



Proceedings of the student session
of the LACL conference 2005

Actes de la session étudiante
de la conférence LACL 2005

Renaud Marlet, Maxime Amblard (Eds.)

Rapport LaBRI n°1356-05

Avril 2005

Proceedings of the student session of the LACL conference 2005

Actes de la session étudiante de la conférence LACL 2005

Renaud Marlet, Maxime Amblard (Eds.)

LaBRI report N°1356-05

April 2005

Abstract. This report contains the proceedings of the student session of the LACL'2005 conference (Logical Aspects of Computational Linguistics), that was held April 28-30 2005, in Bordeaux, France.

LACL'2005 is the 5th edition of a series of international conferences on logical and formal methods in computational linguistics. It addresses in particular the use of proof theoretic and model theoretic methods for describing natural language syntax and semantics, as well as the implementation of natural language processing software relying on such models.

Key-words: defeasible reasoning, DRT, LTAG, question-answering systems, categorial grammars, dynamic semantics, minimalist grammars, Rooth model

Résumé. Ce rapport contient les actes de la session étudiante de la conférence LACL'2005 (Logical Aspects of Computational Linguistics) qui s'est tenue du 28 au 30 avril 2005 à Bordeaux.

LACL'2005 est la 5ème édition d'une série de colloques internationaux portant sur les aspects logiques et formels de la linguistique informatique. On y traite plus particulièrement de la description de la syntaxe et de la sémantique des langues dans le cadre de théories logiques, ainsi que de réalisations informatiques basées sur de tels modèles.

Mots-clés: raisonnement non monotone, DRT, LTAG, systèmes question-réponse, grammaires catégorielles, sémantique dynamique, grammaires minimalistes, modèle de Rooth

Preface

LACL'2005 is the 5th edition of a series of international conferences on logical and formal methods in computational linguistics. It addresses in particular the use of proof theoretic and model theoretic methods for describing natural language syntax and semantics, as well as the implementation of natural language processing software relying on such models. LACL'2005 held April 28-30 2005, in Bordeaux, France.

For the first time, LACL'2005 featured a student session. Students (not having defended yet their PhD thesis or defending it in 2005) were invited to submit short papers on the same topics as LACL. Submitted papers could present only partial but promising work.

Submitted articles were reviewed by a program committee made of a group of experienced researcher as well as a group of chosen PhD students. Each article was reviewed by at least one experienced researcher and two of these PhD students.

We wish to thank all the reviewers for their reactivity given the very short reviewing time and for their effort in providing constructive remarks to the authors. In the end, 60% of the submissions were accepted.

April 2005
Renaud Marlet and Maxime Amblard

Organization

Chairs: Philippe Blache, Edward Stabler, Renaud Marlet

Program Committee – Senior referees

Christian Bassac (Université de Bordeaux 3 / ERSS-CNRS / INRIA, Bordeaux)
 Joan Busquets (Université de Bordeaux 3 / ERSS-CNRS / INRIA, Bordeaux)
 Kim Gerdes (Université de Bordeaux 3 / ERSS-CNRS / INRIA, Bordeaux)
 Marcus Kracht (University of California, Los Angeles)
 Alain Lecomte (Université Pierre Mendès-France, Grenoble)
 Renaud Marlet (LaBRI-INRIA, Bordeaux)
 Richard Moot (LaBRI-CNRS / INRIA, Bordeaux)
 Christian Retoré (Université de Bordeaux 1 / LaBRI-CNRS / INRIA, Bordeaux)

Program Committee – Student Referees

Maxime Amblard (Université de Bordeaux 1 / LaBRI-CNRS / INRIA, Bordeaux)
 Leonoor van der Beek (University of Groningen)
 Paul Egré (Université Paris 4 / IHPST / Institut Jean Nicod, Paris)
 Séverine Fratani (LaBRI, Bordeaux)
 Marie-Laure Guénot (LPL, Aix en Provence)
 Eric Kow (LORIA, Nancy)
 Erwan Moreau (LINA, Nantes)
 Véronique Moriceau (IRIT, Toulouse)
 Jean-Philippe Prost (Macquarie University, Sydney)
 Benoît Sagot (INRIA / Université Paris 7 Talana-Lattice, Paris)

Organizing Committee

Maxime Amblard (Université de Bordeaux 1 / LaBRI-CNRS / INRIA, Bordeaux)
 Joan Busquets (Université de Bordeaux 3 / ERSS-CNRS / INRIA, Bordeaux)
 Renaud Marlet (LaBRI-INRIA, Bordeaux)
 Richard Moot (LaBRI-CNRS / INRIA, Bordeaux)

Sponsoring Institutions (for the LACL conference)

CNRS	INRIA
Université de Bordeaux 1	Université de Bordeaux 3
Pôle universitaire de Bordeaux	Conseil Régional d'Acquitaine
France Télécom	ERSS
CoLogNet	

Contents

Speaker/ Hearer Representation in DRT: Presupposition and Belief <i>Yafa Al-Raheb</i>	7
Counting dependencies and Minimalist Grammars <i>Maxime Amblard</i>	11
Argument sharing in LTAG ? Scope ambiguities in Right Node Raising <i>Eva Banik</i>	15
Clitic Left Dislocation in the Non-Associative Lambek Calculus with Dual Operators <i>Matteo Capelletti</i>	19
Dynamic Semantics and ?Why Don?t You? Speech Acts <i>Scott Grimm</i>	23
Answer Selection in a Cooperative Question-Answering System <i>Véronique Moriceau</i>	27
Why did the accident happen? A norm-based reasoning approach <i>Farid Nouioua</i>	31
Adaptation du modèle de Rooth pour le calcul de la restriction en français <i>Céline Raynal</i>	35
A flexible deductive account of wh-question formation <i>Willemijn Vermaat</i>	39

Speaker/ Hearer Representation in DRT: Presupposition and Belief

Yafa Al-Raheb (University of East Anglia)

1 Introduction

The paper presents a discussion of what constitutes compatible speaker/hearer representation. The aim is to use the representation of belief, presupposition and assertion in DRT more pragmatically, by reconciling two DRS variants.

2 Definitions

Within the context of DRT, the concept of presupposition can be made more pragmatic if it is understood to be a property of the speaker. Presuppositions are generally that part of the utterance that is taken to be 'given' (Lambrecht 1994). 'Given' means known information, information that the speaker regards as known to both speaker and hearer as being part of the context of their dialogue or part of general background knowledge. An alternate is when the speaker introduces the new information to the hearer as given, indicating that the assumed 'given' information is not the focus of the speaker's attention.

When uttering a presupposition, a speaker has some assumptions about the hearer's beliefs about the presupposition. Furthermore, the speaker communicates something about her state of mind when uttering a presupposition. However, the strength of beliefs held by speakers differs from one situation to another, and depends on whether the speaker is introducing the topic of the dialogue. Acceptance is a weaker form of belief and represents the grey area where information is put on hold, not yet believed, but not rejected. Beliefs place constraints on both presupposition and assertion. To introduce a presupposition, the speaker must possess the presupposition in her beliefs or acceptance space. This is termed 'Beliefs Constraint on Presupposition I', BCP1 (cf. Al-Raheb 2004).

Generally, an assertion contains the new information that the speaker wishes to convey in her message, which builds upon the presupposed information in the utterance. 'Beliefs Constraint on Assertion I' (BCA1) means that to utter an assertion, the speaker needs to believe that the hearer does not hold the assertion as a belief. Another constraint beliefs place on assertion is called 'Beliefs Constraint on Assertion II' (BCA2), which means that for a speaker to utter an assertion, the speaker must believe or accept that assertion. When faced with an assertion, the hearer can first accept the new information and later turn that assertion into a belief, by adding it to his belief set.

3 Reconciling Two DRS Variants

Kamp et al. (2005) discuss two variants of DRSs for beliefs and presupposition in DRT. The first, the 'Linguistic Content' DRS, includes presuppositional and non-presuppositional aspects, to represent the linguistic content of an utterance. The linguistic content DRS is the window the hearer has into the speaker's state of mind. It is what influences the hearer recognition, which is represented by a Belief-DRS of the hearer's cognitive state.

The second DRS variant, Beliefs DRS, deals with beliefs, desires and intentions (cf. Kamp et al. 2005). The Beliefs DRS represents an agent's cognitive state when generating an utterance without mention of the presuppositional and non-presuppositional aspects of the utterance. The link between the two DRT variants is not greatly reflected upon in Kamp et al. (2005). However, this link helps explain the connection between speaker generation, speaker's utterance, and hearer recognition. The focus here is on the relationship between speaker generation and the linguistic content, and between the linguistic content and hearer recognition. By analysis of the linguistic content provided by the speaker, the hearer can propose a hypothesis about the speaker's state of mind.

The DRT representation discussed here is derived from Kamp et al.'s (2005) representation with some modifications. First of all, Kamp et al focus on three embedded DRSs within the speaker's cognitive state, namely belief, desire, and intention. The representation discussed in this section uses Kamp et al.'s belief and intention spaces. However, the belief space also includes the speaker's beliefs about the hearer's beliefs. Each DRS representing an agent's, hearer/speaker, cognitive state includes the two personal reference markers 'i' and 'you'. When 'i' is used in a DRS, it refers to the agent's self within that DRS. To refer to the other agent, 'you' is used.

In addition, Kamp et al.'s representation of an agent's intention space can be enriched with more linguistic content to strengthen the link between an agent's intentions and her utterance. Therefore, Kamp et

al.'s intention space has been expanded to include linguistic content. Having both the presupposition and the assertion in the intention space directly reflects the utterance being produced. The speaker's intention is recognized by the hearer through the speaker's linguistic utterance. The hearer's intention space includes the recognized speaker intentions in making the current utterance. The intention space is a separate DRS from the belief space which includes the motivation for making an assertion. This allows the modeling of information that the hearer has recognized but has not yet decided to accept or believe. The belief and acceptance spaces may include previous beliefs or accepted information and not just the current utterance.

Another space or DRS is introduced to represent weaker belief, or 'acceptance' space. This includes the speaker's acceptance space as well as what the speaker takes the hearer to accept. Provided the speaker has sufficient information, the speaker can also have the embedded DRS within the acceptance space that represents what the hearer takes the speaker to accept. The same level of embedding is also introduced within the belief DRS when necessary.

Additionally, to make the link between speaker generation, linguistic content, and hearer recognition more explicit, presuppositions are marked by a presupposition label 'pn', ('n', 0) and assertions are marked by 'an'. 'cn' is a label referring to acceptance, and 'bn' to beliefs. Believed information labeled 'bn' or accepted information labeled 'cn' can be either presupposed or asserted.

Speaker Initial State

The following discussion is based on example 1.

- (1) S1: I must buy Vincent's wife a birthday present.
She likes flowers.

At the start of the dialogue, the assumption is that the conversation is initiated through the motivation of communicating new information. This follows from BCA1 (section 2). As reflected in the DRS representing the speaker's initial state, the speaker does not hold the belief that the speaker believes or accepts the new information provided by the assertion, A. Following BCA2 (section 2), the speaker's belief space also contains A. Figure 1.1 describes the speaker's initial cognitive state, prior to uttering S1. Here, the speaker believes that the hearer believes Vincent is married, i.e. that the speaker can legitimately assume this is known by the hearer. The speaker also assumes that vincent(x) and male(x) are part of the hearer's beliefs.

Hearer Initial State

The hearer's beliefs regarding the conversation may be initially empty. The speaker's utterance permits adoption or indeed rejection of either the presupposition of the utterance or the assertion. Although the hearer may have other beliefs relating or not directly relating to the dialogue, the assumption is that the hearer only has the relevant information about Vincent in his initial state.

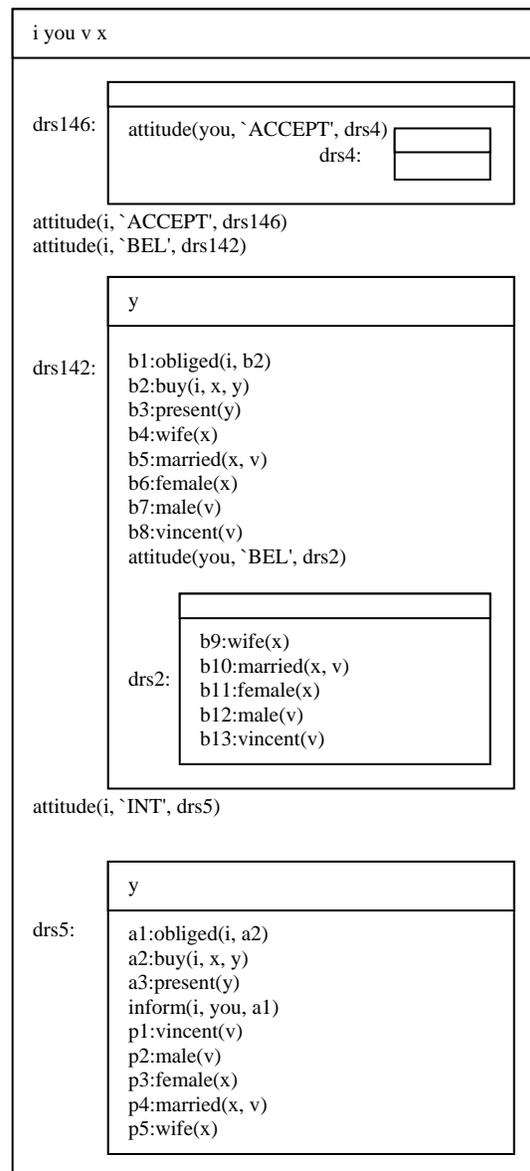


Figure 1.1: Speaker Initial State

Speaker Generation

The speaker communicates to the hearer the new information that she has to buy a present for Vincent's wife, who likes flowers. The assertion is now added to the speaker's belief space. Though this information has always been there, the choice, in the DRS formalism, was made to present the beliefs as they are generated by new utterances, rather than including all possible beliefs. The dialogue act generated by the assertion is to 'inform', whereby the speaker believes the information communicated in the assertion is new information to the hearer, BCA1. The speaker's intention space provides the link to her utterance: $\text{drs}([i, \text{you}, y, z], [p1:\text{vincent}(v), p2:\text{male}(v), p3:\text{female}(x), p4:\text{married}(x, v), p5:\text{wife}(x), a1:\text{obliged}(i, a2), a2:\text{buy}(i, x, y), a3:\text{present}(y), a4:\text{like}(x, z), a5:\text{flower}(z), \text{inform}(i, \text{you}, a1), \text{inform}(i, \text{you}, a2), \text{inform}(i, \text{you}, a3), \text{inform}(i, \text{you}, a4), \text{inform}(i, \text{you}, a5)])$). The assertions are included in the intention DRS, as well as the presuppositions they are based upon. This is meant to enhance the link between speaker generation and the linguistic content of the utterance.

The speaker expects the hearer to accept or believe the new information provided by the assertion. This, however, can be subject to the hearer's feedback. Having no objections or feedback means that the speaker can tentatively assume that the hearer is going along with the new information by accepting the information for the time being. The lack of feedback is considered weak positive feedback (cf. Al-Raheb 2004). Receiving no feedback from the hearer also means that the speaker cannot yet determine whether the hearer has decided to believe the new information. In addition, following from BCP1 and BCA2 (cf. section 2), the speaker expects the hearer to form the belief that the speaker believes there is such a person as Vincent, Vincent has a wife, and that she likes flowers.

Hearer Recognition

Though the information provided by the presupposition is new to the hearer, the hearer 'goes along' (Simons 2003) with the presupposition and does not object to the new information. This is the ideal scenario, in which the hearer lives up to the speaker's expectations that there will be no problems. In this particular example, the speaker is unaware of the presupposition being new to the hearer, as the speaker had wrongly assumed that information to be already believed by the hearer. The hearer also adopts the assertions by placing them in his acceptance space. The hearer adds to his cognitive state that the speaker has the intention to inform him of what the speaker takes as new information to the hearer: $\text{drs}([i, \text{you}, y, z], [p1:\text{vincent}(v), p2:\text{male}(v), p3:\text{female}(x), p4:\text{married}(x, v), p5:\text{wife}(x), a1:\text{obliged}(\text{you}, a2), a2:\text{buy}(\text{you}, x, y), a3:\text{present}(y), a4:\text{like}(x, z), a5:\text{flower}(z), \text{inform}(\text{you}, i, a1), \text{inform}(\text{you}, i, a2), \text{inform}(\text{you}, i, a3), \text{inform}(\text{you}, i, a4), \text{inform}(\text{you}, i, a5)])$). Following BCA1, BCP1, and BCA2, the hearer also now believes that the speaker believes the content of the presuppositions and assertions.

4 Conclusion

The dialogue so far has not provided the speaker with sufficient information to conclude that the hearer believes the assertions: the speaker has to buy a present and Vincent's wife likes flowers. However, as the speaker initiated the topic of the conversation, the hearer has stronger grounds to believe that the speaker believes her utterances. At this stage of the dialogue, the hearer has not yet provided feedback, which, given that the speaker has reason to believe the hearer is cooperating, leaves the speaker to assume the hearer accepts the new information. In summary, this paper has illustrated by way of example the link between two DRS variants, to enhance the link between speaker generation and the linguistic content and the linguistic content and hearer recognition.

5 Bibliography

- Al-Raheb, Y. 2004. 'Presupposition and Belief in DRT: Towards a New Implementation'. In: J. Ginzburg and E. Vallduvi (Eds.). *Catalog 04: Proceedings of the 8th Workshop on the Semantics and Pragmatics of Dialogue, Barcelona*. pp 144-145.
- Kamp, H., van Genabith, J., and Reyle, U. 2005. In: D. Gabbay and F. Guentner (Eds.). *The Handbook of Logic*. <http://www.ims.uni-stuttgart.de/hans/>.
- Lambrecht, K. 1994. *Information Structure and Sentence Form: Topic, focus and the mental representations of discourse referents*. Cambridge University Press.
- Simons, M. 2003. 'Presupposition and Accommodation: Understanding the Stalnakerian picture'. *Philosophical Studies* (112, (3)), 251-278.

- and merge :
$$=1 +2 2 -2 /2/$$

$$+2 2 -2 /2/, /1/, -1 /1/, /2/, -2 /2/,$$
8. Move :
$$/2/, /2/, 2 -2 /2/, /1/, -1 /1/$$
9. Lexical entry of type 3 :
$$=2 +1 1 -1 /1/$$

 and merge :
$$+1 1 -1 /1/, /2/, /2/, -2 /2/, /1/, -1 /1/$$
10. Move :
$$/1/, /1/, 1 -1 /1/, /2/, /2/, -2 /2/$$
11. After this new iteration, there are three /1/ and three /2/. Let us finish derivation. Lexical entry of type 6 :
$$=1 +2 +1 c$$

 and merge :
$$+2 +1 c, /1/, /1/, -1 /1/, /2/, /2/, -2 /2/$$
12. Move :
$$/2/, /2/, /2/, +1 c, /1/, /1/, -1 /1/$$
13. Move :
$$/1/, /1/, /1/, /2/, /2/, /2/, c$$

3 Generalization

This section presents a general algorithm to construct a lexicon generating a language of an N counting dependencies : $1^n 2^n \dots N^n$, and outlines the proof of the language generated by the grammar with this lexicon.

Algorithm Construction of the lexicon.

It will suppose $S_1 < S_2 < \dots < S_{N-1} < S_N$ where :

- $/S_i/$ are the terminals of the derivation, ordered according to appearance in the word

- S_{acc} is the accepting symbol of the grammar.

type 1 : $\langle S_N - S_N / S_N / \rangle$

type 2 : for i from 1 to $(N-1)$

type 3 : from j from 1 to $(N-1)$

$\langle =S_{i+1} S_i - S_i / S_i / \rangle$

$\langle =S_{j+1} + S_j S_j - S_j / S_j / \rangle$

type 4 : $\langle =S_1 + S_N S_N - S_N / S_N / \rangle$

type 5 : $\langle S_{acc} \rangle$

type 6 : $\langle =S_1 + S_N + S_{N-1} \dots + S_1 S_{acc} \rangle$

Theorem Minimalist Grammars generate all counter languages.

Proof The previous part presents how to obtain 2 counting dependencies. Let us see how to extend it to N terminals with the algorithm above.

The synopsis of the analysis is done according to three phases : start-iteration-conclusion. We will take a type of lexical entry according to the different phases :

The first type of lexical entry will combine with the last entry of type 2 ($S_{i+1} = S_N$ pour $i = N - 1$) using merge. Thereafter this structure will combine with the preceding one of the type 2 and so on, until the start phase is finished, i.e. until we have accumulated a terminal of each letter. This is made possible by the structure of the elements of the type 2 because following the selector we find a basic feature with an index decreased by 1 (from where merge with the precedent). Once this phase is finish, a basic feature S_1 is in first position : $S_1 - S_1 / S_1 / , \dots , -S_N / S_N /$

The choice is thus either to pass directly to the conclusion phase, or to pursue with an iteration.

Iteration phase : it starts with a merge of a lexical entry of type 4 designed for this purpose. This new head immediately moves all the elements $/S_N/$ to the front . Then we find the same structure as in the start phase, which enables us to continue the iteration.

The action, in this phase, is, in addition to accumulating a phonological form, to move all elements carrying the same phonological form in first position : $+S_N S_N - S_N / S_N / , \dots , /S_N / , \dots , -S_N / S_N /$ becomes : $/S_N / , \dots , /S_N / , S_N - S_N / S_N / , \dots$

At the end of the this phase, the derivation reaches again in the same configuration as at the end of the start phase. We could either start an iteration again, or conclude.

To conclude, the derivation is merged with an entry of the type 6, which orders all group of the same phonological form. $+S_N \dots +S_{init} S_{acc}, \dots, /S_1/, \dots, -S_1 S_1, \dots, /S_N/, \dots, -S_N /S_N/$ Thus, successive moves reorder the derivation according to each terminal by using the last licensee remaining with phonological forms. As we always added a series of terminal on each iteration phase, they all occur the same number of times.

This grammar generates exactly the counter languages with N terminals : $1^k \dots N^k$ because only the analyses following the synopsis above can succeed. Any variation with in this synopsis will not return an accepting analysis because this kind of derivations are deterministic except at points that we will discuss :

Starting the iteration phase without completing the start phase.

We can start a derivation by merge between an entry of type 1 and one of type 2, by an entry of the type 1 and one of type 3. Into this second case, we introduce a feature '+k' into derivation. There is no element in derivation carrying the equivalent licensee. Therefore, the derivation fails. $+S_{N-1} S_{N-1} -S_{N-1} /S_{N-1}/, -S_N /S_N/$

If that occurs later in the start phase, the problem will be the same.

Returning from the iteration phase to the start phase.

The derivation uses a merge with an entry of type 2 instead of one of type 3. In this case, it misses one '+k', $\forall k \in MF$ in derivation. But the only moment in a derivation where there are two features '-k', is followed by a merge operation with an entry of type 3, but one of them will be unified immediately with the introduced feature '+k'.

In this case, there are two '-k' in the derivation, but only one of them can be unified in the conclusion phase. The analysis will finish with this additional feature '-k' and could not yield a successful derivation : $+S_N \dots +S_1 S_{acc}, \dots, /S_1/, \dots, -S_1 S_1, \dots, /S_N/, \dots, -S_N /S_N/, -S_N /S_N/$

All the other stages of derivation are deterministic, therefor we obtain correctly the words on a counter.

Conclusion and prospects

The languages generated by Minimalist Grammars contain the counter languages. This is the point that distinguishes these grammars from other linguistic formalisms.

A version of $a^{(2^n)}$, $\forall n \in \mathbb{N}$ counts is presented in [Mi 05].

An MG of the *nested counters* is in progress. The *nested counters* are the sentences of the following shape : $1^n 2^k 3^n 4^k \dots N^k$, $\forall n \in \mathbb{N}$, $\forall k \in \mathbb{N}$ which is a context-sensitive language, as counter languages with more than two terminals.

In this respect MG (strongly) differs from other derivational formalizations of NL syntactic structures.

They provide an account for linguistic analysis and we could show these complex syntactic structures by theoretical exploration. The main open question is whether it is possible to generate languages outside the class of natural languages.

Références

- [Ha 01] Harkema H. (2001). A Characterization of Minimalist Languages. *Logical Aspect of Computational Linguistics 2001*. Springer-Verlag.
- [Mi 05] Michaelis J. (2005). A Note on the Complexity of Constraint Interaction : Locality Conditions and Minimalist Grammars. *Logical Aspect of Computational Linguistics 2005*. Springer-Verlag, n°3492, pp114-130.
- [Mi 98] Michaelis J. (1998). Derivational Minimalism Is Mildly Context-Sensitive. *Logical Aspect of Computational Linguistics 1998*. Springer-Verlag, n°2014, pp179-198.
- [Mi Mö Mo 00] J. Michaelis, U. Mönnich and F. Morawietz (2000). Algebraic Description of Derivational Minimalism. *Algebraic Methods in Language Processing*. 125-141
- [St 97] Stabler Ed. (1997), Derivational Minimalism, *Logical Aspect of Computational Linguistics 1997*. vol 1328, Springer-Verlag.

Argument sharing in LTAG – Scope ambiguities in Right Node Raising

Eva Banik
Linguistics Department
University of Pennsylvania
ebanik@babel.ling.upenn.edu

April 15, 2005

Right Node Raising is a term originally used by Postal (1974) to describe coordinate constructions like (1) where an element has been moved out of the left conjunct and attached on the right, at the end of the sentence. The “raised” element is typically preceded by a marked intonation break and the two conjuncts don’t necessarily have the same tense or share the same auxiliary.

(1) I hit and Bill kicked [someone].

a $\exists(x, \text{person}(x), \text{hit}(I,x) \wedge \text{kick}(B,x))$

b $\exists(x, \text{person}(x), \text{hit}(I,x)) \wedge \exists(x, \text{person}(x), \text{kick}(B,x))$

Right Node Raising has typically been analyzed in the linguistic literature as across the board rightward movement of a peripheral element from both conjuncts, but this view has been challenged by many researchers (eg. Neijt (1979), Abels (2004)). This paper adopts an “argument-sharing” analysis in the framework of (Lexicalized) Tree Adjoining Grammars (Joshi et al. (1975))¹ and shows that the analysis suggested by Banik (2004), Banik (2005) that has been problematic for VP coordination structures can be used to model scope relations in Right Node Raising.

An interesting property of RNR constructions is that the ‘raised’ element can be interpreted inside the coordination (1b) as well as having scope above the subject (and therefore also above coordination) (1a), making these sentences ambiguous.

Fig.1. illustrates that the analysis of Right Node Raising structures in TAG involves coordinating two elementary trees on the S level and sharing the object NP. This analysis of coordination is based on Sarkar and Joshi (1997)’s syntax for coordination in LTAG and uses a new operation, *conjoin* which combines three trees into a derived structure (two elementary trees and an instance of the coordination schema). *Conjoin* identifies arguments that are shared by the two conjuncts and links them together.

¹For a detailed description of the formalism see e.g. Joshi and Schabes (1997)

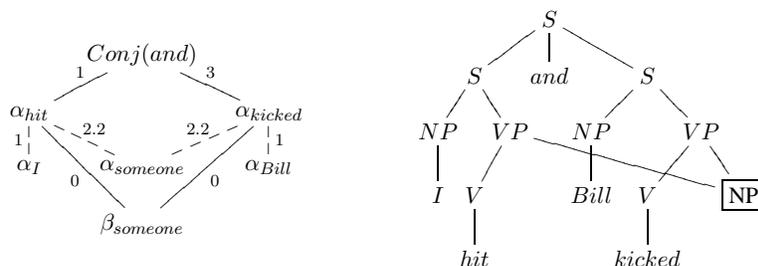


Figure 1: Argument sharing in LTAG

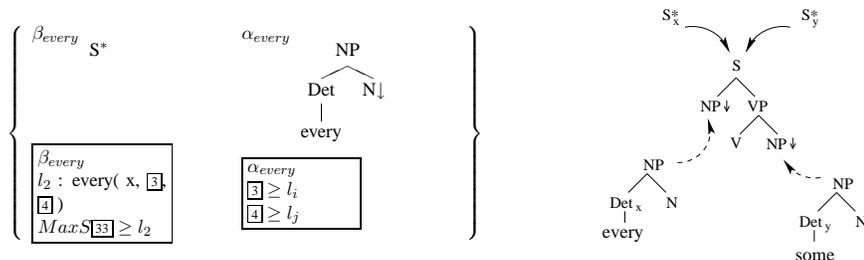


Figure 2: Elementary semantic representation of quantifiers

Operations (substitution or adjunction) performed on a shared node are recorded as if they were carried out on both trees where the shared node belongs².

To model coordination and quantifier scope ambiguities we adopt the semantic framework for TAG defined by Kallmeyer and Joshi (2003), and extended to semantic feature structures in Kallmeyer and Romero (2004). We use a flat semantic representation with labels and holes that represents scope ambiguities by underspecification, similarly to Copestake et al. (1999), Bos (1995), Reyle (1993) among others.

Fig.2. illustrates the semantic representations which are associated with elementary trees in the lexicon: they consist of a set of formulas, a set of scope constraints and semantic feature structures linked to specific node addresses in the elementary tree. Compositional semantics is computed based on the derivation tree by carrying out feature unifications just like in a feature-based LTAG (Vijay-Shanker and Joshi (1991)). These unification operations result in value-assignments to some (but not all) of the feature variables. At the end of the derivation disambiguation is performed on the resulting underspecified representation by specifying a partial order on variables and labels in accordance with the semantic constraints. Quantifiers have a multicomponent representation that contains an empty scope tree and a regular NP tree for predicate argument structure. The composition of quantifier sets with elementary trees has to be tree local.

Using this syntactic and semantic representation we can model different orders of

²In the derivation structure dashed lines represent substitution and solid lines adjoining or conjoining; shared arguments are marked by a box around the node label in the derived structure

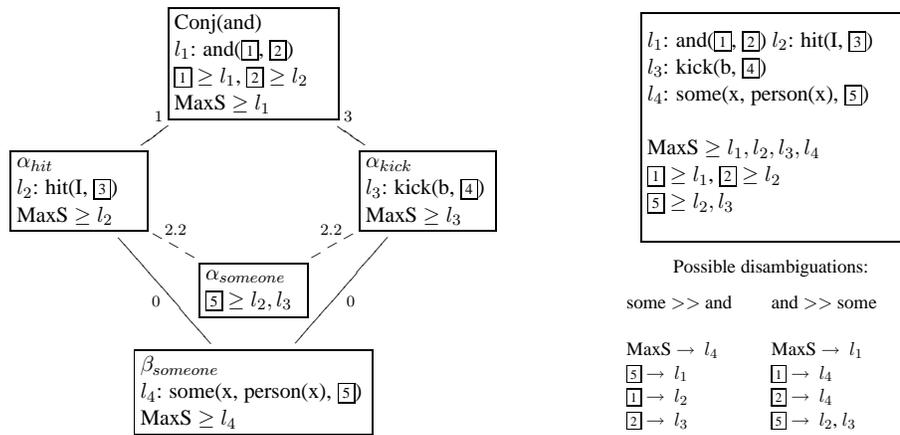


Figure 3: Scope ambiguity and Right Node Raising – “I hit and Bill kicked someone”

scopal elements in a sentence. The basic idea is that whenever two quantifiers are attached to the same S node in an elementary tree, they will be scopally ambiguous.

Banik (2004) and Banik (2005) have applied this framework to VP coordination and Gapping structures but had trouble restricting the number of possible readings. In VP coordination shared quantified subjects always take wide scope over coordination when there is no other scopal element present in the sentence (e.g. *Some girl sang and danced.*), however, if another quantifier appears the number of possible interpretations increases:

(2) Some student likes every professor and hates every course.

- a $\exists [x, \text{stud}(x), \text{like}(x, \text{every prof}) \wedge \text{hate}(x, \text{every course})]$
- b $\forall [y, \text{prof}(y), \exists(x, \text{stud}(x), \text{like}(x, y))] \wedge \forall [z, \text{course}(z), \exists(x, \text{stud}(x), \text{hate}(x, z))]$

If we allow shared subjects to scope under coordination to derive (2) then the system will overgenerate. However if we restrict the possible interpretation of shared subjects to a wide scope reading, the system will undergenerate.

This dilemma doesn’t hold for shared objects in Right Node Raising structures. In this case we always have to allow the shared quantifier to have narrow scope as well as wide scope with respect to coordination. This difference in possible interpretations can be attributed to the level of coordination: whereas coordination in Right Node Raising takes place at the same node where the shared quantifier adjoins, in VP coordination structures the scope part of the shared quantifier adjoins higher than coordination. Since in Right Node Raising constructions the quantifier and the coordination is attached to the same S node, the framework predicts that these two elements can be scopally ambiguous. For example from the representation on Fig.3. two readings can

be derived: a wide scope reading for *some* (1a) and a narrow scope reading (1b). Though this analysis predicts the correct readings, a problem already mentioned in Banik (2004) remains: we still need to define a way to disambiguate the underspecified variables. Deriving the wide scope existential reading (1a) is straightforward: the disambiguation assigns Maximal Scope to l_4 and identifies the body of the quantifier with the coordination. The problematic reading is the narrow scope existential reading where the coordination is assigned Maximal Scope. In this case both of the arguments of *and* (1) and (2) are identified with the quantifier.

Now we are in a situation where the variable in the quantifier's body (5) has to have scope over l_2 in one conjunct and over l_3 in the other.

A way to satisfy this constraint would be if we had two "copies" of the quantifier. A possible solution to this puzzle is to observe that these copies are in a way part of the definition of semantic composition which requires that at a composition step we form a set of the formulas in the individual elementary representations. Since the quantifier is shared, i.e. it undergoes the composition process twice, its formula has to be added to this set twice.

References

- Abels, K. 2004. "right node raising: Ellipsis or across the board movement". In *Proceedings of "NELS" 34*.
- Banik, E. 2004. Semantics of vp coordination in ltag. In *Proceedings of the TAG+7 workshop, Vancouver, Canada, May 20-22*.
- Banik, E. 2005. The semantics of coordinate deletion in ltag. In *Proceedings of IWCS-6, Tilburg*.
- Bos, J. 1995. Predicate logic unplugged.
- Copetake, Ann, Dan Flickinger, and Ivan A. Sag. 1999. Minimal recursion semantics. an introduction. Draft, September 1999.
- Joshi, A. K., L. S. Levy, and M. Takahashi. 1975. Tree adjunct grammars. *Journal of Computer and System Sciences* 10:136–163.
- Joshi, Aravind K., and Yves Schabes. 1997. Tree-adjointing grammars. In *Handbook of formal languages and automata*, ed. Grzegorz Rosenberg and Arto Salomaa, volume 3, 69–124. Springer-Verlag, Heidelberg.
- Kallmeyer, L., and A.K. Joshi. 2003. Factoring predicate argument and scope semantics: Underspecified semantics with LTAG. *Research on Language and Computation* 1:1-2:3–58.
- Kallmeyer, L., and M. Romero. 2004. Ltag semantics with semantic unification. In *Proceedings of TAG+7*.
- Neijt, A.H. 1979. *Gapping: A contribution to sentence grammar*. Dordrecht: Foris.
- Postal, P. 1974. *On raising*. Cambridge, MA, MIT Press.
- Reyle, U. 1993. Dealing with ambiguities by underspecification. construction, representation and deduction. *Journal of Semantics* 10:123–79.
- Sarkar, A., and A. Joshi. 1997. Handling coordination in a tree adjoining grammar. Technical report, Dept. of Computer and Info. Sc., UPenn.
- Vijay-Shanker, K., and A. K. Joshi. 1991. Unification based tree adjoining grammars. In *Unification-based grammars*, ed. J. Wedekind. Cambridge, MIT Press.

Clitic Left Dislocation in the Non-Associative Lambek Calculus with Dual Operators

Matteo Capelletti

UiL OTS, Utrecht

Abstract

We are exploring the logical and linguistic properties of the calculus that has been recently proposed in Moortgat [2004b]. The calculus enriches the Non-Associative Lambek Calculus, Lambek [1961], with the duals of the operators of the tensor family. The residuation rules of the connectives of the dual family (co-tensor, \oplus , and oriented co-implications \oslash and \ominus) can be seen as the mirror image of those of the tensor family. The two families of connectives interact through the weak distributivity postulates of Grishin, (see Grishin [1983], Lambek [1993]). The resulting logic can be called Non-Associative Lambek Calculus with Dual Operators, DNL.

In Moortgat [2004a] it is shown how DNL can offer an elegant solution to non-local scope of quantifiers, based only on the subtyping relations made available by the new logic.

We provide further support for the linguistic application of DNL by addressing in it Italian clitic left dislocation (CLD). In particular, we show how the strategy of Moortgat [2004a] can be applied to the case of an embedded cliticized clause licensing a position to left periphery of the main clause. This operation would require a complex *structural* component in a traditional multimodal setting, while in DNL it follows from the *logical* properties of the calculus.

1 Axiomatic Presentation of DNL

DNL is a deductive system which comprises, besides the residuation laws of NL in (2), the residuation laws for the dual connectives in (3), which are the mirror image of those in (2).

(1) Identities:

$$a \rightarrow a \qquad \frac{a \rightarrow b \quad b \rightarrow c}{a \rightarrow c}$$

(2) Tensor family:

$$\frac{b \rightarrow a \backslash c}{a \otimes b \rightarrow c} \qquad \frac{a \rightarrow c / b}{a \otimes b \rightarrow c}$$

(3) Cotensor family:

$$\frac{a \oslash c \rightarrow b}{c \rightarrow a \oplus b} \qquad \frac{c \ominus b \rightarrow a}{c \rightarrow a \oplus b}$$

At this stage, the theorems of DNL are those of NL, plus their duals, which could be characterized by

(4) if $a \rightarrow b$ is a theorem of NL, then $\tilde{b} \rightarrow \tilde{a}$ is the dual theorem.

where $\tilde{\cdot}$ is a function mapping each formula of NL to its dual. For example, if in NL we have *type raising*, for the dual family we have *type lowering*: $b \oslash (a \otimes b) \rightarrow a$.

DNL is a fragment of bilinear logic, BL. Grishin [1983] explores the properties of various options of structural reasoning for BL. Anyway, the structural packages employed there, seem to be far beyond the requirements for natural language applications and many of them do not even respect the Weak

Sahlqvist form. In order to respect this form, the connectives involved into structural reasoning should have an existential interpretation (so, in DNL, together with the tensor, the coimplications). And in order to be suitable for natural language syntax, they should not lead to permutation closure of the system (as associativity plus mixed commutativity would do).

Moortgat proposes the following set of postulates for the interaction of the connectives:

(5) Grishin Postulates:

$$\begin{array}{ll} \text{mal} & (a \otimes b) \otimes c \rightarrow a \otimes (b \otimes c) \\ \text{mcl} & a \otimes (b \otimes c) \rightarrow b \otimes (a \otimes c) \\ \text{mar} & a \otimes (b \circ c) \rightarrow (a \otimes b) \circ c \\ \text{mcr} & (a \otimes b) \otimes c \rightarrow (a \otimes c) \circ b \end{array}$$

In the postulates for the logical interaction of the connectives are encoded the structural operations of mixed associativity and mixed commutativity. Since these possibilities of restructuring arise only in the interaction between the two families of connectives, neither of the two families will enjoy these structural properties in itself. In application to linguistics, this gives the advantage of integrating the assumption of the most restrictive system of linguistic inference (NL) with the new subtyping relations made available in DNL, which enable interaction and hence structural reasoning.

In order to enlighten the logical and structural properties of DNL, we give some theorem of the system below.

1.1 Some Theorem of DNL

For each of the following theorems, the symmetric and the dual also hold:

Grishin laws:

- (6) $a \setminus (c \oplus b) \vdash (a \setminus c) \oplus b$
- (7) $a \setminus (c \oplus b) \vdash c \oplus (a \setminus b)$
- (8) $a \setminus (c \oplus b) \vdash (c \circ a) \setminus b$
- (9) $(b \setminus c) \circ a \vdash b \setminus (c \circ a)$
- (10) $a \circ (b \circ c) \vdash (c/a) \setminus b$

Distributed Geach reasoning:

- (11) $b \setminus a \vdash (c \circ b) \setminus (c \circ a)$
- (12) $b \setminus a \vdash (b \circ c) \setminus (a \circ c)$
- (13) $b \circ a \vdash (b \circ c) / (a \setminus c)$
- (14) $b \circ a \vdash (c/a) \setminus (b \circ c)$

In the following section we illustrate the syntactic phenomenon we are going to address in DNL. We show then, briefly, how a traditional analysis of it would look like, and how it would be analysed in DNL.

2 Clitic Left Dislocation

The following Italian sentences exemplify the phenomenon we are going to address in DNL. In (15) the feminine object clitic 'la' licenses a left peripheral occurrence of an extraposed constituent agreeing with the clitic on the relevant features.

- (15) Maria, la amo.
Mary, her I love.
I love Mary.

The above sentence can be embedded as the complement of a sentential verb:

- (16) Ho detto che Maria, la amo.
 I have said that Mary her I love.
 I said I love Mary.

However, the satellite is not relegated to this embedded position. It can infact occur at the periphery of the main sentence, as it is shown below:

- (17) Maria, ho detto che la amo.
 Mary, I have said that her I love.
 I said I love Mary.

2.1 A Type for the Clitic

When the clitic licenses an extraposed constituent, it can be seen, semantically, as an identity function, which performs the syntactic reordering of the verb argument it instantiates, to a preverbal position. A lexical assignment performing this operation could be $(n \setminus s)/(s/n)$. In a case like (17), the resolution of the dependency of the satellite from the clitic involves the movement of the satellite from a 'base generated' position to the surface position in which it occurs, as it is shown in the following derivation, where Γ stands for the intervening context (which could be also a negation or an adverb).

$$\frac{\frac{(s/n) \vdash (s/n) \quad \frac{n \vdash n \quad \Gamma, s \vdash s}{\Gamma, (n, n \setminus s) \vdash s}}{n, (\Gamma, n \setminus s) \vdash s} MC}{n, (\Gamma, ((n \setminus s)/(s/n), (s/n))) \vdash s}}$$

In the above deduction, as many steps of MC as the length of Γ are required. Following the strategy proposed in Moortgat [2004a] for non local scope of quantifiers we show how the same operation can be accomplished in DNL. The type inference on which the analysis relies is the following:

- (18) $a \circ (b \circ c) \rightarrow (c/a) \setminus b$

In Moortgat [2004a] this type inference allows the noun phrase type to take sentential scope form an embedded position, the n type resource staying in place and the sentential component of the type matching on the right the type of the main clause.

For our purposes, we assign the clitic the type $n \circ ((s/n) \circ s)$. This type assumes the *postverbal* occurrence of the clitic as the default. This assumption is not motivated by the examples we are presently considering, in which the clitic is *preverbal*, but is justifiable on the basis of the fact that clitics in Italian *can* occur postverbally (if the verb host is non finite). So, since we assign the same type to the preverbal and postverbal occurrence of the clitic, we assume here the postverbal assignment for simplicity. The same problem of permutation we will encounter in the next section would arise if we had assumed the preverbal type as default assignment.

The left dislocated constituent will be assigned the type $s/(s/n)$ which could account also for topicalization. The type of the clitic will license the extraposition of the cliticized argument.

The following inference holds between our type assignment and the traditional one:

- (19) $n \circ ((s/n) \circ s) \rightarrow (s/n) \setminus (s/n)$

2.2 Left Dislocation in DNL

The deduction in (20) below, is based on the sequent presentation of DNL given in Moortgat [2004b]. The sequents are *not intuitionistic*, since the rules operate on structured consequents. The Grishin postulates, given in (5) for the axiomatic formulation, have been incorporated in the rules of proof of the (co)implications. For example, we have the following rules, where if $\Gamma = [a \circ b, \Gamma']$ or $\Gamma = [\Gamma', a \circ b]$, Γ' can be empty:

$$\frac{\Gamma[\Gamma', a] \vdash \Delta, b}{\Gamma[\Gamma', a \circ b] \vdash \Delta} \circ^r L \qquad \frac{\Gamma[\Gamma', a] \vdash \Delta, b}{\Gamma[a \circ b, \Gamma'] \vdash \Delta} \circ^l L$$

together with those obtained from NL through left-right symmetry and duality.

Deduction of (17) in DNL, with *Sat*, the satellite or extraposed phrase, *Cl*, the clitic, *V*, the verb host:

(20)

$$\frac{\frac{\frac{n \vdash n \quad \Gamma, s \vdash s}{\Gamma, (s/n, n) \vdash s} /L \quad s/n \vdash s/n}{\Gamma, (s/n, n) \vdash s/n, (s/n) \otimes s} \otimes R}{\Gamma, (s/n, n \otimes ((s/n) \otimes s)) \vdash s/n} \otimes^r L}{\Gamma, (n \otimes ((s/n) \otimes s), s/n) \vdash s/n} EX \quad \frac{s \vdash s}{s/(s/n), (\Gamma, (n \otimes ((s/n) \otimes s), s/n)) \vdash s} /L}{Sat, (\Gamma, (Cl, V)) \vdash s} LI$$

We notice that the preverbal occurrence of the clitic requires a step of permutation (*EX*) which is not in the logic of the operators. This aspect can be improved by using unary modalities for clitic attachment.

3 Conclusion and Further Work

We have presented an example of how DNL can be applied to long distance dependencies in linguistics. We can see, in the derivation in (20), that the type we assigned to the clitic makes available, more in general, a peripheral position for the satellite from an embedded position. Depending on its lexical assignment, the satellite will be able to occur at the left ($s/(s/n)$) or at the right ($((s/n) \setminus s)$) of the (main) clause. The structural reasoning needed for such an operation is performed in DNL by the Grishin postulates which are required for enabling the logical interaction of the two families of connectives.

Besides the type inference in (18), we are exploring the possible applications of other type inferences available in DNL, like those from (6) to (14).

An aspect which has not been addressed here is related to the problem of multiple type assignment for the clitic pronoun. In the present abstract, we assumed the clitic is semantically an identity function, in order not to saturate the verb argument and 'leave open' an extraposed position. Nonetheless, clitics, as pronouns, are full arguments which saturate, and not only instantiate, a thematic role of the verb, while the satellite is optional. The type we assigned to the clitic does not make justice to the aspect of optionality of the satellite. We are still working to a solution not involving multiple lexical assignment nor violating resource sensitivity.

References

- V.N. Grishin. On a generalization of the Ajdukiewicz-Lambek system. *Studies in Nonclassical Logics and Formal Systems*, pages 315–343, 1983.
- J. Lambek. On the calculus of syntactic types. In R. Jacobson, editor, *Proceedings of the Twelfth Symposium in Applied Mathematics*, volume XII, pages 166–178, 1961.
- J. Lambek. From categorial grammar to bilinear logic. In P. Schroeder-Heister and K. Dosen, editors, *Substructural Logic*, pages 207–238. Clarendon Press, Oxford, 1993.
- M. Moortgat. Reversing time's arrow in grammar. Slide presentation, 2004a.
- M. Moortgat. Combinators, sequents, display logic. Draft, 2004b.

Dynamic Semantics and ‘Why Don’t You’ Speech Acts¹

Scott Grimm

Institute for Logic, Language and Computation, University of Amsterdam

sgrimm@science.uva.nl

Negative why-questions can be used as requests, suggestions or imperatives, despite their interrogative form, as exemplified in (1)–(3).

- (1) Why don’t you pass me the salt?
- (2) Why don’t you connect in Geneva instead?
- (3) Why don’t you get lost!

This qualifies them as a type of speech act where the illocutionary force is not of the same type as that normally associated with the clause type, or with the question intonation in (1-2). Often such speech acts are treated by means of lengthy chains of pragmatic inference, e.g., (Searle, 1969), or even by giving a complex type to such speech acts directly in the grammar, as in (Asher and Lascarides, 2001). By using both a logical analysis of why-questions and tools from dynamic semantics, we propose to treat ‘why don’t you’ (and had we the space, ‘why not’) as a semantic operator equivalent to a consistency check that ranges over imperatives. We shall show this treatment gives a plausible semantic account and matches what is desired to describe the intuitive meaning of this construction. Additionally, an attempt is made to steer the middle course by not relying too heavily on pragmatics or the grammar.

Properties of the ‘Why Don’t You’ Construction

‘Why don’t you’ (and ‘why not’) questions are not mere negations of why-questions, but clearly have a different status as demonstrated by the autonomy of the interrogative prefix. (Gordon and Lakoff, 1975) note that ‘why don’t you’ can undergo phonological and morphosyntactic modifications only when the ‘conventionalized’ indirect suggestion reading is available:

- (4) a. Why don’t you move to California?
b. Why dontcha move to California?
c. Whyntcha move to California?
- (5) a. Why don’t you resemble your father?
b. ??Why dontcha resemble your father?
c. ??Whyntcha resemble your father?

Stronger evidence of syntactic autonomy is provided by displacement of the ‘why don’t you’ prefix, which is not possible for non-negated why-questions:

- (6) Open the window, why don’t you?
- (7) *Open the window, why do you?

¹Thanks to Michael Franke, Jeroen Groenendijk, and Henk Zeevat for comments on previous drafts, materials, good questions and general stimulation.

We note that displacement in (6) is licensed only when the phrase embedded in the negative why-question is an imperative. This is confirmed since displacement is permitted only when certain conditions on agency and aspect are fulfilled, which are identical to those which imperatives must fulfill:

- (8) Why don't you know math?
- (9) *Know math, why don't you?²

Adherence to these conditions on aspect and agency indicates that we are not dealing with bare infinitives, which would not be discriminatory on this point.

Additional evidence for treating the embedded proposition as an imperative comes from the pattern of negation in negative imperatives, as noted in (Rupp, 1999), which is adhered to in negative why-questions:

- (10) Did you not try again?
- (11) *Do you not try again!

Negation via 'not' can occur in the embedded proposition of a negative why-question, but not if the force is that of a suggestion, which apparently requires 'don't':

- (12) Why don't you open the window?
 - a. Why do you not open the window? (habitual reading)
 - b. *Why do you not open the window? (suggestion)

The above observations lead to the conclusion that the 'why don't you' construction differs from simple negative why-questions in that the embedded clause is an imperative and 'why don't you' can be seen as a distinct, autonomous operator.

Semantics of Why-Questions

We rely on the analysis of (Hintikka and Halonen, 1995) which proposes that the semantics of why-questions differ from other wh-questions in that (i) the propositional content is the conclusion of the topic of discussion and (ii) the propositional content is presupposed. Clearly, if someone asks "Why did Jacques move to California?", the assumption is that Jacques did indeed move to California. According to this theory, why-questions result from a gap between the information the inquirer has at her disposal and the information needed to explain the proposition in the why-question. In the simplest case, the question is of the form 'Why is *b* a such-and-such?', where *b* is some entity and being a such-and-such is a one-place predicate, say *P*. Then *T* represents the initial premises, which do not cover the item the inquirer is interested in, the entity *b*. (Should *b* be contained in *T*, the explanandum would no longer qualify as new information.) The totality of answers that the inquirer can obtain from the addressee are represented by *A*. The foregoing considerations result in the schema below:

²It is possible to show that this analysis equally describes 'why not' questions, i.e., those without a realized subject. Space constraints force us to reduce the argument to merely pointing out that the same acceptability patterns are found in 'why not' questions.

- (1) Why not open the window?
- (2) *Why not resemble your father?
- (3) *Why not know math?

$$(13) \quad (T \& A) \vdash P(b) \text{ where } b \text{ does not belong to } T$$

Essentially, the result of a why-question is finding an explanandum in the knowledge of the addressee and adding it to the common ground, where the common ground already contains the propositional content of the why-question. It follows from their analysis that, in the case that the why-question contains a negated proposition, then the non-negated proposition is inconsistent with the common ground. Take $Q(a)$ to represent the negated predicate contained in the why-question, where a may or may not coincide with b . If it is queried why $Q(a)$ is *not* the case, an answer to that query will be inconsistent with any statement asserting that $Q(a)$ *is* the case. Then by adjusting the above schema we then have:

$$(14) \quad (T \& A) \vdash P(b) \text{ such that } P(b) \& Q(a) \rightarrow \perp$$

Now, having noted that negated why-questions boil down to checking for inconsistency, ‘why don’t you’ can be generalized as a consistency checking operator. Such an operator already exists in treatments of modality, namely the might-operator due to Veltman in (Veltman, 1996), defined as follows:

$$(15) \quad s[\diamond\phi] = \{i \in s \mid s[\phi] \neq \emptyset\}$$

where s is a set of information states, and i is an information state

This simply says that the proposition $\diamond\phi$ succeeds in case that ϕ does not lead to contradiction. This is defined in such a way that it is merely a test, and does not affect the common ground in any way except for determining compatibility, which is precisely what one would like as a semantics for suggestions. A suggestion is not obligatorily accepted into the common ground—the addressee can always propose a pre-existing reason for which the suggestion fails.

Semantics of Imperatives

A recent popular treatment of the semantics of imperatives, e.g. (Portner, To appear), involves positing a discourse object, the “to do list”. Taking the essence of imperatives to be actions which the addressee should take, the “to do list” is a structure which organizes the actions each participant should take. When an imperative is uttered, the effect is to add an action to the “to do list”, much in the same way Stalnaker proposed that the force of a declarative is to add an assertion to the common ground. Central to Portner’s proposal is that the denotation of a given imperative is a property rather than a proposition and thus “to do lists” are comprised of properties, which then accounts for the different clause-types of declaratives and imperatives³.

Putting It All Together

Using the above analyses of why-questions and imperatives, we can define ‘why not’ as a consistency operator WN which ranges over properties, the application of which gives all the properties in the “to do list” that are consistent with the suggestion, as formalized in (16), which results in derivations of the type displayed in (17).

$$(16) \quad \text{TDL}[\text{WN}\phi] = \{P \in \text{TDL} \mid \text{TDL}[\phi] \neq \perp\}$$

$$(17) \quad \begin{aligned} & \|\text{Why not take a taxi?}\|^{w^*, c} = \\ & \text{WN}(\|\text{Why not take a taxi?}\|^{w^*, c}) = \end{aligned}$$

³For example, Portner gives the denotation of ‘Leave!’ as the following $\|\text{Leave!}\|^{w^*, c} = [\lambda w \lambda x : x = \text{addressee}(c) . x \text{ leaves in } w]$.

$$\text{WN}([\lambda w \lambda x : x = \text{addressee}(c).x \text{ takes a taxi } w]) = \{P \in \text{TDL}_A | \text{TDL}_A[\lambda w \lambda x : x = \text{addressee}(c).x \text{ takes a taxi } w] \neq \perp\}$$

Now we are in a position to treat both interpretations of (12), as shown in (18).

- (18) Why don't you open the window?
- a. Why [do you not open the window]
 \rightarrow Why [\neg OPENWINDOW(you)]
 - b. Why don't you [open the window]
 \rightarrow WN[$x = \text{addressee}(c), \lambda w \lambda x.x$ opens the window at w]

Finally, we require pragmatic reasoning to make the final step from suggestion to actual imperative, when licensed by the context. It is reasonable to posit that if the speaker suggests something which does not conflict with the addressee's "to do list", then if the addressee is cooperative, she will add it to her "to do list". This is exactly the effect of an imperative according to the analysis of imperatives assumed here.

In conclusion, we have proposed an analysis which side-steps the traditional and problematic stance of considering such constructions to be of one clause type while possessing the force of a different clause type. Rather, we have noted that there are indeed two different clause types in effect, both of which take different operators, thus explaining the divergent interpretations. This approach allows us to capture the intuitive sense of suggestions, the general force of the construction, and reduce the pragmatic reasoning required to derive the force of a command to only one step.

References

- Nicholas Asher and Alex Lascarides. Indirect speech acts. *Synthese*, 128, 2001.
- D. Gordon and G. Lakoff. Conversational postulates. In P. Cole and J. L. Morgan, editors, *Syntax and Semantics*, volume 3. Academic Press, 1975.
- Jaakko Hintikka and Ilpo Halonen. Semantics and pragmatics of why-questions. *The Journal of Philosophy*, 25(12), 1995.
- Paul Portner. The semantics of imperatives within a theory of clause types. In *Proceedings of Semantics and Linguistic Theory 14*. CLC Publications, To appear.
- Laura Rupp. *Aspects of the Syntax of English Imperatives*. PhD thesis, University of Essex, 1999.
- John Searle. *Speech Acts*. Cambridge University Press, 1969.
- Frank Veltman. Defaults in update semantics. *Journal of Philosophical Logic*, 25, 1996.

Answer Selection in a Cooperative Question-Answering System

Véronique Moriceau

Institut de Recherche en Informatique de Toulouse
118 route de Narbonne
31062 Toulouse Cedex, France.
moriceau@irit.fr

1 Introduction

Search engines on the web and most of present question-answering systems provide the user with either a set of hyperlinks or page extracts containing answer(s) to a question. The extraction engine selects the most relevant answers depending on parameters obtained via question analysis (focus, expected answer type, etc.). This leads to answers which may be a priori inconsistent but which are in fact redundant, incomplete, complementary, etc.

Our framework is the cooperative question-answering system WEBCOOP [Benamara, 2004] which provides natural language answers explaining or justifying how answers have been obtained. In this paper, we focus on content determination: we propose a formal approach for deciding which answer the system will provide among several candidate answers which may be inconsistent.

2 Formal aspects of content determination

The aim is to develop a formal framework for content determination of answers dealing with inconsistencies.

2.1 Related works

Let us first look at a simple example showing the main difficulties the system has to solve. The question *When was the independence of Algeria proclaimed?* is submitted to the question-answering system QRISTAL [QRISTAL]. We give here a simplified presentation of its answers:

Question	<i>When was the independence of Algeria proclaimed?</i>
Answer	3 july 1962
Candidate answers	page 1 - 2 - 3 : 3 july 1962 page 4 - 5 : 4 july 1962 page 6 - 7 - 8 - 9 : 5 july 1962

In this example, an *alternative* relation [Webber et al., 2002] exists between the possible answers: the question expects a unique answer and the user gets 4 different ones. In this context, there are several ways of providing answers. For example, we can propose a disjunction of all possible answers but this is not cooperative. Here, QRISTAL ranks the web pages according to a classical relevance criteria (semantic type, comparison of question and answer terms, etc.) and proposes the answer given by the page which is placed first but this answer is incorrect.

Most of existing systems on the web produce a set of answers to a question in the form of hyperlinks or page extracts. In this case, the problem of answer consistency only consists in filtering out answers which are considered as irrelevant. For example, COGEX [Moldovan et al., 2003] use its inference engine (logic prover) to extract lexical relationships between the question and its candidate answers. The outputs of COGEX are the answers ranked based on their proof scores.

Regarding the QALC system [Chalendar et al., 2002], it searches candidate answers both on the web and in a reference corpus (AQUAINT) and assigns to each candidate answer a similarity measure with the question which allows to rank answers according to a relevance order. Then, the system prefers answers found in both sources to answers having a high weight but present only in one source.

Finally, the InferenceWeb system [McGuinness et al., 2004] aims at giving information concerning answer origins and how they were retrieved. The notion of knowledge provenance is used to increase users trust in answers.

In fact, none of these systems takes into account the diversity of answers. This is the point we focus on. Since the reliability of web pages (source, date, author, etc.) is a parameter which is very difficult to evaluate, we consider that all web pages are equally reliable. Then, the problem the system has to solve is to generate an answer to a question even if several possible answers are selected by the extraction engine. For this purpose, we propose to integrate the different possible answers in order to generate a single one which take into account the diversity of answers.

2.2 Answer selection

To integrate the different possible answers to a question, a solution is to provide the most probable answer defined as the one which agrees with the biggest number of extracted pages. In this paper, we focus on questions expecting answers of type *date*.

For this purpose, let us assume that P is the set of web pages p_1, \dots, p_n associated with answers and their respective number of occurrences $(a_1, F_1), \dots, (a_n, F_n)$ (we consider that a web page is associated to only one answer). The propositional language L is defined by:

- $E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n))$ is true if the standard deviation of $a_1 * \dots * a_n$ is less than ε (ε depends on data granularity).

We adapt to web pages the predicates defined in [Cholvy et al., 2003] and add to L :

- $B(Majority, P, a_{max})$ is true if $\exists(a_{max}, F_{max}), \forall 1 \leq j \leq n, F_{max} > F_j$
- $B(Unchallenged, P, a_i)$ is true if $a_1 = \dots = a_n$.
- $B(Inconsistency, P, a_i)$ is true if $\forall 1 \leq i \leq n, \forall 1 \leq j \leq n, F_i = F_j$
- $C(CompleteLack)$ is true if the question has no answer.

A most probable answer a_i exists if it satisfies the following constraints:

$$\begin{aligned} & (E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge B(Majority, P, a_i)) \\ \vee & (E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge B(Unchallenged, P, a_i)) \\ \vee & (E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge B(Inconsistency, P, a_i)) \end{aligned}$$

which are formulated differently in natural language. As our framework is the cooperative system WEBCOOP, the answer proposed to the user has to show or

explain why this answer has been selected. The idea is to introduce modalities or possibility degrees to explain to the user how confident of the answer he can be, for example by the use of adverbs (*certainly* if $B(Unchallenged, P, a_i)$ is true, *probably* if $B(Majority, P, a_i)$ is true, ...).

Example 1

If we now apply this model to the above example about the independence of Algeria, p_1, \dots, p_9 are the 9 web pages and $(A_1, 3), \dots, (A_4, 2), \dots, (A_6, 4), \dots, (A_9, 4)$ the respective answers and their number of occurrences. For example, we have:

- $E(\varepsilon, (a_1, F_1) * \dots * (a_9, F_9)) \wedge B(Majority, (p_1 * \dots * p_9), a_6)$ is true.
- $E(\varepsilon, (a_1, F_1) * \dots * (a_9, F_9)) \wedge B(Unchallenged, (p_1 * \dots * p_9), (a_i)_{1 \leq i \leq 9})$ is false since there are 4 different possible answers.
- $E(\varepsilon, (a_1, F_1) * \dots * (a_9, F_9)) \wedge B(Inconsistency, (p_1 * \dots * p_9), (a_i)_{1 \leq i \leq 9})$ is false since each different a_i has a different number of occurrences.

Consequently, the answer a_6 (*July 5th 1962*) is chosen.

Example 2

Let us now look at a more complicated example.

Question	When did the last music festival take place?
Candidate answers	page 1 - 2 - 3 : 21 june 1982
	page 4 - 5 : 21 june 1983
	page 6 - 9 :
	page 10 ... 16 : 21 june 2003
	page 17 ... 19 : 20 june 2004
	page 20 ... 24 : 21 june 2004
	page 25 : 21 june 2005

In this case, the standard deviation of the answers is important. Moreover, the question imposes some temporal constraints: the answer is either in the past or in the future, the user wants the date of the first or last event,... Let A_q be the subset of $(a_1, F_1) * \dots * (a_n, F_n)$ which satisfies these constraints and P_q the subset of web pages containing these answers. A most probable answer $a_i \in A_q$ exists if:

$$\begin{aligned} & (\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Majority, P_q, a_i)) \\ & \vee (\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Unchallenged, P_q, a_i)) \\ & \vee (\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Inconsistency, P_q, a_i)) \end{aligned}$$

If we now apply this model to the previous example, we have:

- $A_q = \{(a_{17}, 3), \dots, (a_{24}, 5)\}$ because the question expects an answer in the past (only answers before 2005 remain) and the last event (the more recent dates having a standard deviation less than ε).
- $P_q = \{p_{17}, \dots, p_{24}\}$

When we apply the constraints, we have for example:

- $\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Majority, P_q, a_{24})$ is true.
- $\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Unchallenged, P_q, (a_i)_{17 \leq i \leq 24})$ is false since there are 2 different possible answers (June 20th or 21st 2004).
- $\text{not } E(\varepsilon, (a_1, F_1) * \dots * (a_n, F_n)) \wedge E(\varepsilon, A_q) \wedge B(Inconsistency, P_q, (a_i)_{17 \leq i \leq 24})$ is false since each different $(a_i)_{17 \leq i \leq 24}$ has a different number of occurrences.

Consequently, the answer a_{24} (*July 21st 2004*) is chosen.

In this section, we considered only answers of type *date*. The same model can also be applied to temporal intervals. In this case, the most likely answer (a_{max}, F_{max}) is defined as the interval which intersects the biggest number of candidate intervals and whose duration is equal to the average duration.

3 Conclusion

In this paper, we propose an approach for the answer selection in a question-answering system. The problem is to provide the user with a cooperative answer when the candidate answers, obtained by a search engine, are contradictory or inconsistent. We use an approach which is based on constraints on the standard deviation of answers in order to ensure their consistency.

The next steps are:

- to eliminate some candidate answers by analysing in more depth their contexts of occurrence. Linguistic information and semantic knowledge about answer concepts may allow to determine if a candidate answer selected by QRISTAL is appropriate or not,
- to evaluate the answers produced by the system (Is it a correct answer? Is the answer satisfactory compared to the answer produced by a classical system? Is this approach appropriate with other types of data?),
- to define a set of answer templates which explain the decisions made during the process (by using the logical approach defined in [Amgoud et al., 2004]).

References

1. Amgoud L., Prade H. *Using arguments for making decisions: a possibilistic logic approach*. FUZZ-IEEE, 2004.
2. Benamara F. *WEBCOOP: un système question-réponse coopératif sur le Web*. PhD Thesis, Université Paul Sabatier, Toulouse, 2004.
3. Chalendar G., Delmas T., Elkateb F., Ferret O., Grau B., Hurault-Plantet M., Illouz G., Monceaux L., Robba I., Vilnat A. *The Question-Answering system QALC at LIMSI, Experiments in using Web and WordNet*. In Proceedings of TREC 11, 2002.
4. Cholvy L., Garion C. *Querying several conflictual databases*. ECSQARU Workshop "Uncertainty, Incompleteness, Imprecision and Conflict in Multiple Data Sources", Aalborg, 2003.
5. McGuinness D.L., Pinheiro da Silva P. *Trusting Answers on the Web*. New Directions in Question-Answering, chapter 22, Mark T. Maybury (ed), AAAI/MIT Press, 2004.
6. Moldovan D., Clark C., Harabagiu S., Maiorano S.. *COGEX: A Logic Prover for Question Answering*. In Proceedings of HLT-NAACL 2003.
7. QRISTAL. Question-Réponse Intégrant un Système de Traitement Automatique des Langues. www.qristal.fr, Synapse Développement, 2004.
8. Webber B., Gardent C., Bos J. *Position statement: Inference in Question Answering*. LREC, 2002.

Why did the accident happen? A norm-based reasoning approach

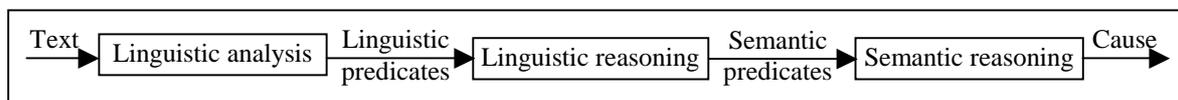
Farid NOUIOUA

Laboratoire d'Informatique de Paris-Nord UMR 7030 du CNRS
Avenue Jean-Baptiste Clément, F-93430 Villetaneuse, France
e-mail : nouiouaf@lipn.univ-paris13.fr

I. Introduction

To understand well a text written in natural language (*NL*), we need our knowledge about the *norms* of its domain. By the word “*norm*”, we mean here the normal and expected course of events in the absence of exceptions [6]. This type of knowledge enables us to infer richer conclusions than those given by means of truth-preserving entailments, for example, from the text: “**Mon véhicule se trouvait arrêté à un stop, quand un véhicule m'a heurté à l'arrière**”, (**My vehicle was stopped at a stop sign, when a vehicle struck me at the back**). Norms provide conclusions like: *vehicle A and me were in the same file and direction, vehicle A had to stop to avoid the shock...* None of these conclusions is explicit. However, any reader infers them immediately. Conclusions obtained by using norms can in general be defeasible, but they are accepted as long as the text does not contradict them. Often, narrative texts do not describe norms explicitly. They focus rather on their violations, by describing generally abnormal situations. In the light of this main remark, our goal consists in looking for the *cause* of an accident from its textual description by hypothesizing that the searched cause (called the *primary anomaly*) is the violation of the most specific norm in the text [3]. The other violations of norms result from the first one and are called *derived anomalies*. We are working on a corpus of 60 car crash reports written in French. Each report is a small text describing briefly the circumstances of an accident. To validate our approach, the reasoning system must find for each text the same answer given by an ordinary human reader to the question: “*what is the most specific violated norm which can be considered as the plausible cause of the accident ?*”. These answers are determined manually for each text at the beginning of the process.

II. Overall architecture



As shown in the figure above, several steps are required in the process of finding the cause. We will explain the role of each step further. We just notice here, that in our methodology, we have started by developing the *semantic reasoning* before dealing with the *linguistic* one. This enabled us to determine a reasonable set of *semantic predicates* (around 50) in terms of which the *linguistic reasoning* should express what is needed, and only what is needed from the explicit content of the text. This methodology enables the reasoning process to deal only with relevant linguistic phenomena. In this work, we focus on the extraction a set of syntactical relations between the words of the text and then we use a reasoning process to transform these relations into a set of semantic predicates.

III. Linguistic analysis

The *tree tagger*¹ is applied to the text. The result is, then, passed to a parser which uses a *context free grammar* enhanced with appropriate *semantic actions* to produce a set of linguistic predicates. These predicates reflect syntactic relations between relevant words of the text. At the end of this step, we obtain from our example:

qualif_n(véhicule, Mon), subject(se_trouver, véhicule), qualif(trouver, arrêté), compl_v(à, trouver, stop), compl_v(quand, trouver, heurter), subject(heurter, véhicule), object(heurter, m'), compl_v(à, heurter, arrière).

IV. Linguistic reasoning

The aim of the linguistic reasoning is to transform the linguistic predicates into semantic ones which express the explicit content of the text. The main idea (The development of this step is still in progress) is to design general transformation rules based on a lexical semantic study of the words. Of course, rules of this kind are, in general, defeasible and one must handle their exceptions. That is why a non-monotonic approach is required at this level.

¹ <http://www.ims.uni-stuttgart.de/projekte/corplex/TreeTagger/DecisionTreeTagger.html>

The linguistic predicates obtained for the example in the previous step are transformed by the linguistic reasoning into the following semantic predicates (see the representation details in the following section)

$Holds(stop, A, 1)$: the agent A is stopped at time 1 .

$Holds(stop_sign, A, 1)$: there is a stop sign for the agent A at time 1 .

$Holds(combine(bump, A), B, 2)$: the agent B bumps the agent A at time 2 .

$Holds(combine(shock_pos, back), A, 2)$: the position of the shock of the agent A is its back.

V. Semantic reasoning

The semantic predicates obtained are the input of the semantic reasoning step. This step uses inference rules based on our knowledge about norms of the road domain to enrich the initial conclusions by further implicit ones, and enables to detect the primary anomaly, which we consider as the cause of the accident. So, our common knowledge about the norms of the road domain are expressed by means of inference rules.

V.1. Language

Before showing what our inference rules look like, let us give briefly the main ingredients of the logical representation language used (see [2] for more details).

Although we need some features that are normally treated by higher order logics, we have chosen, for efficiency reasons, to stay in a first order logic (*FOL*) framework. To do this, we use the usual reification technique to represent modalities and to quantify over predicate names. Thus, a binary predicate $P(X, Y)$ is written $Holds(P, X, Y)$.

Temporal aspect is a central issue in causal reasoning [4]. To deal with this question, our approach is to decompose the scene of the accident into a succession of intervals characterized by the truth values of a set of literals. We add a parameter to each time-dependent predicate. This parameter represents the order number of the interval in which the corresponding predicate or its negation holds. Strictly speaking, the exact meaning of the temporal parameter T depends on the considered property: For properties such that “move”, “stop”, “control”, ... the parameter T represents the whole time interval T . Indeed, this type of properties are generally persistent i.e. they hold all along throughout the time interval T . For properties such that “starts”, “bump”, ..., T represents rather a particular time point that belongs to the time interval T . To simplify, we will use the expression “at time T ” with the two types of properties. Thus, the literal $Holds(P, A, T)$ is true iff property P holds for agent A at time T . For predicates with more than two arguments, we use the binary function *combine* : the ternary $P(A, B, t)$ is written $Holds(combine(P, A), B, t)$. *combine*(P, A) is a composed property. To decide which argument will be in the function *combine* and which one stays in the predicates *Holds*, the criterion is that the second argument of *Holds* is the principal agent of the property whereas the other one is used to construct with the initial simple property a composed one. For example in “ A follows B at time T ”, the principal agent of the property “to follow” is A , using the simple property “follows” and the argument B , we define the composed property “following B ” expressed by: $combine(follows, B)$. The resulting predicate is then: $Holds(combine(follows, B), A, T)$.

In addition to the *Holds* predicate which expresses truth values, we need two modalities: the *Must* modality which expresses duties of agents and the *Able* modality which expresses their capacities: $Must(P, A, T)$ (resp. $Able(P, A, T)$) holds iff at time T , agent A has the duty (resp. is able) to reach the property P .

According to the previous representation, we define two forms for a primary anomaly:

$$Must(P, A, T) \wedge Able(P, A, T) \wedge Holds(P', A, T) \wedge Incompatible(P, P') \rightarrow P_Anomaly$$

$$Holds(combine(Disruptive_Factor, X), A, T) \rightarrow P_Anomaly$$

The first form expresses the fact that if at time T , the agent A has the duty to reach a property P and that it is able at this time to reach it, but that at time $T+1$ a property P' incompatible with P holds, then there is a primary anomaly.

The second form of a primary anomaly is used to detect situations in which there is some disruptive factor that causes the accident and which generally can not be avoided by the agents. It is the case for example of the existence in the road of unforeseeable gravels or oil that cause loss of control to vehicles.

A derived anomaly differs from the first form of a primary anomaly only on the agent’s ability:

$$Must(P, A, T) \wedge \neg Able(P, A, T) \wedge Holds(P', A, T) \wedge Incompatible(P, P') \rightarrow D_Anomaly$$

V.2. Inference rules

Because norm-based conclusions are defeasible, a non-monotonic approach is required in writing the inference rules. We use Reiter's default logic [5]. The inference rules belong to two categories:

- Material implications of the form : $A \rightarrow B$, where A is a conjunction of literals and B is a literal.
- Defaults; we have normal defaults of the form $\frac{A:B}{B}$ (abbreviated by writing $A : B$), and semi-normal defaults of the form $\frac{A: B \wedge C}{B}$ (abbreviated by writing $A : B [C]$), where A and C are conjunctions of literals and B is a literal.

We define a kernel of a few semantic predicates such that all anomalies can be expressed in terms of these predicates. Thus, the reasoning process converges into the kernel predicates, and stops when the primary anomaly is found. The kernel contains six (reified) predicates:

$Holds(stop, A, T)$: the vehicle A is stopped at time T .

$Holds(run_slowly_enough, A, T)$: the speed of the vehicle A is adapted at time T .

$Holds(control, A, T)$: the vehicle A is controlled by its driver at time T .

$Holds(move_back, A, T)$: the vehicle A moves back at time T .

$Holds(combine(Disruptive_Factor, X), A, T)$: there is some disruptive factor X for the vehicle A at time T .

Let us now give some examples of inference rules and their application to our example to infer the primary anomaly. The semantic predicates obtained are those given in section IV.

The rule: $Holds(combine(bump, V), W, T) \rightarrow \neg Holds(stop, W, T)$ means that if W bumps V at time T , then W is not stopped at time T . Its application on the example gives : $\neg Holds(stop, B, 2) (V = A, W = B, T = 2)$.

The rule: $Holds(combine(bump, V), W, T) \rightarrow Holds(combine(shock, V), W, T)$ which means that if W bumps V at time T then there is a shock between V and W at this time T enable to deduce $Holds(combine(shock, A), B, 2) (V = A, W = B, T = 2)$.

The following default expresses that in general, if there is a shock between V and W at time T and the shock position of V is its back, then W was the follower of V in the same file at time $T-1$. This rule is inhibited if W has not the control. By applying this default we infer : $Holds(combine(follows, A), B, 1) (V = A, W = B, T = 2)$.

$$Holds(combine(shock, V), W, T) \wedge Holds(combine(shock_pos, back), V, T) : \\ Holds(combine(follows, V), W, T-1) [Holds(control, W, T-1)]$$

We are now ready to infer B 's duty to stop at time 1 i.e. $Must(stop, B, 1)$ (with $V = A, W = B, T = 1$) :

$Holds(combine(follows, V), W, T) \wedge Holds(stop, V, T) \rightarrow Must(stop, W, T)$. The meaning of this rule is: if W follows V in a file at time T , and at that time V stops, then W must stop too in order to avoid a crash.

To infer the ability of B to stop at T , we use the following basic inference rule:

$$Able(E, A, T) \leftrightarrow (\exists Act) Action(Act) \wedge Pcb(Act, E) \wedge Available(Act, E, A, T)$$

This rule means that an agent A is able to reach some effect E at time T , if and only if there is some action Act that is a potential cause of E (Pcb means 'potentially caused by'), and Act is available to A to reach E at time T . The set of actions, effects and potential causes are stored in static data bases (for example, the data base contains $Pcb(brake, stop)$ to express that stopping is potentially caused by braking). Moreover, we have a default which states that in general, actions are available for the agents to reach the corresponding effects. This rule has a number of exceptions expressed by material implications that inhibit the default [2]. In our case, none of the exceptions is verified. Thus, we obtain: $Available(brake, stop, B, 1)$ and consequently $Able(stop, B, 1)$.

Finally, by applying the first form of a primary anomaly, we can infer the predicate $P_Anomaly$ and the cause of the accident is that " B did not stop at a time where s/he had to stop".

VI. Implementation

To implement the reasoning system, we are using *SMODELS*², an answer set programming language based on the stable model semantics [1]. To give a general idea about the method used to transform default logic rules into *SMODELS* rules we consider the following simple cases where A, B, C are reified first order literals³.

- A material implication $A \rightarrow B$ is translated into the couple of rules: $B :- A.$ and $\neg A :- \neg B$ (for contraposition)
- A normal (resp. semi-normal) default $A : B$ (resp. $A : B [C]$) is transformed into the rule: $B :- A, \text{not } \neg B.$ (resp. $B :- A, \text{not } \neg B, \text{not } \neg C.$)

We have tested our approach on a corpus of 60 short texts (the average length of the texts of the corpus is about 3 lines). For each text, the reasoning system gives successfully the desired primary and derived anomalies. The number of inference rules used actually in the reasoning system is about 200 rules and the answer time varies according to the text between 6 and 30 seconds. Among other things, the answer time depends on the number of time intervals and the number of agents considered in a given text. The former number varies in the corpus between 2 and 6 time intervals whereas the second one varies between 1 and 4 agents.

VII. Conclusion and perspectives

We propose in this work a non-monotonic reasoning system that uses the norms of the car-driving domain to infer automatically the cause of an accident from its textual description. The relationship between the notions of norm and cause is established by considering the cause of the accident as being the most specific norm which has been violated in the text. The next step of our work is to complete the validation of the approach on the remainder of the corpus; then we will finish the implementation of the last part of the system which deals with the linguistic reasoning. We hope in a longer term perspective to generalize the approach to other domains and to explore the idea of indexing textual documents using the norms of their domains.

References

- [1] Gelfond, M and Lifschitz, V. The Stable Model Semantics for logic programming. In *Proceedings/Actes, 5th International Conference on Logic Programming*, pages 1070-1080, 2004.
- [2] Kayser, D and Nouioua, F. Representing Knowledge about Norms, In *Proceedings/Actes, 16th ECAI Conference*, pages 363-367, 2004.
- [3] Kayser, D and Nouioua, F. About Norms and Causes, *International Journal on Artificial Intelligence Tools*. Special Issue on FLAIRS 2004, 14(1 & 2), To appear, 2005.
- [4] McDermott, D.V. A Temporal Logic for Reasoning about Processes and Plans *Cognitive Science* 6, pages 101-155, 1982.
- [5] Reiter, R. A Logic for Default Reasoning, *Artificial Intelligence, Special Issue on Nonmonotonic Logic*, 13(1-2), pages 81-132, 1980.
- [6] Schank, R.C and Abelson, R.P. *Scripts, Plans, Goals and Understanding* Lawrence Erlbaum Ass, 1977.

² *SMODELS* and its front-end *LPARSE* are available in the web page: <http://www.tcs.hut.fi/Software/smodels/>

³ ‘ \neg ’ stands for the hard negation and ‘*not*’ stands for negation by failure.

Adaptation du modèle de Rooth pour le calcul de la restriction en français

Céline Raynal

Université Paris 7 – LaTTICe

Introduction

Cet article se situe dans une perspective plus large d'un travail sur le calcul de la restriction en français. L'expression de la restriction, qui se fait notamment, mais pas exclusivement, par *seul*, *seulement* et *ne que*, a la particularité de véhiculer le sens de deux façons distinctes. Dans une phrase, l'item restrictif déclenche une présupposition qui correspond à la dénotation de la phrase sans cet item, tandis que l'information assertée porte la restriction en tant que telle. Ainsi, (1a) présuppose (1b) et asserte (1c) :

- (1) a. Seule Lili a eu un poste.
 b. Lili a eu un poste.
 c. Si quelqu'un a eu un poste, c'est Lili et personne d'autre.

Nous nous intéressons ici au modèle de Mats Rooth ([Rooth, 1985], [Rooth, 1992]), qui propose un principe d'interprétation du focus, en se penchant notamment sur *only* (item de restriction en anglais, considéré dans la littérature comme sensible au focus). Après avoir présenté le modèle général (section 1), nous verrons comment s'en servir dans notre calcul de la restriction et les modifications à y apporter (section 2). Nous évoquerons enfin notre point de vue concernant le focus, qui se distingue de celui de Rooth, et quelques distinctions entre anglais et français qui vont devoir être traitées (section 3).

1 Modèle

Notons tout d'abord que Mats Rooth postule deux dimensions de sens : une "ordinaire" (*ordinary semantic value*, notée $\| \|^o$), et une " focale " (*focus semantic value*, notée $\| \|^f$). Pour une phrase avec un élément focalisé particulier, la valeur focale correspond à l'ensemble des propositions obtenues à partir de la valeur ordinaire, dans laquelle l'élément focalisé est remplacé par une variable. Ainsi, pour la phrase (2a), la valeur ordinaire correspond à (2b), tandis que la valeur focale est l'ensemble des alternatives (2c).

- (2) a. $[_S \text{ Ben}_F \text{ est venu}]$
 b. $\|S\|^o = \text{venir}(b)$
 c. $\|S\|^f = \{\text{venir}(lili), \text{venir}(jo), \text{venir}(zoe), \dots\}$

La représentation de *only* combiné avec un VP (3) est la suivante :

- (3) a. $[_S \text{ Mary only VP}]$
 b. $\forall P[[P \in C \wedge P(m) \rightarrow P = \|\text{VP}\|^o]]$

Pour toute propriété P faisant partie de l'ensemble C , et s'appliquant à m (Mary), P est égale à la valeur ordinaire du VP. L'ensemble C est l'ensemble qui sert de domaine de quantification à l'opérateur ; il est identifié en partie par le focus et en partie par

la pragmatique¹. C'est pourquoi, Rooth insiste sur le fait que cet ensemble est un sous-ensemble de la valeur focale du VP, est *inclus* dans l'ensemble des alternatives, et non parfaitement identique à lui : $C \subseteq ||VP||^f$.

La partie du sens (3b) donnée par Rooth correspond à l'assertion de la phrase (3a) ; la formulation de la partie présupposée n'est pas mentionnée explicitement mais correspond à la valeur ordinaire du prédicat associée à celle de l'argument : $||VP||^o(m)$. Dans son résumé de la théorie des alternatives, [von Heusinger, 1998] fait quant à lui mention de la présupposition qui apparaît aux côtés de l'assertion (en **gras** ici) :

$$(4) \ ||onlyVP||^o = \lambda x[||VP||^o(x) \ \& \ \forall P \in ||VP||^f [P(x) \rightarrow P = ||VP||^o]]^2$$

2 Application

Afin de voir le résultat du traitement, et dans la mesure où ce dernier fonctionne quasiment de la même manière pour le français et l'anglais, nous proposons un exemple sur des données du français (5), équivalentes à celles proposées par Rooth en anglais :

- (5) a. Zoé [_{VP} a seulement [_{VP} présenté Ben_F à Lili]].
 b. $\forall P[[P \in \{\lambda x[pres(x, y, l)] \mid y \in E\} \wedge P(z) \rightarrow P = \lambda x[pres(x, b, l)]]$ (à la Rooth)
 c. $pres(z, b, l) \ \& \ \forall P \in \{\lambda x [pres(x, y, l)] \mid y \in E\}[P(z) \rightarrow P = \lambda x[pres(x, b, l)]]$
 (repris par von Heusinger : ajout de la présupposition)

Notons la présence de l'ensemble E auquel appartient la variable y . Il regroupe les alternatives de l'élément focalisé ($\{Jo, Paul, \dots\}$), et est caractérisé par le type de ces alternatives, identique au type de l'élément focalisé, (ici, E regroupe ainsi des éléments de type $\langle e \rangle$).

A partir d'une phrase où le focus est repéré, Rooth propose donc une représentation de la restriction (5b) sans faire mention de la présupposition, contrairement à von Heusinger qui l'ajoute au modèle de son prédécesseur (5c), en l'introduisant sur le même plan que l'assertion, les deux informations seulement liées par $\&$. Cette différence entre Rooth et von Heusinger concernant la présupposition n'apparaît toutefois pas comme fondamentale dans la mesure où von Heusinger ne l'exploite pas.

Or, nous nous inscrivons dans la tradition selon laquelle il est préférable de séparer le présupposé du posé afin de mieux rendre compte des problèmes liés à la projection des présuppositions ([Karttunen and Peters, 1979], [van der Sandt, 1992], [Kamp, 2001]). Traditionnellement, si une phrase P, qui présuppose S, est enchâssée dans une phrase Q, alors Q présupposera S. Or ce n'est pas toujours le cas, certains contextes bloquent la présupposition qui, bien que véhiculée par la phrase enchâssée, ne l'est pas par la phrase enchâssante ([Karttunen, 1973]). Le traitement de l'information présupposée d'une phrase est donc soumis à des contraintes qui lui sont propres et se fait en lien avec le contexte avant, au moins autant qu'avec l'assertion qui l'accompagne. C'est en cela que les structures bipartites répondent mieux que les autres à ce que demande ce traitement : avoir un accès direct à la présupposition.

Selon la théorie de Rooth, tout élément a un sens ordinaire et un sens focal. Nous proposons d'ajouter une troisième partie de sens afin de mettre en évidence l'apport présuppositionnel. Dans de nombreux cas, cette dimension sera vide ; elle permettra en revanche

¹ Cela permet de régler les problèmes d'intersection de sens : *Paul a seulement ronflé cette nuit*. Il n'a rien fait d'autre... or il a dormi. La pragmatique intervient à ce niveau pour contraindre l'ensemble C .

² La relation d'inclusion (et donc la distinction) entre C et $||VP||^f$ n'est pas mentionnée.

de mettre en évidence la double contribution d'un item déclencheur de présupposition. Pour [*only VP*] nous avons :

$$(6) \begin{aligned} \|\text{only VP}\|^o &= \forall P \in \|\text{VP}\|^f [P(x) \rightarrow P = \|\text{VP}\|^o] \\ \|\text{only VP}\|^f &= -^3 \\ \|\text{only VP}\|^{\text{psp}} &= \|\text{VP}\|^o \end{aligned}$$

Tandis que pour le VP seul [*présenté Ben_F à Lili*], nous avons :

$$(7) \begin{aligned} \|\text{VP}\|^o &= \lambda x[\text{pres}(x, b, l)] \\ \|\text{VP}\|^f &= \{\lambda x[\text{pres}(x, y, l)] \mid y \in E\} \\ \|\text{VP}\|^{\text{psp}} &= - \end{aligned}$$

Au fur et à mesure des combinaisons, la valeur ordinaire va être incrémentée systématiquement, tandis que les valeurs focale et présuppositionnelle pourront rester les mêmes d'une étape à une autre si le nouvel élément combiné n'est pas focalisé ou n'est pas présuppositionnel. A la fin du traitement, une phrase *S* aura donc ses trois valeursinstanciées : $\|S\|^o$ (la valeur ordinaire, l'assertion), $\|S\|^f$ (la valeur focale) et $\|S\|^{\text{psp}}$ (la présupposition). La présupposition est ainsi accessible, caractère primordial lors de la projection ou même plus simplement lors de la justification⁴. L'intérêt de cette extension du modèle de Rooth avec une dimension présuppositionnelle est qu'elle s'appuie sur les deux dimensions déjà proposées, les laissant toutefois accessibles elles aussi, disponibles lorsque les traitements le nécessitent.

3 Commentaires

Si cette extension de Rooth ne paraît pas poser de problèmes majeurs, il faut impérativement noter que toute cette analyse repose sur le fait que *only* est envisagé comme un item sensible au focus, principe largement admis dans la littérature, bien qu'il ait été remis en question par ([Vallduvi and Zacharski, 1994]). A leur suite, et en ce qui concerne le français, nous avons montré ([Gendrot and Raynal, 2004]) que cette théorie de la sensibilité au focus ne fonctionne pas. En effet, si la sémantique de l'adverbe nécessite un ensemble d'alternatives, cet ensemble n'est pas automatiquement celui donné par le focus (en tant qu'information nouvelle dans la phrase), même si cela peut être le cas comme en (8) où l'adverbe porte sur le constituant focalisé qui répond à une question :

- (8) – Où Anouck a-t-elle rencontré des argentins ?
– Elle a seulement rencontré des argentins [en cours de math].

Ce cas de figure n'est cependant pas le seul, les alternatives peuvent très bien apparaître dans le contexte, la situation d'énonciation, etc. L'argument de *seulement* n'est alors pas un élément nouveau (focus) et appartient à l'ensemble d'alternatives donné précédemment :

- (9) – Cette année, Anouck avait un cours de statistiques, un cours de math et un de philo. Il paraît qu'il y avait beaucoup d'étudiants d'Amérique du Sud. Je crois qu'elle a rencontré des argentins dans ces cours...

³ Ni Rooth, ni von Heusinger ne précise l'identité de cette valeur à ce niveau d'analyse. On peut supposer qu'elle reste la même que pour le VP puisque *only* n'est pas focalisé, et ainsi de suite au fil des combinaisons.

⁴ On entend par justification, la vérification de la présupposition en contexte (pour un récapitulatif : [Beaver, 1996]).

- Elle a seulement rencontré des argentins [en cours de math].

A la différence de Rooth, nous ne basons donc pas l'analyse et le traitement sur le constituant de la phrase qui porte le focus, mais sur celui qui joue le rôle d'argument de l'item restrictif.

Nous pouvons noter par ailleurs que la place de l'adverbe est différente entre l'anglais et le français. En effet, si *only* peut être antéposé au VP tout en portant sur lui, *seulement* se place majoritairement entre l'auxiliaire et le verbe au participe passé lorsque le temps est composé, ou après le verbe à la forme simple : ce qui le place à l'intérieur du VP. Ce problème de surface semble pouvoir être résolu en conservant le principe de Rooth selon lequel le nœud de l'adverbe est le frère de celui du VP dans l'arbre syntaxique. Il mérite toutefois que l'on s'y penche plus précisément, notamment lorsque la lexicalisation de la restriction passe par *ne que* en français.

Bibliographie

- [Beaver, 1996] Beaver, D. (1996). Presupposition. In van Benthem, J. and ter Meulen, A., editors, *Handbook of Logic and Language*, pages 939–1008. Elsevier, Amsterdam.
- [Gazdar, 1979] Gazdar, G. (1979). *Pragmatics: Implicature, Presupposition, and Logical Form*. Academic Press, New York.
- [Gendrot and Raynal, 2004] Gendrot, C. and Raynal, C. (2004). Seulement, la portée de l'adverbe et la sensibilité au focus : réalisation prosodique et statut sémantique. Manuscrit.
- [Jackendoff, 1972] Jackendoff, R. (1972). *Semantic interpretation in generative grammar*. The MIT Press, Cambridge.
- [Kamp, 2001] Kamp, H. (2001). Presupposition computation and presupposition justification: one aspect of the interpretation of multi-sentence discourse. In Bras, M. and Vieu, L., editors, *Semantic and Pragmatic Issues in Discourse and Dialogue. Experimenting with Current Dynamic Theories*, Current Research in the Semantics/Pragmatics Interface, pages 57–84, Oxford. Elsevier.
- [Karttunen, 1973] Karttunen, L. (1973). Remarks on presuppositions. Unpublished manuscript, University of Texas at Austin.
- [Karttunen and Peters, 1979] Karttunen, L. and Peters, S. (1979). Conventional implicature. In Oh, C. and Dineen, D. A., editors, *Syntax and Semantics II: Presupposition*, pages 1–56. Academic Press, New York.
- [Rooth, 1985] Rooth, M. (1985). *Association with focus*. PhD thesis, University of Massachusetts, Amherst.
- [Rooth, 1992] Rooth, M. (1992). A theory of focus interpretation. *Natural Language Semantics*, 1(1):75–116.
- [Vallduvi and Zacharski, 1994] Vallduvi, E. and Zacharski, R. (1994). Accenting phenomena, association with focus, and the recursiveness of focus-ground. In Dekker, P. and Stokhof, M., editors, *Proceedings of the Ninth Amsterdam Colloquium*, pages 683–702, Amsterdam. ILLC.
- [van der Sandt, 1992] van der Sandt, R. A. (1992). Presupposition projection as anaphora resolution. *Journal of Semantics*, 9:333–377.
- [von Heusinger, 1998] von Heusinger, K. (1998). *Association with Focus in Definite NPs*. University of California, Santa Cruz.

A flexible deductive account of wh-question formation

W.K.Vermaat (Willemijn.Vermaat@let.uu.nl)

Utrecht Institute of Linguistics, OTS

1 Introduction

Cross-linguistically, meaning assembly of wh-question formation has a uniform basis, though many languages have different structural realizations for the placement of wh-phrases. In loose terms, a wh-question is interpreted as a sentence which still requires an answer which can serve either as an argument of the main or embedded verb clause or as a verbal or sentential modifier depending on the kind of wh-phrase. In more formal terms, the semantic term computed for a wh-question bears an abstraction over a variable of the type of the questioned constituent where the abstractor binds the variable in the term that is computed for the body of the question. Expressed as lambda term, the meaning assembly of the wh-question ‘*Who saw Mary?*’ may be represented as: $\lambda x.((\text{see } \mathbf{m}) x)$. In Vermaat (Forthcoming), we argue that the recipe for such meaning assembly of wh-question formation is invariant, whereas the structural realizations can vary.

In this presentation, we limit the analysis of wh-question formation to wh-phrases that require an answer that fulfills the argument requirements of the main verb. We show that we can account for flexibility in required answer types while ensuring a uniform meaning assembly on the basis of a uniformly defined wh-operator type schema for wh-phrases. The approach is based on the *structured meaning approach* to the semantics of questions proposed by Krifka (2001). The structured meaning approach is a compositional view on the semantics of questions and captures the idea that the meaning of a wh-question is determined by its possible answers.

To describe the syntactic and semantic dependency of a wh-question on its answer requires a flexible approach to the analysis of wh-questions: interrogative pronouns have to be flexible and not uniformly defined. Groenendijk and Stokhof (1994) refer to this view as “the polymorphic stance”. We propose a flexible account of wh-question formation in the multimodal variant of type-logical grammar. We will show that the polymorphism follows from our account which is based on a logical invariant but structurally flexible reasoning system.

2 The basics

Multimodal categorial grammar (= MMCG), a version of type-logical grammar, is a lexicalized grammar system; derivations are driven by the types assigned to the lexical elements. In a very crude way, we can distinguish two parts which give us a way to express the possible variation in natural language: an invariant logical part and a flexible structural part. (For a more elaborate overview, look at Moortgat (1996).) The two components form the basis of a powerful grammatical reasoning system. The logical and structural reasoning system applies to structured expressions whose subparts are taken from a lexicon. A lexicon consists of basic expressions with type-assignments that describe the syntactic and semantic use of an expression. We first shortly discuss the invariant logical part of the grammatical reasoning system. Secondly, we provide the components of the flexible structural part. Thirdly, we briefly introduce the basics of meaning assembly in type-logical grammar.

Invariant logical part Lexical type formulas (Typ) are inductively built from binary and unary operators on atomic type formulas (Atom). We may distinguish a number

of different modes of composition which are indicated by indices (i, j) . The indices are added to differentiate between distinct structural compositions.

$\text{Typ} ::= \text{Atom} \mid \text{Typ}/_i \text{Typ} \mid \text{Typ} \bullet_i \text{Typ} \mid \text{Typ} \backslash_i \text{Typ} \mid \square_j \text{Typ} \mid \diamond_j \text{Typ}$

The deductive system comes with a complete set of logical rules for these connectives¹, and a direct semantic interpretation for the binary operators (functional application and lambda abstraction). In a natural deduction style presentation the set of logical rules are the elimination and introduction rules of the binary and unary operators. In this presentation, we foremost concentrate on the logical rules of the two slashes, $/$ and \backslash . The elimination rules combine lexical elements with unique type-assignments into larger structures. The introduction rules cause the extraction of an hypothesis from a structure. Complex expressions are derived by recursively applying the logical rules to the lexical type formulas. The expressions are represented as binary tree structures which reflect the linear and hierarchical order as defined in the lexical type-assignments. To allow structural variation, we need to enhance the deductive system with a structural rules.

Flexible structural part Moortgat (2001) explores a set of structural postulates that he uses to derive extraction phenomena. The key idea is that only elements which are decorated with a structural \diamond feature are allowed to move out or into a structure. These postulates can be seen as structural operations that can move a certain element or phrase in a specific structural domain to either the left or a right edge of the structure. The postulates are controlled versions of the restructuring postulates: *associativity* and *mixed commutativity*. The rules are controlled by the placement of unary connectives on the substructure that is being displaced. The following two postulates are the left displacement postulates. Shifting the \diamond decorated arguments from the left to the right yield the right displacement postulates.

$$\begin{aligned} \diamond A \bullet (B \bullet C) \vdash (\diamond A \bullet B) \bullet C & \quad [\text{Whl1}] \\ \diamond A \bullet (B \bullet C) \vdash B \bullet (\diamond A \bullet C) & \quad [\text{Whl2}] \end{aligned}$$

Meaning assembly Based on the Curry-Howard isomorphism, each expression has a meaning assembly represented as a semantic term in the lambda calculus. The semantic term encodes the derivational steps that have led to the composition of the complex expression. Each lexical element receive a semantic term that reflects the semantic relation of the expression to other expression. The structural component is independent of the meaning assembly. Any restructuring of the expression has no direct effect on the semantic term.

3 Type assignments

The deductive system of MMCG with its complete set of logical derivation rules and the above package of structural reasoning rules is completely lexicalized. Any phenomena is determined by the lexical type-assignments of the basic components. In composition, due to the logical requirements and structural restrictions, the basic expressions form complex grammatical expressions, while ungrammatical expressions do not have a derivation.

¹The set of logical rules comes with a Kripke style interpretation, and is complete with respect to this 'structural' semantics. In comparison Steedman's Combinatory Categorical grammar is incomplete, as it does not have general support for hypothetical reasoning. The multimodal variant of CCG in Baldridge (2002) inherits this incompleteness.

Types for wh-questions Wh-questions are typed as sentences which still require an answer: $s/\text{?}A$ where A is the type formula of the answer that is required. The index ? is added to the binary connective to capture the compositional difference between heads and arguments on a sentential level and between questions and answers on a discourse level. The most salient answer type for wh-questions that require an argument type as an answer is gq which is a type abbreviation for generalized quantifiers: $s/(np \setminus s)$. An np -typed argument phrase can always be lifted to a gq type.

Wh-operator types For the type assignment of wh-phrases, we propose the following type schema $\text{WH}(A, B, C)$. The wh-operator is similar to the q -operator, $q(A, B, C)$, which was proposed by Moortgat (1991) to account for in-situ binding of generalized quantifier phrases. The three place operator WH ranges over three arguments: A indicates the type of the argument position that is bound by the wh-operator, B is the type of the domain where the bound argument originates. After applying the wh-operator type to a binding domain B , the domain changes into a domain of type C . Generalizing over different structural instances of the wh-operator, the corresponding application rule for the type schema along with its semantic decomposition is the following (where wh is a semantic term variable for the lexical semantic term assigned to wh-phrases):

$$\frac{\Gamma \vdash wh : \text{WH}(A, B, C) \quad \Delta[x : A] \vdash t[x] : B}{\Delta'[\Gamma] \vdash (wh \lambda x.t[x]) : C} \text{ [WHE]}$$

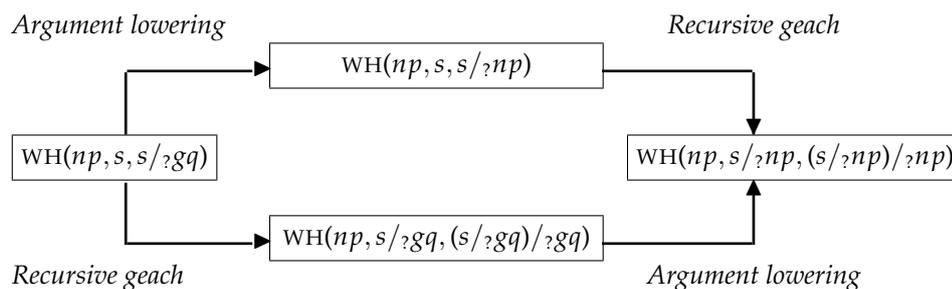
A typical wh-phrase such as 'who' appears fronted in a single constituent question. The wh-phrase is assigned wh-operator type: $\text{WH}(np, s, s/\text{?}gq)$ with lexical semantics $\lambda P^{et}.\lambda Q^{(et)t}.(Q P)$. On the basis of this type, a wh-question such as **Who saw Mary** $\vdash s/\text{?}gq$ has the following derivation:

$$\frac{\lambda P.\lambda Q.(Q P) : \text{who} \quad \text{WH}(np, s, s/\text{?}gq) \quad \begin{array}{c} [x : np] \\ \vdots \\ x : np \circ (\text{saw} \circ \text{mary}) \vdash ((\text{see m}) x) : s \end{array}}{\text{who} \circ (\text{saw} \circ \text{mary}) \vdash \lambda Q.(Q \lambda x.((\text{see m}) x)) : s/\text{?}gq} \text{ [WHE]}$$

John $\vdash j : np$, after being type lifted, and **everybody** $\vdash \forall : gq$ can both serve as answers to this single constituent question.

4 Flexible types

In combinatorial categorial grammar (Steedman, 1987), sets of constrained theorems form the basis of the grammar system. In multimodal categorial grammar, we do not add such theorems to the reasoning system. Any type-shift in the lexical type assignment of expressions must be derivable in the deductive system. On the basis of the multimodal framework, the logical constant derivation rules and the set of uniformly defined structural rules, the following derivability pattern between different instances of the WH -operator type schemata is obtained:



5 Analysis of the data

The above derivability pattern between wh-operator type schemata is used to determine the minimal type assignment for each individual wh-phrase. In the poster presentation, we present some data of English and Serbo-Croatian to explain the use of the wh-operator type schema and the derivability patterns among the type schema. A single constituent questions such as ‘Which man did Mary see?’ requires a single definite answer, whereas a multiple wh-question such as ‘Who sees whom?’ requires a pair of answers that may be used as arguments to the verb phrase ‘to see’.

To derive these wh-questions, the definite interrogative phrase ‘which’ receives a minimal type assignment of a wh-operator with a lowered answer type: $WH(np, s, s/?np)$. While the lexical variant of ‘whom’ that is used as a wh-in-situ phrase receives a minimal type-assignment of a recursively geached wh-operator: $WH(np, s/?gq, (s/?gq)/?gq)$. The wh-in-situ type is applied to a domain of type $s/?gq$ which is the type assigned to single wh-questions. The result structure ‘Who sees whom?’ is typed as a wh-question which requires a pair of answers: $(s/?gq)/?gq$. A similar derivability patterns between wh-operator types applies to wh-question constructions in Serbo-Croatian. Serbo-Croatian is a multiple wh-fronting languages and differs structurally from English. We use the flexible structural reasoning facilities to account for these structural differences.

6 Conclusion

We give empirical and proof-theoretical evidence for a uniform account of the syntactic and semantic properties of wh-question formation in multimodal categorial grammar. The syntactic variation between wh-phrases is merely a distinction on lexical grounds expressed by the minimal type assignment which limits the flexibility of the wh-operator type. The uniform semantic realization of wh-questions is a direct result of typing the wh-phrases uniformly as higher-order wh-operator types.

References

- Baldridge, J. (2002). *Lexically Specified Derivational Control in Combinatory Categorial Grammar*, PhD thesis, University of Edinburgh.
- Groenendijk, J. and Stokhof, M. (1994). *Questions*, Vol. handbook of logic and language, Elsevier, chapter 19, pp. 1–70.
- Krifka, M. (2001). For a structured meaning account of questions and answers, in C. Fery and W. Sternefeld (eds), *Audiatur Vox Sapientia. A Festschrift for Arnim von Stechow*, Akademie Verlag, Berlin, pp. 287–319.
- Moortgat, M. (1991). Generalized quantifiers and discontinuous type constructors, in W. Sijsma and A. van Horck (eds), *Discontinuous constituency*, De Gruyter.
- Moortgat, M. (1996). Categorial type logics, in J. van Benthem and A. ter Meulen (eds), *Handbook of Logic and Language*, Elsevier and MIT Press, Amsterdam and Cambridge MA, chapter 2, pp. 93–177. ([pdf](#)).
- Moortgat, M. (2001). Structural equations in language learning, in P. de Groote (ed.), *Lecture notes in Computer Science*, Proceedings LACL 2001 edn, Springer-Verlag, pp. 1–16.
- Steedman, M. J. (1987). Combinatory grammars and parasitic gaps, *Natural Language and Linguistic Theory* 5: 403–439.
- Vermaat, W. (Forthcoming). *Wh-question formation: hypothetical reasoning and structural control*, PhD thesis, Utrecht University, UiL-OTS.