IN PARTNERSHIP WITH:
CNRS

Université de Lorraine

Activity Report 2013

Project-Team SÉMAGRAMME

Semantic Analysis of Natural Language

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

RESEARCH CENTER
Nancy - Grand Est

THEME
Language, Speech and Audio

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Project-Team SÉMAGRAMME

Keywords: Logics, Natural Language, Semantics, Linguistics

Creation of the Team: 2011 January 01*, updated into Project-Team:* 2013 July 01.

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2. Overall Objectives

2.1. Overall objectives

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 [44] are based on substructural logics specified by Gentzen sequent calculi. Finally, model-theoretic grammars [55] amount to sets of logical constraints to be satisfied.

At the level of semantics, the most common approaches derive from Montague grammars, [45], [46], [47] 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 [50] 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 [30]. 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 [42] gave rise to sophisticated ‘dynamic’ logics [39]. 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 modelling 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 in the following paragraphs.

2.1.1. 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 is 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 [63]. This correspondence is the keystone of the syntax-semantics interface of modern type-logical grammars [48]. It also motivated the definition of our own Abstract Categorial Grammars [58].

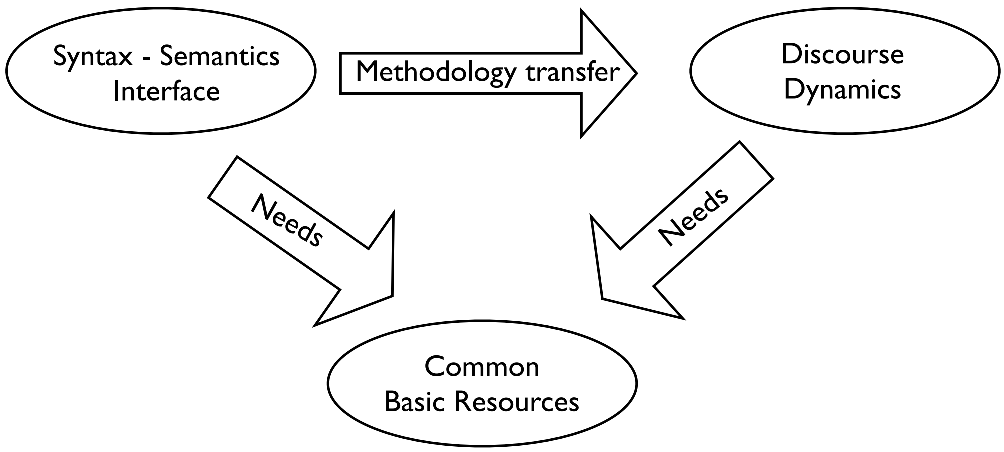

Figure 1.

Technically, an Abstract Categorial Grammar consists simply 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. [59], [61], [62], [53], [43], [54]

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.

2.1.2. 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 [57], [31], [32], [56] and the related theories of functional control operators [36], [37].

We have indeed successfully applied such techniques in order to model the way quantifiers in natural languages may dynamically extend their scope [60]. 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?

2.1.3. 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 developped the notion of interaction grammar [40] as a model of natural language syntax. This includes the development of grammar for French, [52] 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.

2.2. Highlights of the Year

Dr. Ekatarina Lebedeva (together with Wesley H. Holliday, Stanford University) winned the E.W. Beth Dissertation Prize, awarded by FoLLI (the Association for Logic, Language, and Information) to outstanding dissertations in the fields of Logic, Language, and Information. Dr. Ekatarina Lebedeva prepared her PhD thesis in the Sémagramme team, under the supervision of Philippe de Groote. She obtained her PhD degree from the *Université de Lorraine* in April 2012.

3. Research Program

3.1. Foundations

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.

3.1.1. 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.

3.1.2. 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 capture 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.

3.1.3. 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, [38] 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,
- dialogue 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. Software and Platforms

5.1. Leopar

Participants: Bruno Guillaume [correspondent], Guy Perrier, Tatiana Ekeinhor.

5.1.1. Software description

Leopar is a parser for natural languages which is based on the formalism of Interaction Grammars [40]. It uses a parsing principle, called "electrostatic parsing" which consists in neutralizing opposite polarities. A positive polarity corresponds to an available linguistic feature and a negative one to an expected feature.

Parsing a sentence with an Interaction Grammar consists in first selecting a lexical entry for each of its words. A lexical entry is an underspecified syntactic tree, a tree description in other words. Then, all selected tree descriptions are combined by partial superposition guided by the aim of neutralizing polarities: two opposite polarities are neutralized by merging their support nodes. Parsing succeeds if the process ends with a minimal and neutral tree. As IGs are based on polarities and under-specified trees, Leopar uses some specific and non-trivial data-structures and algorithms.

The electrostatic principle has been intensively considered in Leopar. The theoretical problem of parsing IGs is NP-complete; the nondeterminism usually associated to NP-completeness is present at two levels: when a description for each word is selected from the lexicon, and when a choice of which nodes to merge is made. Polarities have shown their efficiency in pruning the search tree:

- In the first step (tagging the words of the sentence with tree descriptions), we forget the structure of descriptions, and only keep the bag of their features. In this case, parsing inside the formalism is greatly simplified because composition rules reduce to the neutralization of a negative feature-value pair $f \longleftarrow v$ by a dual positive feature-value pair $f \longrightarrow v$. As a consequence, parsing reduces to a counting of positive and negative polarities present in the selected tagging for every pair (f, v): every positive occurrence counts for $+1$ and every negative occurrence for -1, the sum must be 0.
- Again in the tagging step, original methods were developped to filter out bad taggings. Each unsaturated polarity p in the grammar induces constraints on the set of contexts in which it can be used: the unsaturated polarity p must find a *companion* (*i.e.* a tree description able to saturated it); and the set of companions for the polarity p can be computed statically from the grammar. Each lexical selection which contains an unsaturated polarity without one of its companions can be safely removed.
- In the next step (node-merging phase), polarities are used to cut off parsing branches when their trees contain too many non neutral polarities.

5.1.2. Current state of the implementation

Leopar is presented and documented at http://leopar.loria.fr; an online demonstration page can be found at http://leopar.loria.fr/demo.

It is open-source (under the CECILL License http://www.cecill.info) and it is developed using the InriaGforge platform (http://gforge.inria.fr/projects/semagramme/)

The main features of current 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),
- visualization of grammars produced by XMG-2 or of sets of description trees associated to some word in the linguistic resources.

One of the difficulties with symbolic parsing is that several solution can be produced for a single sentence and we want te be able to rank them. Tatiana Ekeinhor, during her second year Master Intership (from February to June 2013), implemented a ranker based on statistical techniques. Using the Sequoia TreeBank as a training corpus, she obtained an improvement of the system compared to the handcrafted rules.

5.2. ACG Development Toolkit

Participants: Sylvain Pogodalla [correspondent], Philippe de Groote.

In order to support the theoretical work on ACG, we have been developing a support system. The objectives of such a system are twofold:

1. To make possible to implement and experiment grammars the modeling of linguistic phenomena.
2. To make possible to implement and experiment results related to the ACG formalisms. Such results can concern parsing algorithms, type extensions, language extensions, etc.

The ACG Development toolkit development effort is part of the POLYMNIE project (see Section 7.2.1.1). It will support the experimentation and evaluation parts of the project.

The current version of the ACG development toolkit prototype [1] issues from a first release published in October 2008. Further releases have been published before the ESSLLI 2009 course on ACG. It 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. As a major limitation, this version only considers transformation from abstract terms to object terms, and not the other way around.

The prototype now enables the transformation from the object terms to the abstract terms. The parsing algorithm follows [43]'s 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're 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.

5.3. Grew

Participants: Bruno Guillaume [correspondent], Guy Perrier.

Graph rewriting, Interface syntaxe-sémantique

Grew is a Graph Rewriting tools dedicated to applications in NLP. It is freely-available (from the page http://grew.loria.fr) and it is developed using the InriaGforge platform (http://gforge.inria.fr/projects/semagramme/)

We list below some of the major specificities of the GREW software.

- Graph structures can use a build-in notion of feature structures.
- The left-hand side of a rule is described by a graph called a pattern; injective graph morphisms are used in the pattern matching algorithm.
- Negative pattern can be used for a finer control on the left-hand side of rules.
- The right-hand side or rules is described by a sequence of atomic commands that describe how the graph should be modified during the rule application.
- Rules can be parametrized by lexical information.
- Filters can be used at the output of each module to control the structure produced are well-formed.

[1] Available at http://acg.gforge.inria.fr with a CeCILL license.

- Subset of rules are grouped in modules; the full rewriting process being a sequence of module applications.
- The Grew software has support both for confluent and non-confluent modules; when a non-confluent modules is used, all normal forms are returned and then ambiguity is handled in a natural way.
- Grew can be used on Corpus mode with statistics about rules usage or with an a Graphical User Interface which can show all intermediate graphs used during the rewriting process (useful either to debug rewriting system or for demonstrations).

The Grew software was used for several kind of applications manipulating syntactic and/or semantic graph representations. It was used to build DMRS semantic representation from syntactic dependency trees in the French TreeBank [51].

More recently, it was used in the project “Deep Syntax Annotation of the Sequoia French Treebank”. First, it was used as a pre-annotation tool and; second, it is used to detect ill-formed structures that don’t fit the annotation guide requirement.

5.4. Other developments

Participants: Bruno Guillaume [correspondent], Maxime Amblard [correspondent].

Concordancer, Dependencies, Graphical tools Other peripheral developments of the team are available either as web service of as downloadable code:

- A concordancer named CONDOR which is usable online: http://condor.loria.fr. With Condor, it is possible to search for all inflexions (given by a lexicon) of some lemma; it is possible to search for a couple of lemmas to find collocations.
- A program (named DEP2PICT) to build graphical representations (PNG, SVG or PDF) of dependency structures. It is presented in http://dep2pict.loria.fr; it is usable online http://dep2pict.loria.fr/demo.
- a management chain of the transcriptions of interviews for the SLAMproject. including the production of a full anonymized randomized version of the resources.
- A program which use Distagger and propose different analyze of the repartition of disfluencies.

6. New Results

6.1. Syntax-Semantics Interface

6.1.1. TAG, Dependency Grammars, and ACG

Aleksandre Maskharashvili and Sylvain Pogodalla gave an ACG account of [41]’s process of transformation of the derivation trees of Tree Adjoining Grammar (TAG) into dependency trees. They made explicit how the requirement of keeping a direct interpretation of dependency trees into strings results into lexical ambiguity. Since the ACG framework has already been used to provide a logical semantics from TAG derivation trees, it results in a unified picture where derivation trees and dependency trees are related but independent equivalent ways to account for the same surface–meaning relation. This result has been published in [15].

6.1.2. Semantics of Neg-Raising Predicates in TAG

Laurence Danlos, Philippe de Groote, and Sylvain Pogodalla proposed a lexical semantic interpretation of Neg-Raising (NR) predicates that heavily relies on a Montague-like semantics for TAG and on higher-order types. NR verbs form a class of verbs with a clausal complement that show the following behavior: when a negation syntactically attaches to the ma- trix predicate, it can semantically attach to the embedded predicate, as the implication of (2) by (1) shows. This corresponds to the NR reading of this predicate.

- *Marie ne pense pas que Pierre partira.*
- *Marie pense que Pierre ne partira pas.*

As a base case, the approach lexically provides both NR and non-NR readings to NR predicates. The proposal is implemented in the ACG framework as it offers a fairly standard interface to logical formal semantics for TAG. This result has been published in [13].

6.1.3. Intensionalization

Makoto Kanazawa and Philippe de Groote have defined a general intensionalization procedure that turns an extensional semantics for a language into an intensionalized one that is capable of accommodating truly intensional lexical items without changing the compositional semantic rules [10]. They have proved some formal properties of this procedure and have clarified its relation to the procedure implicit in Montague's PTQ.

6.2. Lexical Disambiguation

Guy Perrier adapted the methods of lexical disambiguation presented in Mathieu Morey's PhD thesis [49] to the formalism of Tree Adjoining Grammar (TAG) in a common work with Claire Gardent, Yannick Parmentier and Sylvain Schmitz [24].

More precisely, the algorithm of lexical disambiguation for TAG uses the one-to-one relations between substitution nodes and roots of elementary tress in the parsing process and it takes also into account the position of the subsitution nodes with respect to the anchors in elementary trees, to discard lexical selections that do not respect some constraints. These constraints are implemented through a polarization of the elementary trees and for sake of efficiency, the lexical selections are represented in a compact way with automata.

A major default of the methods of lexical disambiguation presented in Mathieu Morey's PhD thesis is that they ignore local contexts. To overcome this default, Guy Perrier proposed an algorithm to foresee the elementary structures of the grammar that can be inserted between two words that will interact in the parsing process [20]. This algorithm applies to lexicalized grammars, in which the elementary structures are trees.

6.3. Linguistic Resources

6.3.1. Large Scale Grammatical Resources

Guy Perrier and Bruno Guillaume continued to develop FRIGRAM [2] a French grammar with a large coverage, written in the formalism of Interaction Grammars [16].

A major challenge in this task is to guarantee and to maintain the consistency of the grammar while aiming at the largest coverage. For this, they resorted an original property coming from the polarization of the elementary structures of an interaction grammar : the *companion property*. It is possible to determine all elementary structures (the *companions*) that are able to interact with a given elementary structure, in a static computation on the whole non anchored grammar, using the systeme of polarities. The knowledge of the companions of every elementary structure is very useful to check the linguistic consistency of a grammar.

Guy Perrier wrote a detailed documentation on FRIGRAM illustrated with a lot of examples [26].

6.3.2. Deep Syntax Annotation of the Sequoia French Treebank

Marie Candito, Guy Perrier, Bruno Guillaume, Corentin Ribeyre, Karën Fort, Djamé Seddah and Eric de la Clergerie started a project of annotating the Sequoia French Treebank with deep syntax dependencies.

The Sequoia French Treebank [33] is a 3 200 sentence treebank covering several domains (news, medical, europarl and fr-wikipedia). It is freely available and has already been annotated with surface dependency representations.

The participants in the project have defined a deep syntactic representation scheme for French, which abstracts away from surface syntactic variation and diathesis alternations. The goal is to obtain a freely available corpus, which will be useful for corpus linguistics studies and for training deep analyzers to prepare semantic analysis.

[2] http://wikilligramme.loria.fr/doku.php?id=frigram:frigram

The different steps of the annotation process were conducted in a collaborative way. As the members of the project are located in two different French towns (Paris and Nancy), they decided to produce a complete annotation of the TreeBank in both towns and to collaboratively adjudicate the two results. In Nancy, Line Heckler, Mathilde Huguin and Alice Kneip produced a double annotation of the corpus and Guy Perrier was in charge of the adjudication.

At the beginning of the project, a mini reference was selected randomly, composed of 250 sentences from the Sequoia Corpus. Its annotation was conducted in parallel to the production of the annotation guide, in order to get feedback for the guide. Each team separately produced an initial annotated version of the mini reference. The final version, resulting from several iterations and adjudications, is already available [3].

The full version of the Sequoia French Treebank with deep syntax dependencies and its annotation guide will be released during Spring 2014.

6.3.3. Agile Annotation

In [19], Bruno Guillaume and Karën Fort present a methodology, inspired from the agile development paradigm, that helps preparing an annotation campaign. The idea behind the methodology is to formalize as much as possible the instructions given in the guidelines, in order to automatically check the consistency of the corpus being annotated with the guidelines, as they are being written. To formalize the guidelines, the authors use a graph rewriting tool, that allows to use a rich language to describe the instructions. This formalization allows to spot the rightfully annotated constructions and, by contrast, those that are not consistent with the guidelines. In case of inconsistency, an expert can either correct the annotation or update the guidelines and rerun the process.

6.3.4. Integration of Multiple Constraints in ACG

In [14], Jiri Marsik and Maxime Amblard present a first step toward the integration of multiple constraints in ACG. However, all of the known treatments only consider tiny fragments of languages. We are interested in building a wide-coverage grammar which integrates and reconciles the existing formal treatments of discourse and allows us to study their interactions and to build discourse representations automatically.

This proposal is a first step towards a wide-coverage Abstract Categorial Grammar (ACG) that could be used to automatically build discourse-level representations. We focus on the challenge of integrating the treatment of disparate linguistic constraints in a single ACG and propose a generalization of the formalism: Graphical Abstract Categorial Grammars.

6.4. Graph Rewriting

Guillaume Bonfante and Bruno Guillaume studied formal properties of the Graph Rewriting in [12]. It is well-known that some linguistic phenomena do not cope properly with trees as the core mathematical structure to represent linguistic informations. In a former paper, the authors showed the benefit of encoding linguistic structures by graphs and of using graph rewriting rules to compute on those structures.

The Graph Rewriting formalism they consider is a formalization of the system which is implemented in the Grew software. Justified by some linguistic considerations, this Graph Rewriting formalization is characterized by two features: first, there is no node creation along computations and second, there are non-local edge modifications. Under these hypotheses, the article shows that uniform termination is undecidable and that non-uniform termination is decidable. Two termination techniques based on weights are described and a complexity bound on the derivation length for these rewriting systems is given.

6.5. Discourse in Pathological context

Maxime Amblard, Manuel Rebuschi and Michel Musiol continue to analyze in fine details pathological dialogues from the SLAM project. They present all theses results in [22] [21] and [11]. Schizophrenia is well-known among mental illnesses for the severity of the thought disorders it involves, and for their widespread

[3] http://talc2.loria.fr/mini_sequoia/

and spectacular manifestations: from deviant social behavior to delusion, not to mention affective and sensitive distortions. The goal of our interdisciplinary work is to (i) analyze linguistic troubles in conversational contexts in which one of the speakers is schizophrenic, (ii) construe how the concept of rationality and logicality may apply to them, and (iii) propose a formal representation about this specific manifestation.

7. Partnerships and Cooperations

7.1. Regional Initiatives

7.1.1. SLAM: Schizophrenia and Language, Analysis and Modeling

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

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 SLAMproject started from 2013 January 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.

This year, the first transcriptions of pathological interviews are analyses. The management chain was implemented for anonymization. Moreover, we use Distagger (Matthieu Constant and Anne Dister) to tag disfluences in the interviews wich give interesting results. We also use Jsafran (Christophe Cerisara) and FRMG (Eric de la Clergerie) in order to have dependencies.

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 SLAMproject was supported by the MSH–Lorraine, USR 3261, and won a one year PEPS project HuMaIn (mission pour l'interdisciplinarité du CNRS). The CNRS part of the budget help to organize a workshop which gather linguists, psychologists and computer scientists in december : http://webloria.loria.fr/~amblard/SLAM/index.php?n=Main.In-coh%E9rence13

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], Sai Qian.

POLYMNIE[4] 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 define two languages: an abstract language for the abstract forms, and an object language for the surface forms.

[4] 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 it 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 formulation have been proposed. In particular, a formulation based on continuation semantics allow them to be expressed quite naturally in the ACG architecture. Dynamic effects of discourse, in particular those related to anaphora resultion or rhetoretical 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 [5].

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.

POLYMNIEfocuses 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 relate to the automatic construction of summaries or to text simplification. This has to be considered in the limits of the modelling 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 modelling. It will consist in extending and stabilizing a software implementing the functionnalities 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. Internships

- Ahmed Abbache (Université Hassiba Benbouali, Algeria) did a 5 month internship in the Sémagramme team. He has been working on a formalization of the neokhalilian theory using ACGs.

7.3.2. Visits to International Teams

- Philippe de Groote, Aleksandre Maskharashvili, and Sylvain Pogodalla visited Pr. Makoto Kanazawa at NII, Tokyo, Japan, Oct. 21-25 2013.
- Philippe de Groote gave an invited talk at the Center for Logic and Philosophy of Science of the Tilburg University, on the occasion of Reinhard Muskens' 60th birthday.

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

8. Dissemination

8.1. Scientific Animation

- Maxime Amblard:
  - coordinator of the SLAM project (MSH-Lorraine - PEPS HuMaIn),
  - organizer and chair of the workshop *(In)Cohérence du discours* http://webloria.loria.fr/~amblard/SLAM/index.php?n=Main.In-coh%E9rence13,
  - member (elected) of the “conseil d'UFR" of the UFR mathematics and computer science, Université de Lorraine,
  - membre (elected) of the “conseil de laboratoire" - Loria,
  - member (elected) of the “conseil scientifique" of the Université de Lorraine,
  - member of the CA of the french scientific association for natural language processing : ATALA,
  - member of the “comité de sélection" McF 0542 Loria - Université de Lorraine,
  - member of the scientific committee of conference. *Traitement Automatique des Langues Naturelles (TALN) 2013*.
- 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 (CNRL-NCNL, Belgium).
- Karën Fort:
  - coordinator for the inter-annotator agreement working group, including researchers from LIMSI (Orsay), LNE (Trappes), GREYC (Caen),
  - co-writer of the Ethics and Big Data Charter http://wiki.ethique-big-data.org,
  - expert for the CNRS linguistic federations (TUL and ILF) and DGLFLF (Délégation Générale à la Langue Française et aux Langues de France) concerning the digitalization and archiving process for oral corpora, under the supervision of B. Habert (ENS of Lyon): interviews of the participants, analysis of the process and audit report,
  - member of the CA of the french scientific association for natural language processing : ATALA,
  - member of the scientific committee of the conferences *Traitement Automatique des Langues Naturelles (TALN) 2013*, *Linguistic Annotation Workshop (LAW) 2013*, *International Conference on Software Language Engineering (SLE 2013)*,
  - reviewer for the journal *Language and Linguistics Compass*,
  - Subreviewer for the conference *CICLing 2013*.
- Bruno Guillaume:
  - head of the department “Knowledge & Language management” of the LORIA laboratory (since Sep 2013),
  - member (elected) of the “pôle scientifique” AM2I of Université de Lorraine,
  - member of the COMIPERS Inria Nancy Grand-Est.
- Guy Perrier:
  - member of the editorial board of the journal *Traitement Automatique des Langues*,
  - member of the scientific committee of the conference *Traitement Automatique de Langues Naturelles (TALN) 2013*,

- member of the program committee of the conference PolTAL 2014, which will be held in Warsaw, Poland.
- Sylvain Pogodalla:
  - member of the editorial board of the journal Traitement Automatique des Langues,
  - coordinator of the POLYMNIE ANR Project.
  - local coordinator of the Erasmus Mundus Master program Language and Communication Technologies for the Université de Lorraine,
  - member of the program committee of conference *Journées francophones des langages applicatifs (JFLA) 2014*,
  - member of the scientific committee of conference *Traitement Automatique des Langues Naturelles (TALN) 2013*,
  - member of the Inria Nancy research scientist (CR2) hiring committee,
  - commentator of a paper at the Tsinghua Logic Conference, Beijing, 14-16 October 2013. It has been published in [17].

8.2. Teaching - Supervision - Juries

8.2.1. Teaching

Licence : Maxime Amblard, *Formalismes de représentation et raisonnement* 20h, L3, Université de Lorraine, France

Licence : Maxime Amblard, *Algorithmique Avancée* 50h, L2, Université de Lorraine, France

Licence : Maxime Amblard, *Introduction au Traitement Automatique des Langues* 20h, L2, Université de Lorraine, France

Master : Philippe de Groote, *Logique formelle*, 50h, M2, Université de Lorraine, France.

Master : Philippe de Groote, *Structures Informatiques et Logiques pour la Modélisation Linguistique* , 18h, M2, MPRI, France.

Licence : Karën Fort, *Introduction à l'informatique*, 65h, L3, Université de Lorraine, France

Licence : Karën Fort, *Séminaire informatique et Internet*, 12h, L3, Université de Lorraine, France

Master : Karën Fort, *E-business*, 30h, M1, Université de Lorraine, France

Master : Karën Fort, *Génie logiciel*, 14h, M1, Université de Lorraine, France

Master : Karën Fort, *UML*, 20h, M1, Université de Lorraine, France

Master : Karën Fort, *Pépites algorithmiques*, 10h, M1, Université de Lorraine, France

Master : Bruno Guillaume, *Linguistic Resources and NLP Toolchain*, 30h, M2, Université de Lorraine, France

Licence : Guy Perrier, *Outils conceptuels*, 24h, L3, Université de Lorraine, France

Master: Guy Perrier, *Initiation au TAL*, 30h, M1, Université de Lorraine, France

Master: Guy Perrier, *Programmation pour le TAL*, 30h, M1, Université de Lorraine, France

Master: Guy Perrier, *Formal Languages*, 30h, M2, Université de Lorraine, France

Licence : Sylvain Pogodalla, Informatique, 20h, L1, Université de Lorraine (Mines de Nancy)

Master : Sylvain Pogodalla, *Formalisms of Computational Linguistics*, 25h, M2, Université de Lorraine, France

8.2.2. Supervision

PhD: Florent Pompigne, *Modélisation logique de la langue et Grammaires Catégorielles Abstraites*, Université de Lorraine, Dec. 11 2013

PhD in progress: Aleksandre Maskharashvili, *Generation and Discourse with Abstract Categorial Grammars*, since November 2012, Philippe de Groote and Sylvain Pogodalla.

PhD in progress: Sai Qian, *Structure of variable's accessibility for natural language semantics*, since september 2009, Philippe de Groote and Maxime Amblard

PhD in progress: Jiri Marsik, *Modeling Discourse in a Dynamics framework : formal integration and evaluation*, since september 2013, Philippe de Groote and Maxime Amblard

8.2.3. Juries

- Philippe de Groote and Sylvain Pogodalla were member of the PhD committee of Florent Pompigne, *Modélisation logique de la langue et Grammaires Catégorielles Abstraites*, Dec. 11 2013, Université de Lorraine.
- Guy Perrier was president of the PhD committee of Laura Perez, *Natural Generation for Language Learning*, Université de Lorraine, April 19 2013

8.3. Popularization

- Maxime Amblard is member of editorial board od interstices)i(, a french virtual revue of popularization for computer science : http://interstices.info.
- Maxime Amblard published an article which summarizes the main questions of natural language processing for)i(: https://interstices.info/jcms/ni_74169/real-humans-des-machines-qui-parlent-comme-des-hommes-ou-presque.
- Maxime Amblard was organizer of the exhibition *Proj'SC*, about master student's works for the University library, January 2013.

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