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Project-Team SEMAGRAMME

Semantic Analysis of Natural Language

IN COLLABORATION WITH: Laboratoire lorrain de recherche en informatique et ses applications (LORIA)

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Project-Team SEMAGRAMME

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Other Research Topics and Application Domains:

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2. Overall Objectives

2.1. Scientific context

Computational linguistics is a discipline at the intersection of computer science and linguistics. On the theoretical side, it aims to provide computational models of the human language faculty. On the applied side, it is concerned with natural language processing and its practical applications.

From a structural point of view, linguistics is traditionally organized into the following sub-fields:

- Phonology, the study of language abstract sound systems.
- Morphology, the study of word structure.
- Syntax, the study of language structure, i.e., the way words combine into grammatical phrases and sentences.
- Semantics, the study of meaning at the levels of words, phrases, and sentences.
- Pragmatics, the study of the ways in which the meaning of an utterance is affected by its context.

Computational linguistics is concerned by all these fields. Consequently, various computational models, whose application domains range from phonology to pragmatics, have been developed. Among these, logic-based models play an important part, especially at the "higher" levels.

At the level of syntax, generative grammars [34] may be seen as basic inference systems, while categorial grammars [56] are based on substructural logics specified by Gentzen sequent calculi. Finally, model-theoretic grammars [75] amount to sets of logical constraints to be satisfied.

At the level of semantics, the most common approaches derive from Montague grammars, [60], [61], [62] which are based on the simply typed λ-calculus and Church's simple theory of types [35]. In addition, various logics (modal, hybrid, intensional, higher-order...) are used to express logical semantic representations.

At the level of pragmatics, the situation is less clear. The word *pragmatics* has been introduced by Morris [66] to designate the branch of philosophy of language that studies, besides linguistic signs, their relation to their users and the possible contexts of use. The definition of pragmatics was not quite precise, and for a long time several authors have considered (and some authors are still considering) pragmatics as the wastebasket of syntax and semantics [28]. Nevertheless, as far as discourse processing is concerned (which includes pragmatic problems such as pronominal anaphora resolution), logic-based approaches have also been successful. In particular, Kamp's Discourse Representation Theory [52] gave rise to sophisticated 'dynamic' logics [46]. The situation, however, is less satisfactory than it is at the semantic level. On the one hand, we are facing a kind of logical "tower of Babel". The various pragmatic logic-based models that have been developed, while sharing underlying mathematical concepts, differ in several respects and are too often based on *ad hoc* features. As a consequence, they are difficult to compare and appear more as competitors than as collaborative theories that could be integrated. On the other hand, several phenomena related to discourse dynamics (e.g., context updating, presupposition projection and accommodation, contextual reference resolution...) are still lacking deep logical explanations. We strongly believe, however, that this situation can be improved by applying to pragmatics the same approach Montague applied to semantics, using the standard tools of mathematical logic.

Accordingly:

> *The overall objective of the Sémagramme project is to design and develop new unifying logic-based models, methods, and tools for the semantic analysis of natural language utterances and discourses. This includes the logical modeling of pragmatic phenomena related to discourse dynamics. Typically, these models and methods will be based on standard logical concepts (stemming from formal language theory, mathematical logic, and type theory), which should make them easy to integrate.*

The project is organized along three research directions (i.e., *Syntax-semantics interface*, *Discourse dynamics*, and *Common basic resources*), which interact as explained below.

2.2. Syntax-semantics interface

The Sémagramme project intends to focus on the semantics of natural languages (in a wider sense than usual, including some pragmatics). Nevertheless, the semantic construction process is syntactically guided, that is, the constructions of logical representations of meaning are based on the analysis of the syntactic structures. We do not want, however, to commit ourselves to such or such specific theory of syntax. Consequently, our approach should be based on an abstract generic model of the syntax-semantic interface.

Here, an important idea of Montague comes into play, namely, the "homomorphism requirement": semantics must appear as a homomorphic image of syntax. While this idea is almost a truism in the context of mathematical logic, it remains challenged in the context of natural languages. Nevertheless, Montague's idea has been quite fruitful, especially in the field of categorial grammars, where van Benthem showed how syntax ans semantics could be connected using the Curry-Howard isomorphism [85]. This correspondence is the keystone of the syntax-semantics interface of modern type-logical grammars [65]. It also motivated the definition of our own Abstract Categorial Grammars [6].

Technically, an Abstract Categorial Grammar simply consists of a (linear) homomorphism between two higher-order signatures. Extensive studies have shown that this simple model allows several grammatical formalisms to be expressed, providing them with a syntax-semantics interface for free [7], [82], [84], [72], [55], [74].

We intend to carry on with the development of the Abstract Categorial Grammar framework. At the foundational level, we will define and study possible type theoretic extensions of the formalism, in order to increase its expressive power and its flexibility. At the implementation level, we will continue the development of an Abstract Categorial Grammar support system.

As said above, to consider the syntax-semantics interface as the starting point of our investigations allows us not to be committed to some specific syntactic theory. The Montagovian syntax-semantics interface, however, cannot be considered to be universal. In particular, it does not seem to be that well adapted to dependency and model-theoretic grammars. Consequently, in order to be as generic as possible, we intend to explore alternative models of the syntax-semantics interface. In particular, we will explore relational models where several distinct semantic representations can correspond to a same syntactic structure.

2.3. Discourse dynamics

It is well known that the interpretation of a discourse is a dynamic process. Take a sentence occurring in a discourse. On the one hand, it must be interpreted according to its context. On the other hand, its interpretation affects this context, and must therefore result in an updating of the current context. For this reason, discourse interpretation is traditionally considered to belong to pragmatics. The cut between pragmatics and semantics, however, is not that clear.

As we mentioned above, we intend to apply to some aspects of pragmatics (mainly, discourse dynamics) the same methodological tools Montague applied to semantics. The challenge here is to obtain a completely compositional theory of discourse interpretation, by respecting Montague's homomorphism requirement. We think that this is possible by using techniques coming from programming language theory, in particular, continuation semantics [78], [29], [30], [76] and the related theories of functional control operators [38], [39].

We have indeed successfully applied such techniques in order to model the way quantifiers in natural languages may dynamically extend their scope [83]. We intend to tackle, in a similar way, other dynamic phenomena (typically, anaphora and referential expressions, presupposition, modal subordination...).

What characterize these different dynamic phenomena is that their interpretations need information to be retrieved from a current context. This raises the question of the modeling of the context itself. At a foundational level, we have to answer questions such as the following. What is the nature of the information to be stored in the context? What are the processes that allow implicit information to be inferred from the context? What are the primitives that allow a context to be updated? How does the structure of the discourse and the discourse relations affect the structure of the context? These questions also raise implementation issues. What are the appropriate datatypes? How can we keep the complexity of the inference algorithms sufficiently low?

2.4. Common basic resources

Even if our research primarily focuses on semantics and pragmatics, we nevertheless need syntax. More precisely, we need syntactic trees to start with. We consequently need grammars, lexicons and parsing algorithms

to produce such trees. During the last years, we have developed the notion of interaction grammar [5] as a model of natural language syntax. This includes the development of grammar for French, [70] together with morpho-syntactic lexicons. We intend to continue this line of research and development. In particular, we want to increase the coverage of our French grammar, and provide our parser with more robust algorithms.

Further primary resources are needed in order to put at work a computational semantic analysis of utterances and discourses. As we want our approach to be as compositional as possible, we must develop lexicons annotated with semantic information. This opens the quite wide research area of lexical semantics.

Finally, when dealing with logical representations of utterance interpretations, the need for inference facilities is ubiquitous. Inference is needed in the course of the interpretation process, but also to exploit the result of the interpretation. Indeed, an advantage of using formal logic for semantic representations is the possibility of using logical inference to derive new information. From a computational point of view, however, logical inference may be highly complex. Consequently, we need to investigate which logical fragments can be used efficiently for natural language oriented inference.

3. Research Program

3.1. Overview

The Sémagramme project relies on deep mathematical foundations. We intend to develop models based on well-established mathematics. We seek two main advantages from this approach. On the one hand, by relying on mature theories, we have at our disposal sets of mathematical tools that we can use to study our models. On the other hand, developing various models on a common mathematical background will make them easier to integrate, and will ease the search for unifying principles.

The main mathematical domains on which we rely are formal language theory, symbolic logic, and type theory.

3.2. Formal language theory

Formal language theory studies the purely syntactic and combinatorial aspects of languages, seen as sets of strings (or possibly trees or graphs). Formal language theory has been especially fruitful for the development of parsing algorithms for context-free languages. We use it, in a similar way, to develop parsing algorithms for formalisms that go beyond context-freeness. Language theory also appears to be very useful in formally studying the expressive power and the complexity of the models we develop.

3.3. Symbolic logic

Symbolic logic (and, more particularly, proof-theory) is concerned with the study of the expressive and deductive power of formal systems. In a rule-based approach to computational linguistics, the use of symbolic logic is ubiquitous. As we previously said, at the level of syntax, several kinds of grammars (generative, categorial...) may be seen as basic deductive systems. At the level of semantics, the meaning of an utterance is captured by computing (intermediate) semantic representations that are expressed as logical forms. Finally, using symbolic logics allows one to formalize notions of inference and entailment that are needed at the level of pragmatics.

3.4. Type theory and typed λ-calculus

Among the various possible logics that may be used, Church's simply typed λ-calculus and simple theory of types (a.k.a. higher-order logic) play a central part. On the one hand, Montague semantics is based on the simply typed λ-calculus, and so is our syntax-semantics interface model. On the other hand, as shown by Gallin [43], the target logic used by Montague for expressing meanings (i.e., his intensional logic) is essentially a variant of higher-order logic featuring three atomic types (the third atomic type standing for the set of possible worlds).

4. Application Domains

4.1. Introduction

Our applicative domains concern natural language processing applications that rely on a deep semantic analysis. For instance, one may cite the following ones:

- textual entailment and inference,
- dialog systems,
- semantic-oriented query systems,
- content analysis of unstructured documents,
- text transformation and automatic summarization,
- (semi) automatic knowledge acquisition.

However, if the need for semantics seems to be ubiquitous, there is a challenge in finding applications for which a deep semantic analysis results in a real improvement over non semantic-based techniques.

4.2. Text Transformation

Text transformation is an application domain featuring two important sub-fields of computational linguistics:

- parsing, from surface form to abstract representation,
- generation, from abstract representation to surface form.

Text simplification or automatic summarization belong to that domain.

We aim at using the framework of Abstract Categorial Grammars we develop to this end. It is indeed a reversible framework that allows both parsing and generation. Its underlying mathematical structure of λ-calculus makes it fit with our type-theoretic approach to discourse dynamics modeling. The ANR project Polymnie (see section 7.2.1.1) is especially dedicated to this aim.

5. New Software and Platforms

5.1. Abstract Categorial Grammar Development Toolkit (ACGtk)

The current version of the ACG development toolkit prototype focuses on providing facilities to develop grammars. To this end, the type system currently implemented is the linear core system plus the (non-linear) intuitionistic implication, and a special attention has been paid to type error management. Since 1.0b released in Feb. 2014, ACGtk allows for transformations both from abstract terms to object terms, and from object terms to abstract terms (ACG parsing). The parsing algorithm follows a method which is being implemented for second-order ACGs. It is based on a translation of ACG grammars into Datalog programs and is well-suited to fine-grained optimization.

However, since we are interested not only by recognizability (hence whether some fact is provable) but also by the parsing structure (hence the proof), the Datalog solver has been adapted to produce not only yes/no answer to queries, but also all the proofs of the answers to the queries. The next steps concern optimization and efficiency. Note however that in the general case, the decidability of translating an object term to an abstract one is still an open problem.

We also have enriched the ACG development toolkit with graphical output. The new module includes a small functional OCaml library for manipulating images which enables users to customize the rendering of formulas as pictures.

The software is implemented in OCaml and is available as OPAM [1] package. Version 1.3.0 was released on November 30th.

- Contact: Sylvain Pogodalla
- URL: http://www.loria.fr/equipes/calligramme/acg/

5.2. Grew

Grew is a Graph Rewriting tool dedicated to applications in NLP. Grew takes into account confluent and non-confluent graph rewriting and it includes several mechanisms that help to use graph rewriting in the context of NLP applications (built-in notion of feature structures, parametrization of rules with lexical information).

A online version of Grew for graph matching was presented as a demo in the TALN conference [19].

- Contact: Bruno Guillaume
- URL: http://grew.loria.fr

5.3. ZombiLingo

Crowdsourcing is nowadays a way of constructing linguistic resources which is more and more used. In the crowdsourcing area, one of the way to motivate a large amount of people to contribute to a project is to present it as a game. Games used in this particular way are called GWAPs (Game With A Purpose). ZombiLingo is a GWAP where gamers have to give linguistic information about the syntax of French natural language sentence.

At the end of 2015, 460 players are registered on the game website and they have produce 63,000 annotations.

In 2015, an Inria ADT started based on the prototype built in 2014. The engineer (Nicolas Lefebvre) worked on this project since October 2015. The main improvement were: migration towards a new framework (Laravel) and code refactoring, integration of new designs into the game and internationalization of the interface to prepare the game for application to other natural Languages.

- Participants: Bruno Guillaume, Karën Fort (Université Paris Sorbonne) and Nicolas Lefebvre
- Contact: Bruno Guillaume
- URL: http://zombilingo.org/

5.4. SLAMtk

A management chain of the transcriptions of interviews for the SLAM project which products of a full anonymized randomized version of the resources. Some extensions have been implemented based on Distagger (disfluencies) and MElt (POS and lemma) and propose different analyses of repartition, mainly during the Théophane De Logivière internship.

- Contact: Maxime Amblard
- URL: http://slam.loria.fr

5.5. Dep2pict

Dep2pict is a program for drawing graphical representation of dependency structures of natural language sentences.

- Contact: Bruno Guillaume
- URL: http://dep2pict.loria.fr

[1] https://opam.ocaml.org/

5.6. LEOPAR

Leopar is a parser for natural languages which is based on the formalism of Interaction Grammars. The main features of the current version of the software are: automatic parsing of a sentence or a set of sentences, dependency and parse-tree representation of sentences, interactive parsing (the user chooses the couple of nodes to merge) and visualization of grammars produced by XMG-2 or of sets of description trees associated to some word in the linguistic resources.

- Participants: Guillaume Bonfante, Bruno Guillaume and Guy Perrier
- Contact: Bruno Guillaume
- URL: http://leopar.loria.fr

6. New Results

6.1. Syntax-semantics interface

6.1.1. Lexical Semantics

The interpretation of natural language utterances relies on two complementary elements of natural language modeling. On the one hand, the description of the combinatorics of natural language expresses how elementary units, or *lexical units* (typically the word), combine in order to build more complex elements, such as sentences or discourses. On the other hand, the description of these elementary units specifies how they contribute to the meaning of the whole by their *lexical meaning*. This specification should also take into account how the different parts of the lexical meanings combine during the *composition* process and how they relate to their underlying meaning concepts. For instance, the verbs *buy* and *sell* should refer to a common conceptual representation. However, their syntactic arguments (e.g., the subject) play a different (semantic) role with respect to the *transaction* concept that they share.

The modeling of these concepts and how they relate to each other gave rise to Frames Semantics as a representation format of conceptual and lexical knowledge [40], [31], [26], [59]. Frames consists of directed graphs where nodes correspond to entities (individuals, events, ...) and edges correspond to (functional or non-functional) relations between these entities. Providing a fine-grained representation of the internal concept structure allows both for a *decomposition* of the lexical meaning and for a precise description of the sub-structural interactions in the semantic composition process [58].

Frames can be formalized as extended typed feature structures [71], [50] and specified as models of a suitable logical language. Such a language allows for the composition of lexical frames on the sentential level by means of an explicit syntax-semantics interface [50]. Yet, this logical framework does not provide a direct link between Frames and truth-conditional semantics, where natural language utterances are considered with respect to the conditions under which they are true or false. In particular, it does not provide means for the lexical items to introduce explicit quantification over entities or events.

To overcome these limitations, we proposed use Hybrid Logic (HL) [27], [25]. HL is an extension of modal logic. As such, it is well-suited to the description of graph structures. Moreover, HL introduce *nominals*, that allow the logical formulas to refer to specific nodes of the graph. It is then possible, for example, to specify when two edges should meet. Moreover, it introduces *variables* for nodes, and the associated *quantifiers*, that can appear in the logical formulas. We used this framework to model quantification in Frame Semantics [23], [18]

6.1.2. Compositionality and Modularity

One says that a semantics is compositional when it allows the meaning of a complex expression to be computed from the meaning of its constituents. One also says that a system is modular if it is made of relatively independent components. In the case of a semantic system (e.g, a Montague grammar), we say that it is modular if the ontology on which it is based (including notions such as *truth, entities, events, possible worlds, time intervals, state of knowledge, state of believe, ...*) is obtained by combining relatively independent simple ontologies.

The intensionalization procedure introduced in [4] provides a first step towards modularity. It allows the extensional interpretation of a language to be transformed into an intensionalized interpretation that offers room for accommodating truly intensional phenomena. Moreover, this procedure is conservative in the sense that it preserves the truth conditions of sentences. Another instance of such a procedure is provided by the dynamization procedure described in [57], which allows a static interpretation to be turned into a dynamic one capable of accommodating phenomena related to discourse dynamics.

In [15], we showed that both the intensionalization and dynamization procedures are instances of an abstract general scheme for which conservativity results may be established using the notion of logical relation.

6.1.3. Abstract Categorial Parsing

Kanazawa [53], [54] has shown how parsing and generation may be reduced to datalog queries for a class of grammars that encompasses mildly context-sensitive formalisms. These grammars, which he calls *context-free λ-term grammars*, correspond to second-order abstract categorial grammars.

In [14], we showed how Kanazawa's reduction may be carried out in the case of abstract categorial grammars of a degree higher than two. To this end, we reduced the parsing problem for general Abstract Categorial Grammars to a provability problem in Multiplicative Exponential Linear Logic.

6.2. Discourse dynamics

6.2.1. Discourse Structure Modeling

It is usually assumed that the internal structure of a text, typically characterized by discourse or rhetorical relations, plays an important role in its overall interpretation. In order to build such a structure, some approaches rely on discourse grammars. The key idea is to consider the structural regularities in discourse structure similarly as syntactic regularities. A particular trend relies on tree grammars. This trend has been further developed by integrating the modeling of both clausal syntax and semantics, and discourse syntax and semantics within the frameworks of Tree-Adjoining Grammar (TAG) [48], [49] and TAG for Discourse (D-LTAG) [79], [41], [80], [42].

Two important features characterize these approaches. First, while they use a single grammatical formalism, two different grammars are used for syntactic parsing and then for discourse parsing. In addition to adding an intermediate processing step, this two-tiered treatment both complicates the modeling of connectives that are ambiguous in their syntactic and discourse use, and prevents using standard disambiguation techniques. Second, some discourse structures better represented by directed acyclic graphs (DAG) than by trees are not accounted for.

In order to address the second issue of building DAG structures, [36], [37] have proposed Discourse Synchronous TAG (D-STAG), a TAG based approach together with a higher-order interpretation of sentences using Synchronous Tree-Adjoining Grammar (STAG) [67], [77].

We developed a method to interface a sentential grammar and a discourse grammar without resorting to an intermediate processing step. The method is general enough to build discourse structures that are DAG and not only trees. Our analysis is based on D-STAG. We also use an encoding of TAG into ACG. This encoding allows us to express a higher-order semantic interpretation that enables building DAG discourse structures on the one hand, and to smoothly integrate the sentential and the discourse grammar thanks to the modular capability of ACG. The results has been published [13] and all the examples of the article have been implemented and may be run and tested with the ACGtk software (see 5.1).

6.2.2. Effects and Handlers

We made the argument that pragmatics are to semantics what side effects are to calculations in a programming language. We demonstrated this parallel on two aspects.

First off, both pragmatics and side effects serve the same function. Side effects in programming languages account for the effects of expressions that reach beyond their scope and for the way a language interacts with the world of its users. Pragmatics is concerned with phenomena that also involve the non-immediate effects of expressions (e.g., discourse anaphora, presupposition accommodation) and with the way language interacts with the world of its users. Secondly, we pointed out that very similar formal theories are being used to treat the both of them (i.e. monads and continuations).

Having established this parallel, we then put forward a preliminary proposal of integrating semantics and pragmatics while keeping them separate by assigning effectful computations of truth values as meanings of linguistic expressions. In this way, we can implement the pragmatics at the level of the side effects and then focus on pure semantics at the level of values.

6.3. Common basic resources

6.3.1. Graph Rewriting

Bruno Guillaume and Guy Perrier have proposed to use Graph Rewriting for parsing syntactic dependencies [17]. It is an application of a Graph Rewriting formalism that they have established with Guillaume Bonfante and Mathieu Morey [32] and implemented in the Grew software [47]. They have developed a system of rewriting rules dedicated to French, which they have evaluated by parsing the Sequoia corpus [33].

6.3.2. Categorial Logic

Elaborating on the work of Grishin [45], Moortgat has introduced the non-associative Lambek-Grishin calculus (**LG**) as the foundations of a new kind of symmetric categorial grammar [63], [64], which allows for the treatment of linguistic phenomena such as displacement or discontinuous dependencies.

In [16], we compared **LG** with the non-associative classical Lambek calculus (**CNL**) introduced by de Groote and Lamarche [81]. We provided a translation of **LG** into **CNL**, which allows **CNL** to be seen as a non-conservative extension of **LG**. We then introduced a bimodal version of **CNL** that we called 2-**CNL**. This allowed us to define a faithful translation of **LG** into 2-**CNL**. Finally, we showed how to accommodate Grishin's interaction principles by using an appropriate notion of polarity. From this, we derived a new one-sided sequent calculus for **LG**.

6.3.3. Deep Syntax Annotation of the Sequoia French Treebank

Deep-sequoia introduces a deep syntactic representation scheme for French, built from the surface annotation scheme of the Sequoia corpus and abstracting away from it [69]. This scheme expresses the grammatical relations between content words. When these grammatical relations take part into verbal diatheses, the diatheses are considered as resulting from redistributions from the canonical diathesis, which is retained in the annotation scheme. The first version of the deep-sequoia corpus was released in 2014.

In November 2015, a new version (7.0) of the corpus was release (see http://deep-sequoia.inria.fr). Most of the modifications were corrections of annotations that improve the overall consistency of the corpus. Marie Candito and Guy Perrier have published the annotation guidelines associated with the corpus in [22].

6.3.4. Large Scale Grammatical Resources

Guy Perrier and Bruno Guillaume have achieved the development of a French grammar FRIGRAM with a large coverage [12] in the formalism of Interaction Grammars [5]. The originality of the formalism lies in its system of polarities which expresses the resource sensitivity of natural languages and which is used to guide syntactic composition. We present the principles underlying grammar design, highlight its modular architecture and show that the lexicon used is independent of the grammar formalism. We also introduce the "companion property", and show that it helps to enforce grammar consistency.

6.3.5. Universal Dependency Treebank

Bruno Guillaume participates with Marie-Catherine de Marneffe to the production of the French sub-corpus of the Universal Dependency Treebank [68]. In November 2015, the version 1.2 was released. On the French sub-corpus, Grew was used to detect inconsistency and to correct automatically systematic errors.

7. Partnerships and Cooperations

7.1. Regional Initiatives

Participants: Maxime Amblard [coordinator], Philippe de Groote, Sylvain Pogodalla, Karën Fort.

SLAM: Schizophrenia and Language, Analysis and Modeling

Schizophrenia is well-known among mental illnesses for the strength of the thought disorders it involves, and for their widespread and spectacular manifestations: from deviant social behavior to delusion, not to speak about affective and sensitive distortions. It aims at exploring a specific manifestation, namely disorders in conversational speech. This is an interdisciplinary research, both empirical and theoretical from several domains, namely psychology, philosophy, linguistic and computer science.

The SLAM project starts for three years at the Maison des Sciences de l'Homme de Lorraine (MSH–Lorraine, USR 3261). While this year work was dedicated to the test protocol definition, the coming years will be devoted to building an open-access corpus of pathological uses of language.

The first transcriptions of pathological interviews are analyses. The management chain was implemented for disfluencies and POS. Moreover, we have focused on implementing the treatment of lexicography issues and proposed an interface for SDRT-annotations.

Other participants are: Denis Apotheloz (ATILF, Université de Lorraine),Valérie Aucouturier (Centre Léo Apostel, Université Libre de Bruxelles), Katarina Bartkova (ATILF, Université de Lorraine), Fethi Bretel (CHS Le Rouvray, Rouen), Michel Musiol (InterPSY, Université de Lorraine), Manuel Rebuschi (Archives Poincaré, Université de Lorraine).

The SLAM project was supported by the MSH–Lorraine, USR 3261, and won a PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget allowed the organization of the third workshop which gathers linguists, psychologists and computer scientists in December: http://discours.loria.fr.

The SLAM project was chosen for the bi-annual report of the CNRS MI as a major illustration.

7.2. National Initiatives

7.2.1. ANR

7.2.1.1. Polymnie: Parsing and synthesis with abstract categorial grammars. From lexicon to discourse

Participants: Maxime Amblard, Philippe de Groote, Aleksandre Maskharashvili, Sylvain Pogodalla [coordinator].

POLYMNIE[2] is a research project funded by the French national research agency (ANR). It relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. As a consequence:

- ACG allows for the encoding of a large variety of grammatical formalisms such as context-free grammars, Tree Adjoining grammars (TAG), etc.
- ACG defines two languages: an abstract language for the abstract forms, and an object language for the surface forms.

[2] http://semagramme.loria.fr/doku.php?id=projects:polymnie

Importantly, the notions of object language and abstract language are relative to each other. If we can naturally see surface forms as strings for instance and abstract forms as the associated syntactic trees, we can also consider to associate this abstract form to a first order logical formula as surface (object) form. This property is central in our project as it offers a unified approach to text analysis and text generation, in particular considering the underlying algorithms and their complexity.

ACG definition uses type-theory and lambda-calculus. From this point of view, they smoothly integrate formal semantics models issuing from Montague's proposal. Theories that extend to the discourse level such as Discourse Representation Theory (DRT) and Dynamic Predicate Logic (DPL) were not initially formulated using lambda-calculus. But such formulations have been proposed. In particular, a formulation based on continuation semantics allows them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resolution or rhetorical relation inference, have then to be expressed by lexical semantics or computed from the syntactic rules as studied in the Inria Collaborative Research Project (ARC) CAuLD [3].

It has been shown that the discourse structure of texts plays a key role in their understanding. This is the case for both human readers and automatic processing systems. For instance, it can enhance text transformation systems such as the ones performing automatic summarization.

POLYMNIE focuses on studying and implementing the modeling of sentences and discourses in a compositional paradigm that takes into account their dynamics and their structures, both in parsing and in generation. To that end, we rely on the ACG framework. The kind of processing we are interested in relates to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modeling of the linguistic processes (as opposed to inferential processes for instance) these tasks involve.

The complexity of the phenomena, of their formal description, and of their interactions, require to set up a testing and development environment for linguistic modeling. It will consist in extending and stabilizing a software implementing the functionalities of the ACG framework. It will provide a tool for experimentation and validation of the approach.

Partners:

- Sémagramme people,
- Alpage (Paris 7 university & Inria Paris-Rocquencourt): Laurence Danlos (local coordinator), C. Braud, C. Roze, Éric Villemonte de la Clergerie,
- MELODI (IRIT, CNRS): Stergos Afantenos, Nicholas Asher (local coordinator), Juliette Conrath, Philippe Muller,
- Signes (LaBRI, CNRS): Jérôme Kirman, Richard Moot, Christian Retoré (local coordinator), Sylvain Salvati, Noémie-Fleur Sandillon-Rezer.

7.3. International Research Visitors

7.3.1. Visits of International Scientists

7.3.1.1. Sabbatical programme

Pogodalla Sylvain

Date: Aug 2014 - Jul 2015

Institution: HHU (Germany)

The objective of the research project dealt with studying the syntax-semantics interface. It was relying on two alternative approaches of this interface for mCSG: a unification based approach for Lexicalized Tree Adjoining Grammars (LTAG) [48], [49] as proposed in [44], [51], and a type-theoretic approach using Abstract Categorial Grammars (ACG) [6], [72], [73].

[3] http://www.loria.fr/~pogodall/cauld/

On the semantic side, the project focused on the modeling of quantification in Frame Semantics [40], [31], [59]. We proposed to use Hybrid Logic (HL) [27]. We developed a syntax-semantics interface with ACG to model scope ambiguity [18], as well as a syntax-semantics interface in LTAG for iterative events [23].

8. Dissemination

8.1. Promoting Scientific Activities

8.1.1. Scientific events organisation

8.1.1.1. General chair, scientific chair

- Maxime Amblard organized the workshop (In)Cohérence du discours 3, with the SLAM project (Schizophrenia and Language: Analysis and Modeling).

  The objective of the workshop was to discuss the latest advances in the modelling of discourses in particular those with pathological issues. The adopted modeling paradigm is that of formal semantics, which falls within the scope of both linguistics and logic while also making ties to the philosophy of language.
- Maxime Amblard co-organized with Karen Fort and Gilles Adda the first workshop ETeRNAL about ethics in natural language processing.

8.1.1.2. Member of the organizing committees

- Maxime Amblard and Jiří Maršík were members of the organization committee of the workshop (In)Cohérence du discours 3.

8.1.2. Scientific events selection

8.1.2.1. Chair of conference program committees

- Philippe de Groote and Sylvain Pogodalla are members of the steering committee of the international conference series *Logical Aspects of Computational Linguistics (LACL)*.
- Maxime Amblard is member of the steering committee of the workshop (In)Coherence of Discourse

8.1.2.2. Member of the conference program committees

- Guy Perrier was member of the program committee of the ACL workshop “Grammar Engineering Across Frameworks” (GEAF2015), 30 July 2015, Bejing (China).
- Philippe de Groote was member of the program committee of the 20th Conference on Formal Grammar (Barcelona, Spain, August 8–9, 2015).

8.1.2.3. Reviewer

- Maxime Amblard:
  - Reviewer for Traitement Automatique des Langues Naturelles (TALN) 2015
  - Reviewer for Journées de Phonétique Clinique (JPC) 6
  - Reviewer for (In)Cohérence du discours 3
  - Reviewer for the workshop ETeRNAL 1
- Sylvain Pogodalla:
  - Reviewer for the international workshop on *Logic and Engineering of Natural Language Semantics 12 (LENLS12)*.
- Bruno Guillaume:
  - Reviewer for the international conference *Language Resources and Evaluation Conference* (LREC 2016).

8.1.3. Journal

8.1.3.1. Member of the editorial boards

- Philippe de Groote:
  - Area editor of the *FoLLI-LNCS series*.
  - Associate editor of *Higher-Order and Symbolic Computation*.
  - Member of the editorial board of *Cahiers du Centre de Logique*.
- Sylvain Pogodalla: Member of the editorial board of the journal Traitement Automatique des Langues, in charge of the *Résumés de thèses* section.

8.1.3.2. Reviewer - Reviewing activities

- Maxime Amblard: Reviewer for the special issue of the TAL revue (55-3) 'TAL et Cognition'
- Guy Perrier: reviewer for the *Journal of Logic, Language and Information*.
- Sylvain Pogodalla:
  - reviewer for the Computational Linguistics.
  - reviewer for Linguistic Issues in Language Technology LiLT

8.1.4. Scientific expertise

- Maxime Amblard has provided scientific evaluation for the AAP ASTRID (Accompagnement spécifique des travaux de recherches et d'innovation défense)

8.1.5. Research administration

Maxime Amblard is member of:

- Scientific council of the Univ. Lorraine
- board of the Scientific council of the Univ. Lorraine
- Lab council (LORIA)
- management council of the "Maison des sciences de l'homme" MSH-Lorraine

Maxime Amblard is the head of the master second year in Natural Language Processing.
Bruno Guillaume is the head of the department Natural Language Processing and Knowledge Discovery.
Bruno Guillaume was one of the two animators of the CPER 2015-2020 project "Langues, Connaissances et Humanités Numériques" (Languages, Knowledge and Digital Humanities) in which ten laboratories of the Université de Lorraine are implied.
Bruno Guillaume is an elected member of the "Pôle scientifique AM2I" of the Université de Lorraine.
Bruno Guillaume is a member of the Comipers (Inria committee for PhD and Post-doctoral selection).

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

Licence: Maxime Amblard, Traitement Automatique des Langues, 3h, L1, Univ. Lorraine, France

Master: Maxime Amblard, Formalisms: from Syntax to Discourse, 50h, M2, Univ. Lorraine, France

Master: Maxime Amblard, Remise à niveau TAL, 5h, M2, Université de Lorraine, France

Master: Maxime Amblard, Algorithms for Artificial Intelligence, 43h, M1, Univ. Lorraine, France

Master: Philippe de Groote, Formal logic, 35h, M2, Université de Lorraine, France

Master: Philippe de Groote, Computational structures and logics for natural language modeling, 18h, M2, Université Paris Diderot, France

Licence: Bruno Guillaume, Algorithmique et programmation, 44h, L1, Université de Lorraine, France

Master: Bruno Guillaume, Linguistic resources and NLP toolchain, 30h, M2, Université de Lorraine, France

Licence: Jiří Maršík, Ingénierie linguistique, 25h, L3, Université de Lorraine, France

Master: Jiří Maršík, IA fondamentale : représentation des connaissances et fouille de données, 11.5h, M1, Université de Lorraine, France

Master: Jiří Maršík, Communication scientifique, 15.5h, M1, Université de Lorraine, France

Master: Jiří Maršík, Cognitive Aspect of Computational Linguistic, 31.5h (15h in English and 16.5h in French), M2, Université de Lorraine, France

Master: Jiří Maršík, Remise à niveau TAL, 10h, M2, Université de Lorraine, France

Master: Sylvain Pogodalla, Formal Language Theory, 27.5h, M2, Univ. Lorraine, France

8.2.2. Supervision

- PhD in progress: Clément Beysson, "Quantificateurs généralisés dynamiques pour l'analyse discursive", since september 2015, Philippe de Groote and Bruno Guillaume
- PhD in progress: Jiří Maršík, "Modeling Discourse in a Dynamics framework: formal integration and evaluation", since september 2013, Philippe de Groote and Maxime Amblard
- PhD in progress : Aleksandre Maskharashvili, "Generation and Discourse with Abstract Categorial Grammars", since November 2012, Philippe de Groote and Sylvain Pogodalla.

8.2.3. Juries

- Guy Perrier was reviewer of the PhD thesis of Jérôme Kirman, *Mise au point d'un formalisme syntaxique de haut niveau pour le traitement automatique des langues*, Dec. 4, 2015, Université de Bordeaux.
- Philippe de Groote was member of the jury of the HDR of Sylvain Salvati, Dec. 10, 2015, Université de Bordeaux.

8.3. Popularization

- Maxime Amblard is member of the editorial board of interstice)i(, a french revue popularisation for computer sciences (http://interstices.info). He is the head of the rubric informatique -ou presque- dans les films and co-author of the series of article on where we could find computer science in real life.

- Maxime Amblard delivered an invited talk “Le langage, logique !” at the “Conférence Curieuse” of Univ. Lorraine, at the Nancy musée aquarium (September 17th 2015).
- Maxime Amblard delivered an invited talk “Le langage, logique !” at the Luxembourg University (October 15th 2015).
- Bruno Guillaume presentend the game ZombiLingo during the conference Science&You in Nancy (June).
- Nicolas Lefebvre demonstrated the prototype ZombiLingo and Jiří Maršík the ACGtk during the “Forum Sciences Cognitive” in Nancy (November).

9. Bibliography

Major publications by the team in recent years

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Articles in International Peer-Reviewed Journals

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