge structures are regularly identified (e.g. folksonomies, named graphs) and old ones re-launched (e.g. thesauri and SKOS). This kind of abstract construct can be used and reused across graph representations such as RDF, Topic Maps, Social network, etc.

There exists now an extensive body of work in Graph-based Knowledge Representation [55] that we align with the ones needed for semantic web data structures (e.g. [1] [10] [15]) and in the short term we intend to continue specifying the required characteristics of such a language and systematically evaluate their effectiveness in implementing these abstract graph models in real applications [6][7].

Likewise will extend our abstract graph machine not only to cover as many features as possible of the upcoming SPARQL 1.1 language and the RIF rule format, but a challenge is also to integrate other operators with classical graph manipulation in particular approximation, clustering, analysis operations, spreading algorithm, temporal reasoning and extend them to work on typed graphs. For instance one can consider the near linear time algorithm to detect community structures in large scale network RAK/LP [54] based on label propagation and change the propagation algorithm to take semantics into account as we did in SemTagP [19]. In the short term, graph operators (joint, homomorphism, propagation, distances, etc.) allow us to perform a broad range of queries and reasoning operations. An example of abstract graph operation is an ERMapping [1]. Let G and H be two ERGraphs, an ERMapping$_{<X>}$ from H to G for a binary relation X over $L \times L$ is a partial function M from E_H to E_G such that:

- $\forall e \in M^{-1}(E_G), (l_G(M(e)), l_H(e)) \in X$
- $\forall r' \in R_{H'}\ \exists r \in R_G$ such that
  - $card(n_{H'}(r')) = card(n_G(r))$
  - $\forall 1 \leq i \leq card(n_G(r)), M(n_{H'}{}^i(r')) = n_G{}^i(r)$
- $\forall r' \in R_{H'}\ \exists r \in M(r')$ such that $(l_G(r), l_H(r')) \in X$

where H' is the sub-ERGraph of H induced by $M^{-1}(E_G)$.

This mapping operator can then be used and reused for many operations (searching, deriving, grouping, etc.) across many graph formalisms. In particular when X is a preorder over L, it

captures a hierarchy such as the taxonomical skeleton of an ontology, a thesaurus, a partonomy, etc. We believe that type-based inference algorithms (e.g. conceptual graph projection, inference rules) and type-parameterized operators (e.g. parameterized betweeness centrality) provide declarative formalisms to flexibly define operations to monitor, filter, query, mine, validate, protect, etc. these imbricated graph structures taking into account constraints spanning several types of network at once.

2.4.4 Long term objectives for formalizing and reasoning on typed graph oriented models

In the longer term we intend to build on our experience with such formalisms to identify, propose and characterize fragments of typed graph formalisms best suited for each type of model identified before. We will restrain ourselves to specify the required characteristics of a limited number of formalisms (ideally one) and systematically evaluate their effectiveness in implementing these abstract graph models in real applications.

The mixed representations identified in section 2.3 call for hybrid reasoning methods merging semantic Web inferences, social graph analysis and content mining in cross-dimensional indicators and operators. The key problem is to have integrated operators on these formalisms, able to perform at the same time exact reasoning and more approximate one to combine all aspects of the problem. For instance a centrality [53] can be computed on a social network taking into account only some relation types [18] or some topics of interest using an extension of regular expressions to graph paths [10]. This same centrality can be computed by using a complete walk algorithm or approximated by using random walks but in both cases the ability to consider and reason on types of links and nodes will be a core problem.

Our final goal is to have both an abstract language dissociated from the concrete languages and an extensible abstract machine to process them. In particular this would allow us to define parameterizable graph operators for instance to revisit classical structural metrics and adapt their definition to go beyond the pure structural calculation and take into account the types in the graphs. In the longer term, not only can we perform search (e.g. homomorphism) and logical derivation (e.g. homomorphism and merge) but also approximation (e.g. distances), clustering (e.g. propagation), analysis (e.g. centrality), etc. We target the design of an abstract graph machine generalizing operations needed by and sometime shared across different languages (e.g. SPARQL, RIF, POWDER, RDF/S and OWL inferences) and operations. In addition we also believe it is interesting to study alternatives to OWL stack and the associated DL-reasoning. For instance a rule-based semantic web with an alternative stack (RDF/S + SPARQL + RIF) provides certain advantages: rules are often more natural for humans, they support event-based programming and web service integration, they are usable both for domain independent and domain dependent inferences, etc.

To adapt to web growth and dynamics, we intend to evaluate other approaches (e.g. Random walk on graphs approaches) that do not naturally use labels but could be indirectly parameterized (e.g. making a correspondence between probabilistic distributions and the types of links) and also to consider temporal reasoning approaches to include temporal context and change patterns to identify trends, mine temporal propagation to build oriented networks, track behavioral patterns to qualify actors and communities (e.g. detect a dying community) extending models from [61] for instance.

We believe that moving to graph languages with open-world logics, temporal aspects, distributed and loosely coupled algorithms and model-driven programming relying on higher abstractions (e.g. formal ontologies) provides an adequate theoretical and operational framework to allow at the same time the specification and operationalization of the models and algorithms and the opening of these black boxes to be able to explain, document, prove and trace results for the users. The same graph-based formalisms we propose to use in representing our models can be used to declaratively capture workflows of our operations [22], interpret them and execute them. This is the approach we would like to explore to support different operations

on heterogeneous and distributed data [2] and automated explanation, trace and documentation of the processes.

2.5 Impact and outputs

Wimmics will provide models and algorithms to bridge formal semantics and social semantics by formalizing and reasoning heterogeneous semantic graphs.

The models we intend to design include: users, their profiles, their requirements, their activities and their contexts; social links, social structures, social exchanges and processes; conceptual models including ontologies, thesauri, and folksonomies. Whenever possible these models will be formalized and published according to standardized web formalisms and may motivate research and suggestions on extending these standards. The schemas and datasets produced will be published as linked data following the web architecture principles.

Algorithms we intend to design include: typed graphs indexing, reasoning and searching; hybrid processing merging logical inferences, rules and metrical inferences; approximation and propagation algorithms; distributed and scalable alternatives to classical reasoning. These algorithms will be implemented and distributed as part of a generic open source platform and library.

The targeted communities for the scientific publication of these models and algorithms include ISWC, WI, WWW, ESWC, KR, JWS, JODS, COLD, EKAW, IC, EGC, and others.

We also have the culture of producing prototypes of applications and extensions of existing applications relying on web languages as demonstrators and proofs of concept. At the core of our prototypes will be the abstract graph library we develop, maintain and publish as open-source software. In particular ou platform Corese/KGRAM currently implements W3C standards (in particular RDF/S and SPARQL 1.1) and is both a research result and a library on top of which we test new ideas and algorithms. Currently KGRAM (Knowledge GRaph Abstract Machine) is the new SPARQL 1.1 interpreter at the core of the Corese 3.0 Semantic Web Factory maintained by the team and extensively used in several applications such as: Isicil, Neurolog and VIP ANR projects. It is also used at CSTB, Liganz, Alcatel Lucent Bell (Cifre PhD Thesis), etc.[1] We intend to continue in that direction and maintain the Corese/KGRAM platform as we extend the graph formalism and operators we study.

Finally we will continue to participate to the extension, specifications, implementation, tests, deployment and teaching of W3C Web standards.

2.6 Risks and mitigation actions

The first risk is to work on rapidly changing domains. Another one is to bet on the wrong formalism or language. To mitigate these two risks our involvement in W3C gives us the opportunity not only to contribute and influence standardization but also to monitor and follow new trends. In addition the choice of relying on an abstract graph model and an abstract graph machine allow us to port our models and algorithms to different languages with a reduced overhead.

It should also be stressed that while the web is known for its constant changes it is also true to say that there is an inertia to its architecture: the core principles of the web (URI, HTTP, LINKS) cannot be changed without breaking the web. They induce a certain stability and continuity on which our modeling and computing choices are based.

Likewise the risk of having big players entering the scene is constant on the web. But not only is this true for the whole computer science domain, it is also often the case that the same problem dealing with the open web or an intranet, a small dynamic graph or a large distributed graph will be solved with very different solutions. Big players are often threaten on the web by a new usages or new approaches, and some of them have been working with us (Alactel-Bell-Lucent,

[1] See http://wimmics.inria.fr/corese for a complete list of applications.

SAP, Orange, etc.) to integrate our results to their systems. Many types of graphs are used on the web and even big players are not mastering them all.

Intrinsic to the structure of this proposal is the risk created by the dependency between the research activities to provide models (section 2.3) and the research activities to formalize these models (section 2.4). A possible risk is for the latter to wait for the former. However this is no longer a risky dependency as, as we mentioned in section 2.3, there already are a number of models available to start from including, FOAF, SIOC, SemTAG, SRTag, OCSO, NiceTag,, Webmarks, PRISSMA, S4AC, SemSNA. The availability of these models should prevent any cold start effect until they are replaced or extended by more expressive ones.

Finally, we do not have specialist in Graph theory, Probabilities, Databases, Grids, Network Protocols, etc. in our team although all of these computer science areas would be relevant to some aspects of our work (graph analysis, random walks, storage, distribution, etc.). However for each one of these aspects we collaborate or collaborated with other teams in the past and we intend to keep it so. Our goal is to remain specialists of one topic at the cross road of several of such domains: graph-based knowledge systems on the web.

3 Team description

3.1 Members

Permanent researchers:

- Michel Buffa, MdC (UNS)
- Olivier Corby, CR1 (INRIA)
- Catherine Faron-Zucker, MdC (UNS), Vice Team Leader
- Fabien Gandon, CR1, HDR (INRIA), Team Leader
- Alain Giboin, CR1 (INRIA)
- Nhan Le Thanh, Pr. (UNS)
- Isabelle Mirbel, MdC, HDR (UNS)
- Peter Sander, Pr. (UNS)
- Andrea G. B. Tettamanzi, Pr. (UNS)
- Serena Villata, RP (INRIA)

Assistants:

- Christine Foggia (INRIA)
- Sarah Choulet (I3S)

PhD Students:

- Pavel Arapov, 1st year (EDSTIC-I3S)
- Adrien Basse, 3rd year (UGB-INRIA)
- Franck Berthelon, 3nd year (UNS-EDSTIC)
- Ahlem Bouchahda, 3rd year (UNS-SupCom Tunis)
- Khalil Riad Bouzidi, 3rd year (UNS-CSTB)
- Luca Costabello, 2nd year (INRIA-CORDI)
- Papa Fary Diallo, 1st year (AUF-UGB-INRIA)
- Corentin Follenfant, 2nd year (SAP)
- Maxime Lefrançois, 2nd year (EDSTIC-INRIA)
- Nguyen Thi Hoa Hue, 1st year (Vietnam-CROUS)
- Nicolas Marie, 2nd year (Bell-ALU, INRIA)
- Rakebul Hasan, 1st year (INRIA ANR-Kolflow)
- Oumy Seye, 2nd year, (INRIA Rose Dieng allocation)
- Imen Tayari, 3rd year (UNS-Sfax Tunisie)

Post-doc:

- Zeina Azmeh (I3S)
- Elena Cabrio (CORDIS)

Research engineers:

- Julien Cojan (INRIA, Ministry of Culture)
- Christophe Desclaux (Boost Your Code, Inria)
- Erwan Demairy (ADT)
- Amosse Edouard (I3S)

External collaborators:

- Nicolas Delaforge (INRIA, ANR ISICIL)
- Claude Frasson (University of Montreal)
- Alexandre Monnin (La Sorbonne, IRI Georges Pompidou)

3.2 Short CVs and positioning of permanent members

Michel Buffa: teaches web technologies at the University of Nice, France, since 1994. He is co-author of the semantic wiki SweetWiki and co-supervised recently two PhDs on semantic social network analysis and on semantic enrichment of folksonomies.

Goal in Wimmics: 1) Social network analysis, develop models and tools for representing and exploiting social network graphs, i.e. help classifying and exploring resources produced by social network members based on the social network activity/analysis. 2) Tools for better exploiting the web of data.

Main research theme: 2.3 users, communities and interactions on the Social Semantic Web

Olivier Corby: PhD from University of Nice Sophia Antipolis, he is researcher (CR) at INRIA. His research topics are Knowledge Engineering and Semantic Web. He is a specialist of Knowledge Representation software environment and is the designer of the Corese Semantic Web Factory.

Goal in Wimmics: design abstract model for labeled graph and abstractions of graph operations to provide a graph abstract machine that can operate on heterogeneous graph models

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

Catherine Faron-Zucker: Assistant Professor at University Nice Sophia Antipolis (UNS) since 2002 She got a PhD in Artificial Intelligence from the University Paris 6 (UPMC) in 1998. Her main research focuses are Knowledge Engineering and Modeling, Graph based Knowledge Representation and Reasoning, Ontologies, Semantic Web and Social Web. Her main application domains are Web-based Collective Memories and Intelligent Tutoring Systems (ITS).

Goal in Wimmics: querying and reasoning with graph operators and in composing and integrating sources and operators, while relying on Semantic Web standards ; context and social representation and analysis in ITS and more generally in communities.

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

Fabien Gandon: senior research scientist and HDR in Informatics and Computer Science at Inria and Advisory Committee representative of Inria at the World-Wide Web Consortium where he also participates in several standardization groups. His professional interests include: web, semantic web, social web, ontologies, knowledge engineering and modeling, mobility, privacy, context-awareness, semantic social network, semantic analysis of social network, intraweb. He previously worked for the Mobile Commerce Laboratory of Carnegie Mellon University.

Goal in Wimmics: models and algorithms to bridge and analyze resource-centric social semantic networks on the web.

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

Alain Giboin: PhD in Experimental Psychology, Alain Giboin specialized in Ergonomics of HCI and of CSCW, and later on in Knowledge Engineering. He organized and entered the program committee of several conferences and workshops on these domains, and animated several working research groups. He also teaches ergonomics in the "Parcours IHM" of EPU Nice and in the Master "Sociologie et Ergonomie des Technologies numériques" of UNS. In this context, he initiated a training in HCI involving both students in computer science and students in ergonomics working around a common project of HCI design.

Goal in Wimmics: Designing methods and tools to articulate, formal and formalization operations (mainly applied by software developers, knowledge engineers, and computer systems) to "informal" representations and "informalization" operations (mainly applied by domain experts, "usage analysts" and end-users).

Main research theme: 2.3 users, communities and interactions on the Social Semantic Web

Nhan Le Thanh: engineering degree in Computer Sciences at ENSEEIHT, ENPT in 1983, and "Docteur d'Etat" in Mathematics and Computer Science at the University of Nice-Sophia Antipolis in 1986, where he was named "Maître de Conférences" in 1988 and "Professeur des universités" in 1992. He currently teaches in the Computer Sciences Department of the IUT Nice-Côte d'Azur. His current research activities are centralized on the combining of semantic web formalisms such as description logics, RDF, OWL and other formalisms such as graph theory, colored Petri nets, to model information systems.

Goal in Wimmics: modeling distributed information systems and usage in the domain of social networks and digital personal patrimonies.

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

Isabelle Mirbel: associate professor and HDR at University Nice Sophia Antipolis. In 1996, she got a PhD entitled object-oriented design scheme integration from University Nice Sophia Antipolis and she defended her HDR about modeling, reuse and flexibility of information systems in 2008. She is currently in charge of courses about database management systems and requirement engineering. She is also vice-head of MIAGE and vice-dean of Science Department. Her research interests include information system engineering, method engineering and requirement engineering.

Goal in Wimmics: designing methods and tools relying on web based interactions to help stakeholders and designers to articulate their representations and processes; proposing models and methods to take advantage of social semantic networks for collaborative requirement engineering.

Main research theme: 2.3 users, communities and interactions on the Social Semantic Web

Peter Sander: professor at the Polytechnic School of the University of Nice - Sophia Antipolis. His research interests include the use of the internet and social networks for healthcare applications. He is studying affective computing, involving human emotions, as a key element in future healthcare, particularly for enabling seniors to continue living securely at home, as well as for other applications including serious games.

Goal in Wimmics: affective computing is increasingly recognized as an important contributing factor to informal social semantics. Modeling individual behavior through complex systems will lead to a better understanding of individual input to social cooperative knowlege systems.

Main research theme: 2.3 users, communities and interactions on the Social Semantic Web

Andrea Tettamanzi: PhD in Computational Mathematics and Operations Research in 1995 from the University of Milan with a thesis on evolutionary algorithms; he became assistant professor at the University of Milan in 1998 and associate professor at the same university in 2002. His research interests focused on combining different methods of computational intelligence, namely evolutionary algorithms, fuzzy logic, and neural networks, to solve real-world problems

in presence of imprecision, noisy data, and ill-defined optimization criteria, leading him to investigate the management of vagueness and uncertainty in knowledge representation.

Goal in Wimmics: extend graph-based knowledge representation formalisms to take uncertainty, imprecision, and the temporal dimension into account; adapt data mining methods to socio-semantic networks; bring possibility theory, belief revision, and results from cognitive agency to integrate data coming from heterogeneous sources by taking trust and reliability into account.

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

Serena Villata: starting research position at INRIA. She received a PhD in Computer Science in 2010 from the University of Turin with a thesis on argumentation theory. She is member of the W3C Linked Data Platform working group. Her research interests focused on using argumentation theory for explanations and justification in non-monotonic reasoning frameworks, coupling argumentation theory with natural language processing for decision making in social semantic networks, reasoning on trust, access control models and data licensing in the web of data, normative reasoning.

Goal in Wimmics: apply semantic-based reasoning techniques to control, explain and argument about interactions, trustworthiness and data in the web; unify semantic web standards and argumentation theory to support normative specifications, dynamics and reasoning in the web.

Main research theme: 2.4 formalizing and reasoning on heterogeneous semantic graphs

3.3 Rationale

Wimmics results from the merging of two research teams collaborating for several years: Edelweiss and Kewi.

The research team Edelweiss (INRIA), previously known as Acacia, aimed at offering models, methods and techniques for supporting knowledge management and collaboration in virtual communities interacting with information resources through the Web and using graph-based and ontology-based formalisms and algorithms. Latest research topics included: multilingual interaction with knowledge bases, mobile access to the Web of data, rule-based semantic Web formalisms, online presence and resource centric sociality, semantic Web in business intelligence, automatic indexing of triple-stores. The reason for closing down the Edelweiss INRIA team was the decease of its leader Rose Dieng-Kuntz.

The research team Kewi (I3S), was interested in knowledge engineering techniques and web-based applications to capture, extract analyze, organize, store and share knowledge. Latest research topics included: semantic Web and graph-based knowledge modeling; semantic security and access control; affective computing and emotion detection; requirement engineering and collaborative work.

The two teams have been collaborating for now more than eight years. As shown by their short descriptions, they exhibit both common interests (web, semantic web, graph-based formalisms, ontologies, access control, etc.) and complementarities (interaction design, affective computing, triple-stores, rules, etc.). Merging the two teams really is a natural acknowledgement of an ongoing collaboration and of numerous co-publications. Moreover this merge will create a group including full-time researchers, assistant professors and professors that could naturally cover all the activities of a research team.

Compared to other research teams it must be noted that Wimmics operates in a highly technological field. This has implications in terms of member activities and member profiles for the team. We need a strong complementarity and a good balance, between theoretical and applied profiles. We need members who can work on human and social aspects, members who can work on conceptual and formal aspects but also members who can follow and stay up to speed with rapidly changing technological aspects and software engineering framework, in particular for the web. For all these aspects we need members able to contribute and teach.

Finally there are philosophical concerns and even ethical concerns in working with web data and web users. This is the main reason for having full members, collaborators and projects partners with a strong background in humanities and we intend to keep these partnerships very strong in the future.

4 Diffusion and Collaborations

4.1 Relevant current projects

In this section we selected seven recent projects directly linked to the two core research topics we identified for Wimmics. We present each one of them briefly to show how they contribute to our research agenda.

Ocktopus (started in December 2012) is a research project funded by the French national research agency (ANR). Its goal is to increase the potential social and economic benefit of the large and quickly growing amounts of user-generated content. We believe that it is possible to considerably improve upon existing generic Information Retrieval techniques by exploiting the specific structure of this content and of the online communities which produce it. We focus on analyzing the communities of these content management systems, the web resources they manage and their evolutions in order to extract indicators of important actors and important content pieces and restructure the site and its indexing according to these indicators.

CrEDIBLE (started in June 2012) is a research project funded by the Interdisciplinary mission of CNRS in the MASTODONS program. Due to the increasing on-line availability of various biomedical data sources, the ability to federate heterogeneous and distributed data sources becomes critical to support multi-centric studies and translational research in medicine. The aim of this project is to gather scientists from all disciplines involved in the setup of distributed and heterogeneous medical image data sharing and processing systems. In this context our team studies the distribution of the metadata about images and the processing they go through and the querying and reasoning above the distributed typed-graph they form.

DBpedia.fr (started in November 2011) is a project funded by the French Ministry of Culture. It proposes the creation of a French version of the DBpedia base used in many applications in English, in particular for the publication of cultural collections. Unfortunately, DBpedia is focused on the English version of Wikipedia and ignores some of the French topics and their data. DBpedia.fr aims at extracting a maximum of RDF data from the French version of Wikipedia and providing a stable and scalable end-point for them.

Kolflow[2] (started in February 2011) is a research project funded by the French national research agency. Its goal is to reduce the overhead of communities in the process of continuously building knowledge by extending collective intelligence with smart agents relying on automated reasoning. It intends to do so by building a social semantic space based on distributed semantic wikis where humans collaborate with smart agents in order to produce knowledge understandable by humans and machines.

Datalift[3] (started in September 2010) is a research project funded by the French national research agency. Its goal is to develop a platform to publish and interlink datasets on the Web of data. Datalift will both publish datasets coming from a network of partners and data providers and propose a set of tools for easing the datasets publication process.

[2] http://kolflow.univ-nantes.fr/
[3] http://datalift.org/en/

SegViz[4] (until autumn 2012) is an ADT INRIA Grant for the development of a Semantic Web Gephi Plugin coupling Corese and the Gephi Open Graph Visualization Platform to provide a framework to query and visualize RDF data taking into account their schemas. The current version of this SemanticWebImport plugin supports the import of semantic data into Gephi by processing a SPARQL CONSTRUCT request on any standard web data source or file.
ISICIL[5] (until autumn 2012) is a research project funded by the French national research agency. The project studies and experiments with the usage of new tools for assisting corporate intelligence tasks. These tools rely on web 2.0 advanced interfaces (blog, wiki, social bookmarking) for interactions and on semantic web technologies for interoperability and information processing.

4.2 Selected past projects

In this section we give a very synthetic overview of chosen past project showing past results on which we intend to build and their applications.

PUSLearn (until 2012) was a 3-year scientific cooperation project with the University of Annaba in Algeria funded by CNRS and DPGRF (Algeria). It aims to study the personalization and socialization of ubiquitous e-learning systems based on semantic web models and techniques.
ImmunoSearch/RBP (until 2011): was a project to design biomarkers for controlling the harmlessness of the molecules used in perfumes, aromatics and cosmetics. The purpose of this research was to conduct comparative studies of in vivo and in vitro test models on the skin (irritation, allergy) and to propose alternative methods defining the new norms applicable in this field. In this context, we proposed methodological and software support for capitalization and valorization of knowledge resulting from experiments and techniques to preserve and reuse data. We relied on the semantic web technologies (semantic annotations, ontologies, RDF, SPARQL, etc.).
DESIR[6] (ended 2009) was a small COLOR (pre)project aimed at supporting the activities of a community of agronomists and geneticists through a semantic collective memory. It highlighted the need for the capitalization, reuse and sharing of queries and more generally search processes and is the basis for a future project proposal on distributed query workflows.
E-Wok Hub[7] (ended 2009) was a research project funded by the French national research agency. It designed a set of communicating data and service portals offering both: (a) web applications accessible to end-users through online interfaces, and (b) web services accessible to applications through programmatic interfaces. As applicative objectives, the project aimed at enabling management of the memory of several projects on CO2 capture and storage, integrating results of technological watch on the domain.
SeaLife[8] (ended 2009) was a European project that designed a semantic grid browser for the Life Sciences Applied to the Study of Infectious Diseases Project Reference. The browser has access to comprehensive background knowledge of life science topics consisting of domain specific ontologies and dictionaries of proteins. It comprises an advanced text-mining module, which is able to automatically extract ontology terms from free text to form Semantic Hyperlinks and a service module, which enables users to access through semantically identified terms, web and grid services to facilitate actions on the data identified.

[4] http://wiki.gephi.org/index.php/SemanticWebImport
[5] http://isicil.inria.fr/
[6] http://www-sop.inria.fr/edelweiss/projects/desir/wakka.php?wiki=ColorDesirHomePage
[7] http://www-sop.inria.fr/edelweiss/projects/ewok/
[8] http://www.biotec.tu-dresden.de/sealife

SevenPro[9] (ended 2008) was a European project that developed tools supporting deep mining of product engineering knowledge from multimedia repositories and enabling semantically enhanced 3D interaction with product knowledge in integrated engineering environments
Palette[10] (ended 2008) was a European project aimed at facilitating and augmenting individual and organizational learning in Communities of Practice (CoPs). Towards this aim, an interoperable and extensible set of innovative services as well as a set of specific scenarios of use were designed, implemented and thoroughly validated in CoPs of diverse contexts: information services, knowledge management services (based on an ontology dedicated to communities of practice) and mediation services for CoPs. Eleven pilot CoPs were involved in the participatory design of Palette services.
GRIWES (ended 2008) was a small COLOR (Inria funding) project aimed to specify a generic platform for graph-based knowledge representation and reasoning. We considered multiple languages of representation, such as conceptual graphs, RDF/S, and various extensions of these languages. It provided the foundations of our reflection on abstract graph models.

4.3 Partnerships

We selected the most important partnerships here and grouped them according to four kinds of motivations.

A first group of partnerships allow us to explore new kinds of reasoning and new types of operators to analyses typed-graphs:

- Alcatel Bell-Lucent: with the Ph.D. (CIFRE) of Nicolas Marie we collaborate on the capture and modelling of online user presence and object-centric sociality on the web. We currently focus on using linked data and social networks to support exploratory search and recommendation.
- SAP: with the Ph.D. (CIFRE) of Corentin Follenfant we collaborate on the integration of semantic web inside Business Intelligence reporting processes in particular to facilitate the reuse of knowledge from previous reports.
- Collaborations with Orange (CIFRE, ANR), PhD thesis of Guillaume Erétéo on “Semantic Social Network Analysis” defended the 11th of April 2011
- Collaborations with Ipernity (CRE) on medium-size social network semantic analysis using typed-graph representations and combining logical inferences and metrics to characterise and study their social network (60K profiles, 500K typed social links)

A second group of partnerships allow us to work on interaction design with semantic-based systems:

- Collaboration with the neuropsychologists of the Laboratoire de Psychologie Cognitive et Sociale, Université de Nice – Sophia Antopolis (experiments on emotional interactions).
- ICR (University of Luxembourg): The ICR group is an interdisciplinary research team at the University of Luxembourg. The group is driven by the insight that intelligent systems (like humans) are characterized not only by their individual reasoning capacity, but also by their social interaction potential. Its overarching goal is to develop and investigate comprehensive formal models and computational realizations of individual and collective reasoning and rationality. ICR and Wimmics cooperate on the formalization of normative reasoning in the Web using semantic technologies, and the definition of

[9] http://www.sevenpro.org/
[10] http://palette.ercim.org/

models and techniques to allow the actors of semantic social networks to interact based on argumentation theory.

- IM Group (University of Torino, Italy): The IM group carries out research on natural language processing, cognitive social agents, and normative ontologies. IM and Wimmics cooperate on the research topic of normative ontologies, with a particular attention to all the problems dealing with the licenses on the Web, and the assessment of the trustworthiness of the sources on the Web.

A third group of partnerships considers domain-specific applications:

- Philips Semiconductors France (now called NXP) in the framework of the KmP-Philips (or KM2) project funded by this industrial company. This two-year project aimed at designing and validating a prototype supporting the strategic management of individual and collective competencies within this firm. During this first year, the prototype was implemented using SeWeSe and Corese, and tested. The second year will be devoted to getting and analyzing usage feedback of the prototype within the enterprise.
- IFP, BRGM and EADS, in the framework of the ANR RNTL project e-WOK_Hub which aimed at enabling management of the memory of several projects on CO2 capture and storage, with use of results of technological watch on the domain. It enabled the diffusion of Corese to these application partners IFP and BRGM, the application of our semi-automatic annotation techniques from texts and our web–service architecture on a real-world application, with a collaboration with EADS on these techniques.
- Semantic Systems (Spain), LivingSolids (Germany), Estanda (Spain) and ItalDesign (Italy), in the framework of the 3-year STREPS project Sevenpro. Semantic Systems and LivingSolids are two IT small and medium enterprises specialized in Semantic and Virtual Reality for engineering technologies. Estanda, a SME manufacturer of metal castings and ItalDesign, a big engineering company play the roles of end-users in Sevenpro. We collaborate with Semantic Systems on the use of RDF(S) and on annotation of CAD files. We apply our semi-automatic annotation techniques to the corpora provided by Estanda and ItalDesign. Moreover, we play the role of support to these end-users on ontology development and on RDF(S) use.
- GDF/Suez: a consulting mission was done in 2010 to evaluate the opportunities of semantic web applications in their IT infrastructure and in their core activities, e.g. smart counters with online interfaces and data.
- Centre Scientifique et Technique du Bâtiment (CSTB): we are involved in a long-term collaboration on the management of technical and regulatory knowledge based on semantic web models and techniques. CSTB has already funded two Ph.D. on this domain.

Finally we have several partnerships for diffusion and standardization:

- We take part in W3C working groups and interest groups: In particular we participated to the note release of the Semantic Web Best Practice working groups and we are editors and co-authors of two drafts of the GRDDL (Gleaning Resource Descriptions from Dialects of Languages) working group (a mechanism to extract RDF from XML dialects) as well as SPARQL, RDFa, RIF, and RDF 1.1
- Yearly exchange with UGB (University of Gaston Berger, Senegal) for lectures, internships and co-supervised Ph.D. students (Adrien Basse, Oumy Seye)
- One of the leaders of the project NiceCampus with the University of Danang (Vietnam) to create a campus and a research Lab.

4.4 Education and diffusion

Members of Wimmics are in charge of lectures in several universities and contexts.

The biggest part of our lectures is done at University Nice Sophia Antipolis (UNS, Polytech) at the Master 2 level and it includes: a course on Semantic Web (IFI, 45 hours), a course on Knowledge Engineering (IFI, 32 hours), a course on Agile Web at UNS (IFI, 32 hours), a course on XML languages (IMAFA, 24 hours), a course on Human-Computer Interaction (IFI, 48 hours), a course on Ergonomics of digital technologies (Socio-Ergonomics of digital technologies, 6 hours).

We perform a course on ICT Ergonomics at IUP Sophia Antipolis (Master 2 "Economie des TIC et Conseils en e-business", 15 hours)

For six years we bootstraped a course on Semantic Web at University Gaston Berger, Saint Louis du Sénégal (18 hours).

In the context of a partnership University of Danang we also give English versions of the previous lectures as distant courses.

We provide lighter versions of the courses on semantic Web and software ergonomics in the context of license pro IUT UNS.

Finally we perform introduction courses to semantic web at Ecole Centrale Paris, Ecole Normale Cachan, master MBDS UNS, master Miage UNS, Master "info" UNS.

Therefore, we are currently involved in the KIS course of study of master IFI at the University of Nice and in MIAGE. We intend to reinforce and focus this action on developing an ecosystem to train and support professionals of the web and semantic web. We envision an evolution toward a double curriculum:

- An evolution of the course of study KIS toward a "Web Science" course of study possibly as a European KIC master 2.
- A reinforcement of the Web courses in MIAGE toward a "Web Information System" course of study master 2.

This may also require reinforcing web courses and internships for master 1.

4.5 Current Ph.D. Thesis

We currently have Ph.D. students working on thesis linked to one or both research direction identified in this proposal.

Querying and reasoning on semantic web and linked data:

- Ahlem Bouchahda: a semantic approach to secure data base accesses (co-supervised with SupCom Tunis)
- Adrien Basse: graph index for distributed queries (co-supervised Univ. Gaston Berger, Senegal)
- Nicolas Marie: spreading activation for exploratory search and recommendation (CIFRE Alcatel-Bell-Lucent)
- Nguyen Thi Hoa Hue: schema checking and orchestration of SPARQL queries (Vietnam-CROUS)
- Oumy Seye: rules for the Web of data (Lirima grant, Univ. Gaston Berger, Senegal)

Corporate semantic web and domain-specific models and reasoning:

- Khalil Riad Bouzidi: management of technical and regulatory knowledge, (CIFRE CSTB)
- Corentin Follenfant: semantic Web and Business Intelligence (CIFRE SAP)

Interaction with semantic web and linked data:

- Luca Costabello: customized and secure mobile access to the Web of data (INRIA Grant)

- Franck Berthelon: detecting emotional states in serious games (UNS)
- Imen Tayari : representing, annotating and detecting emotions in multimodal signals , (co-supervised with Sfax Tunisie)
- Maxime Lefrançois: collaborative management of interlingual knowledge (UNS)
- Hasan Rakebul: explaining distributed query on the semantic web (ANR-Kolflow).

Social web and community management through semantics:

- Pavel Arapov: semantic application wikis to allow collaborative design of web applications the same way wiki allow you to collaboratively build web sites (UNS)
- Papa Fary Dialo : Community building of ontologies and bases of micro-cultural knowledge bases in limited technological environments (co-supervision UGB, Senegal)
- Zeng Mide: temporal and semantic analysis of richly typed social networks from user-generated-content sites on the web (ANR OCKTOPUS)

5 Positioning and collaborations

The other actors in the domain of Wimmics have been described and positioned in this section starting from the closest teams from a thematic point of view.

5.1 Semantic web and knowledge representation

5.1.1 Graph based approaches

The closest teams to Wimmics combine semantic web formalisms with graph-based knowledge representation and reasoning to address epistemic problems i.e. propose information systems relying on graph-based formalizations and algorithms to assist their users in knowledge intensive tasks.

- At LIRMM, Montpellier, the team GraphIK was created in 2010 to work on Knowledge Representation and Reasoning (KRR) following a logic-oriented approach of the field with a graph-based vision of KRR. GraphIK focuses on some of the main challenges in KRR, such as querying large knowledge bases, dealing with hybrid knowledge bases (i.e., composed of several modules having their own reasoning mechanisms), or reasoning with imperfect knowledge (i.e., vague, uncertain, partially inconsistent, ...). GraphIK and Wimmics collaborated in the Griwes project that led both teams to align their graph models and share their results. Although GraphIK is the closest INRIA team from Wimmics, it does not focus on semantic web nor on social web.
- At LINA, Nantes, the team COD studies ontology engineering using semantic web formalisms, data mining using graph approaches and preference integration with visual support to decision making. COD works on social network analysis but does not focus on that subject nor does it focus on bridging graph approaches and semantic web formalisms.
- At IRIT, Toulouse, the team IC^3 works on knowledge models engineering for cooperative systems and cooperative systems engineering. They use semantic web formalisms for ontology engineering and textual corpus analysis methods and lately they developed graph approaches to suggest query patterns and ease the access to triple stores. However the team does not focus on graph operationalization of semantic web formalisms nor on semantic web approaches to social network analysis.
- At LIC, Laboratory of Computational Intelligence of Laval University, Canada, the team studies Conceptual Graphs formalism for Knowledge Discovery, Data Mining and in conjunction with multi agent systems applied to the semantic web. Again, here the difference is that the

collective aspects come from the multi agent point of view not really social networks and the focus of the LIC team remains on conceptual graphs formalism not semantic web formalisms.

Therefore the approach of relying on graph formalisms unified in an abstract graph model and operators unified in an abstract graph machine to formalize and process semantic web data, web resources, services metadata and social web data is a characteristic very specific to Wimmics.

5.1.2 Approaches with other formalisms

The closest teams w.r.t. Wimmics are the teams working on knowledge management, knowledge engineering and semantic Web. Through the GRACQ network (Groupe de Recherche sur l'Acquisition des Connaissances) and conferences like IC and EGC, we have regular contacts with most of the French teams working on knowledge engineering. Through networks of excellence, consortiums and communities (e.g. ISWC) we have contacts with the most active international teams.

Generally speaking, we identified the following close teams in France:

- EXMO: This team produces theoretical and software tools for enabling interoperability in formalized knowledge exchange. EXMO focuses on three topics: semantic properties in knowledge representation language translation, semantic adaptation of multimedia documents and ontology matching for interoperability. In Wimmics ontology alignment is not a main topics as for EXMO but it may be useful in case of interactions involving multiple ontologies. In this case, results of existing alignment algorithms could be exploited such as those offered by EXMO among others. EXMO and Wimmics have cooperated in the past and currently cooperate in the ANR project Datalift where: EXMO focuses on resource alignment while Wimmics focuses on access control and privacy.
- Orpailleur: The main objective of this team is to extract knowledge units from different sources and to design structures for representing the extracted knowledge units. The research of Orpailleur is at the intersection of knowledge extraction, knowledge representation, and semantic Web. Wimmics and Orpailleur rely on different knowledge representation formalisms (cf. Description logics and Galois Lattices for Orpailleur, Knowledge Graphs for Wimmics), but Wimmics future work on knowledge graphs may take into account the Galois lattice representation studied in Orpailleur. Orpailleur and Wimmics cooperate in the ANR project Kolflow where Orpailleur studies knowledge incoherencies and Wimmics studies proof and explanations in queries and reasoning.
- GEMO/LEO: The main theme of this team is the integration of information and its approach combines Artificial Intelligence techniques and Database techniques: integration of heterogeneous data; mediation between sources of information; data warehouses on the web; active XML approach to integrate web services; data model theory. This team historically focuses on XML, Description Logics and databases. Clearly the database-oriented aspect of LEO is a difference with Wimmics and they do not work on the social web either.

We identified the following close teams abroad:

- Karlsruhe University: this university produces KAON an environment for ontology development, ontology learning, semi-automatic annotation from texts, semantic web services, ontology mapping, ontology evolution and versioning, and evaluation of ontology-based tools. KAON v1 and v2 are based on frame systems and OWL. The formalisms used in this team and the fact they don't study social structures and representations are clear differences.
- Vrije University Amsterdam: this university is a co-proposer of OWL and produces the SESAME system. They also have a background in description logics, ontology alignment,

ontology modularity and ontology versioning. Again, the models used in this team and the fact they do not study social aspects are clear differences.

- Departamento de Inteligencia Artificial, Politecnica Madrid: this research department produced the MethOntology method, the WebODE environment for ontology development, and studies interoperability, peer-to-peer architecture, and semantic grid. This team is extremely active on ontology engineering and ontology based knowledge representations using semantic web formalisms. They do not study graphs structures nor social representations
- The Musen Lab, Stanford: this lab studies methods for building intelligent computer systems that support the work of clinicians and basic scientists. The overall goal is to support e-science and clinical decision making using systems that store encoded knowledge. The laboratory investigates the use of components for building knowledge-based systems, controlled terminologies and ontologies, and technology for the Semantic Web. They produced the well-known PROTEGE ontology editor, Anchor-Prompt platform for ontology alignment and have numerous and huge applications in medical domain. Their application domain and the formalisms they use are again differentiators with Wimmics.
- Manchester University: this university is a co-author of OWL, they study OWL extensions for instance with rules, semantic web services, ontologies in biomedical domain and applications in bioinformatics. We collaborated with them in the framework of the SeaLife project on biomedical ontologies. The group focuses on OWL and description logics and not on graph-based knowledge representations.
- DERI, Galway: this institute is a leading international web science research center. They work on many aspects of the semantic web e.g. semantic web services, rule languages for semantic web. The institute has three overall complementary research strands: Social Semantic Information Spaces, Semantic Reality, and Application Oriented Research Domain. The first one is the closest from us but does not focus on graph models.
- CSAIL DIG/W3C MIT: at the Computer Science and Artificial Intelligence Laboratory of the Massachusetts Institute of Technology (MIT), Tim Berners-Lee directs the W3C and leads the Decentralized Information Group (DIG). The group explores explore the consequences of information on the Web and build tools to help people control the policies governing information, and automated reasoning systems to help determine whether information use complies with policy. Their focus on policies and accountability, and ou focus on typed graph are our main differences.
- Trento University: this university has a group studying epistemological foundations of ontologies (e.g. DOLCE top-level ontology) ontology engineering and alignment. Their work is very interesting for the theoretical part of our models (e.g. methodologies for formal ontologies) but not directly comparable to the agenda of Wimmics.
- The Knowledge and Media Technologies department of Salzburg: this department studies social media, content management and semantic technologies. We follow their work on KiWi (Knowledge in a Wiki) combining the wiki philosophy with methods of the Semantic Web and IKS (Interactive Knowledge Stack) providing an open source technology platform for semantically enhanced content management systems. In Wimmics wikis are only one of the web 2.0 platforms we consider and we really are interested in a graph based formalism bridging the different social web data structures and semantic web formalisms.
- UMBC Ebiquity Research Group : this team explores the interactions between mobile and pervasive computing, the (semantic) web and other web facets, multi-agent systems and artificial intelligence, security/privacy/trust, and services. Their latest and most recurrent

interests include policies, security, trust, context awareness and mobility. In particular, they specialize in ubiquitous access to semantic web.

- ICS-Forth: this group is developing the ICS Forth Suite for RDF which is directly based on relational database approaches which is not the case of Wimmics where our graphs could be stored in very different stores
- Kno.e.sis (Ohio Center of Excellence in Knowledge-enabled Computing): this team researches, develops, and applies semantic and knowledge-enabled techniques. Their work addresses web, social web, sensor web, mobile accesses, services, and Cloud Computing.
- HP Jena: this team has been developing Jena for RDF above relational databases. We use parts of the Jena platform in CORESE and KGRAM and interact with them through our W3C activities. Wimmics designs and experiments with many extensions of standards and considers other aspects not covered by standards such as approximate matching.

Again the approach of relying on graph models and operators and the importance given to social dimensions are clearly differentiators of Wimmics with regard to the other teams reviewed here.

5.2 Data and knowledge based systems

A number of other teams are interacting with us or partially relevant to one of our subjects:

- MODALIS: this I3S team aims at modeling and exploiting large scale distributed computing infrastructures such as grids. Its research works include the design of flexible service architectures taking into account user needs. Several members of both teams regularly have discussions on knowledge modeling and we jointly participate to the CrEDIBLE project.
- KEIA: this I3s team focuses on knowledge extraction and knowledge mining algorithms. As such we have many exchanges with this team and even common publications. Note that MODALIS, KEIA and Wimmics belong to the "Pôle GLC", a research structure gathering I3S and Inria teams working in the domain of software and knowledge engineering.
- LARIA, Amiens: this team now studies organizational semantic webs with a strong emphasis on ontology engineering.
- UTC (COSTECH) Compiègne: that group studies epistemological foundations of ontologies, multi-agents approach for KM, learning memory combining semantic web and eLearning,
- UTT (Tech-CICO), Troyes: this multidisciplinary team studies cooperative approaches for knowledge management, action communities, socio-semantic web, project memory and memory for professional training.
- LIRIS, Lyon: this group is working on knowledge-based systems, case-based reasoning and trace modeling. They use semantic web formalisms to represent their models.
- LIPN, Paris: this group works on terminology and NLP tools, and has developed TERMINAE, a tool supporting construction of ontologies from texts.
- Sheffield University: this university produces NLP tools such as GATE or Amilcare, used by their partners of the AKT project in UK. We relied on their NLP platform GATE in our previous work on semi-automatic generation of annotations from text.

5.3 Interaction design and knowledge systems

- IN-SITU: This interdisciplinary project develops new interaction techniques, new tools and new methods for designing interactive systems. The goal is to develop situated interfaces, i.e. interfaces that are adapted (or adaptable) to their contexts of use, taking advantage of the complementary aspects of humans and computers. Two IN-SITU research themes are close to Wimmics' themes: 1) Participatory design; 2) Engineering of interactive systems - A new research action could be particularly worth considering by Wimmics, namely: End User

Interaction with Semantic Web Data. Precisely, IN-SITU is exploring the problem of displaying RDF data in a user-friendly manner through the development of visualization applications based on state-of-the-art interaction techniques, as well as through the specification of new languages for describing Semantic Web data presentation knowledge. In the social semantic applications design projects it undertakes, Wimmics uses whenever possible participatory design methods (i.e., methods encouraging user participation in the design of the applications). Wimmics also designs applications supporting a participatory design approach: this is the case for example of the collaborative editor ECCO; this editor supports a participatory approach to building ontologies.

- GRAVITE: this team aims at designing interactive visualization methods and tools to analyze and mine large datasets. Their emphasis is on the visualization of graph structures to help users gain insights from large datasets and large-scale simulations, to understand the data and/or the underlying model, and ultimately, to identify intrinsic properties or emergent phenomenon. With the ADT of Erwan Demairy we are currently evaluating how graph visualization tools like the ones designed by GRAVITE could be adapted to take advantage of typed graphs like the one processed in Wimmics.
- KMI, Open University: this group is known for platforms like the Watson semantic web search engine. They also study semantic web services for e-Learning, WSMX for semantic web services, MnM for annotation edition and MAGPIE for Web browsing. We collaborated with them in the framework of the Knowledge Web network. Their closest activity is on interaction design for the semantic web and could be a potential subject of collaboration in the future.
- AVIZ is a multidisciplinary project-team that seeks to improve analysis and visualization of large, complex datasets by tightly integrating analysis methods with interactive visualization. If we share with AVIZ some research goals (e.g., studying collaborative visualization, developing user-oriented methods for evaluating visualization tools) or a research approach (multidisciplinarity), a clear difference is that AVIZ focuses on visual analytics, which is not the case for Wimmics. Wimmics could however make some suggestions to include semantics in visual analytics.
- AXIS: This team performs research on: (1) Web Usage Mining and Reuse, (2) Semantics and Web sites, (3) Design management of Web sites. Axis focuses on knowledge mining while Wimmics focuses on knowledge representation and the processing it supports.
- RAINBOW: the research area of this team covers software engineering for ambient computing, from middleware to Human Computer Interaction. Both teams are complementary and collaborate on model and HCI composition and transformation.
- WAM aims at making it easier to develop and use rich multimedia contents and applications on the web. They focus on multimedia documents and applications that tightly integrate different types of media objects, be they discrete (text, images, equations) or continuous (video, audio, animations). We collaborated with this team in the context of PALETTE and we share with them the use and study of web formalisms. A main difference is our focus on knowledge representation while they are experts on multimedia documents and flows.

5.4 Social Network analysis and knowledge systems

The domain of social network analysis is a whole research domain in itself. Important teams in this domain include: the team of Mark Newman (Michigan University), the team of Ulrik Brandes (Konstanz University), the team of Santo Fortunato (Complex Network Lagrange Lab, Institute for Scientific Interchange, Turin), the team of Albert Barabasi (Boston, Northern University), etc. However we do not intend to contribute on the core theory of social networks like these teams

do but rather focus on what can be done with typed graphs in this domain. In other words we are not specialists of pure graph theory and we do not intend to work on theorems on graph structures or graph features in general. We intend to focus on typed graphs results and extend them whenever needed.

5.5 Semantic Requirement Engineering and knowledge systems

Finally, different attempts have been made to "semantify" requirement engineering, especially to improve requirement elicitation. The group of John Mylopoulos (University of Toronto), in collaboration with Ivan Jureta (Louvain School of Management) are currently working on foundations of Requirements Engineering and provide a core ontology about requirement engineering. Duisburg-Essen University and Leipzig University collaborated in the framework of the Softwiki project and proposed the SWORE ontology as a mean to support functional requirements elicitation. Nonfunctional requirements have also been addressed, for instance by the group of Pericles Loucopoulos (Manchester university), which proposed the OWL ontology ElicitO. Seok Won Lee (University of Nebraska Lincoln, USA) currently works on the Onto-ActRE and GenOM framework relying on ontologies to link together different requirement elicitation paradigms.

6 Some selected peer-reviewed publications

From books and book chapters:

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- Rose Dieng, Olivier Corby, Fabien Gandon, Alain Giboin, Joanna Golebiowska, Nada Matta, Myriam Ribière, Knowledge management: Méthodes et outils pour la gestion des connaissances, 3ème édition, DUNOD, 2005
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- Luca Costabello, Serena Villata, Fabien Gandon, Context-Aware Access Control for RDF Graph Stores. 20th European Conference on Artificial Intelligence ECAI 2012
- Olivier Corby, Alban Gaignard, Catherine Faron-Zucker and Johan Montagnat, KGRAM Versatile Inference and Query Engine for the Web of Linked Data, IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, Macau, China, 2012
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