INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

Project-Team Calligramme

Linear Logic, Proof Nets and Categorial Grammars

Nancy - Grand Est

THEME SYM

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1. Team

Research Scientist

Philippe de Groote [DR INRIA, Team Leader, HdR]
François Lamarche [DR INRIA, HdR]
Bruno Guillaume [CR INRIA]
Sylvain Pogodalla [CR INRIA]

Faculty Member

Guy Perrier [Professor, University Nancy 2, HdR]
Maxime Amblard [Lecturer, University Nancy 2]

PhD Student

Joseph Le Roux [defense on October 17th 2007, Assistant teacher at the "IUT Charlemagne" until August 31th 2008]
Robert Hein [INRIA CORDI fellow (since September 18th 2006), defense planned in 2009]
Sarah Maarek [MESR fellow (since October 1st 2006), defense planned in 2009]
Jonathan Marchand [MESR fellow (since October 1st 2006), defense planned in 2009]
Ekaterina Lebedeva [INRIA CORDI fellow (since December 1st 2007), defense planned in 2010]
Mathieu Morey [MESR fellow (since October 1st 2007), defense planned in 2010]
Novak Novakovic [INRIA fellow (since December 1st 2007), defense planned in 2010]
Florent Pompigne [ENS fellow (since October 1st 2008), defense planned in 2011. Formerly Master student in Calligramme (March 2008–August 2008)]

Post-Doctoral Fellow

Daniel de Carvalho [INRIA postdoctoral fellow (since October 1st 2007)]

Visiting Scientist

Alessio Guglielmi [Chaire d'Excellence ANR]
Carl Pollard [Full Professor, Ohio State University, US]

Administrative Assistant

Céline Simon [INRIA]

Other

Karën Fort [INRIA until September 2008]
Paola Bruscoli [Research Assistant INRIA since October 1st 2008]

2. Overall Objectives

2.1. Overall Objectives

Keywords: *categorial grammar*, *lambda calculus*, *linear logic*, *proof nets*, *semantics of natural languages*, *sequent calculus*, *syntactic analysis of natural languages*, *type theory*.

Project-team Calligramme's aim is the development of tools and methods that stem from proof theory, and in particular, linear logic, in the area of computational linguistics. Two fields of application are emphasized: the modelling of the syntax and semantics of natural languages.

3. Scientific Foundations

3.1. Introduction

Project-team Calligramme's research is conducted at the juncture of mathematical logic and computer science. The scientific domains that base our investigations are proof theory and the λ-calculus, more specifically linear logic. This latter theory, the brainchild of Jean-Yves Girard [40], results from a finer analysis of the part played by structural rules in Gentzen's sequent calculus [38]. These rules, traditionally considered as secondary, specify that the sequences of formulas that appear in sequents can be treated as (multi) sets. In the case of intuitionistic logic, there are three of them:

$$\frac{\Gamma \vdash C}{\Gamma, A \vdash C}\ \text{(Weakening)} \qquad \frac{\Gamma, A, A \vdash C}{\Gamma, A \vdash C}\ \text{(Contraction)} \qquad \frac{\Gamma, A, B, \Delta \vdash C}{\Gamma, B, A, \Delta \vdash C}\ \text{(Exchange)}$$

These rules have an important logical weight: the weakening rule embodies the fact that some hypotheses may be dropped during a derivation; in a similar fashion the contraction rule specifies that any hypothesis can be used an unlimited number of times; as for the exchange rule, it stipulates that no order of priority holds between hypotheses. Thus, the presence of the structural rules in the ordinary sequent calculus strongly conditions the properties of the logic that results. For example, in the Gentzen-style formulations of classical or intuitionistic logic, the contraction rule by itself entails the undecidability of the predicate calculus. In the same manner, the use of the weakening and contraction rules in the right half of the sequent in classical logic is responsible for the latter's non-constructive aspects.

According to this analysis, linear logic can be understood as a system that conciliates the constructivist aspect of intuitionistic logic and the symmetry of classical logic. As in intuitionistic logic, the constructive character comes from the banning of the weakening and contraction rules in the right part of the sequent. But simultaneously, in order to preserve symmetry in the system, the same rules are also rejected in the other half.

	Propositional linear logic			
	Rudimentary linear logic			
	Negation	Multiplicatives	Additives	Exponentials
Negation	$A^{\perp}$			
Conjunction		$A \otimes B$	$A \& B$	
Disjunction		$A \parr B$	$A \oplus B$	
Implication		$A \multimap B$		
Constants		$\mathbf{1}, \perp$	$\top, \mathbf{0}$	
Modalities				!A, ?A

The resulting system, called *rudimentary linear logic*, presents many interesting properties. It is endowed with four logical connectors (two conjunctions and two disjunctions) and the four constants that are their corresponding units. It is completely symmetrical, although constructive, and equipped with an involutive negation. As a consequence, rules similar to De Morgan's law hold in it.

In rudimentary linear logic, any hypothesis must be used once and only once during a derivation. This property, that allows linear logic to be considered as a resource calculus, is due, as we have seen, to the rejection of structural rules. But their total absence also implies that rudimentary linear logic is a much weaker system than intuitionistic or classical logic. Therefore, in order to restore its strength, it is necessary to augment the system with operators that recover the logical power of the weakening and contraction rules. This is done via two modalities that give tightly controlled access to the structural rules. Thus, linear logic does not question the usefulness of the structural rules, but instead, emphasizes their logical importance. In fact, it rejects them as epitheoretical rules [36] to incorporate them as logical rules that are embodied in new connectors. This original idea is what gives linear logic all its subtlety and power.

The finer decomposition that linear logic brings to traditional logic has another consequence: the Exchange rule, which so far has been left as is, is now in a quite different position, being the only one of the traditional structural rules that is left. A natural extension of Girard's original program is to investigate its meaning, in other words, to see what happens to the rest of the logic when Exchange is tampered with. Two standard algebraic laws are contained in it: commutativity and associativity. Relaxing these rules entails looking for non-commutative, and non-associative, variants of linear logic; there are now several examples of these. The natural outcome of this proliferation is a questioning of the nature of the structure that binds formulas together in a sequent: what is the natural general replacement of the notion of (multi) set, as applied to logic? Such questions are important for Calligramme and are addressed, for example, in [53].

The activities of project-team Calligramme are organized around three research actions:

- Proof nets, sequent calculus and typed λ-calculi.
- Grammatical formalisms.
- Implicit complexity of computations.

The first one of these is essentially theoretical, the other two, presenting both a theoretical and an applied character, are our privileged fields of application.

3.2. Proof Nets, Sequent Calculus and Typed Lambda Calculi

Keywords: *Curry-Howard isomorphism*, *denotational semantics*, *lambda calculus*, *proof nets*, *sequent calculus*, *type theory*.

The aim of this action is the development of the theoretical tools that we use in our other research actions. We are interested, in particular, in the notion of formal proof itself, as much from a syntactical point of view (sequential derivations, proof nets, λ-terms), as from a semantical point of view.

Proof nets are graphical representations (in the sense of graph theory) of proofs in linear logic. Their role is very similar to lambda terms for more traditional logics; as a matter of fact there are several back-and-forth translations that relate several classes of lambda terms with classes of proof nets. In addition to their strong geometric character, another difference between proof nets and lambda terms is that the proof net structure of a proof of formula T can be considered as a structure which is *added* to T, as a coupling between the atomic formula nodes of the usual syntactic tree graph of T. Since not all couplings correspond to proofs of T, there is a need to distinguish the ones that do actually correspond to proofs; this is called a *correctness criterion*.

The discovery of new correctness criteria remains an important research problem, as much for Girard's original linear logic as for the field of non-commutative logics. Some criteria are better adapted to some applications than others. In particular, in the case of automatic proof search, correctness criteria can be used as invariants during the inductive process of proof construction.

The theory of proof nets also presents a dynamic character: cut elimination. This embodies a notion of normalization (or evaluation) akin to β-reduction in the λ-calculus.

As we said above, until the invention of proof nets, the principal tool for representing proofs in constructive logics was the λ-calculus. This is due to the Curry-Howard isomorphism, which establishes a correspondence between natural deduction systems for intuitionistic logics and typed λ-calculi.

Although the Curry-Howard isomorphism owes its existence to the functional character of intuitionistic logic, it can be extended to fragments of classical logic. It turns out that some constructions that one meets in functional progamming languages, such as control operators, can presently only be explained by the use of deduction rules that are related to proof by contradiction [41].

This extension of the Curry-Howard isomorphism to classical logic and its applications has a perennial place as research field in the project.

3.3. Categorial Grammars

Keywords: *Montague semantics*, *categorial grammar*, *semantics of natural languages*, *syntactic analysis of natural languages*, *syntactic inference*, *tree description*.

Lambek's syntactic calculus, which plays a central part in the theory of categorial grammars, can be seen a posteriori as a fragment of linear logic. As a matter of fact it introduces a mathematical framework that enables extensions of Lambek's original calculus as well as extensions of categorial grammars in general. The aim of this work is the development of a model, in the sense of computational linguistics, which is more flexible and efficient than the presently existing categorial models.

The relevance of linear logic for natural language processing is due to the notion of resource sensitivity. A language (natural or formal) can indeed be interpreted as a system of resources. For example a sentence like *The man that Mary saw Peter slept* is incorrect because it violates an underlying principle of natural languages, according to which verbal valencies must be realized once and only once. Categorial grammars formalize this idea by specifying that a verb such as *saw* is a resource which will give a sentence S in the presence of a nominal subject phrase, NP, and only one direct object NP. This gives rise to the following type assignment:

Mary, Peter:	NP
saw	$(NP \setminus S)/NP$

where the slash ($/$) (resp. the backslash ($\setminus$)) are interpreted as fraction pairings that simplify to the right (resp. to the left). However we notice very soon that this simplification scheme, which is the basis of Bar-Hillel grammars [34], is not sufficient.

Lambek solves this problem by suggesting the interpretation of slashes and backslashes as implicative connectors [42], [43]. Then not only do they obey the *modus ponens* law which turns out to be Bar-Hillel's simplification scheme

$$\frac{\Gamma \vdash A \quad \Delta \vdash A \setminus B}{\Gamma,\Delta \vdash B} \text{ (modus ponens)} \qquad \frac{\Gamma \vdash B/A \quad \Delta \vdash A}{\Gamma,\Delta \vdash B} \text{ (modus ponens)}$$

but also the introduction rules:

$$\frac{A,\Gamma \vdash B}{\Gamma \vdash A \setminus B} \setminus\text{-intro} \qquad \frac{\Gamma,A \vdash B}{\Gamma \vdash B/A} /\text{-intro}$$

The Lambek calculus does have its own limitations. Among other things it cannot treat syntactical phenomena like medial extraction and crossed dependencies. Thus the question arises: how can we extend the Lambek calculus to treat these and related problems? This is where linear logic comes into play, by offering an adequate mathematical framework for attacking this question. In particular proof nets appear as the best adapted approach to syntactical structure in the categorial framework.

Proof nets offer a geometrical interpretation of proof construction. Premises are represented by proof net fragments with inputs and outputs which respectively model needed and offered resources. These fragments must then be combined by pairing inputs and outputs according to their types. This process can also be interpreted in a model-theoretical fashion where fragments are regarded as descriptions for certain classes of models: the intuitionistic multiplicative fragment of linear logic can be interpreted on directed acyclic graphs, while for the implicative fragment, trees suffice [45].

This perspective shift from proof theory to model theory remains founded on the notion of resource sensitivity (e.g., in the form of polarities and their neutralization) but affords us the freedom to interpret these ideas in richer classes of models and leads to the formalism of Interaction Grammars. For example:

- Where previously we only considered simple categories with polarities, we can now consider complex categories with polarized features.
- We can also adopt more expressive tree description languages that allow us to speak about dominance and precedence relations between nodes. In this fashion, we espouse and generalize the monotonic version of Tree Adjoining Grammars (TAG) as proposed by Vijay-Shanker [51].
- Contrary to TAG where tree fragments can only be inserted, Interaction Grammars admit models where the interpretations of description fragments may overlap.

4. Application Domains

4.1. Modelling the Syntax and Semantics of Natural Languages

4.1.1. Abstract Categorial Grammars

Abstract Categorial Grammars (ACGs) are a new categorial formalism based on Girard's linear logic. This formalism, which sticks to the spirit of current type-logical grammars, offers the following features:

- Any ACG generates two languages, an abstract language and an object language. The abstract language may be thought as a set of abstract grammatical structures, and the object language as the sets of concrete forms generated from these abstract structures. Consequently, one has a direct control on the parse structures of the grammar.
- The languages generated by the ACGs are sets of linear λ-terms. This may be seen as a generalization of both string-languages and tree-languages.
- ACGs are based on a small set of mathematical primitives that combine via simple composition rules. Consequently, the ACG framework is rather flexible.

Abstract categorial grammars are not intended as yet another grammatical formalism that would compete with other established formalisms. It should rather be seen as the kernel of a grammatical framework in which other existing grammatical models may be encoded.

4.1.2. Interaction Grammars

Interaction Grammars (IGs) are a grammatical formalism based on the notion of polarity. Polarities express the resource sensitivity of natural languages by modelling the distinction between saturated and unsaturated syntactic structures. Syntactic composition is represented as a chemical reaction guided by the saturation of polarities. It is expressed in a model-theoretic framework where grammars are constraint systems using the notion of tree description and parsing appears as a process of building tree description models satisfying criteria of saturation and minimality.

The formalism of IGs stems from a reformulation of proof nets of Intuitionistic Linear Logic (which have very specific properties) in a model-theoretical framework [48] and it was at first designed for modelling the syntax of natural languages [47].

Even if the model of the syntax can be plugged with various representations of the semantics of natural languages, it can be also adapted to the semantics [49]: tree descriptions are replaced with DAG descriptions and semantic composition is driven by a similar operation of cancellation between polarized semantic features; the synchronization between the syntactic and the semantic levels is realized in a flexible way by a partial function that maps syntactic nodes to semantic nodes.

4.1.3. Grammatical and lexical resources for French

The relevance of new linguistic formalisms needs to be proved by experiments on real corpora. Parsing real corpora requires large scale grammars and lexicons. There is a crucial lack of such resources for French and all researchers committed in natural language processing (NLP) projects for French based on different formalisms are confronted with the same problem. Now, building large scale grammars and lexicons for French demands a lot of time and human resources and it is crucial to overcome the multiplicity of existing formalisms by developing common and reusable tools and data. This is the sense of two directions of research:

1. The modular organization of formal grammars in a hierarchy of classes allows the expression of linguistic generalizations and it makes their development and their maintenance on a large scale possible. To be used in NLP applications such modular grammars have to be compiled into operational grammars. By comparison with the area of programming languages, we write source grammars in a language with a high abstraction level and then we compile them automatically to object grammars, directly usable by NLP applications.

   Considering the multiplicity of linguistic formalisms, it would be interesting to express the various source grammars that can be written in different formalisms, in a common abstract language and to compile them with the same tool associated to this language. XMG is a first experiment in this direction: for the moment, it allows the edition and the compilation of source grammars for TAGs and IGs. Moreover, we can hope that the use of a common language of syntactic description with a high level of abstraction makes easier the reusability of some parts of grammars from one formalism to another.

2. With the same preoccupation of reusability, it is important to develop syntactic and semantic lexicons which contain only purely linguistic information and which are independent of the different existing grammatical formalisms. Now, a mechanism must be foreseen to combine these lexicons with the grammars built in the various formalisms. A convenient way of doing this is to design the entries of such lexicons in the form of feature structures and to associate also feature structures with the elementary constructions of the grammars. Then, their anchoring in the lexicons is realized by unification of the two kinds of feature structures. The construction of a syntactic and a semantic lexicon for French can be envisaged either by acquisition from corpora or by re-use of existing lexical information.

5. Software

5.1. Leopar

Keywords: *Interaction Grammar*, *parsing*.

Participants: Bruno Guillaume [correspondant], Guy Perrier, Guillaume Bonfante [CARTE team], Sylvain Pogodalla, Joseph Le Roux, Jonathan Marchand, Jennifer Planul [student].

5.1.1. Software description

LEOPAR is a parser for natural languages which is based on the formalism of Interaction Grammars [46]. 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 for the following two steps:

- 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.
- In the second 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 at http://leopar.loria.fr. It is also a public project on the InriaGforge platform. It is freely available under the CECILL License (http://www.cecill.info). LEOPAR's first release (version 1.0) was published in 2008.

The main features of the first release are:

- automatic parsing of a sentence or a set of sentences,
- interactive parsing (the user chooses the couple of nodes to merge),
- visualization of grammars produced by XMG or of sets of description trees associated to some word in the linguistic resources,
- a graphical interface (using GTK) which is useful for debugging grammars.

The main changes this year:

- development of an English grammar: the English grammar was derived from the French one and was evaluated on the TSNLP (Test Suite for Natural Language Processing): 85% of the sentences are parsed.
- development of large scale French resources,
- A web-based interface for online parsing.

LEOPAR was presented at the demo session of Coling 2008 [15]

5.2. XMG

Keywords: *metagrammar*.

Participants: Guy Perrier [correspondant], Joseph Le Roux, Yannick Parmentier [TALARIS team].

The eXtensible MetaGrammar (XMG) is a tool for generating large coverage grammars from concise descriptions of linguistic phenomenena (the so-called metagrammar). This software is a Calligramme and TALARIS joint work and was formerly known as The Metagrammar Workbench.

This software is based on two important concepts from logic programming, namely the Warren's Abstract Machine and constraints on finite sets. It has been developed by Benoît Crabbé, Yannick Parmentier, Denys Duchier and Joseph Le Roux. It is available at http://sourcesup.cru.fr/xmg. It is now maintained by Ph.D students Yannick Parmentier and Joseph Le Roux.

At current stage of implementation, XMG generates Tree Adjoining Grammars, Multi-Component Tree Adjoining Grammars and Interaction Grammars but the underlying formalism is generic so it could be extended to others grammars like dependency grammars or lexical functional grammars, depending on users' requests.

XMG is used in the research field (by Guy Perrier, Claire Gardent, Laura Kallmayer and Owen Rambow) to design lexicalized grammars for NLP parsers and in computational linguistics teaching.

5.3. ACG support system

Keywords: *Abstract Categorial Grammars*.

Participants: Sylvain Pogodalla [correspondant], Philippe de Groote, Sarah Maarek.

The new and rewritten version of the ACG development toolkit prototype has been released in October 2008. It focuses on providing facilities to develop grammars. Next features to be added are parsing algorithms (in case of second order and in the general case) and theoretical extensions of the type system. Users are mainly members of the INRIA associate team "Lambda & Grammars" (see section 6.2.1) and the NWO network "A Global Network for Lambda Grammars and Abstract Categorial Grammars" (see section 7.2.2). It is available at http://acg.gforge.inria.fr with a CeCILL license.

6. New Results

6.1. Proof Nets, Sequent Calculus and Typed Lambda Calculi

Keywords: *linear logic*, *proof nets*, *sequent calculus*.

Participants: Daniel de Carvallo, François Lamarche, Alessio Guglielmi.

6.1.1. Semantics measures of execution time for Proof Nets

The paper [5] is another version of [23] and will appear in Girard's Festschrift, special issue of Theoretical Computer Science. In this work Daniel de Carvalho, Michele Pagani and Lorenzo Tortora di Falco give a semantic account of the execution time (i.e. the number of cut elimination steps leading to the normal form) of an untyped Multiplicative-Exponential Linear Logic (MELL) proof net. In particular, the authors prove that we can compute the number of cut elimination steps leading to a cut free normal form of the net obtained by connecting two cut free nets by means of a cut-link, from the interpretations of the two cut free nets in the multiset based relational semantics. The results of this paper are inspired by [21], a similar work for the untyped lambda-calculus.

6.1.2. Weak monads

Daniel de Carvalho's [19] gives a generalized notion of monad on a category that corresponds much better to the real-world semantics the author constructed in his thesis.

6.1.3. Proof nets for intuitionistic linear logic

In [26], François Lamarche constructs a class of proof nets that are specifically geared for Intuitionistic Linear logic (without the "plus" connector), with a novel correctness criterion. This fragment has special deterministic properties, which allows the definition of a class of paths that, unlike the paths used by say Danos-Regnier, are oriented, always starting at the conclusion formula. In particular this permits the encoding of !-boxes by totally local means, meaning that only special unary "box edge" links are needed, without additional information. The proof of normalization is remarkably simple, once the behavior of paths in correct nets has been established.

6.1.4. Homotopy by paths in the category of categories

In [25], François Lamarche presents a new foundation for homotopy theory in the category of small categories by the means of a path endofunctor, and gives a new proof the well-known theorem (first proved by Quillen in 1973) that the fundamental groupoid of a small category is its universal associated groupoid. This gives an approach which is much more concrete, elementary and closer to traditional topological practice. The logical interest is that such a path endofunctor can act as a Martin-Löf identity type in the right semantics for dependent types, work which is being pursued by Robert Hein in his thesis research. This research is also being extended to directed homotopy for concurrency, as first proposed by Eric Goubault.

6.2. Categorial Grammars

Keywords: *Abstract Categorial Grammars*, *Earley algorithm*, *Interaction Grammars*, *discourse dynamics*, *scope ambiguity*.

Participants: Philippe de Groote, Guy Perrier, Sylvain Pogodalla, Bruno Guillaume, Maxime Amblard, Joseph Le Roux, Jonathan Marchand.

6.2.1. Abstract Categorial Grammars

2008 was the second year of the associate team Lambda & Grammars between Calligramme and Makoto Kanazawa (NII, Japan). The new results about ACG are twofold: about the study and the characterisation of ACG as a formal language and parsing algorithms and about the development of case studies in the modelling of linguistic phenomena.

6.2.1.1. Theoretical properties of the formalism

In the last two years, it was shown how to encode various grammatical formalisms into ACG. Together with a method to compile second order ACG into Datalog program and with optimisation techniques in Datalog (magic set rewritting), Makoto Kanazawa gives new parsing algorithms for Tree Adjoining Grammars and for multipe context-free grammarsin [7].

Philippe de Groote generalized to higher-order a dynamic logic he proposed in order to give a type-theoretical interpretation of discourse representation (invited talk at the 5th LCFG workshop).

Philippe de Groote, Sylvain Pogodalla and Carl Pollard studied the relation between ACG and Convergent Grammars (CVG, a grammatical formalism proposed by Carl Pollard). It has resulted in a modeling of the CVG architecture into ACG.

6.2.1.2. Modelling of linguistic phenomena

Using the extented type system of ACG, Florent Pompigne proposed in his Master's thesis a modeling of overt movements in French, focusing on the constraints against extraction.

Sylvain Pogodalla proposed an extension of the type-theoretical approach to discourse representation in order to take into account the behavior of discourse referents introduced by proper nouns, as opposed as the ones introduced by indefinites. He also gave in this framework an account of the accessibility constraints induced by the rhetorical structure of the discourse [16]

6.2.2. Interaction Grammars

Guy Perrier has enriched the method of lexical disambiguation based on polarity automata. The initial method [35] can be summarized as parsing with a simplified grammar. The simplification consists in considering syntactic structures as bags of polarities and forgetting their structuration. Then parsing reduces to counting polarities to find a neutral global balance. An efficient way of implementing the method is using automata. The main drawback of the abstraction is that it does not take word order into account. Guy Perrier proposes a less brutal abstraction [27] that keeps the position of every polarity in syntactic structures with respect to the words that anchor them. This introduces new constraints and it remains to show that it improves filtering without decreasing efficiency significantly. Charif Alchiekh Haydar has implemented this proposal in his master's thesis [29] by means of new filtering automata.

Bruno Guillaume and Guy Perrier have written an updated presentation of interaction grammars in [24]. They give a full presentation of the formalism with some features that were not in the previous versions. The paper gives detailled linguistic motivations for the IG formalism and compares it with many other known formalisms.

As a preliminary study to fully understand the meaning of IG derivations and their connection with semantics, Joseph Le Roux has investigated Tree Adjoining Grammar (TAG) derivations. This is joint work with Sylvain Schmitz (TALARIS Team). TAG derivations can be expressed as Regular Tree Grammars (RTGs), but RTGs don't take feature unifications into account. The authors have proposed an extension of this formalism (Feature-Based Regular Tree Grammars) that solve this problem [12], [11].

6.2.3. Semantic analysis

Following an idea of Guy Perrier [28], Maxime Amblard, Mathieu Morey and Guy Perrier propose a general two-step algorithm which transforms a graph expressing the semantic dependencies between the words of an utterance into logic formulae representing the different semantic interpretations of the utterance [33]. The algorithm focuses on the scopal elements of the utterance, i.e. quantifiers and scopal predicates. First, the scope of every scopal element is computed as a subgraph of the whole graph, given an order on these elements. Second, these scopes with their order are used to build a logic formula incrementally from the most internal to the most external scopal elements.

6.3. Development of linguistic resources

Keywords: *French formal grammar*, *Gross' grammar lexicon*, *lexicon*, *subcategorisation*.

Participants: Guy Perrier, Bruno Guillaume, Karën Fort, Mathieu Morey, Jennifer Planul.

6.3.1. Development of an English grammar

During her master's thesis work, Jennifer Planul has developed an English interaction grammar [32]. Starting from the French interaction grammar built by Guy Perrier [50], she extracted a kernel that is language independent. Then, she added specific features of the English grammar to this kernel to obtain a grammar that was tested on the English TSNLP test suite [44].

6.3.2. Development of tools for human validation of syntactic lexicons

Lexicon production is essential but complex and all creation methods (automatic acquisition or manual creation) require human validation. For this purpose, Karën Fort and Bruno Guillaume propose a freely available Web-based framework, named Sylva. The main point of the framework is that it handles multi-level validations and keeps track of the resource history. The expert linguist's task is made easier : (s)he has only to consider data on which annotators disagree. The Sylva tool was presented at the TALN conference [13].

This tool has been used during the year by four students in order to validate a French syntactic lexicon (SynLex [37]). About 80% of the resources have been validated. For 75% of the lexicon entries, the two annotators give the same judgment, then the expert linguist has only 25% of the entries left to consider.

7. Other Grants and Activities

7.1. National Actions

7.1.1. Agence Nationale de la Recherche (ANR) Inval

Headed by Eric Goubault at the CEA, this three-year "programme blanc" action (which will end on Dec 1) aims at the study and development of algebraic invariants of computation, inspired by traditional homology and homotopy in algebraic topology. One general meeting was held in 2008, in Lyons on September 25th to 26th. The co-ordinator for the Loria site is François Lamarche and Yves Guiraud (Paréo) is also one of the original members.

Webpage: http://www.pps.jussieu.fr/~inval/

7.1.2. Agence Nationale de la Recherche (ANR) Infer

This three-year "programme blanc" project on the theoretical and applicative development of deep inference began in December 2006. Two Inria-Lorraine teams, Calligramme and Paréo, are involved in it, along with teams at INRIA-Futurs and the PPS lab (Université Paris VII). The head of the project is Lutz Straßburger (Parsifal, INRIA-Futurs), and the local co-ordinator is François Lamarche. One meeting was held at the Loria on June 18th.

Webpage: http://www.lix.polytechnique.fr/~lutz/orgs/infer.html

7.1.3. Agence Nationale de la Recherche (ANR) Prelude

Calligramme is involved in the ANR-Blanc action PRELUDE http://prevert.upmf-grenoble.fr/~alecomte/PRELUDE.htm. This action is starting and aims at giving a theory of pragmatics based on ludics [39] and continuations [52]. The partner teams are: Structures Formelles de la Langue[1](co-ordinator), Institut Mathématique de Luminy[2], the Signes INRIA project[3] and Calligramme.

7.1.4. Chaire d'Excellence ANR Démosthène

The Chaire d'Excellence is a new ANR program that offers two-year fellowships that are specifically targeted at high-level scientists from outside of France. Alessio Guglielmi, then at the University of Bath (UK) won one of these fellowships, and he is now at the Loria collaborating with François Lamarche, who is the local co-ordinator of the Chaire. The research program centers on the new geometric invariants obtainable from deep inference, their algebric formulation and the new complexity measures that they give rise to. Out of about a hundred applicants, only 15 fellowships were attributed for the whole of France. Paola Bruscoli also benefits from that fellowship as research assistant.

7.2. International Actions

7.2.1. Associate Team

In 2007 started an associate team program with Calligramme and Makoto Kanazawa (NII, Japan). Members of this associate team also include Sylvain Salvati (research scientist, SIGNES INRIA team) and Pierre Bourreau (PhD student, SIGNES INRIA team). This program is supported by the Associate Team Program of INRIA (http://www-direction.inria.fr/international/EQUIPES_ASSOCIEES/index.eng.html). The second annual report is published at: http://www.loria.fr/equipes/calligramme/acg/equipe-associee/2009.html.

7.2.2. NWO

The Calligramme project belongs to the network entitled "A Global Network for Lambda Grammars and Abstract Categorial Grammars"[4]. The other partners of this network are: the NII, Japan, the Technion, Israel, and Tilburg University, Netherlands (co-ordinator of this network). It started in 2007 for a three years period. It is supported at 80% by the Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO, national agency for science of the Netherlands).

7.2.3. Van Gogh Action

The Calligramme team is part of a Van Gogh action (from the programme Hubert Curien) with the Utrecht Institute of Linguistics OTS (Utrecht University) about "Dynamique du discours et continuations".

7.3. Visits and invitation of researchers

- Carl Pollard, Professor at Ohio State University, US visited Calligramme from March 2008 to September 2008. His visit was supported by the "Chaires Internationales" program of the Région Lorraine and the "Professeurs invités" program of INRIA.
- Alessio Guglielmi from the University of Bath was offered a two-year ANR "Chaire d'Excellence" invited Professorship to be spent in Calligramme as François Lamarche's guest. Only 15 Chaires d'Excellence were given in the whole of France out of a hundred applicants from all over the world.
- Sylvain Salvati visited Calligramme from December 1st to 7th.
- Mati Pentus, Professor at the Moscow State University, visited Calligramme from September 15th to September 26th.

[1] UMR 7023, Paris 8, http://recherche.univ-paris8.fr/red_fich_equ.php?OrgaNum=48
[2] CNRS, http://iml.univ-mrs.fr/
[3] http://signes.labri.fr/
[4] http://www.nwo.nl/projecten.nsf/pages/2300136194?opendocument

- Makoto Kanazawa, NII, visited Calligramme from December 1st to December 5th.
- Philippe de Groote and Sylvain Salvati (member of the SIGNES INRIA team and of the associate team) visited Makoto Kanazawa (NII, Japan) from March 24th to 25th and gave an invited talk at the 5th LCFG workshop (http://research.nii.ac.jp/~kanazawa/lcfg5.html).
- Philippe de Groote, Pierre Bourreau (member of the SIGNES INRIA team and of the associate team) and Sylvain Pogodalla visited Makoto Kanazawa (NII, Japan) from July 6th to 19th.
- Philippe de Groote and Sylvain Salvati visited Yoad Winter (Haifa University, Israel) from October 12th to 19th and gave an invited talk at the 6th LCFG workshop (http://www.cs.technion.ac.il/~bagilad/lcfg6/).
- Philippe de Groote visited Professor Hadj Salah, at the *Académie Algérienne de la Langue Arabe*, Algiers, from November 22nd to November 26th.
- Philippe de Groote visited Professor Moortgat, Utrecht, for December 15th to December 19th.
- Daniel de Carvalho regularly visits the team PPS (Paris) (at least six times this year) for collaborations with Michele Pagani, Christine Tasson (on a new work about quantitative properties of differential nets) and Giulio Manzonetto (on a new work about the semantics of the lambda-calculus).
- Lutz Straßburger (Parsifal, Inria-Futurs) and François Lamarche met through many of the workshops mentioned elsewhere, and also conducted several personal visits.
- Tom Gundersen, University of Bath, visited Calligramme from November 6st to 10th and December 8st to 12th.
- Mathieu Morey and Guillaume Bonfante (CARTE team) visited João Tiago Mexia in Caparica, Portugal on October 18th to 26th.

8. Dissemination

8.1. Activism within the scientific community

- Philippe de Groote is member of the editorial board of the journal *Higher-Order and Symbolic Computation*. He is member of the ESSLLI standing committee, and the Formal Grammar conference series standing committee.
- Philippe de Groote was member of the program committees of GoTAl and FG'09.
- Sylvain Pogodalla was part of the scientific committee of TALN 08 (Avignon, France).
- Guy Perrier was member of the program committee of the international conference GoTAl, which was held in Göteborg (Sweden) August 25th to 27th.
- Guy Perrier is member of the board of the spring school "logique et sémantique du langage naturel", which is held annually in the framework of the GDR "sémantique et modélisation" and the RTP "langage naturel, logique et philosophie du langage".
- Guy Perrier is member of the board of the "Département de Formation doctorale" of the "Ecole Doctorale IAE+M" of the universities from Lorraine.
- François Lamarche was co-organizer with Dominique Duval (Université Joseph Fourier, Grenoble), of a special one-day session on categories and computation at the joint meeting of the Groupes de rencontres (GDR) Informatique Mathématique (IM) Geocal (Géométrie du Calcul) and LAC (Logique, Algèbre et Calcul). The meeting was held at Paris XIII (Villetaneuse) on March 6th to 7th.
- François Lamarche organized the workshop "Deep Inference, its Algebra, Geometry and Syntax", sponsored by the ANR Infer project, which was held at the Loria, on June 18th. In addition to people from the Loria, there were participants from Bath, Paris, Bern and Vienna.

  Webpage: http://www.loria.fr/~lamarche/deepinf.html

- Paola Bruscoli was member of the scientific committee of CLAC 2008 (Workshop on Classical Logic and Computation), affiliated to ICALP 2008, Reykjavik and LPAR 2008 (Doha).
- Maxime Amblard is vice-treasurer of the Association pour le Traitement Automatique des Langues (ATALA).
- Maxime Amblard is member of the organization committee of the 50 years of ATALA.

8.2. Teaching

- Philippe de Groote is teaching, with Gérard Huet, the course "Structures Informatiques et Logiques pour la Modélisation Linguistique" of the *Master Parisien de Recherche en Informatique*.
- Philippe de Groote is teaching the course "Computational Sementics" of the Nancy computer science master, specialization "Traitement Automatique des Langues".
- Sylvain Pogodalla is teaching the course “Corpus linguistics and linguistics resources” of the Nancy computer science master, specialization “Traitement Automatique des Langues”.
- Guy Perrier is the head of the common specialization "Traitement Automatique des Langues" of the computer science and cognitive science masters from Nancy.
- Guy Perrier is teaching the courses "tools and algorithms for NLP", "initiation to NLP" and "programming for NLP" in the common specialization "Traitement Automatique des Langues" of the computer science and cognitive science masters from Nancy.
- Bruno Guillaume is teaching the course ”Grammatical formalisms” of the Nancy computer science master, specialization ”Traitement Automatique des Langues”.

8.3. Academic Supervision

- Philippe de Groote is supervising the thesis works of Sarah Maarek and Ekaterina Lebedeva.
- Philippe de Groote and Sylvain Pogodalla supervised the Master’s thesis work of Florent Pompigne.
- Alessio Guglielmi is supervising the thesis of Tom Gundersen (student at the University of Bath).
- François Lamarche is supervising the thesis work of Robert Hein (since October 2006) and Novak Novakovic (since December 2007).
- François Lamarche is supervising the postdoctoral research of Daniel de Carvalho, due to end at the end of December.
- Guy Perrier and Bruno Guillaume are co-supervising the thesis work of Jonathan Marchand.
- Guy Perrier is supervising the thesis work of Mathieu Morey.
- Guy Perrier has supervised the master thesis of Jennifer Planul and Charif Alchiekh Haydar.

8.4. Participation to colloquia, seminars, invitations

- Alessio Guglielmi spent three days as invited researcher at the LIX laboratory (École Polytechnique), working with members of the INRIA Parsifal team and he gave a talk.
- Alessio Guglielmi participated in the workshop ‘Structural Proof Theory’ in Paris, from November 19th to 21nd, with an invited talk.
- Alessio Guglielmi has been invited to give a talk at the University of Oxford, December 2008.
- Daniel de Carvalho gave a talk at the Workshop on Implicit Computational Complexity (ANR NO-CoST) in Villetaneuse, February 11th to 13th 2008.
- Daniel de Carvalho attended the “Ecole Jeunes Chercheurs en Informatique Mathématique”, Marseilles, March 31th to April 4th 2008.

- Daniel de Carvalho gave a talk at the "Rencontre Logique Linéaire Différentielle" organized by the "Gruppo di Logica e Geometria della Cognizione of Roma III", Rome, April 28th to 30th 2008.
- Daniel de Carvalho, Robert Hein, François Lamarche and Novak Novakovic attended the International Conference in Category Theory (ICTC08), held in Calais on June 21th to 28th 2008.
- François Lamarche attended the conference Algebraic Topological Methods in Computer Science (ATMCS) held in Paris on July 7th to 11th 2008, and chaired a session.
- François Lamarche attended the “B and B Days” held in honor of Francis Borceux and Dominique Bourn in Brussels, on October 10th to 11th 2008, and chaired a session.
- François Lamarche was invited speaker at the workshop “Structural Proof Theory” held in Paris on November 19th to 21nd 2008.
- Kären Fort, Bruno Guillaume, and Joseph Le Roux attended TALN 08 in Avignon, France, June 9th to 13th 2008.
- Sylvain Pogodalla and Mathieu Morey attended the "Journées Sémantiques et Modélisation", April 3th to 4th 2008, Toulouse, France and the "Atelier Jeunes Chercheurs", March 31st to April 2nd 2008. Sylvain Pogodalla gave a talk [16].
- Makoto Kanazawa and Joseph Le Roux attended the 9th international workshop on Tree Adjoining Grammars and Related Formalisms (TAG+), June 7th to 8th 2008, Tübingen, Germany. Makoto Kanazawa gave a talk [7].
- Makoto Kanazawa attended the 15th Workshop on Logic, Language, Information and Computation (WoLLIC 2008), July 1st to 4th 2008, Edinburgh, Scotland, and gave an invited tutorial [30] and an invited talk [31].
- Carl Pollard attended the 15th Workshop on Logic, Language, Information and Computation (WoLLIC 2008), July 1st to 4th 2008, Edinburgh, Scotland, and gave a talk [10].
- Carl Pollard attended the European Summer School in Language, Logic and Information (ESSLLI 2008) and gave a talk [17] at the Workshop on What Syntax feeds Semantics and a talk [18] at the Workshop on Continuations and Symmetric Calculi.
- Philippe de Groote attended the European Summer School in Language, Logic and Information (ESSLLI 2008) and gave an invited talk at the Workshop on Continuations and Symmetric Calculi.
- Ekaterina Lebedeva, Mathieu Morey, Jonathan Marchand, Joseph Le Roux, Bruno Guillaume attended the NaTAL workshop on June 24th to 26th, 2008. Mathieu Morey, Jonathan Marchand, Joseph Le Roux, Bruno Guillaume gave a talk at the NaTAL workshop on June 26th.
- Ekaterina Lebedeva, Mathieu Morey, Jonathan Marchand, Novak Novakovic and Robert Hein attended the ESSLLI summer school in Hamburg, Germany on August 4th to 15th 2008.
- Ekaterina Lebedeva and Robert Hein attended the Conference on Advances in Modal Logic (AiML 2008) in Nancy, France on September 9th to 12th 2008.
- Ekaterina Lebedeva attended the workshop on Deep Inference, its Algebra, Geometry and Syntax in Nancy, France on June 18th 2008.
- Ekaterina Lebedeva attended the Workshop on Classical Logic and Computation (CL&C 2008) in Reykjavik, Iceland on July 13th 2008.
- Ekaterina Lebedeva attended Workshop on Mathematically Structured Functional Programming (MSFP 2008) in Reykjavik, Iceland on July 6th 2008.
- Ekaterina Lebedeva attended the Conference on Logical Models of Reasoning and Computation (LMRC 2008) at Steklov Mathematical Institute in Moscow, Russia on May 5th to 8th 2008.
- Novak Novakovic gave an invited talk on 22nd February 2008 at the EMCL Student Workshop, Universidade Nova de Lisboa, on Proof-theoretic Approach to Subsumption w.r.t. Hybrid EL TBoxes and Computing Least Common Subsumer, when awarded the Best EMCL Thesis 2007 award.

- Novak Novakovic gave an invited talk on July 1st 2008, at Technische Universität Dresden, on Proof-theory in Description Logics, as a representative for the Theoretical Computer Science institute for the Day of the Faculty of Informatics.
- Novak Novakovic and Robert Hein attended the Midlands Graduate School (MGS) in the Foundations of Computing Science, Birmingham, UK, April 14th to 18th 2008.
- Novak Novakovic attended the International Category Theory Conference 2008, Calais, France, June 22th to 28th 2008.
- Novak Novakovic and Robert Hein attended the workshop on Deep Inference, its Algebra, Geometry and Syntax in Nancy, France on June 18th 2008.
- Joseph Le Roux, Jonathan Marchand and Karën Fort attended COLING 2008 in Manchester, UK (August 18th to 22th 2008).

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