Only the Strong: Restricting Situation Variables

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1. Introduction

Linguists often assume that possible worlds and times are represented as pronouns in natural language (see Cresswell 1990, Percus 2000, Kusumoto 2005, Keshet 2008). This paper will construe such pronouns as world-time pairs, which will be referred to as situations, for simplicity. A predicate taking such a pair as an argument is evaluated in the world and the time specified by that situation, effectively determining whether it is *de re* or *de dicto*. Researchers such as Percus (2000) have noted that such a system overgenerates and proposed generalizations describing where this overgeneralization occurs. This paper will examine three such generalizations: Percus's (2000) Generalization X, a generalization by Musan (1997), and a new generalization covering modifiers of nouns. Ultimately, a unified generalization will be proposed, stating that only strong DPs ever may receive a *de re* interpretation. An explanation for this generalization is offered, involving a change in the semantic type system, under which only strong determiners may take situation pronouns.

2. Restrictions on Situation Pronouns

The first question to arise once situation pronouns are posited is whether there are any constraints on these pronouns' distribution and indexing. To answer this question, I will begin by assuming the least restrictive theory possible concerning the distribution and indexing of situation pronouns. This null hypothesis might be as follows:

(1) **Free Situation Pronoun Hypothesis**: A situation pronoun may be freely inserted and indexed wherever it is sister to a node of type $\langle s, \alpha \rangle$.

This section describes three generalizations (one new) pertaining to cases where the Free Situation Pronoun Hypothesis overgenerates. Last, a new, unified generalization is proposed to cover all three cases.

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2.1. Generalization X

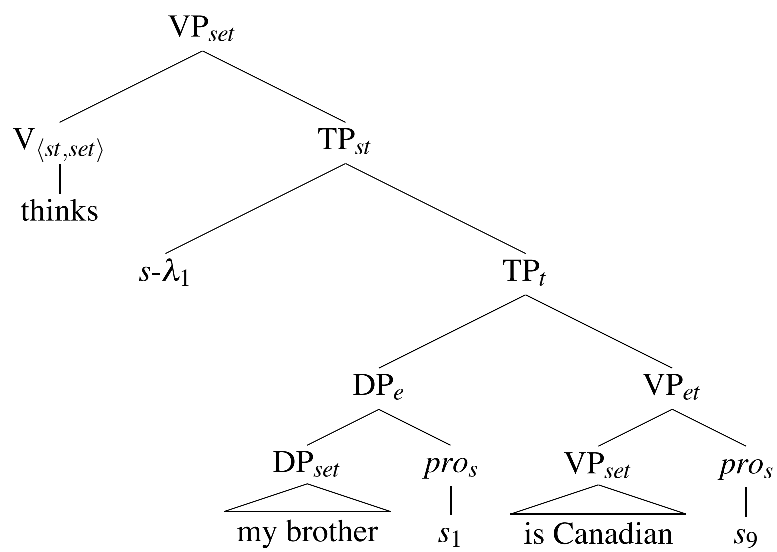
Percus (2000) proposes his Generalization X based on the fact that the following sentence is missing a reading predicted under the Free Situation Pronoun Hypothesis:

(2) Mary thinks my brother is Canadian. (= Percus's 26a)

The embedded sentence in (2) has two predicates which take type-*s* arguments – *my brother* and *is Canadian* – and therefore, according to the Free Situation Pronoun Hypothesis, a structure like (4) should be available, given the definitions in (3).

(3) a. $[\![\textbf{my brother}]\!] = \lambda s_s \,.\, \lambda x_e \,.\, x$ is my brother in s
    b. $[\![\textbf{is Canadian}]\!] = \lambda s_s \,.\, \lambda x_e \,.\, x$ is Canadian in s

(4)



When a situation pronoun s in the scope of an intensional operator α is not bound by a λ operator directly below α, any predicates that are evaluated in the world and time denoted by s can be *de re* (with respect to α). In (4), therefore, the VP *is Canadian* can be *de re*, since it is evaluated at the world and time determined by the situation pronoun s_9, which is not bound by the λ operator directly below the verb *thinks*. Note that in order for this structure to be non-trivial, the subject *my brother* must be *de dicto*. Otherwise, there would be nothing at all bound by the s-λ_1.[1]

Percus notes that despite this possible structure, there is no reading where *is Canadian* is *de re*. He describes the meaning of such a reading as follows:

(5) "... we would take the sentence to be true whenever there is some *actual* Canadian who *Mary thinks* is my brother – even when this person is not my brother in actuallity, and *even when Mary mistakenly thinks that he is not Canadian*" (p. 200).

[1] See Percus's footnote 18, p. 200, for discussion.

In other words, it would mean that someone Mary thinks is my brother is Canadian. Based on this and other evidence, Percus proposes his Generalization X:

(6) **Generalization X**: The situation pronoun that a verb selects for must be coindexed with the nearest λ above it (=34, p. 201).

2.2. Musan's Generalization

Musan (1997) makes the observation that while strong DPs can be evaluated at a time independent from the main predicate of their clause, weak NPs must be evaluated at the same time as this main predicate:

(7) **Musan's Generalization**: A noun phrase can be temporally independent if and only if it is in a strong DP ($\approx$ Musan's 10, p. 60).[2]

(8) **Definitions**: A noun phrase is **temporally dependent** if its time of evaluation must be same as the time of evaluation for the main predicate of its sentence. Otherwise, the noun phrase is **temporally independent**.

Take the following sentence, for instance, which is an adaptation of Musan's examples:

(9) Some members of congress knew each other in college. In fact, . . .
   a. . . . three U.S. Senators were attending Harvard together in 1964.
   b. #. . . there were three U.S. Senators attending Harvard together in 1964.

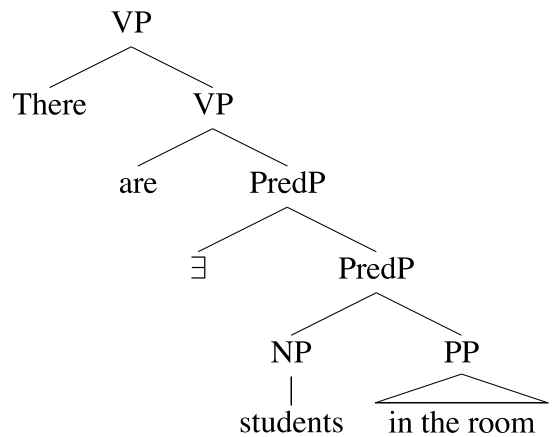
In (9-a), the subject *three U.S. Senators* may be evaluated in the present, meaning something like *three current U.S. Senators*. The VP *were attending Harvard together*, on the other hand, is evaluated in the year 1964. If the two were instead evaluated at the same time, the sentence would sound odd, since most college students are too young to be senators (who must be at least 30 years old according to the U.S. constitution). And, in fact, (9-b) does sound odd for this very reason: the two contradictory descriptions are required to hold at the same time. According to Musan, this odd reading is due to the fact that *three U.S. Senators* is a weak NP in (9-b), as evidenced by the fact that it appears in the Existential There Construction. Since it is weak, the NP must be evaluated at the same time as its main predicate, *attending Harvard together*.

I assume that the NP and the post-nominal predicate in an Existential There Construction are interpreted via the Predicate Modification composition rule. Discounting situation arguments for a moment, I will assume a structure similar to the one shown in (10):

(10) a. There are students in the room.

[2]Musan later revises this generalization to include facts about existence-independent predicates like *is famous*; I will ignore such predicates.

b.

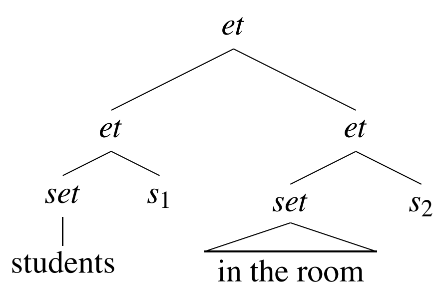


Here the NP *students* combines with *in the room* via Predicate Modification to form a node denoting students who are in the room, before undergoing existential closure. Once you add situation pronouns into the picture, the Free Situation Pronoun Hypothesis predicts at least the three structures in (12) for the node marked *PredP* in (10), assuming the lexical entries in (11):

(11) a. $[\![\textbf{students}]\!] = \lambda s \,.\, \lambda x_e \,.\, x$ comprises students in s

b. $[\![\textbf{in the room}]\!] = \lambda s \,.\, \lambda x_e \,.\, x$ is in the room in s

(12) a.



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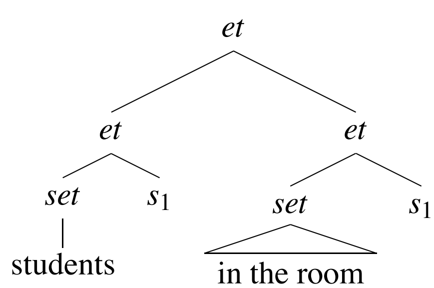
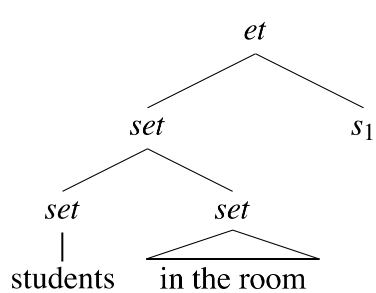


c.



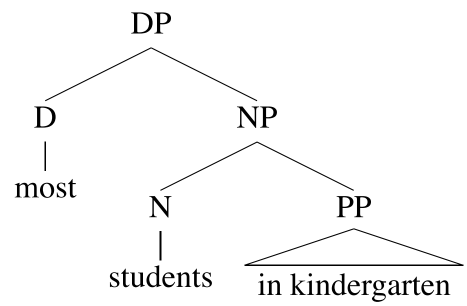
In each structure above, *students* and *in the room* combine via Predicate Modification. (This combined predicate is then existentially closed higher in the structure.)

However, how these two phrases combine with situation pronouns differs in each structure. In (12-a), the NP and the predicate take two different situation variables, s_1 and s_2; in (12-b), they take two coindexed pronouns; and in (12-c), they only take one pronoun. Musan's Generalization is only compatible with the latter two structures, where the NP *three students* is evaluated at the same world and time as the predicate *in this room*.

2.3. Nouns and Intersective Modifiers

The new generalization arises in another case of two phrases being composed via Predicate Modification: a noun and an intersective modifier (Jackendoff 1977). In an extensional system, such a configuration looks like the following:

(13)



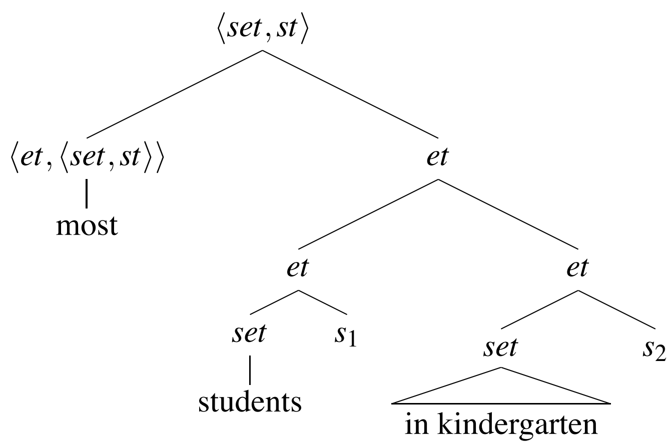
The noun and the modifier in (13) combine via Predicate Modification. Once situation pronouns are factored in, the Free Situation Pronoun Hypothesis would predict all the structures in (15) for (13), given the lexical entries in (14):

(14) a. $[\![\textbf{students}]\!] = \lambda s_s \,.\, \lambda x_e \,.\, x$ comprises students in s

b. $[\![\textbf{in kindergarten}]\!]\ \lambda s_s \,.\, \lambda x_e \,.\, x$ is in kindergarten in s

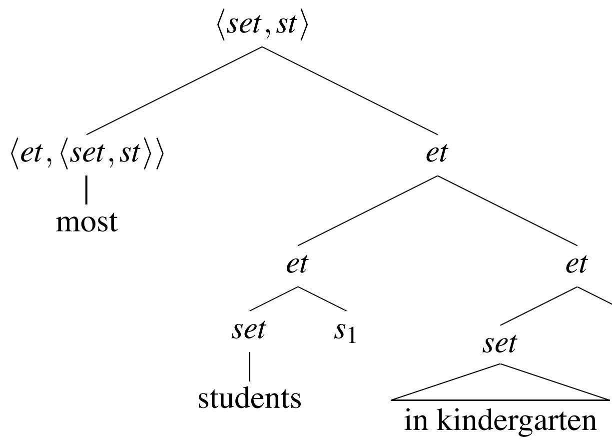
c. $[\![\textbf{most}]\!] = \lambda P_{et} \,.\, \lambda Q_{set} \,.\, \lambda s_s$. for most x such that $P(x)$. $Q(s)(x)$[3]

(15) a.

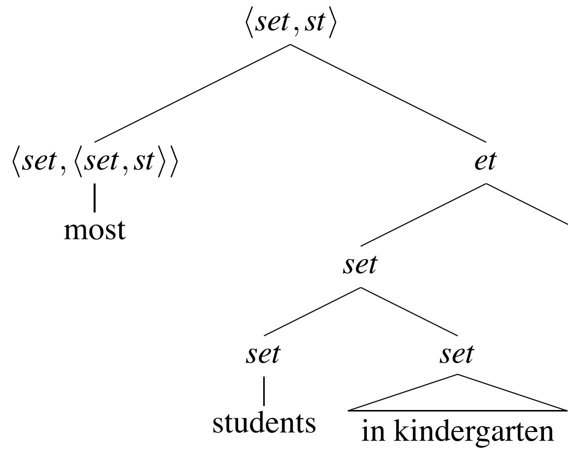


[3]See section 4.2 for a revised definition for generalized quantifiers.

b.



c.



In (15-a), the noun and its modifier take different situation pronouns; in (15-b) they take coindexed pronouns; and in (15-c) they only take one situation pronoun. The generalization defended in this section (given in (16)) is upheld only in the latter two structures, where the noun and its modifier must be interpreted at the same world and time.

(16) **Noun-Modifier Generalization**[4]: A noun and an intersective modifier must be evaluated at the same time and world.

I will show evidence for this generalization, first relative to times and then relative to possible worlds:

(17) #In 1964, every U.S. Senator at Harvard got straight A's.

(18) Every U.S. Senator who was at Harvard in 1964 got straight A's in college.

If the noun *U.S. Senator* in (17) and its modifier *at Harvard* could hold at different times, then the sentence might mean the same as (18)[5]. However, consistent with the Noun-Modifier Generalization, this reading is not available. The sentence sounds odd since it entails that there were people who were sitting senators and at

[4]A suggestion along these lines was first made to me by Jon Gajewski, p.c.

[5]In (18), the noun holds at the same time as the entire modifier *who was at Harvard in 1964*; the phrase *at Harvard* holds at the time shifted backwards by the past tense on *was*.

Harvard at the same time.

(19) #Mary thinks the married bachelor is confused.

The reasoning follows similarly for the case in (19). Here, *bachelor* and *married* must be in the same world, despite the fact that it leads to an odd reading.

2.4. *Unified Generalization*

Consider the following summary of the results above:

(20)

Phrase	Domain	Non-local?	Generalization
Strong DP	CP	✓	
Weak NP	CP	X	Musan
VP	CP	X	Percus (X)
Noun Modifier	NP/DP	X	Noun-Modifier

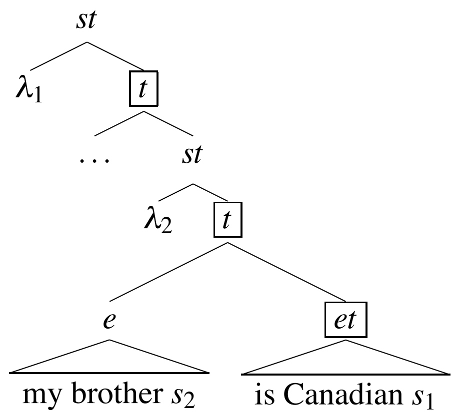
Musan's Generalization states that weak NPs must be *de dicto* within the CP, Percus's Generalization X that VPs must be *de dicto* within the CP, and the Noun-Modifier Generalization that modifiers of nouns must be "*de dicto*" in the sense that they are evaluated at the time and world local to their head noun. The only items that are ever *de re* are strong DPs. One way of combining these three generalizations is the following:

(21) A node may be interpreted *de re* (i.e., at a non-local world or time) iff it is a strong DP.

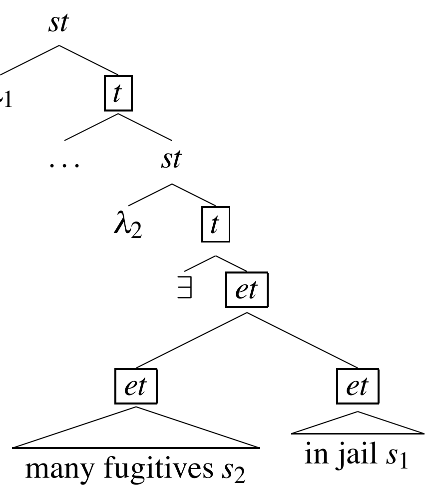
3. Observation

Before an explanation of this unified generalization is tendered, first let us examine a pattern to the structures which violate the generalization. Repeated below are structures representative of violations of Percus's Generalization X, Musan's Generalization, and the Noun-Modifier Generalization. In each case, a situation pronoun combines with a node to form another node whose denotation has an extensional type – i.e., a type containing no situations (*s*'s). These nodes have been framed by boxes in the diagrams below:

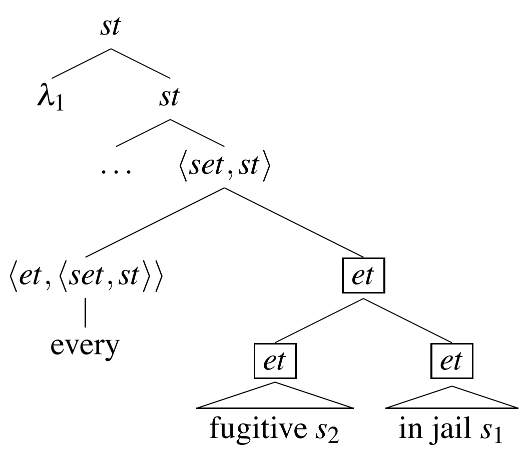
(22) Violation of Percus's Generalization



(23) Violation of Musan's Generalization



(24) Noun-Modifier Generalization Violation



Based on this observation, the intuition behind the proposal below will be the following: if there were no extensional types, structures such as these would not be possible, preventing violations of the generalizations.

4. Proposal

The implementation of this intuition comes in the form of a modification to the semantic type system, along the lines of that proposed by Cresswell (1973) and Kratzer (1991). The new system is as follows (cf. Heim and Kratzer 1998):

(25) **Semantic types**

a. e, s, and p are types.
b. If α and β are types, then $\langle \alpha, \beta \rangle$ is a type.
c. Nothing else is a type.

(26) **Semantic domains**

Let W be the set of all possible worlds. Let I be the (ordered) set of all times. Let S be $W \times I$, the set of all situations (i.e., pairs of worlds and times). Associated with each situation s in S is the domain of all individuals existing in s. Let D be the union of the domains of all situations.

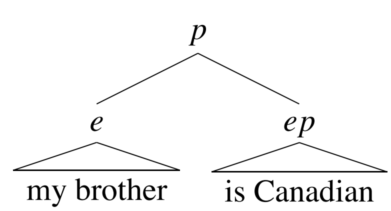
a. $D_e = D$
b. $D_s = S$
c. D_p = the power set (set of all subsets) of S
d. If α and β are semantic types, then $D_{\langle \alpha, \beta \rangle}$ is the set of all functions from D_α to D_β.

The major difference between this system and the one in Heim and Kratzer (1998) is that this system has no type t (for truth value). Instead there is a type p (for proposition) which is the type for sets of situations. (This type is roughly equivalent to $\langle s, t \rangle$ in Heim and Kratzer's system.) A simple sentence, such as *it's raining*, therefore will denote a set of situations, and the utterance of such a sentence will assert that the situation comprising the real world and the utterance time is in that set.

4.1. Explanation of Generalizations

Let us see how the examples which were problematic for the Free Situation Pronoun Hypothesis are treated in this new system. First, consider our example for Percus's Generalization X:

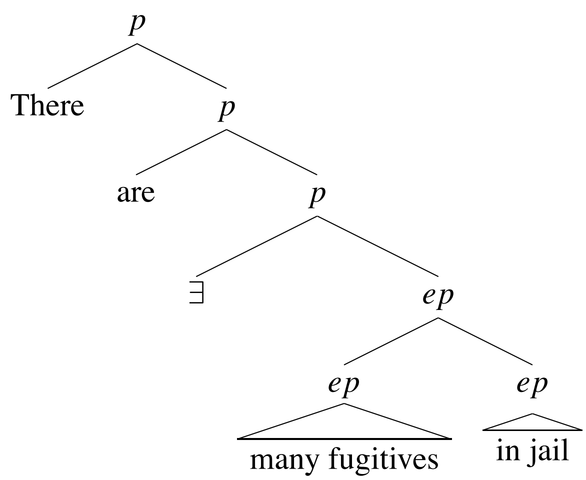
(27)



Whereas in the old system there was a question of whether one-place predicates had the type $\langle e, \langle s, t \rangle \rangle$ or $\langle s, \langle e, t \rangle \rangle$, under the new system all such predicates are of type $\langle e, p \rangle$. Therefore, in (27), the VP does not take an argument of type s at all, so it can only receive a *de dicto* interpretation.

Next, consider the example for Musan's Generalization:

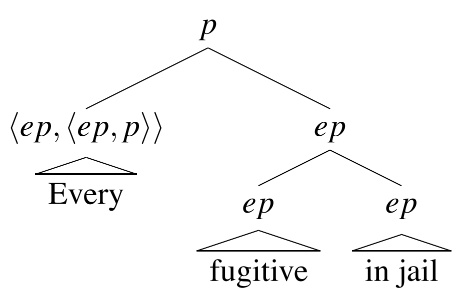
(28)



Weak DPs in this new system are also of type *ep*. In the Existential There Constructure, they combine with their main predicates via Predicate Modification before existential closure applies (Milsark 1974, Heim 1982, Diesing 1992). Once again, there is no type-*s* argument.

Last, (29) is an example of the Noun-Modifiers Generalization:

(29)

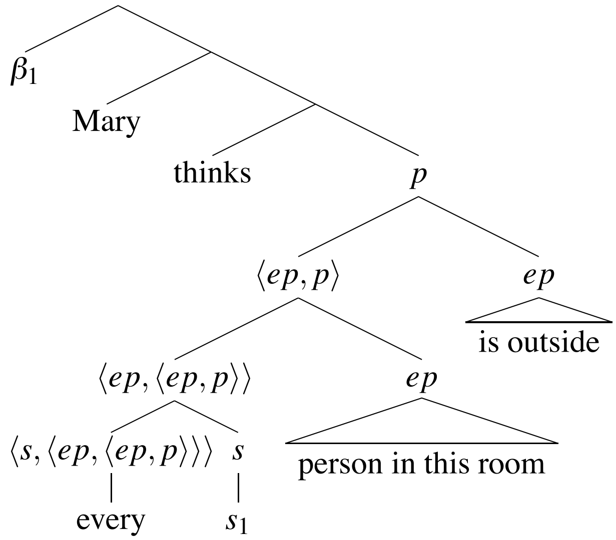


And similarly to the previous case, a noun and its modifiers combine via Predicate Modification, without a type-*s* argument.

4.2. Strong Quantifiers

So far, the new system has achieved the goal of ruling out cases in which a node that is not a strong DP receives a *de re* interpretation. Now let us turn our attention to strong DPs themselves and see how they can receive *de re* interpretations. Strong determiners, I assume, take a situation argument as represented below (the β operator will be explained in a moment):

(30)



In (30), the determiner *every* has the type $\langle s, \langle ep, \langle ep, p\rangle\rangle\rangle$, and therefore its first argument is a situation pronoun. I further assume that this situation argument determines the time and world in which the quantifier's restrictive clause is interpreted, but not the time and world in which the nuclear scope is interpreted. In this way, the strong DP (i.e., the restrictive clause) may be *de re*, but the VP (i.e., the nuclear scope) may not.

In order to correctly define such a determiner, though, I must first introduce two new operators, whose purpose is to convert objects of type p – sets of situations – into the characteristic functions of those sets, and vice versa. These operators are written $^{\cup}$ and $^{\cap}$ after Chierchia (1998):

(31) a. $^{\cup}P \leftrightarrow [\lambda s \,.\, s \in P]$, for any $P \in D_p$.
b. $^{\cap}f \leftrightarrow \{s : f(s) = 1\}$, for any $f \in [D_s \rightarrow D_t]$.

$^{\cup}$ converts a set of situations into a function from situations to truth values and $^{\cap}$ does the reverse. I assume that these operators are only available in the meta-language, and are tied to the definitions of only a small number of lexical items.

Given these operators, we can now define *every*:

(32) $[\![\textbf{every}]\!] = \lambda s \,.\, \lambda P_{ep} \,.\, \lambda Q_{ep} \,.\, ^{\cap}[\lambda s' \,.\, \forall x \,.\, [^{\cup}P(x)](s) = 1 \rightarrow [^{\cup}Q(x)](s') = 1]$

Under this definition, *every* first takes a situation argument s, then two predicates P and Q of type $\langle e, p\rangle$. The situation s is applied to P, the quantifier's restrictive clause, via use of the $^{\cup}$ operator. Through use of both the $^{\cup}$ and $^{\cap}$ operators, the denotation of the node containing *every* once it takes all its arguments is of type p – a set of situations. Notably, this set is linked to the argument of Q, the nuclear scope of the quantifier, and therefore the nuclear scope (the VP) will never be *de re*, only *de dicto*. Only the restrictive clause, which is linked to the situation argument s may be *de re*. Therefore, only the strong DP itself may be *de re*, and not the VP, or any part of the DP. Weak noun phrases do not take such a situation argument and therefore may not be *de re*, as shown above.

4.2.1. Binding

One remaining question about this system is how the situation pronoun argument of a strong determiner is bound. For this question, we turn to a proposal of Schueler (2007), who adapts the β operator of Büring (2005). Büring's β_i (binder prefix) operator takes a predicate with an open individual argument slot, and binds anything indexed i in its scope to this open argument slot. So, it takes a node of type $\langle e,t \rangle$ and returns one of type $\langle e,t \rangle$; the only change it makes is to the assignment function. Schueler extends the assignment function to return items not only of type e, but also of type s; he then extends the β operator to take nodes with an open situation argument (type $\langle s,t \rangle$) and bind co-indexed situation pronouns to this slot. My definition, given in (33), follows Schueler; the only difference comes about due to the new type system and the $^{\cup}$ and $^{\cap}$ operators:

(33) $[\![\beta_i \ \mathbf{X}]\!]^g = {}^{\cap}[\lambda s \ . \ {}^{\cup}[\![\mathbf{X}]\!]^{g[i \rightarrow s]}(s)]$

Given this operator, the binding works as follows:

(34) a. de re:
[β_1 Mary thinks [β_2 every s_1 boy is outside]].
b. de dicto:
[β_1 Mary thinks [β_2 every s_2 boy is outside]].

When a situation pronoun s is bound by a non-local β operator, any nodes whose world and time of evaluation are determined by s will be *de re*. When a situation pronoun is bound by a local β operator, any such nodes will be *de dicto*.

5. Conclusion

This paper has shown how three generalizations constraining the situation at which natural language expressions may be evaluated can be unified into one: namely, that only strong DPs may be evaluated *de re*. Any method of restricting the system such that only strong DPs can take situation pronouns will suffice to explain this generalization: even simply stipulating it. However, this paper tried to explain the generalization in a slight more principled manner, by restricting the type system. By not allowing the type t for denotations, we prevented violations of the three original generalizations. Some questions still remain, however, since we had to stipulate that the operators required to apply a situation argument to a predicate were lexically linked to strong determiners and the β operator. Also, the reason why a strong determiner applies its situation argument to its restrictive clause instead of its nuclear scope is left unexplained. The trade-off for these few stipulations, though, is a very simple system that explains all three original generalizations parsimoniously.

References

Büring, D.: 2005, *Binding Theory*. Cambridge University Press.

Chierchia, G.: 1998, 'Reference to Kinds across Language', *Natural Language Semantics* **6**, 339–405.

Cresswell, MJ: 1973, *Logics and Languages*. London: Methuen.

Cresswell, M.J.: 1990, *Entities and indices*. Kluwer Academic Publishers Boston.

Heim, I. and A. Kratzer: 1998, *Semantics in Generative Grammar*. Blackwell Publishers.

Jackendoff, R.: 1977, *X′ syntax*. MIT Press Cambridge, Mass.

Keshet, Ezra: 2008, *Good Intensions: Paving Two Roads to a Theory of the* De re/De dicto *Distinction*, Doctoral Dissertation, MIT.

Kratzer, A.: 1991, 'Modality', *Semantics: An International Handbook of Contemporary Research* 639–650.

Kusumoto, K.: 2005, 'On the Quantification over Times in Natural Language', *Nat. Lang. Sem.* **13**, 317–357.

Musan, R.: 1997, *On the temporal interpretation of noun phrases*. Garland.

Percus, O.: 2000, 'Constraints on Some Other Variables in Syntax', *Natural Language Semantics* **8**, 173–229.

Schueler, D.: 2007, 'World Variable Binding and Beta Binding', *Proceedings of NELS 38*.