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The Syntax and Semantics of Relative Clause Modification

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Abstract

Semantic construction for DPs with relative clauses is problematic on the basis of a surface-oriented syntactic analysis if standard tenets of the syntax-semantics interface are upheld, because due to these tenets the relative clause must be part of the NP argument of the determiner. The flexibility offered in semantic underspecification formalisms can overcome these problems. It allows semantic construction for DPs with relative clauses even if determiner and NP form a constituent first, which is modified by the relative clause. This covers the modification of indefinite pronouns like *everyone* as well as Turkish DPs with relative clauses whose determiner stands between the modifier and the NP argument. This analysis extends easily to the distinction between restrictive and non-restrictive relative clauses.

4.1 Introduction

Semantic construction for DPs with relative clauses is a problem for surface-oriented syntactic frameworks, where constituents are *not rearranged* on some syntactic level, if standard tenets of the syntax-semantics interface are adopted:

Proceedings of the Sixteenth Computational Linguistics in the Netherlands.
Edited by: Khalil Sima'an, Maarten de Rijke, Remko Scha and Rob van Son.
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- semantic construction proceeds by *functional application*, which does not look into the inner structure of the semantic expression it combines with
- the involved syntactic constituents are *sisters*
- semantic contributions of constituents have the *same types* across languages[4]
  - determiners: relations between properties; $\langle\langle e,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$ (Barwise and Cooper 1981)
  - nouns: properties; $\langle e,t\rangle$
  - relative clauses (and other noun modifiers like adjective phrases): functions from properties to properties; $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$
  - whole DPs: sets of properties; $\langle\langle e,t\rangle,t\rangle$

The first consequence of these principles is that the only way of constructing the DP semantics is by *first* combining noun and modifier semantics. The determiner semantics comes last, its application *finishes* the process of deriving the DP semantics. Consider e.g. the semantic construction for DPs like (4.5):

(4.5) every girl whom I love

The meanings of article, noun, and relative clause are given in (4.6a-c), the meaning of (4.5) as a whole is a *set of properties* (those that every girl I love has), (4.6d):

(4.6) (a) $\lambda Q\lambda P\forall x.Q(x)\rightarrow P(x)$
(b) $\lambda P\lambda x.P(x)\wedge\mathbf{love'}(\mathbf{speaker'},x)$
(c) $\lambda x.\mathbf{girl'}(x)$
(d) $\lambda P\forall x.\mathbf{girl'}(x)\wedge\mathbf{love'}(\mathbf{speaker'},x)\rightarrow P(x)$

If the only way of combining the expressions (4.6a-c) into (4.6d) is functional application, then (4.6b) must be applied to (4.6c) first, the result of this application is then the argument of (4.6a). I.e., the semantics of the head noun and its modifiers must be combined first, then the resulting expression is combined with the determiner semantics, and once the semantic contribution of the determiner has been integrated, the semantics of the nominal expression cannot be augmented further.

As noted by Partee (1975), this strategy presupposes that the involved constituents form a constituent (are syntactic sisters) in the underlying (binary branching) syntactic structure. I.e., in a sequence `Det–N–RelCl`, noun and relative clause must *form a constituent first*, which is then the sister of the determiner. Following Partee, this means that the structure (4.7a) must be preferred over (4.7b):[5]

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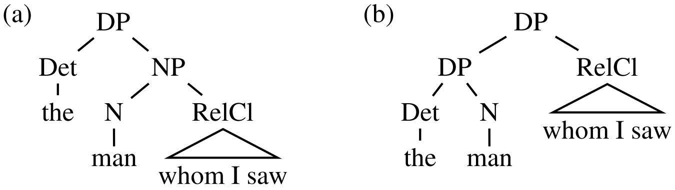
[4] For expository purposes, I will use extensional semantic representations as long as possible (i.e., up to section 4.8). A *property* is thus a set of individuals.

[5] Her tree structures have been adapted to the DP analysis of constituents such as *the man whom I love*.

(4.7)



Another consequence of the tenets is that they predict a *peripheral* position of the determiner in the DP. Otherwise, the head noun could not form a constituent with the modifying relative clause. I.e., the possible orderings of determiner, nominal modifier, and head noun are as in (4.8a) and the impossible orderings as in (4.8b). E.g., English DPs exhibit the first or the second of the word orders in (4.8a):[6]

(4.8) (a) Det Mod N   Det N Mod   Mod N Det   N Mod Det
(b) Mod Det N   N Det Mod

However, the restriction to the syntactic analysis (4.7a) seems to raise problems for several kinds of DPs with relative clauses. First, Bach and Cooper (1978) and Cooper (1979) note that in DPs with *extraposed relative clauses* like in (4.9), determiner and noun must form a constituent of their own, due to the syntactic position of the relative clause. This would bar a direct combination of noun and relative clause semantics during semantic construction.

(4.9) Ik heb het meisje gezien dat je hebt ontmoet
I have the girl seen which you have met
‘I have seen the girl whom you have met’

Indefinite pronouns like *everyone* and *something* seem to comprise *both* a determiner and a noun and could thus be described as an expression of category DP. But these quantifiers can be modified by a relative clause, which contributes to the *restriction* of the quantification introduced by the modified expression, thus, (4.10) denotes the set of properties shared by every person whom the speaker loves:

(4.10) everyone whom I love

Finally, the restriction to structure (4.7a) – as well as the prediction of possible word orders – would run counter to evidence from *crosslinguistic* semantic construction, e.g., for most *Turkish* DPs with relative clauses (for similar data from other languages, see Kathol 1999). In (4.11), the nominalisation construction *sevdiğim* ‘of my loving’, which is the closest equivalent to a relative clause in English, is separated from the head noun *kız*

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[6] The intransitive determiner *a* can exceptionally be preceded by APs including a specifier like *too* or *how* and *such*, but this order is very idiosyncratic as it does not generalise to other APs and other determiners in English, consider e.g. *every such function* and **good a man*.

‘girl’ by the determiner *her* ‘every’:[7]

(4.11) sev- diğ- -im her kız
love NOM POSS.1Sg every girl
‘every girl whom I love’ (literally, ‘of my loving every girl’)

In this paper, I will present an analysis of DPs with relative clauses that relinquishes the condition that semantic construction should proceed by functional application. The proposed analysis is not the first one to do so, but it is novel in that it allows semantic construction on the basis of structure (4.7b) without additional assumptions like syntactic decomposition of indefinite pronouns and Cooper Storage mechanisms (see section 4.2). What is more, the approach extends naturally to the distinction between restrictive and non-restrictive relative clauses as in (4.12) and (4.13):

(4.12) The train which leaves at 11:30am is waiting on platform 5
(4.13) The train, which leaves at 11:30am, is waiting on platform 5

While the latter sentence entails that there is only one train (which happens to leave at 11:30am), the departure time is (at least, pragmatically) necessary in (4.12) to distinguish the denoted train from other trains.

The paper is structured as follows: First I will discuss previous analyses of the problematic examples, then I will sketch my intuitions on the examples presented in this introduction and outline the general framework of the flexible syntax-semantics interface of Egg (2004). Then I will extend this interface to DPs with relative clauses (including non-restrictive relative clauses) and conclude with an outlook on further topics in the syntax-semantics interface for relative clauses.

4.2 Previous analyses

As soon as the techniques of semantic construction are no longer limited to functional application, (4.7a) is no longer the only syntactic structure on which a syntax-semantics interface for DPs with relative clauses can be built.

The analyses of Cooper (1979) and Janssen (1983) for the extraposed relative clauses in Hittite regard the matrix clause and the relative clause as syntactic sisters. The restriction of the semantics of the DP the relative clause belongs to contains a *predicate variable*, which is inherited by the semantics of the matrix clause. Subsequent λ-abstraction over this variable turns the semantics of the matrix clause into a function whose application to the semantic contribution of the relative clause yields the desired semantic interpretation.

(4.14) illustrates the semantic construction for (4.9) in terms of such an analysis. The semantics of main clause, relative clause, and the result of constructing the semantics for

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[7] In the gloss, ‘NOM’ is short for ‘nominalisation,’ ‘POSS.1Sg’ indicates a possessive suffix of the first person singular, the Turkish equivalent to English *my*.

(4.9) as a whole are given in (4.14a-c). $\exists!x.[P(x)] \wedge Q(x)$ abbreviates $\exists x.(\forall y.P(y) \rightarrow y = x) \wedge Q(x)$:

(4.14) (a) $\exists!x.[\mathbf{girl}'(x) \wedge R(x)] \wedge \mathbf{see}'(\mathbf{speaker}', x)$
(b) $\lambda y.\mathbf{meet}'(\mathbf{hearer}', y)$
(c) $\lambda R\big(\exists!x.[\mathbf{girl}'(x) \wedge R(x)] \wedge \mathbf{see}'(\mathbf{speaker}', x)\big)\big(\lambda y.\mathbf{meet}'(\mathbf{hearer}', y)\big) =$

$$\exists!x.[\mathbf{girl}'(x) \wedge \mathbf{meet}'(\mathbf{hearer}', x)] \wedge \mathbf{see}'(\mathbf{speaker}', x)$$

Bach and Cooper (1978) and Janssen (1983) extend this analysis (introducing a predicate variable in the semantics of the modified constituent) to DPs with relative clauses whose structure is (4.7b). The variable indicates where the modifier semantics is to be integrated; the integration proceeds via λ-abstraction over the variable. But such abstractions usually occur in the semantics of a subcategorising constituent to indicate where the semantic contribution of a subcategorised constituent should go. Using them for the integration of the semantics of a *modifier* thus treats modifiers as complements just for the sake of semantic construction.

Treating modifiers as complements has been suggested before (e.g., in Bouma, Malouf and Sag 2001), but has been motivated on independent syntactic grounds (e.g., extraction data). Since I will show that an analysis of the data is possible that need not treat modifying relative clauses as complements, further syntactic evidence should be adduced to back up this treatment of modifiers.

The modification of indefinite pronouns like in (4.10) has given rise to analyses that derive the meaning of the resulting constituents from a not directly visible level of syntax. Abney (1987) suggests a movement analysis in which a (bound) noun, e.g., *one*, is first modified by the relative clause and then incorporated with the determiner after subsequent head-to-head movement.[8] Such analyses (see also Kishimoto 2000, Sag 1997) can remain faithful to the abovementioned principles and still assume an underlying syntactic structure of the type (4.7a). For advocates of surface-oriented syntactic frameworks, however, no such strategy is open.

Data like (4.11) - as well as the exceptional English DPs noted in footnote 6 - could be handled by Janssen's (1983) 'Det-S' analysis of DPs with relative clauses or in Ginzburg and Sag's (2000) account of exceptional Mod-Det ordering as in *too big a house*: Here determiner and modifier combine first, and the result is combined with the noun (phrase). The analyses show that the syntax-semantics interface can derive the desired semantic structures from this syntactic structure with rules much more complex than mere functional application.

Ginzburg and Sag (2000) attribute this structure for the English cases to a *lexical* prop-

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[8] Abney uses the fact that indefinite pronouns are morphologically transparent in English. But this does not hold universally, consider e.g. German *jemand* 'someone'. This would enforce different analyses of the phenomenon in English and German, which seems unintuitive. He must also stipulate an ambiguity of words like *one* or *body* between a free and a bound variant with considerably different interpretations.

erty of the indefinite English determiner (optional selection for a gradable AP), which is justified by the idiosyncrasy of the construction in English. But then examples like (4.11), where there is no such idiosyncrasy, call for a different analysis.

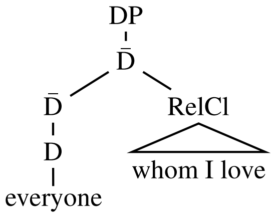
Finally, the question of how to do semantic construction for DPs with relative clauses in HPSG is not yet settled. Kathol's claim that the HPSG syntax-semantics interface can use either structure in (4.7) holds only for versions of HPSG with quantifier storage (e.g., Pollard and Sag 1994, Ginzburg and Sag 2000) where the semantic content of a determiner expression is the one of its NP argument. In more recent versions of the theory where Minimal Recursion Semantics (Copestake, Flickinger, Pollard and Sag 2005) is used as the semantic representation formalism, however, semantic construction on the basis of (4.7b) would run into problems.[9]

In the following, I will show how to do semantic construction for DPs with relative clauses on the basis of the syntactic structure (4.7b). Following Kathol (1999) and Egg (2004), I assign this syntactic structure to (4.10). This analysis extends naturally to (4.11), it could be used for further kinds of DPs with relative clauses (as argued for e.g. by Kathol 1999), but I will not discuss this question in this paper.

4.3 Underlying intuitions

This section will further analyse the examples presented in the introduction on an intuitive level, the formalisation will then be presented in sections 4.4-4.7. Starting point is the analysis of Egg (2004) for the semantic construction of (4.10). Indefinite pronouns emerge as intransitive determiners, and there is adjunction of the relative clause to the pronoun (after projection to the bar level), which then projects to DP:

(4.15)



The mismatch between syntactic and semantic structure is handled in the syntax-semantics interface. The challenge is the derivation of (4.16a), the semantics of (4.10), from the pronoun meaning (4.16b) and the modifier meaning (4.16c). Applying (4.16c) to the underlined part of (4.16b) only would yield (4.16a).[10]

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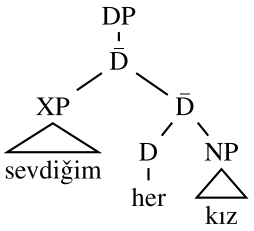
[9] At the level of D̄ or DP, the NP constituent would no longer be visible for semantic construction, because its HANDLE value (its 'address') is no longer available as the LTOP value.

[10] Merely type-lifting the relative clause to an expression of type $\langle\langle\langle e,t\rangle,t\rangle,\langle\langle e,t\rangle,t\rangle\rangle$ would not suffice: This strategy could not by itself make sure that the modifier ends up as part of the restriction, in the scope of the quantification introduced by the pronoun.

(4.16) (a) $\lambda P \forall x.\mathbf{person}'(x) \wedge \mathbf{love}'(\mathbf{speaker}, x) \rightarrow P(x)$
(b) $\lambda P \forall x.\underline{\mathbf{person}'}(x) \rightarrow P(x)$
(c) $\lambda P \lambda x.\overline{P(x) \wedge}\, \mathbf{love}'(\mathbf{speaker}, x)$

The Turkish example exhibits a very similar syntactic structure: Since Turkish DPs can consist of determiner and noun alone (e.g., *her kız* 'every girl'), it makes sense to assume that they form a D̄-constituent in (4.11), too. Then the XP *sevdiğim* (whose category is not relevant for the presented analysis) adjoins to this constituent, and, finally, it projects to DP:

(4.17)



Now the challenge is the derivation of the semantic representation of (4.11) on the basis of (4.17). However, as soon as the striking resemblance of (4.17) to the structure (4.15) of example (4.10) is taken into account (modification of a D̄ constituent in either case), it is possible to reformulate the challenge in analogy to (4.16): How can (4.18a), the semantic representation of (4.11), be derived using (4.18b) and (4.18c), the meanings of the modified D̄-constituent and of the XP, respectively?

(4.18) (a) $\lambda P \forall x.\mathbf{love}'(\mathbf{speaker}, x) \wedge \mathbf{girl}'(x) \rightarrow P(x)$
(b) $\lambda P \forall x.\underline{\mathbf{girl}'}(x) \rightarrow P(x)$
(c) $\lambda P \lambda x.\overline{\mathbf{love}'}(\mathbf{speaker}', x) \wedge P(x)$

Semantic application of (4.18c) to (4.18b) or vice versa is not possible, however, if one could apply (4.18c) only to the underlined part of the D̄ semantics, which indicates the semantic contribution of the NP, one would immediately get (4.18a). I.e., once again we encounter the question of how to apply the semantics of a modifier only to the restriction of a quantification introduced in the modified expression.

The close similarity between the syntactic and semantic structures of (4.10) and (4.11) suggests that the syntax-semantics mapping works in a very similar way. Since the modified *her kız* in (4.11) is syntactically *complex*, it will be derived by appropriate interface rules. The output of these rules should have the same structure as the lexical entry for the semantics of an indefinite pronoun. In this way, one could handle the semantic effect of modifying Turkish Det-N constituents as well as of English indefinite pronouns by one single rule of the syntax-semantics interface.

The next topic addressed in the introduction were *non-restrictive* relative clauses. Following the intuition of Bartsch (1979), non-restrictive relative clauses are seen as part of the *scope* of the quantifier. The differences in the interpretation of restrictive and nonrestrictive relative clauses follow immediately, consider the semantic representations for (4.12) and (4.13) in (4.19a) and (4.19b).

(4.19) (a) $\exists!x[\mathbf{train'}(x) \wedge \mathbf{leave\text{-}at\text{-}11{:}30am'}(x)] \wedge \mathbf{wait\text{-}on\text{-}p5'}(x)$
(b) $\exists!x[\mathbf{train'}(x)] \wedge \mathbf{wait\text{-}on\text{-}p5'}(x) \wedge \mathbf{leave\text{-}at\text{-}11{:}30am'}(x)$

The property with respect to which the denoted entity in (4.19b) is unique is being a train, i.e., there are no other trains. In contrast, the denoted entity in (4.19a) is the unique train leaving at 11:30 am, thus, there might be others.

The difference between these semantic representations is put down to the specific intonation for nonrestrictive relative clauses as indicated by the commas.[11]

4.4 The formalism

In this section, the *underspecification formalism* Constraint Language for Lambda Structures CLLS; (CLLS; Egg, Koller and Niehren 2001), on which the proposed analysis is built, is expounded in an abbreviated form. Its expressions are (meta-level) *constraints* that describe a set of semantic representations. In this paper, the described semantic representations are λ-terms.

Semantic representations are called *solutions* of a constraint when they are described by or compatible with it. For the present paper, we can restrict ourselves to a subset of solutions, viz., those that comprise only material explicitly mentioned in the constraint. Under this restriction, constraints can be regarded as a *partial order* on a set of fragments of semantic representations. There are many other underspecification formalisms, e.g., Lexical Resource Semantics (LRS; Richter and Sailer 2004), or Minimal Recursion Semantics (MRS; Copestake et al. 2005).

If one uses such a formalism in the syntax-semantics interface, one can derive the different readings of a structurally ambiguous expression by mapping one (surface-oriented) syntactic structure to one constraint C such that the set of semantic representations described by C corresponds exactly to the readings of the expression. This strategy has been successfully used for accounts of scope ambiguity. My claim is that it can be applied to DPs with relative clauses, too (even if these DPs are themselves not structurally ambiguous), because it makes possible an extremely flexible syntax-semantics interface.

E.g., the result of the syntax-semantics mapping for (4.10) is the CLLS constraint (4.20). Please ignore for the time being any labels like '$[\![\mathtt{C}]\!]$', I will explain them in section 4.5.

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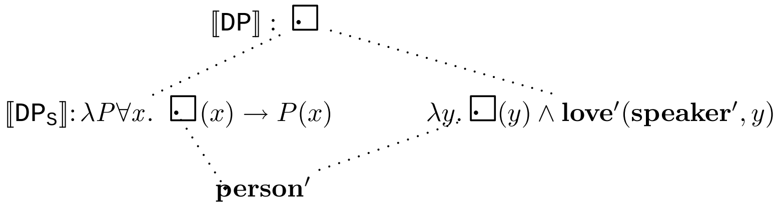
[11] See Carlson (1977) for further syntactic differences between the two kinds of relative clauses.

(4.20)



This constraint illustrates the ingredients of simplified CLLS expressions:

- *fragments* of λ-terms
- not yet known parts of these fragments, indicated by '*holes*'
- *dominance relations* (depicted by dotted lines) that link fragments to holes[12]

Dominance relations between a fragment and a hole indicate that the fragment is an (im-)proper part of what the hole stands for. These dominance relations model scope, and are therefore also used to model quantifier scope ambiguities.

In the constraint (4.20), the semantic representation for the relative clause constitutes the right hand fragment. The meaning of the pronoun is expressed in the left and the bottom fragment, which together make up (4.16b). The underlined part of (4.16b), viz., the restriction of the quantification, emerges as a fragment of its own in (4.20). This bottom fragment is dominated by the right and the left fragment, thus, ends up in the scope of both the quantification and the modifier. The scope between the right and the left fragment is undecided, since they are both dominated by the same hole at the top. Structures like (4.20) are called *dominance diamonds*.

The fact that there is only a hole on top in (4.20) indicates that we do not yet know what a λ-term described by the constraint looks like. However, due to the dominance relations between this hole and the fragments on the right and the left we know that these fragments are the immediate parts of such a λ-term.

To resolve the ambiguity in constraints, information is added monotonically, in particular, by strengthening dominance relations between holes and fragments to *identity*. For (4.20), there is only one choice, viz., identifying the bottom fragment with the hole in the modifier fragment, the modifier fragment, with the hole in the quantifier fragment, and the quantifier fragment, with the top hole. This returns (4.21), where the relative clause pertains only to the restriction of the quantification introduced by the pronoun.

(4.21) [= (4.16a)] $\lambda P \forall x.\mathbf{person'}(x) \wedge \mathbf{love'}(\mathbf{speaker'}, x) \rightarrow P(x)$

The other option (which starts by identifying the bottom fragment with the hole in the quantifier fragment) is ruled out by the types of the involved fragments. I.e., (4.20) is an adequate representation of the semantics of (4.10) in spite of the potential ambiguity it

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[12] I will talk about fragment F_1 dominating another fragment F_2 (instead of talking about dominance between a hole h in F_1 and F_2) when the identity of h is clear from the context.

expresses; it does not overgenerate, as unwanted ambiguity is blocked.

4.5 The interface rules

In this part of the paper, I will use this formalism to define a very flexible syntax-semantics interface which allows the derivation of constraints like (4.20) on the basis of a surface-oriented underlying syntactic analysis. The interface presumes that the semantic contribution of every syntactic constituent is *structured* in that it distinguishes a *main* and an *embedded* fragment. In CLLS constraints like (4.20), '$[\![\mathsf{C}]\!]$' indicates the main fragment of a constituent C and '$[\![\mathsf{C_S}]\!]$', the secondary fragment of C. '$[\![\mathsf{C}]\!]\mathsf{:F}$' expresses that the main fragment of C is defined as fragment F. Consider e.g. the lexical entry for the semantics of *everyone*, where the restriction of the quantification is singled out as the secondary fragment, while the rest of the semantic representation shows up in the main fragment:

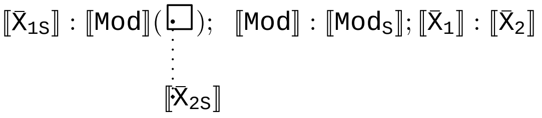
(4.22)
$$\begin{tikzcd}[\![\mathsf{D}]\!] : \lambda P \forall x.\ \square\,(x) \rightarrow P(x) \arrow[d, dash, dotted] \\ [\![\mathsf{D_S}]\!] : \mathbf{person'}\end{tikzcd}$$

Interface rules specify for a constituent C how the constraints Con_1 and Con_2 of its immediate constituents C_1 and C_2, inherited by C, are combined into a new constraint for C. The main and the secondary fragments of Con_1 and Con_2 are accessible to the rules; they combine Con_1 and Con_2 by addressing their main and secondary fragments and subsequently determine these features for C. For instance, the simple rule that non-branching $\bar{\mathrm{X}}$ constituents inherit their fragments from their heads is written as (4.23). In the syntactic part of such rules, a subscripted label after the opening bracket indicates the category of the constituent C:

(4.23) $$[_{\bar{\mathsf{X}}}\ \mathsf{X}] \quad \overset{\text{(SSI)}}{\Rightarrow} \quad [\![\bar{\mathsf{X}}]\!] : [\![\mathsf{X}]\!]; \qquad [\![\bar{\mathsf{X}}_\mathsf{S}]\!] : [\![\mathsf{X_S}]\!]$$

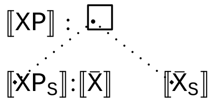
The semantic representation of modification (adjunction) structures like (4.10) and (4.11) is constructed by the interface rule (4.24). The main fragment $[\![\bar{\mathsf{X}}_\mathsf{1}]\!]$ of the whole constituent is defined as $[\![\bar{\mathsf{X}}_\mathsf{2}]\!]$, the one from the modified expression. In contrast, its secondary fragment $[\![\bar{\mathsf{X}}_\mathsf{1S}]\!]$ is not inherited from this expression, instead, it consists of an application of the modifier fragment $[\![\mathsf{Mod}]\!]$ to a hole that dominates the secondary fragment $[\![\bar{\mathsf{X}}_\mathsf{2S}]\!]$ of the modified expression. This yields the bottom half of a dominance diamond, in which $[\![\mathsf{Mod}]\!]$ and $[\![\bar{\mathsf{X}}_\mathsf{1}]\!]$ are scopally ambiguous in that they both dominate $[\![\bar{\mathsf{X}}_\mathsf{2S}]\!]$. Dominance between $[\![\bar{\mathsf{X}}_\mathsf{1}]\!]$ and $[\![\bar{\mathsf{X}}_\mathsf{2S}]\!]$ is specified in the semantic representation of $\bar{\mathrm{X}}_2$ (recall that $[\![\bar{\mathsf{X}}_\mathsf{1}]\!]$ is equated with $[\![\bar{\mathsf{X}}_\mathsf{2}]\!]$), e.g., it can eventually follow from lexical entries as (4.22). The equation of the modifier fragments ($[\![\mathsf{Mod}]\!]$: $[\![\mathsf{Mod_S}]\!]$) is introduced to facilitate reading.

(4.24) $[_{\bar{\mathtt{X}}_1}\mathtt{Mod}\ \bar{\mathtt{X}}_2]$ $\overset{\text{(SSI)}}{\Rightarrow}$



The rule that constructs the upper half of the dominance diamond corresponds to the syntax rule `XP -> X̄`. The main fragment of the XP is a hole that dominates both fragments of the X̄ constituent:

(4.25) $[_{\mathtt{XP}}\ \bar{\mathtt{X}}]$ $\overset{\text{(SSI)}}{\Rightarrow}$

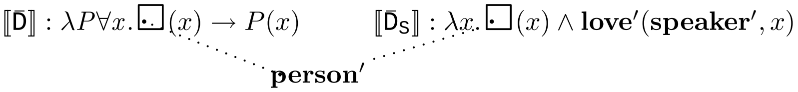


Semantic construction for *everyone I love* now starts with the semantic representations (4.22) and (4.26) of pronoun and relative clause (whose derivation is omitted here). Rule (4.23) states that (4.22) is the semantics of the D̄ *everyone* too.

(4.26) $[\![\mathtt{RelCl}]\!]$, $[\![\mathtt{RelCl_S}]\!]$: $\lambda P \lambda x.P(x) \wedge \mathbf{love}'(\mathbf{speaker}', x)$

Rule (4.24) combines the constraints of D̄ and RelCl into (4.27), the lower half of a dominance diamond as a consequence of adjoining the relative clause to the D̄ *everyone*. This lower half serves as input to rule (4.25), which yields the dominance diamond (4.20). Rule (4.25) applies because the D̄ *everyone that I love* projects to DP.

(4.27)



4.6 The analysis

The interface rules (4.23)-(4.25) can now be reused for the syntax-semantics interface of Turkish. These rules handle the modification of the D̄ constituent *her kız* (and the subsequent projection of the complete modification structure to DP); in addition, we need one more rule to describe the semantic consequence of forming D̄ constituents out of a determiner and its NP complement: The main fragment of such a D̄ constituent is the main D fragment applied to the main NP fragment; the NP's secondary fragment becomes the one of the D̄.

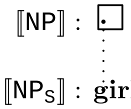
(4.28) $[_{\bar{\mathtt{D}}}\ \mathtt{D}\ \mathtt{NP}]$ $\overset{\text{(SSI)}}{\Rightarrow}$ $[\![\bar{\mathtt{D}}]\!]$: $[\![\mathtt{D}]\!]([\![\mathtt{NP}]\!])$; $[\![\bar{\mathtt{D}}_{\mathtt{S}}]\!]$: $[\![\mathtt{NP_S}]\!]$

Semantic construction for (4.11) will assign it a semantic representation in analogy to the construction of (4.10). In particular, the secondary fragment of the modified expression will be the restriction of a quantifier in its primary fragment. We start with simple lexical entries for the meaning of *her* and *kız*, respectively:

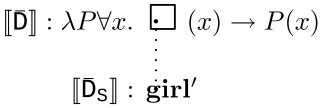
(4.29) (a) $[\![\mathsf{D}]\!]$, $[\![\mathsf{D_S}]\!]$: $\lambda Q \lambda P \forall x. Q(x) \rightarrow P(x)$
(b) $[\![\mathsf{N}]\!]$, $[\![\mathsf{N_S}]\!]$: $\mathbf{girl}'$

According to (4.23) these meanings are inherited to the projections of *her* and *kız* to $\bar{\mathrm{D}}$ and $\bar{\mathrm{N}}$ level. Next comes the derivation of (4.30), the semantics of *kız* as a NP constituent, which involves rule (4.25). Then rule (4.28) combines (4.30) with the semantics of *her* to derive (4.31), the semantics of *her kız* as $\bar{\mathrm{D}}$:

(4.30)



(4.31)

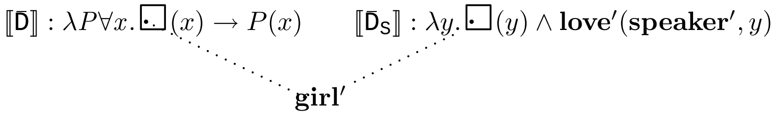


(4.31) is the desired input for the interface rule for modification. The restriction of the quantifier introduced by the $\bar{\mathrm{D}}$ emerges as the embedded fragment of this constituent, which can then be addressed by the modification interface rule (4.24).

This rule combines (4.31) and (4.32), the semantics of *sevdiğim*, into (4.33), the semantics of the $\bar{\mathrm{D}}$ expression *sevdiğim her kız*. This constraint constitutes the lower half of a dominance diamond.

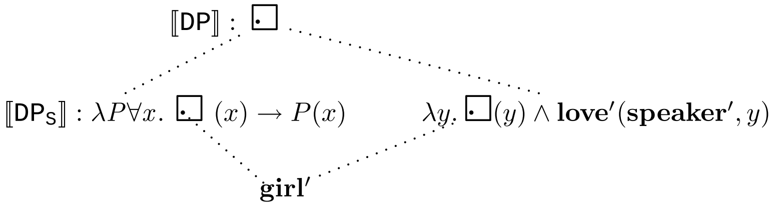
(4.32) $[\![\mathsf{XP}]\!]$,$[\![\mathsf{XP_S}]\!]$: $\lambda P \lambda x. P(x) \wedge \mathbf{love}'(\mathbf{speaker}', x)$

(4.33)



Rule (4.25) then yields the dominance diamond (4.34) on the basis of (4.33). The sole solution of this constraint is (4.35).

(4.34)



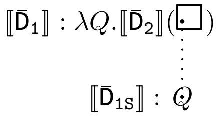
(4.35) [= (4.18a)] $\lambda P \forall x. \mathbf{girl}'(x) \wedge \mathbf{love}'(\mathbf{speaker}', x) \rightarrow P(x)$

In sum, a flexible syntax-semantics interface allows a unified semantic analysis of relative clause modification in typologically diverse languages. In the following section, this analysis will be extended to non-restrictive relative clauses.

4.7 Non-restrictive relative clauses

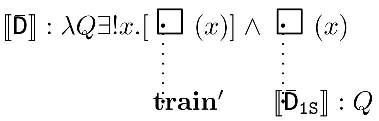
On the basis of this general approach to relative clauses we can now sketch a treatment of nonrestrictive relative clauses. To this end, we need a rule that is the semantic correlate of the specific intonation that distinguishes non-restrictive relative clauses. Since the written reflex of the intonation is a comma between the modified noun and the relative clauses, I will (roughly) characterise the rule that prepares $\bar{\mathrm{D}}$ constituents for modification by a non-restrictive relative clauses as a rule that 'interprets the comma'. I.e., the rule defines the semantics of a constituent $\bar{\mathrm{D}}_1$ consisting of a constituent $\bar{\mathrm{D}}_2$ and a comma in terms of the semantics of $\bar{\mathrm{D}}_2$:

(4.36) $[_{\bar{\mathrm{D}}_1}\ \bar{\mathrm{D}}_2,]\ \overset{(SSI)}{\Rightarrow}$



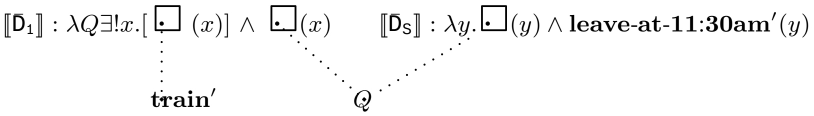
In the resulting constraint, the secondary fragment is defined as the *scope* of the quantification, no longer as its restriction. Consider e.g. the result of applying (4.36) to the semantic representation of *the train*:

(4.37)

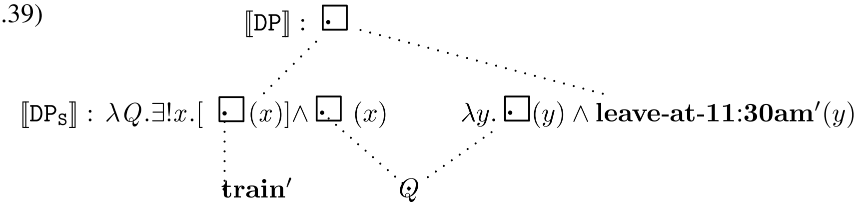


Subsequent modification, which pertains to the secondary fragment of the modified expression, will then end up in the scope of the quantifier. As an example, the result of modifying *the train* by the non-restrictive *which leaves at 11:30am* according to the rules (4.24) and (4.25) is sketched in (4.38) and (4.39):

(4.38)



(4.39)



The only solution for this constraint is (4.40), the set of properties such that the unique train has them in addition to the property of leaving at 11:30am:

(4.40) $\lambda Q \exists ! x.[\mathbf{train}'(x)] \wedge Q(x) \wedge \mathbf{leave\text{-}at\text{-}11{:}30am}'(x)$

With the solution we have sketched so far, we can tackle a related phenomenon, viz., modification of proper names as in (4.41):

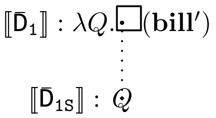
(4.41) Bill, who is a friend of mine

Once again one must combine an expression of type $\langle\langle e,t\rangle,t\rangle$ with a function from properties to properties into another expression of type $\langle\langle e,t\rangle,t\rangle$. But with the help of rule (4.36), semantic construction for (4.41) is straightforward.

Starting from the semantics of *Bill* as sketched in (4.42),[13] the application of (4.36) to (4.42) returns (4.43), where the scope of *Bill* emerges as secondary fragment.

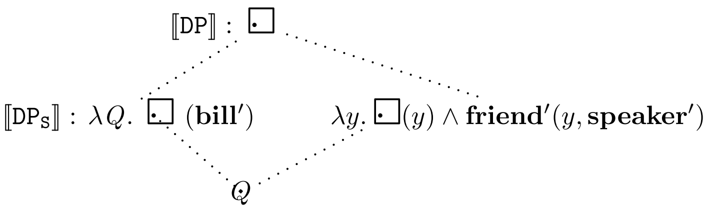
(4.42) $[\![\mathtt{D}]\!], [\![\mathtt{D_S}]\!]: \quad \lambda P.P(\mathbf{bill}')$

(4.43)



This constraint can then be combined with the semantics of the relative clause into a dominance diamond following the rules (4.23)-(4.25):

(4.44)



The sole solution of this diamond is the desired λ-term (4.45), the set of Bill's properties apart from being a friend of the speaker:

(4.45) $\lambda Q.Q(\mathbf{bill}') \wedge \mathbf{friend}'(\mathbf{bill}', \mathbf{speaker}')$

At first glance, the modification of proper nouns seems to resemble the modification of indefinite pronouns as in (4.10). If one would model the semantics of proper names by an explicit existential quantification (e.g., as the set of properties such that an entity named *Bill* has them), one could indeed handle (4.41) in analogy to (4.10), viz., by letting the relative clause pertain semantically only to the restriction of the modified expression (the property of being named *Bill*).

However, such a strategy would fail to take into account the difference between the two phenomena, viz., the fact that the modification of indefinite pronouns can involve restrictive and non-restrictive relative clauses.[14] In contrast, proper names can only be

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[13] The syntactic characterisation of proper names as intransitive determiners is motivated by the fact that they can form DPs by themselves, can be modified, and are incompatible with determiners.

[14] Here are some examples of indefinite pronouns modified by non-restrictive relative clauses:

modified by non-restrictive relative clauses, because the proper name itself suffices for the identification of its referent.[15]

4.8 Outlook

The analysis sketched in this paper captures a number of challenging cases for the semantic construction of expressions with relative clauses, but there remain enough issues for further research. One such issue that seems to be fruitfully analysable in terms of a suitable extension of the proposed analysis is the interaction of the relative clause with a nominal expression that it modifies.

Consider one of the examples discussed by Bhatt (2002). This DP has two readings, one referring to the first book of which John claimed that Tolstoy wrote it (relevant is the order of *claiming*), and the other, to the book that - according to John - is the first book that Tolstoy wrote (relevant is the order of *writing*):

(4.46) the first book that John said that Tolstoy wrote

The two readings are due to a scope ambiguity between *first* and *say*, but the first reading raises the question of how material from the modified nominal expression *first book* can end up in the scope of an operator in the relative clause.

Bhatt (2002) assumes movement of this expression from within the embedded relative clause *that Tolstoy wrote*. The interpretation of such structures chooses one of the elements of this movement chain (movement proceeds by copying) and ignores the others. I.e., one can interpret the NP locally, in the scope of *say*.

While it is pretty straightforward to represent the two readings in a dominance diamond like (4.47), whose solutions model the two readings of (4.46), the question of how to derive the constraint (4.47) in the presented analysis is still open.

(i) Everyone in this room, who has worked together for this common goal, should celebrate (`http://www.chnonline.org/2002/2002-07-04/newsstory4.html`)

(ii) Each and everyone in this room, who are members of The Grand Lodge of Canada in the Province of Ontario (`http://freemasonry.org/nking/Orient\%20Lodge\%20-\%20Education.htm`)

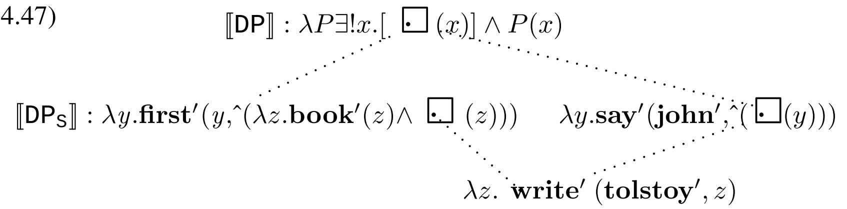
[15] One reviewer adduces sentences like (i) as counterargument to this claim:

(iii) I'm talking about Kim who works in the sales department, not about Kim who works in the cleaning team

I do share the reviewer's intuition that the relative clause has a restricting effect in (iii) in that it identifies the person talked about. However, I attribute this effect to the fact that there is constrastive focus marking on *sales department*. According e.g. to the Alternative Semantics approach to focus (Rooth 1992), this means that the first sentence in (iii) implies that all contextual alternatives to this sentence (where the speaker talks about a person named Kim, and this Kim works in another contextually relevant place) are ruled out. If there are several Kims in the context, this restriction will identify the relevant one.

In addition, some native speakers accept sentences like (iii) only with definite articles before the proper names. In this case, the counterargument does not even arise, because the use of the article shows that proper names are reanalysed as proper nouns here (for the name *X*, the set of persons named *X*).

(4.47)



In this analysis, $\mathbf{first'}(x, P)$ is true for a world-time pair $\langle w, t\rangle$ iff $P(x)$ is true for $\langle w, t\rangle$ and for all $x' \neq x$ such that $P(x')$ for a $\langle w, t'\rangle$ it follows that $t < t'$ (in prose: x is the first entity with the property P).

(4.48) (a) $\lambda P \exists ! x.[\mathbf{say'}(\mathbf{john'}, \hat{}\mathbf{first'}(x, \hat{}(\lambda z.\mathbf{book'}(z) \wedge \mathbf{write'}(\mathbf{tolstoy'}, z))))] \wedge P(x)$

(b) $\lambda P \exists ! x.[\mathbf{first'}(x, \hat{}(\lambda z.\mathbf{book'}(z) \wedge \mathbf{say'}(\mathbf{john'}, \hat{}\mathbf{write'}(\mathbf{tolstoy'}, z))))] \wedge P(x)$

(4.48a-b) stand for the properties of an entity that is unique with respect to a specific property. In (4.48a), it is the property of being designated by John as the first book written by Tolstoy. In (4.48a), it is the property of being the first book that John designates as being written by Tolstoy.

In (4.48a), the semantic contributions of the modified NP *first book* and the modifying relative clause are interleaved in such a way that the semantics of the modified expression is inserted within the modifier semantics, which is exactly the reverse pattern from the analysis of modification sketched in the analyses of (4.10) and (4.11). Further work is necessary to develop a suitable syntax-semantics interface to derive semantic structures like (4.47) from surface-oriented syntactic analyses.

References

Abney, S.(1987), *The English noun phrase in its sentential aspect*, PhD thesis, MIT.

Bach, E. and Cooper, R.(1978), The NP-S analysis of relative clauses and compositional semantics, *Linguistics and Philosophy* **2**, 145–150.

Bartsch, R.(1979), The syntax and semantics of subordinate clause constructions and pronominal coreference, *in* F. Heny and H. Schnelle (eds), *Syntax and Semantics 10*, Academic Press, New York, pp. 23–59.

Barwise, J. and Cooper, R.(1981), Generalized quantifiers and natural language, *Linguistics & Philosophy* **4**, 159–219.

Bhatt, R.(2002), The raising analysis of relative clauses: evidence from adjectival modification, *Natural Language Semantics* **10**, 43–90.

Bouma, G., Malouf, R. and Sag, I.(2001), Satisfying constraints on adjunction and extraction, *Natural Language and Linguistic Theory* **19**, 1–65.

Carlson, G.(1977), Amount relatives, *Language* **53**, 520–542.

Cooper, R.(1979), The interpretation of pronouns, *in* F. Heny and H. Schnelle (eds), *Syntax and Semantics 10*, Academic Press, New York, pp. 61–93.

Copestake, A., Flickinger, D., Pollard, C. and Sag, I.(2005), Minimal Recursion Semantics. An introduction, *Research on Language and Computation* **3**, 281–332.

Egg, M.(2004), Mismatches at the syntax-semantics interface, *in* S. Müller (ed.), *Proceedings of the 11th International Conference on Head-Driven Phrase Structure Grammar*, CSLI Publications, Stanford, pp. 119–139.

Egg, M., Koller, A. and Niehren, J.(2001), The Constraint Language for Lambda-Structures, *Journal of Logic, Language, and Information* **10**, 457–485.

Ginzburg, J. and Sag, I.(2000), *Interrogative investigations*, CSLI Publications, Stanford.

Janssen, T.(1983), *Foundations and applications of Montague Grammar*, PhD thesis, Mathematisch Centrum, Amsterdam.

Kathol, A.(1999), Restrictive modification and polycategorial NPs in English, *in* G. Bouma et al. (eds), *Constraints and resources in natural language syntax and semantics*, CSLI Publications, Stanford, pp. 83–100.

Kishimoto, H.(2000), Indefinite pronouns and overt N-raising, *Linguistic Inquiry* **31**, 557–566.

Partee, B.(1975), Montague Grammar and Transformational Grammar, *Linguistic Inquiry* **6**, 203–300.

Pollard, C. and Sag, I.(1994), *Head-driven Phrase Structure Grammar*, CSLI and University of Chicago Press.

Richter, F. and Sailer, M.(2004), Basic concepts of Lexical Resource Semantics, *in* A. Beckmann and N. Preining (eds), *European Summer School in Logic, Language and Information 2003*, Kurt Gödel Society, Wien, pp. 87–143.

Rooth, M.(1992), A theory of focus interpretation, *Natural Language Semantics* **1**, 75–116.

Sag, I.(1997), English relative clause constructions, *Journal of Linguistics* **33**, 431–484.