Semantics of VP coordination in LTAG

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Abstract

This paper proposes to give an analysis of VP coordination in the LTAG semantics framework of (Kallmeyer and Joshi, 2003). First the syntax of VP coordination is described using an operation called *conjoin*. Then we discuss interactions of coordination scope and quantifier scope in simple sentences and their analysis in LTAG. Finally we point out coordination scope ambiguities in embedded sentences that present a problem for the present analysis.

1 Introduction

Perhaps the most natural account of coordination is given in Combinatory Categorial Grammar where the fact that sentences are assigned ambiguous structures not only provides an explanation for all kinds of coordination constructions but also leads to a fully compositional and appropriate semantics.

(Joshi and Schabes, 1991) and (Sarkar and Joshi, 1996) have shown that it is possible to provide a CCG-like account for coordination while preserving the fixed phrase structure of LTAGs by introducing a notion of derivation that allows for the flexibility needed for handling coordination phenomena.

This paper proposes a compositional semantics for VP coordination in LTAG using the notion of derivation as defined by (Sarkar and Joshi, 1996).

The term VP coordination is not fully appropriate to describe the range of phenomena considered here which also includes V- and S-coordination. We will use the term VP coordination to describe coordination phenomena that requires the identification of the shared arguments of two (verbal) predicates.

2 Background

2.1 Syntax of Coordination in LTAG

Because of the locality of arguments in LTAG, it is necessary to introduce a notion of argument sharing in order to handle coordination in this framework.

Making the notation of substitution and adjunction explicit, (Sarkar and Joshi, 1996) represent LTAG trees as an ordered pair of a tree structure and an ordered set of substitution/adjunction nodes from its frontier (see Fig. 1).

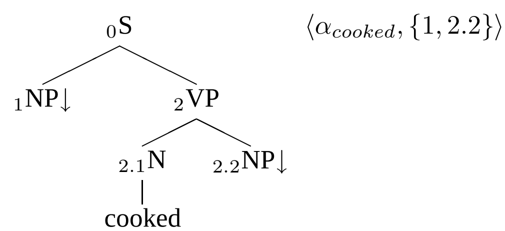

Figure 1: α_{cooked} represented as an ordered pair

Identification of shared arguments is achieved through building contraction sets with the operation *build-contraction*.

Build-contraction takes an elementary tree $\langle \gamma, S \rangle$, places a subset $s \subset S$ from its second projection into a contraction set and assigns the difference $S - s$ to the second projection of the new elementary tree: $\langle \gamma', S - s \rangle$. For example, applying build-contraction to the NP node at address 2.2 in the tree $\langle \alpha_{cooked}, \{1, 2.2\} \rangle$ yields a tree with contraction set $\{2.2\}$: $\langle \alpha_{cooked\{2.2\}}, \{1\} \rangle$ ($\alpha_{cooked\{2.2\}}$ for short). The output of *build-contraction* is shown on Fig.(2).

Coordination is handled by a general coordination schema illustrated in Fig. 3 and a new operation called conjoin (in addition to substitution and adjunction). Conjoin takes three trees and combines them to give a derived tree. One of the trees is always obtained by spe-

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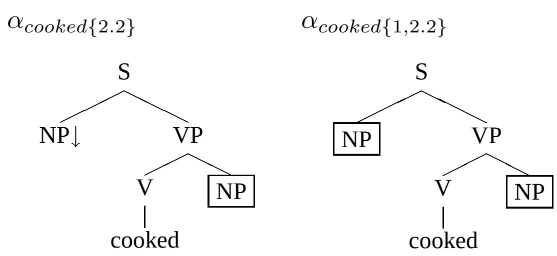

Figure 2: Output of build-contraction

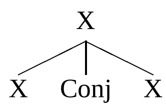

Figure 3: Coordination schema

cializing the coordination schema for a particular category and lexicalizing it with the conjunction. The two trees being coordinated are substituted into the conjunction tree in a special way: the node that is substituted into the conjunction tree is not necessarily the root node but can be some internal node, given by an algorithm called *FindRoot*. *FindRoot* takes into account the contraction sets of the two trees and returns the lowest node dominating all nodes in the second projection of the elementary tree. E.g. FindRoot($\alpha_{cooked\{1,2.2\}}$) will return node address 2.1, corresponding to the *V Conj V* instantiation of the coordination schema, FindRoot($\alpha_{cooked\{1\}}$) will return address 2, corresponding to *VP Conj VP* and FindRoot($\alpha_{cooked\{2.2\}}$) will return the root node, corresponding to *S Conj S* coordination.

The conjoin operation substitutes two elementary trees, T_1 and T_2 into an instance of the coordination schema C using the FindRoot algorithm, creates edges between identical nodes in the contraction sets of T_1 and T_2 and contracts each edge. For example, applying conjoin to Conj(and), $\alpha_{eats\{1\}}$ and $\alpha_{drinks\{1\}}$ gives the derivation tree and derived structure in Fig. 4 and Fig. 5.

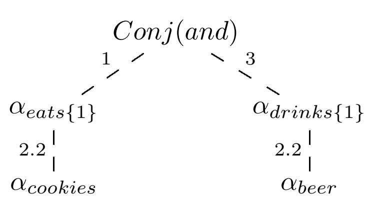

Figure 4: Derivation tree

The contraction set corresponds to a set of arguments that remain to be supplied to a functor. A node in a derivation tree with a non-empty contraction set indicates that

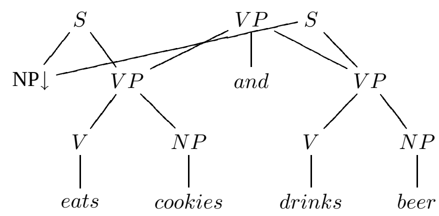

Figure 5: Derived structure

the derivation is incomplete.

A consequence of introducing contraction and the conjoin operation is that the derivation tree has to be extended to an acyclic derivation graph. If a contracted node in a tree (after the conjoin operation) is a substitution node, then the argument is recorded as a substitution into both elementary trees simultaneously as illustrated in Fig. 6.

(1) Chapman eats cookies and drinks beer

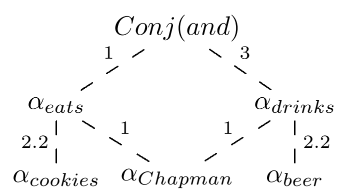

Figure 6: Derivation tree for (1)

An alternative way of viewing the conjoin operation is as a construction of an auxiliary structure from an elementary tree. For example, the conjoin operation would create $\langle\beta_{drinks\{1\}}, \{2.2\}\rangle$ from the elementary tree $\langle\alpha_{drinks}, \{1, 2.2\}\rangle$. In this case, the adjunction operation would create contractions between nodes in the contraction sets of the two trees it applies to.

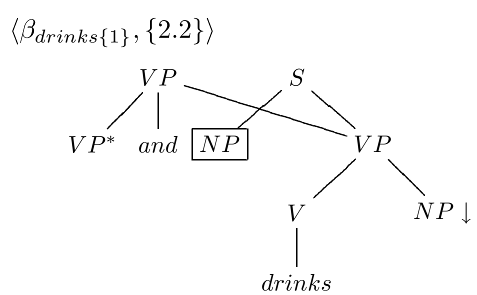

Figure 7: Representing *conjoin* as adjunction

Although this approach requires the same machinery to determine the instantiation of the coordination schema

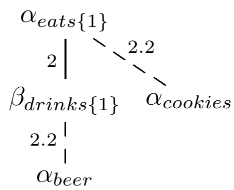

Figure 8: *Conjoin* as adjunction - derivation tree

and to identify shared arguments, it has the advantage that it only uses the traditional LTAG operations of substitution and adjunction. A consequence of this perspective is that the right conjunct is treated as a kind of "modifier" on the left conjunct.

Since we associate semantic representations with individual elementary trees in the lexicon, creating a semantics "on the fly" for the second conjunct combined with the tree for coordination seems less attractive than selecting three elementary trees from the lexicon and combining them with the conjoin operation.

In the rest of the paper we will use the *conjoin* operation to represent the syntax of coordination.

2.2 Semantics in LTAG

We give an analysis in a variant of (Kallmeyer and Joshi, 2003)'s framework. Basic semantic representations are associated with individual elementary trees in the lexicon. They consist of a set of formulas, a set of scope constraints of the form $x \geq y$ (where x,y are propositional labels or propositional variables) and semantic feature structures linked to specific node addresses in the elementary tree (see Kallmeyer and Romero, this volume). Each feature structure linked to a node in the elementary tree consists of a top and a bottom feature structure. Each top and bottom feature structure consists of a feature p and a feature i. The possible values of p are propositional labels and propositional variables, and the possible values for i are individual variables.

Compositional semantics is computed based on the derivation tree. At a substitution or adjunction step, the feature structures are unified just like in a feature-based LTAG (see (Vijay-Shanker and Joshi, 1991))[1]

These unification operations result in value-assignments to some of the variables in the elementary semantic representations. At the end of the derivation, some of the variables will not be assigned a value, therefore the final representation will be underspecified.

The constraints in the final representation specify a partial order on variables and labels (corresponding to the partial ordering on holes and labels in (Kallmeyer and Joshi, 2003)). Disambiguation is performed by assigning values to the remaining variables.

Quantifiers are assigned a multicomponent representation that contains an empty scope tree and a regular NP tree for predicate argument structure[2]. Fig.9 shows the derivation tree for a sentence containing two quantifiers.

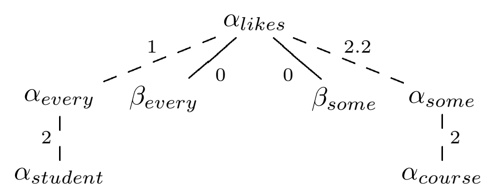

Figure 9: Derivation tree for *"Every student likes some course"*

Following (Kallmeyer and Romero, 2004) (this volume), the semantic representation of quantifiers contains a feature called MaxS to make sure that in a sentence like *"Mary thinks that John likes everybody"* the quantifier can't take scope over *thinks*. The value of the MaxS feature of a quantifier will be identified with the MaxS feature linked to the S node of the tree where the scope part adjoins. Fig.10 illustrates the semantic features associated with the derivation tree in Fig.9. When the two nouns are substituted into the NP parts of the two quantifiers, the individual variables x and y are identified with variables $\boxed{6}$ and $\boxed{7}$ and when the quantifier is combined with the verb tree the propositional variables $\boxed{81}$ and $\boxed{31}$ are identified with l_5 and l_3 respectively. Other feature unifications during semantic composition include $\boxed{41} = l_1$, $\boxed{91} = l_1$, MaxS $\boxed{21}$ = MaxS $\boxed{23}$, MaxS $\boxed{20}$ = MaxS $\boxed{23}$. The final (underspecified) representation along with the two possible disambiguations is given on Fig.11.

3 Interactions of Quantifier scope and Coordination scope

Analogously to the two perspectives on the syntax of coordination in LTAG (*conjoining* or creating an auxiliary tree from the left conjunct), there have been two approaches to coordination phenomena in the literature: conjunction reduction (deriving coordination from deletion within conjoined sentences) and base generated phrasal conjunction.

[1] At a substitution step, the top feature of the substitution node in the host tree is unified with the top feature of the root node in the substituting tree. At an adjunction step, the top feature of the root of the adjoined tree is unified with the top feature of the node where adjunction takes place and the bottom feature of the foot node is unified with the bottom feature structure of the adjunction site.

[2] In this paper, we adopt a substitution analysis for determiners, i.e. nouns are substituted into the determiner tree (as opposed to the determiner tree being adjoined onto the noun)

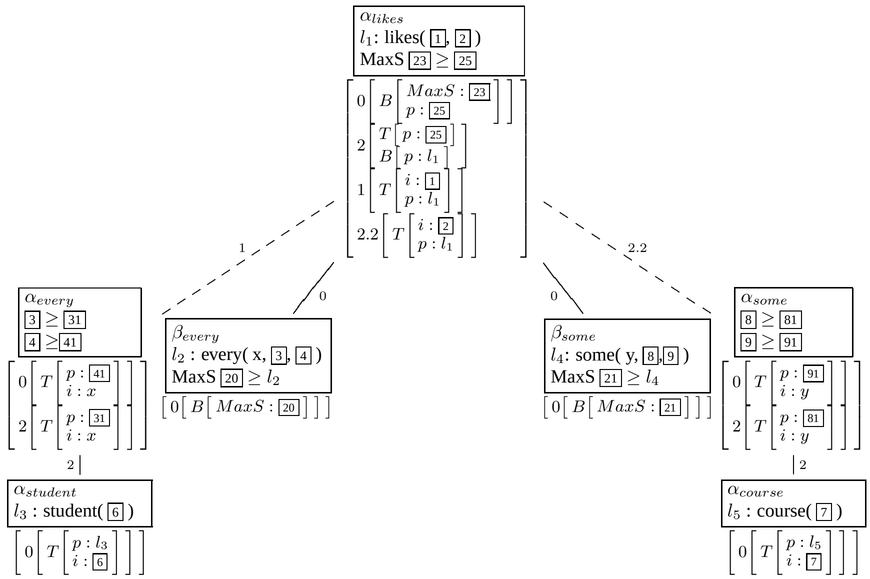

Figure 10: Derivation tree enhanced with semantic features for *"Every student likes some course"*

l_4 : some(y, l_5, $\boxed{9}$)
l_5 : course(y)
l_2 : every(x, l_3, $\boxed{4}$)
l_3 : student(x)
l_1 : like(x,y)

$\boxed{23} \geq l_2$, $\boxed{23} \geq l_4$
$\boxed{23} \geq l_1$, $\boxed{9} \geq l_1$
$\boxed{4} \geq l_1$

I. $\boxed{23} \rightarrow l_2$
$\boxed{9} \rightarrow l_1$
$\boxed{4} \rightarrow l_2$

every(x, l_3, some(y, l_5, l_1))

II. $\boxed{23} \rightarrow l_4$
$\boxed{9} \rightarrow l_2$
$\boxed{4} \rightarrow l_1$

some(y, l_5, every(x, l_3, l_1))

Figure 11: Semantics for "*Every student loves some course"*

Based on evidence from e.g. agreement and binding phenomena in various languages, it has been argued that the two conjuncts are not syntactically equivalent. One example is (Munn, 1993) which presents arguments for treating coordinate structures structurally identical to adjuncts. However, semantically the arguments of coordination seem to be of the same type. Various researchers (e.g. (Keenan and Faltz, 1978), (Partee and Rooth, 1983)) have shown that conjunction can be generalized to provide a uniform meaning for *and* and *or*. Although it has also been suggested (e.g. (Larson, 1985), (Winter, 1995), (Winter, 2000)) that conjunction and disjunction have different scopal properties, in this paper we will follow the former line of analysis and assign them equivalent denotations.

First we consider the interaction of quantifier scope and coordination in simple sentences. We say that coordination has wide scope in a construction $Y\ [X_1\ coord\ X_2]$ if the meaning of the construction can be paraphrased as $[Y\ X_1]\ coord\ [Y\ X_2]$.

In cases like (2) the wide scope and the narrow scope readings are logically equivalent, therefore impossible to distinguish.

(2) a Every girl sang and danced.
b Some girl sang or danced.
c John sold or bought a car.
d John caught and ate every fish.

However, coordination scope should be in principle visible in case of disjunction in scope of a universal (every(A, B $\cup$ C)) and in case of conjunction in the scope of an existential (some(A, B$\cap$ C))[3]. (3) illustrates two such contexts with the quantifier occurring in subject position.

(3) a Some girl sang and danced.
$\exists x[\ girl(x) \wedge sang(x) \wedge danced(x)\ ]$
b Every girl sang or danced.
$\forall x[\ girl(x) \rightarrow sang(x) \vee danced(x)\ ]$

In both cases only the narrow scope reading is available (i.e. the quantifier has scope over the coordination). The same effect can be observed if we replace *some* and *every* with any of the following quantifiers: no girl, not every girl, at least/most five girls, exactly five girls, most girls. Similar scope relations can be observed in (4) where the quantifiers occur in object position.

[3]We are not concerned here with coordination in the restriction of quantifi ers. For an account of NP coordination in this framework see (Babko-Malaya, 2004), this volume.

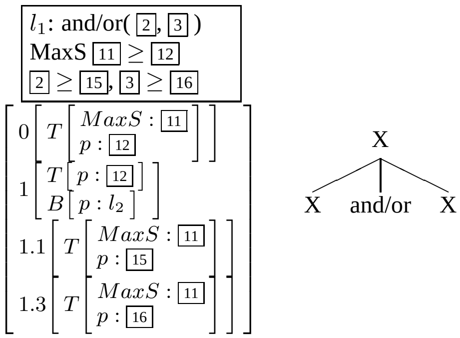

Figure 12: Semantics for *and*/*or*

(4) a John sold or bought every house in this neighborhood.
$\forall x[house(x) \rightarrow sell(j,x) \wedge buy(j,x)]$

b John caught and ate a fish.
$\exists x[fish(x) \wedge caught(j,x) \wedge ate(j,x)]$

However, world knowledge often influences the preferred interpretation. C.f. (5) where the wide scope reading (5b) is prominent.

(5) John sold and bought a car.

a $\exists x[car(x) \wedge sell(j,x) \wedge buy(j,x)]$

b $\exists x[car(x) \wedge sell(j,x)] \wedge \exists x[car(x) \wedge buy(j,x)]$

As a first approximation, we will assume that quantifiers take highest scope in the clause [4] and delegate sentences like (5) to world knowledge or pragmatic factors.

Fig.12 illustrates the elementary semantic representations assigned to *and* and *or*. Note how the MaxS features of both conjuncts are identified with the MaxS of the coordination, resulting in one single MaxS value for the coordinated sentence. This means that the quantifiers that are attached to both conjuncts will automatically have scope over the coordination.

Since coordination doesn't target the root node but takes place at the lowest node that dominates the non-shared arguments of the conjoined elementary trees we need to add the same MaxS feature to all the nodes where coordination can potentially take place (i.e. to V and VP nodes in addition to S)[5].

Fig.13 illustrates the derivation tree extended with semantic features for (4b) and Fig.14 shows the final semantic representation after feature unification and disambiguation. Notice how the desired scope relations are achieved by identifying the MaxS feature of the quantifier with both of the conjuncts and the coordination. The relevant feature identities are $\boxed{11} = \boxed{21} = \boxed{31} = \boxed{14}$.

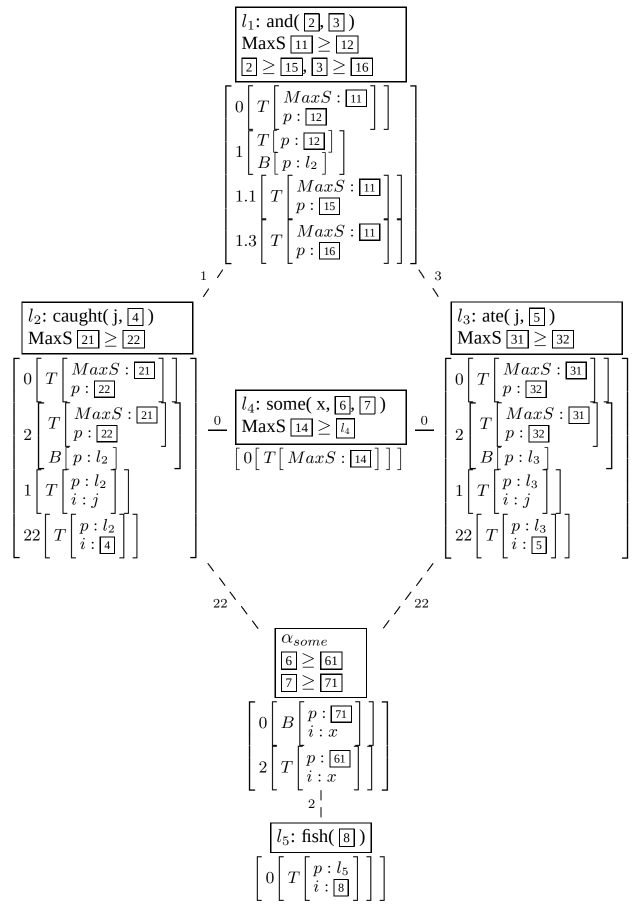

Figure 13: Semantics for *"John caught and ate a fish"*

This analysis of coordination has the consequence that whenever two quantifiers are shared between the two VPs like in (6), both will have scope over the coordination but their relative scope will be underspecified. The resulting semantic representation after feature unification is underspecified for the two readings in (6a) and (6b). Fig.15 shows the semantics and the two possible disambiguations for (6).

(6) Most girls dated and kissed a guy from the neighborhood.

a *most(x,girl(x), some(y,guy(y),and(date(x,y),kiss(x,y))))*

b *some(y,guy(y), most(x,girl(x),and(date(x,y),kiss(x,y))))*

The two readings result from identifying the "highest" MaxS ($\boxed{11}$) with either the label of $some$ or the label of

[4] We assume for the moment that there are no other scope-taking elements (e.g. wh-phrases) in the clause.

[5] Alternatively, we could define a different kind of semantics for *conjoining* that would have access to the features from the S nodes of the two conjuncts as well as to the features of the node where conjoining takes place.

l_1: and(l_2, l_3)
l_2: caught(j,x)
l_3: ate(j,x)
l_4: some(x, $\boxed{6}$, $\boxed{7}$)
$\boxed{S_1} = \boxed{14} = \boxed{21} = \boxed{31} = \boxed{11}$

$\boxed{S_1} \geq l_4$, $\boxed{S_1} \geq l_3$
$\boxed{S_1} \geq l_2$, $\boxed{S_1} \geq l_1$
$\boxed{7} \geq \boxed{71} = l_3, l_2$
$\boxed{6} \geq \boxed{61} = l_5$

$\boxed{S_1} \rightarrow l_4$
$\boxed{7} \rightarrow l_1$
$\boxed{6} \rightarrow l_5$
l_4: some(x, l_5, l_1)
l_1: and(l_2, l_3)
l_2: caught(j,x)
l_3: ate(j,x)

Figure 14: Final semantic representation for (4b)

l_1: and(l_2,l_3)
l_2: dated(y,x)
l_3: kissed(y,x)
l_4: some(x, guy(x),$\boxed{7}$)
l_5: most(y, girl(y),$\boxed{17}$)

MaxS $\boxed{11} \geq l_1$,
$\boxed{11} \geq l_2$, $\boxed{11} \geq l_5$
$\boxed{11} \geq l_3$, $\boxed{11} \geq l_4$
$\boxed{7} \geq l_2$, $\boxed{7} \geq l_3$
$\boxed{17} \geq l_2$, $\boxed{17} \geq l_3$

I. $\boxed{11} \rightarrow l_5$
$\boxed{17} \rightarrow l_4$
$\boxed{7} \rightarrow l_1$

most >> some >> and

II. $\boxed{11} \rightarrow l_4$
$\boxed{17} \rightarrow l_1$
$\boxed{7} \rightarrow l_5$

some >> most >> and

Figure 15: Final representation for (6)

$most$. If we give $some$ highest scope ($\boxed{11} \rightarrow l_4$) that will force $most$ to appear in the scope of $some$ and the coordination to be identified with the scope of $most$ (since both quantifiers have to have scope over the coordination). The reverse scope reading is computed analogously.

(7) illustrates a sentence where both conjuncts have two quantified arguments but only one of the arguments is shared by the two verbs. Our analysis predicts that in this case the shared quantified argument will take scope over the coordination while the two non-shared arguments will have scope below the coordination, i.e. we will get the reading $most >> and >> some_{1,2}$.

(7) Most girls dated a student but had a crush on a teacher.
most(y,girl(y),
∃(x, stud(x), date(y,x))∧∃(z,tea(z),crush(y,z)))

The semantic representation of (7) after feature unification is illustrated in Fig.16. There is only one possible disambiguation in this case. Theoretically, either $some_1$, $some_2$, and or $most$ could have widest scope in the sentence. However, if we identified $\boxed{11}$ with l_4 or l_6 we would end up with a contradiction where an argument variable (e.g. $\boxed{8}$) would be identified with the

l_1: and($\boxed{2}$,$\boxed{3}$)
l_2: dated(y,x)
l_3: crush(y,z)
l_4: some$_1$(x,student(x),$\boxed{7}$)
l_5: most(y, girl(y), $\boxed{17}$)
l_6: some$_2$(z,teacher(z),$\boxed{8}$)

MaxS $\boxed{11} \geq l_1$,
$\boxed{11} \geq l_2$, $\boxed{11} \geq l_3$
$\boxed{11} \geq l_4$, $\boxed{11} \geq l_6$
$\boxed{11} \geq l_5$, $\boxed{17} \geq l_2, l_3$
$\boxed{7} \geq l_2$, $\boxed{8} \geq l_3$

$\boxed{11} \rightarrow l_5$
$\boxed{17} \rightarrow l_1$
$\boxed{1} \rightarrow l_4$
$\boxed{7} \rightarrow l_2$
$\boxed{2} \rightarrow l_6$
$\boxed{8} \rightarrow l_3$

most >> and >> some$_{1,2}$

Figure 16: Final representation for (7)

label of the proposition it occurs in (l_6). Identifying $\boxed{11}$ with l_1 (i.e. giving the coordination widest scope) would result in a representation where one occurrence of y is outside of the scope of the quantifier that introduced it: [most(y, girl(y), some$_1$(x, student(x, date(y,x))))] AND [some(z, teacher(z), crush(y,z))]. The only possible disambiguation (illustrated in Fig.16) is when $most$ takes widest scope, i.e. $\boxed{11}$ is identified with l_5.

4 Other Coordination scope ambiguities

Unfortunately, the above analysis of coordination only works for simple sentences. There are several contexts when coordination can have a wide scope reading. The most famous examples are cases of wide scope readings of *or* in intensional contexts. (Rooth and Partee, 1982), (Larson, 1985) pointed out that when *or* is embedded under one or more intensional operators multiple scopal readings are possible similar to quantified NPs. Most famous examples involve NP coordination (e.g *"Mary is looking for a maid or a cook"*) but there are also cases of wide scope *or* readings for VP disjunction, like the sentence in (8) which is three ways ambiguous.

(8) John believes that Bill said that Mary was drinking or playing video games.

a *J. believes B. said [drink(m) ∨ play(m)]*
b *J. believes ([B. said drink(m)] ∨ [B. said play(m)])*
c *[J. believes B. said drink(m)] ∨*
[J. believes B. said play(m)]

Although they are harder to find, there are also unexpected wide scope readings of *and* (example from (Winter, 1995)):

(9) A woman discovered Radium but a man invented the electric light bulb and developed the theory of relativity.

(9) doesn't attribute the invention of the light bulb and developing the theory of relativity to the same person, rather it says that a man invented the electric light bulb and a man developed the theory of relativity.

There are also examples of wide scope *or* outside of intensional contexts as (10) shows.

(10) (The girls didn't all do equally well in the exam but) every boy failed or got an A.

Unlike the scope of quantifiers, the scope of coordination can appear over a that-clause as well. Consider the scope of *or* in (11) (from (Winter, 1995)).

(11) Mary says that [$_{S_1}$ John is going to marry Sue] OR [$_{S_2}$ Sue is going to divorce Bill].

a Mary says "S_1 or S_2"

b Mary says S_1 or Mary says S_2

A critical situation that distinguishes the two possible readings illustrated in (11a) and (11b) would be the following: Mary says: " Sue and John are going to get married.". Reading (11a) would be false in this situation whereas the sentence in (11) would be true which shows that reading (11b) is attested.

The same phenomenon can be observed with the scope of *and* in (12).

(12) Mary denies that [$_{S_1}$ John is going to marry Sue] AND [$_{S_2}$ Sue is going to divorce Bill].

a Mary denies "S_1 or S_2"

b Mary denies S_1 or Mary denies S_2

A critical situation here would be the following: Mary says:"I don't think John and Sue are going to get married but I'm sure Sue and Bill are going to get divorced". Sentence (12) would be false in this situation, whereas (12a) would be true which means reading (12b) is attested.

The above examples show that the scope of coordination doesn't always obey the syntactic restriction on the scope of quantifiers.

It seems that all the instances of wide scope coordination involve embedding under a matrix verb or some other contextually determined operator (e.g. possible generic reading in (9)). However, not all such embeddings result in scope ambiguities. Complex NPs for example are islands for coordination scope as the unambiguous sentence in (13a) (cf. the ambiguous ((13)b)) shows.

(13) a John maintains the claim that Bill should resign or retire.

b John maintains that Bill should resign or retire.

Since an account of the wide scope readings of coordination would require a more complex semantic theory, I will not attempt to give a full analysis of the examples discussed above. In the rest of this paper I will settle for pointing out some potential problems that an analysis in the LTAG semantics framework would have to face dealing with these facts.

The first problem our analysis would encounter would be picking an S node where a matrix verb could be adjoined. In a derived tree containing VP coordination (see e.g. Fig.5) there are two available S nodes. We could simply equate the two nodes and adjoin a matrix verb on top. This would have the consequence that nothing else could come in between the matrix verb and the coordinated trees, i.e. nothing else could be adjoined onto either of the conjuncts.

Another solution would be to extend the coordination schema and add an S node on top of the coordination for each possible instantiation of the schema. This would have the advantage that the S nodes of the two conjuncts would be distinct and still available for adjunction in case something else (e.g. an adverb) adjoins to one of the conjuncts. The extended instances of the coordination schema are illustrated in Fig.17.

To decide between these two alternatives we would need to consider more data about sentences that involve adjunction at the S node in addition to coordination.

Figure 17: Extended coordination schema

Keeping quantifier scope separate from coordination scope constitutes another challenge for the semantic theory. In a sentence like (8) we need to make sure that coordination can scope over the verb tree it is substituted into, i.e. we need to derive the following scope relations: $believe >> or >> said$ and $or >> believe >> said$. At the same time we also have to make sure that the scope of quantifiers that are embedded in the conjuncts doesn't get passed up the derivation tree. One way to ensure this is to define a feature for coordination scope that is different from the MaxS feature used for representing quantifier scope.

Finally, another problem is that in order to account for the wide scope readings of sentences like (8) we need more than one copy of a formula, instantiated with different arguments.

To model readings (8b) and (8c) we would need the following variable assignments given the simplified semantic representation in Fig.18. To give *or* scope over *said* we need to identify both arguments of the coordination with the label of *said*, yielding the formula

a)	b)	c)
l_1: believe(j, $\boxed{1}$)	$l_1 >> l_3 >> l_2$	$l_3 >> l_1 >> l_2$
l_2: said(b, $\boxed{2}$		
l_3: and($\boxed{3}$, $\boxed{4}$)	$\boxed{1} \rightarrow l_3$	$\boxed{3} \rightarrow l_1$
l_4: drink(m)	$\boxed{3} \rightarrow l_2$; $\boxed{2} \rightarrow l_4$	$\boxed{1} \rightarrow l_2$; $\boxed{2} \rightarrow l_4$
l_5: pvg(m)	$\boxed{4} \rightarrow l_2$; $\boxed{2} \rightarrow l_5$	$\boxed{4} \rightarrow l_1$
		$\boxed{1} \rightarrow l_2$; $\boxed{2} \rightarrow l_5$

Figure 18:

$believe(or(said(l)4), said(l_5))$. Similarly, in the case of reading c) where *or* has widest scope, we need to identify both of its arguments with the label of *believe* resulting in the reading $or(believe(said(l_4)), believe(said(l_5)))$.

However, this doesn't mean simply assigning the same value to two different variables: in both cases the most embedded arguments of the formula have to be different (l_4 and l_5). This means that for reading b) we need two copies of l_2 ($said$) and for reading c) we need two copies of l_1 ($believe$) and two copies of l_2 ($said$), each time with a different argument, as if the two verbs were 'distributed' over the arguments of or..

5 Conclusions

We have defined a compositional semantics for VP coordination in LTAG using the framework of (Kallmeyer and Joshi, 2003) extended with semantic features. We have discussed interactions between quantifier scope and coordination scope in simple sentences, proposed an elementary semantic representation for coordination and showed that it yields the correct interpretation for basic scope interactions.

The analysis predicts that in simple sentences quantifiers that are shared arguments of two coordinated elementary trees will have scope over coordination whereas quantifiers that are attached to only one of the conjuncts will have narrow scope with respect to the coordination.

We have discussed cases of wide scope disjunction and conjunction in complex sentences that present a problem for this account and pointed out directions for further improving the analysis.

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