Computing adverbial quantifier domains

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ABSTRACT. This paper describes a method for computing the domain of quantification of an adverbially quantified sentence. This method relies on the accommodation of presuppositions in the scope of a quantificational adverb and on the resolution of the domain in context. This paper also describes a computational system for processing such sentences based on this method.

1 Introduction

This paper is concerned with the computation of the logical form of adverbially quantified sentences, which are those sentences modified by an explicit quantificational adverb (qadverb), such as *always, usually, sometimes*, or *never*. The primary challenge in computing the logical form of an adverbially quantified sentence (which we will call qadverb sentences) is determining the domain of quantification (there are additional challenges associated with interpreting such a logical form, including the strange modal nature and quantificational force of generics, but we are leaving those aside for this paper). We propose that qadverbs quantify over situations which are restricted both by presuppositions of the scope of the qadverb and by context. Furthermore, we propose that such domain restrictions can be computed by a method based on the presupposition resolution algorithm of van der Sandt (1992), and we demonstrate this with a DRT-based grammar and parser based on the system of Blackburn and Bos (1999).

2 Quantificational adverbs

Syntactically, a qadverb can modify either a verb phrase or a sentence:

(1) John usually takes out the trash.

(2) Usually, John takes out the trash.

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Semantically, however, we take them to be sentential operators, because they give rise to scope ambiguities with quantified noun phrases (NPs):

(3) Someone usually takes out the trash.

In fact, we take the logical form of a qadverb sentence to be similar to that of a sentence containing a quantified NP. The qadverb, like a quantificational determiner, corresponds to an operator which takes three arguments. The first argument is a discourse marker, which serves as the variable of quantification. The second argument (the restrictor) indicates the domain of quantification; the third argument (the nuclear scope) indicates the predication which is asserted of the members of the domain. In the DRT-based logical form language, the second and third arguments are each a DRS. The variable of quantification is introduced in the restrictor DRS, which is accessible to the nuclear scope DRS, much like the arguments of a conditional operator. For a quantificational determiner, the restrictor is provided by the remainder of the NP, and the nuclear scope, by the remainder of the sentence. For a qadverb, the situation is not so straightforward.

Unlike a quantificational determiner, there is no syntactically determined relationship between a qadverb and constituents which might provide its restrictor. The earliest work on qadverb sentences (starting with Lewis, 1975) focuses on examples in which an *if*- or *when*-clause provides the restrictor:

(4) If a man owns a donkey, he always beats it.

Without such a clause (and sometimes, even with one), any part of a qadverb sentence may map to the restrictor argument. Milsark (1974) provides an oft-cited example:

(5) Typhoons arise in this part of the Pacific.

This sentence has two readings. One is an implausible reading in which the set of typhoons serves as the restrictor argument; on such a reading, it is taken to be a general property of typhoons that they arise in a particular part of the Pacific. In the other, more natural, reading, the restrictor argument is the set of situations involving the indicated part of the Pacific; on such a reading, the occasional arising of a typhoon is taken to be a property of situations in a particular part of the Pacific. De Swart (1991) and Rooth (1985) give examples of sentences in which even an explicit *when*-clause does not necessarily map to the restrictor:

(6) When John was young, he often took walks in the gardens.

(7) John usually shaves when he showers.

In (6), the *when*-clause only serves to set the situation in time. In (7), focal stress determines whether the *when*-clause maps to the restrictor.

Focal stress and explicit *if*- and *when*-clauses are just two of the many factors that have been implicated in the determination of the restrictor argument of a qadverb. Diesing (1992) proposes with her Mapping Hypothesis that it is syntactic structure which is primarily responsible for determining what overt material (in particular, which NPs) in a qadverb sentence is associated with the qadverb restrictor. Her theory requires the syntactic machinery of GB and fails to take into account much of the semantic complexity of the data. Opposed to this syntactic view are those who claim that it is the topic-focus or topic-comment structure of a sentence that determines its division into restrictor and matrix. According to this view, the topic of a qadverb sentence is its restrictor; its focus, the matrix (proponents of this approach include Chierchia, 1992 and Jäger, 1997; see Partee, 1995 for a list of others). This approach is closely related to Rooth's observations on the association of qadverb restrictors with focal stress (exemplified by (7), above). Cohen (1996) proposes that qadverbs quantify over appropriate sets of alternatives which may be generated in a variety of ways, including by focal stress or by presuppositions.

Several other authors have noticed that presuppositions of the scope of a qadverb are incorporated into its restrictor (Schubert and Pelletier 1987; Berman 1991):

(8) John usually beats Marvin at ping pong.

(9) John usually regrets missing a lecture by Chomsky.

Schubert and Pelletier note that in a qadverb sentence with a presuppositional verb, such as *beat*, the qadverb quantifies only over situations which satisfy the presupposition associated with the verb (in the case of (8), situations in which John plays Marvin at ping pong). Berman provides examples for other kinds of presuppositions, such as factives (*regrets* in (9)) and aspectual verbs. The range of presuppositional material considered by Schubert and Pelletier and by Berman is somewhat narrow, and both consider presupposition incorporation to be only a part of process of determining a qadverb restrictor. When we consider the full range of presuppositions which may be accommodated by a qadverb restrictor, however, we find that most of the overt material which has been claimed to be incorporated into the restrictor consists of presuppositions of the scope.

3 Presuppositions

A wide range of linguistic phenomena gives rise to presuppositions. Keenan (1971) includes as examples of presupposition triggers: definite descriptions, factive predicates, cleft constructions, selectional restrictions, temporal subordinate clauses, certain aspectual verbs, iteratives, and presuppositional adverbs; to this list, van der Sandt (1988) adds focal stress, lexical presupposition, and quantifiers. Additionally, Milsark (1977) and Fodor and Sag (1982) distinguish between two readings of indefinites, one of which corresponds to existential quantification and the other of which is essentially presuppositional. If we simply allow that sentential presuppositions are what determine a qadverb restrictor, we have an account which subsumes the above-mentioned accounts. Explicit *if*- and *when*-clauses fall together with other presupposed subordinate clauses. The NPs with which Diesing is concerned fall into one of the following classes: definite descriptions, which are the paradigm case of presuppositionality; quantified NPs, which are taken to presuppose their domains; and indefinites, which on certain interpretations are presuppositional. The most illustrative cases of topic-focus articulation (cleft constructions and focal stress) are also subsumed as presuppositions.

In order to make our presuppositional theory work, we need a separate account of presuppositions. The most widely accepted account of presuppositional phenomena is that of van der Sandt (1992), which is well-suited to our purposes. Van der Sandt proposes that presuppositions are simply informationally rich anaphors. Like an ordinary anaphor, a presupposition requires an antecedent, and if one is found in the appropriate context, then the presupposition is satisfied. Unlike an ordinary anaphor, though, the inability to find an antecedent does not necessarily lead to failure. Since a presupposition is informationally rich, i.e. it has its own descriptive content, an antecedent may be constructed for it, under the appropriate conditions.

Van der Sandt casts his account in a version of DRT, which allows him to handle projection in configurational terms, using the DRT notion of accessibility. On his analysis, presupposing elements introduce their elementary presuppositions in a local DRS just as anaphoric elements introduce anaphors in the local DRS. Each elementary presupposition must then be resolved, either by binding or accommodation. The resolution process proceeds from the local DRS for an elementary presupposition along its projection line looking for an appropriate marker which can be unified with the elementary presupposition. If one is found, then an anaphoric link is created between the presupposition and its antecedent, and the presupposition has been satisfied by binding. If one is not found, the presupposition must be accommodated at some accessible level in which constraints on binding, consistency, informativeness, and efficiency can be satisfied. Accommodation simply consists of copying the presupposition to the embedding DRS.

4 Qadverb analysis

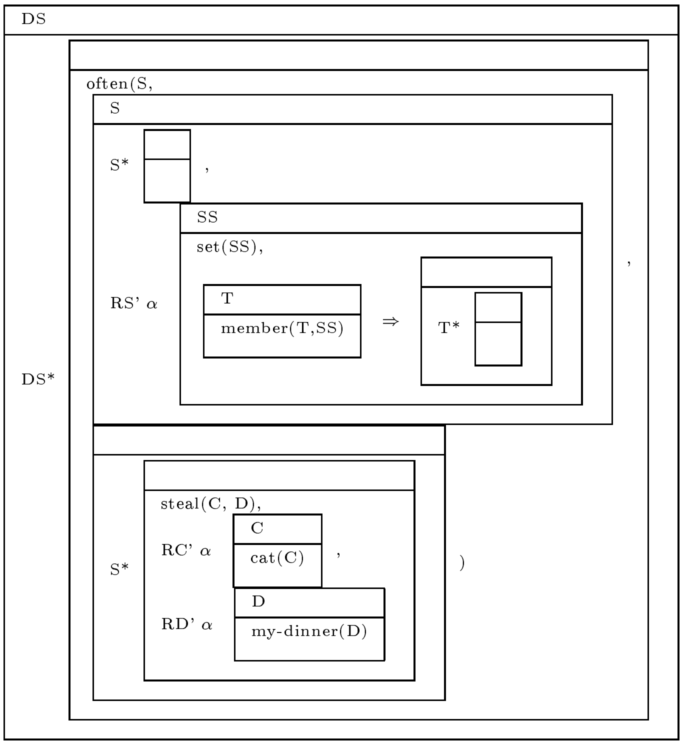
Following Berman (1987), Heim (1990), and von Fintel (1995), we take qadverbs to be quantifiers over situations (rather than unselective quantifiers or quantifiers over time as others have proposed), which allows us to restrict both temporally and informationally the entities being quantified over and also allows us to make the connection between qadverb restrictors and presuppositions clearer. Following Poesio (1994), we take presuppositions to be situation descriptions, and the resolution of a presupposition to consist of binding or accommodating a situation parameter associated with the description. Since there is no descriptive content initially associated with a qadverb restrictor, the restrictor in our initial logical form consists solely of a situational discourse marker with no conditions. The presupposition resolution process resolves presuppositions of the scope with the restrictor by binding the situation parameters associated with these presuppositions to the situational discourse marker introduced in the restrictor. This binding of situation parameters accounts for the presupposition accommodation observed by Schubert and Pelletier and Berman and also accounts for most of the other overt material which has been claimed to restrict the domain of quantification of qadverbs.

As we mentioned above, the domain of quantification of a quantificational determiner is presupposed. A qadverb also presupposes its domain of quantification. In both cases, what is presupposed is the existence of a set corresponding to the quantification domain. Thus, for a qadverb, the restrictor is taken to be a situation description which provides the membership conditions of the presupposed set of situations. This set of situations is associated with a situation parameter of its own. Note that this situation parameter is a separate entity from the situational discourse marker introduced in the restrictor. This discourse marker indicates the situations over which the qadverb quantifies and, as described above, binds presuppositions in the nuclear scope. The situation parameter associated with the domain presupposition provides the resource situation in which those entities are situated. It is the resolution of this parameter in the context of the rest of the discourse which results in the anaphoricity of qadverb domains that is observed by von Fintel (1995).

For example, consider the sentence (10). (We will illustrate one plausible resolution, though there are others.) The initial representation for this sentence (11) introduces a global discourse situation *DS*, which supports the dinner-stealing proposition. (The support relation * between a situational discourse marker and a DRS is transparent to accessibility.) The quantificational condition deriving from the qadverb *often* takes three arguments: S, which is the variable of quantification; the restrictor DRS, which contains a situation parameter *RS'* associated with the resource domain presupposition; and the nuclear scope DRS, which contains situation parameters associated with the presuppositions corresponding to *the cat* and *my dinner*. Situational parameters are distinguished by a prime and are associated to a presupposition via the α relation.

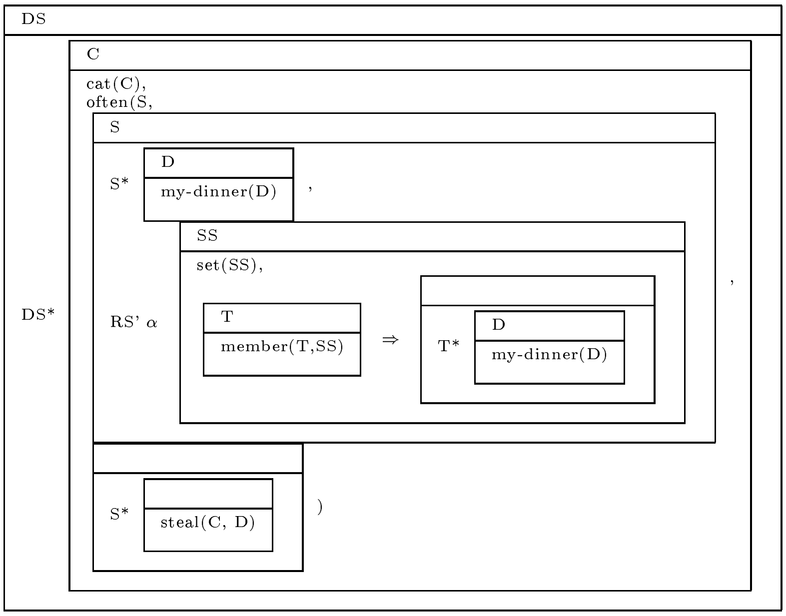
(10) The cat often steals my dinner

(11)



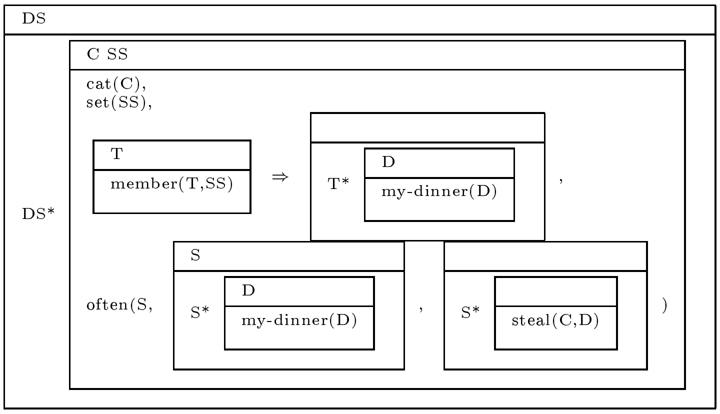
In the representation (12), the presupposition for *the cat* has been accommodated globally by binding *RC'* to *DS* and adding the conditions of *RC'* to the situation supported by *DS*. The presupposition corresponding to *my dinner* has been accommodated in the restrictor, by binding *RD'* to *S* and adding the conditions of *RD'* to the situation supported by *S*. These conditions are also added to resource domain presupposition.

(12)



The resolution process is completed by binding *RS'* to *DS* and adding its conditions, as well, resulting in representation (13).

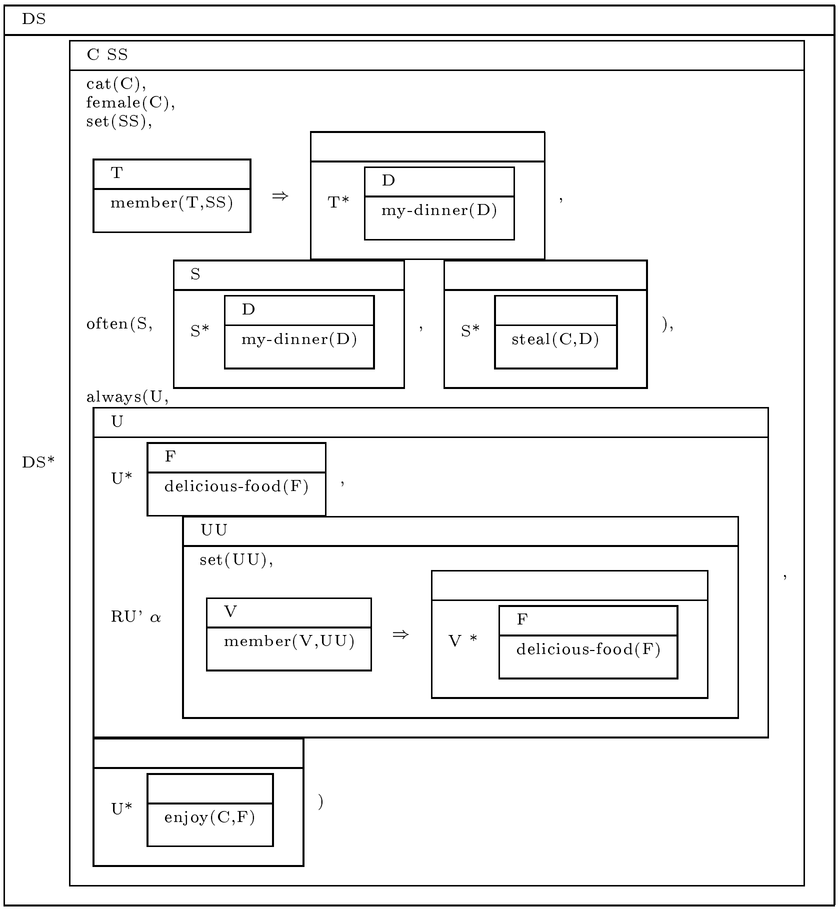
(13)



The discourse may be continued with sentence (14), which, after resolving the presuppositions associated with *she* and *the delicious food*, results in the representation (15).

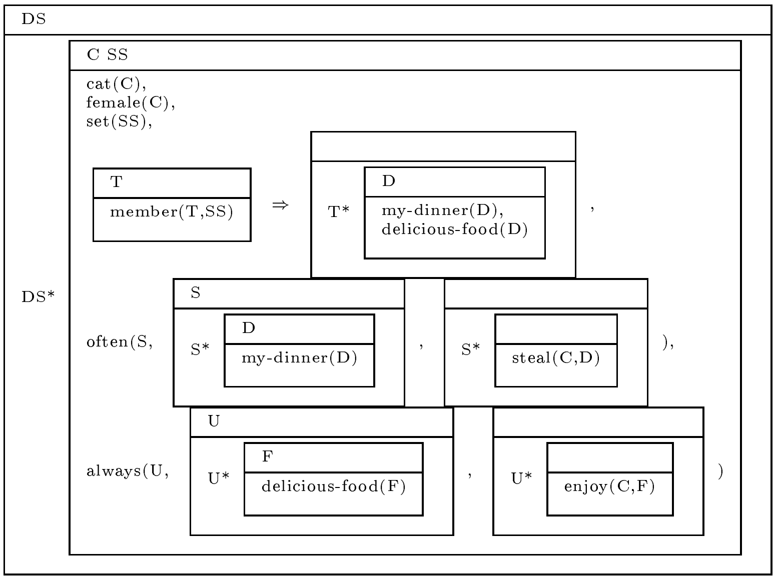
(14) She always enjoys the delicious food.

(15)



The final representation (16) is completed by binding *RU'* to *DS* and equating *UU* to *SS*. In collapsing the membership conditions for *UU* and *SS*, *F* and *D* are also equated.

(16)



In the above example, the resource domains associated with the qadverbs were resolved by accommodation or by binding. In binding the resource domain for *always* to the accommodated set for *often*, we equated the two sets. In general, however, the relation between an existing set and a resource domain which is bound to it is not equality. Consider the following example:

(17) John ate every piece of fruit in the bowl. Most (of the) oranges were tasty.

In this case, the set of fruit should bind the set of oranges, even though the two sets are not necessarily equal. Instead, the set of oranges should be taken to be a subset of the set of fruit. We see the same situation with qadverb domains:

(18) My friends always vacation in strange places. My best friend John usually goes to Antarctica.

The set of situations accommodated for the first sentence consists of situations in which the speaker's friends go on vacation. The resource domain for the second sentence is the set of situations in which John goes somewhere. Clearly, this set should be bound to a subset of the first set—those situations in which John goes on vacation. Thus, we expand the notion of binding to include binding a presupposed set to a subset of an existing set.

As the example (10)-(16) demonstrates, presuppositions arising in the scope of a qadverb are not necessarily resolved with the restrictor. Whether or not a presupposition must be bound to the situational discourse marker introduced in the restrictor depends on a number of factors. Most important is whether or not the sentence is coherent without such binding. Since we claim that a qadverb essentially quantifies over situations (which default to time intervals of contextually determined granularity in the absence of any bound presuppositions), any presuppositions that are resolved at a discourse level superordinate to the quantification must be constant for each of the situations over which the qadverb quantifies. For many presupposed elements, this is not possible. Consider, for example:

(19) The fog usually lifts before noon here.

There cannot be a single, unique instance of fog which repeatedly lifts; instead, the definite description must be bound to the qadverb restrictor, resulting in separate instances of fog for each lifting event. We are still developing a way to formalize this notion of persistence so that it can be used to evaluate possible resolutions.

One shortcoming of our analysis of qadverbs is that once the resource domain is resolved, the connection between the set of situations constituting the resource domain and the set of situations over which the qadverb quantifies is lost. One way to maintain this connection is to include an additional condition in the restrictor which indicates that the situation corresponding to the variable of quantification is a member of the resource domain. For example (11), the condition would be *member(S,SS)*. Once this is done, the additional conditions in the restrictor would seem to be redundant, except that they are necessary to maintain accessibility for the nuclear scope.

Geurts and van der Sandt (1999) present an account of quantifier domain restriction that is in spirit very similar to ours. They, however, introduce a new kind of entity—a propositional discourse marker—which allows them to handle acessibility non-structurally. On their analysis, a quantifier is not a relation between descriptions of sets but between propositional discourse markers, which are sets of embedding functions specified as separate conditions. Thus, there is a direct connection between the presupposed resource domain and the restrictor argument. They build in conservativity by stipulating that the propositional discourse marker associated with the nuclear scope is an extension of the marker associated with the restrictor and, as a result, they get accessibility of the restrictor from the nuclear scope for free.

5 Computational implementation

We are presently at work on a small computational system to process qadverb sentences. It is based on the DRT parser in the textbook by Blackburn and Bos (1999), which is focused on the problems of quantifier scope ambiguity and presupposition resolution. Thus far, we have added grammar rules and lexical entries to allow for plural nouns and quantificational adverbs and modified existing rules and entries to associate situational discourse markers with DRSs. We do use the existing notation for presuppositions, which differs somewhat from ours, and have not modified it to associate situation parameters with presuppositions. Thus, instead of introducing a presupposition inside the DRS in which its extent begins, a presupposition is introduced via an alpha expression which takes scope over the DRS in which its extent begins.

We have had to modify the presupposition resolution algorithm itself. The original algorithm resolves each presupposition before resolving any presuppositions triggered within its scope; in order for the resource domain of a qadverb to have any descriptive content to be resolved, however, the presuppositions of the nuclear scope (which falls within the scope of the resource domain presupposition) must be resolved first. Also, a resource domain presupposition (both for qadverbs and for quantified NPs, for which we have also added such a presupposition) may be bound either to an existing set or to a subset of an existing set. The semantic macro that produces the semantic portion of the lexical entry for a qadverb is as follows:

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advSem(Sym, qadv, lambda(P, lambda(X,
       alfa(SS,qresource,
            drs([SS],[set(SS),
                      drs([S],[member(S,SS)])>drs([],[])]),
            drs([],[qcond(Sym,S,drs([S],[S * drs([],[])]),
                               drs([],[S * P@X])]))))))
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Since a qadverb is syntactically a VP operator, its first argument is a predicate, and its second, an individual. The resulting expression is a resource domain presupposition (SS is the set of situations) whose scope is the quantificational condition (Sym is the translation of the qadverb). Presuppositions arising from $P@X$ (i.e. P applied to X) may be accommodated in the restrictor. Material from the restrictor is copied into the membership conditions of the resource domain, and the resource domain is then resolved.

This system is still a work-in-progress. We have not yet built a mechanism to check consistency when binding sets, and we still have to introduce situation parameters into presuppositional expressions to mirror our analysis more closely. We are considering trying to use propositional discourse markers, a la Geurts and van der Sandt (1999), since in addition to handling the connection between the restrictor and the resource domain more neatly, such an approach would obviate the need for a different order of resolution just for qadverbs. Changes would be necessary to handle accessibility through linked propositional discourse markers, as well as through structural embedding. Nonetheless, the current system computes qadverb domains in accordance with the theoretical analysis outlined above, using only presuppositional information.

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