Scope and Anaphoric Links in Dynamic Discourse Representation Theory

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Abstract. This paper analyzes anaphoric links in conditional and quantificational structures in which more than one operator occurs. To this end, we adopt the indexing system and the basic principles of Dynamic Discourse Representation Theory proposed by Chung (2008a, 2008b, 2009) and extend them to the structures in question. We also propose that a restrictor discourse representation structure of a quantification or conditional operator is an island which blocks any quantification or conditional operator inside it from introducing its own restrictor DRS out of it. This implies that a quantifier phrase can have wide scope over another quantifier or conditional operator only when the first occurs in the scope DRS of the latter.

Keywords: discourse representation structures, quantificational structures, conditional structures, anaphoric resolution, scope

1 Introduction

1.1 Purpose

This paper discusses anaphoric links between pronouns and their antecedents in conditional and quantificational structures, particularly where more than one operator occurs. The analysis we propose here is of pure semantics in that it does not resort to any particular syntactic theory and in that the rules and principles are defined solely in terms of lexical information and accessibility between discourse representation structures and discourse referents.

1.2 Motivation

Even though quantification structures and anaphoric resolutions have been one of the central issues in Discourse Representation Theory since its birth in Kamp (1984), not many works have discussed why the coreferential readings in (1a) and (1c) are blocked. Just a few papers including Robert (1987), Asher and Wada (1989), and van Deemter (1990) have discussed it in terms of Discourse Representation Theory. Most of them, however, have attributed its grammaticality to the violation or non-violation of some kinds of syntactic principles such as Binding Conditions of the Generative Syntax, rather than accessibility between discourse referents.

(1) a. *A senator who likes him$_1$ supports every representative$_1$.
b. Every senator$_1$ meets most representatives who support him$_1$.
c. *Most representatives who like him$_1$ vote for every senator$_1$.

Only a couple of papers such as Chung (2008) and Kamp and Reyle (1993), to my knowledge, have tried to provide an explanation of their grammaticality in terms of accessibility. But, neither of them has discussed, in terms of accessibility and discourse representation structures, why the universal quantifier cannot have wide scope over another quantifier as in (2a) below

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and over the conditional operator as in (2b), consequently not being able to have the intended coreferential readings with the pronouns. They have not dealt with what blocks a coreferential reading between the universal quantifier and the pronoun in (2c), either.

(2) a. *Most representatives who like every senator$_1$ will vote for him$_1$.
b. *If every senator$_1$ likes Mary, he$_1$ will vote for her.
c. *If he$_1$ likes Mary, every senator$_1$ will vote for her.

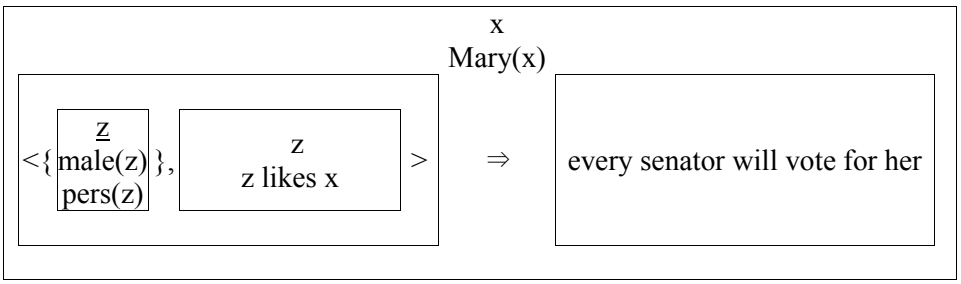
The purpose of this paper is to examine what kinds of construction rules are needed to explain the grammaticality of these sentences in terms of Discourse Representation Theory. In the next sections, we will first see some problems which examples in (1) and (2) raise for the current DRT in Kamp, Genabith and Reyle (to appear), and then briefly discuss Dynamic Discourse Representation Theory proposed in Chung (2008). We will also discuss what construction rules are needed to account for the grammaticality of such structures as (2).

2 Problems with current Discourse Representation Theory

In this section, we will discuss why structures like (2) are problematic for most of the analyses in DRT, such as the ones in Kamp and Reyle (1993) and Kamp, Genabith and Reyle (to appear). For the sake of space, we will limit our discussion to the most widely cited version of DRT, the one in Kamp, Genabith and Reyle (to appear) (henceforth, KGR).

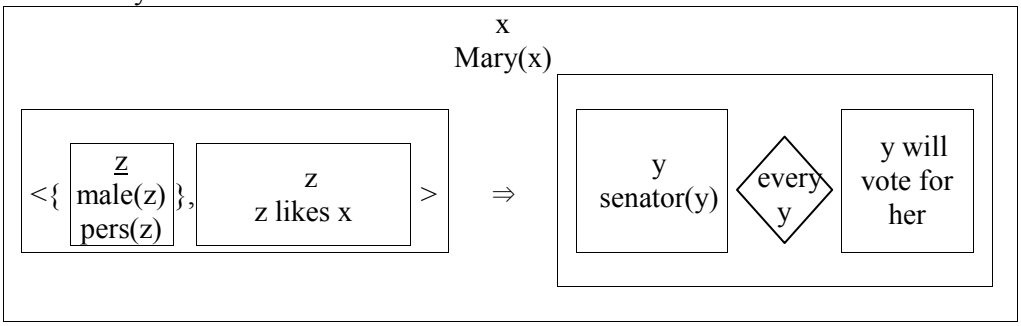
Following KGR, the preliminary **discourse representation structure** (henceforth, DRS) of (2c) would be like (3) below.

(3) Preliminary DRS for (2c)

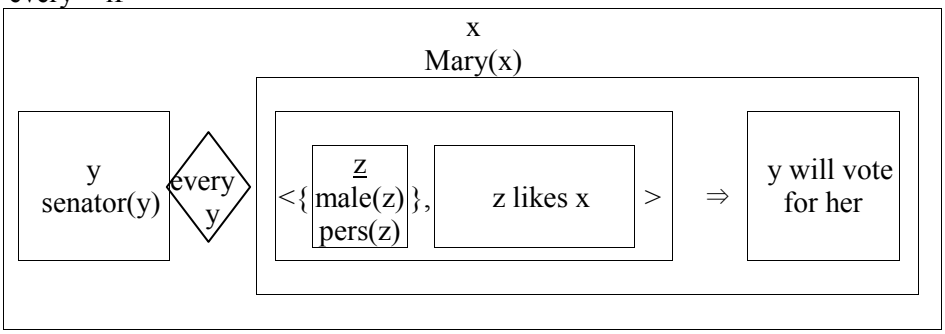


DRS (3) can be further developed into two different intermediate DRSs, depending on the relative scope of the universal quantifier phrase *every senator* with respect to the conditional operator. When the universal quantifier phrase has a narrower scope than the conditional operator, the intermediate DRS would be (4a). On the other hand, if the quantifier has a wide scope, (4b) would be the intermediate DRS.

(4) a. if > every



b. every > if



In DRS (4a), the discourse referent introduced by the universal quantifier, *y*, is not accessible from the discourse referent introduced by the pronoun, *z*. Thus, the coreferential reading of the pronoun and the universal quantifier phrase is not allowed. This fits the intuition of English native speakers.

In DRS (4b), however, such a coreferential reading is allowed since the discourse referent *y* is accessible from the discourse referent *z*, on the contrary to our intuition. The problem with the bottom-up version of DRT in KGR (to appear) and any other similar versions is that there are no principles or rules to block this undesirable derivation from (3) to (4b).

3 Dynamic Discourse Representation Theory

In the following sections, we will show that the theoretical problem we have discussed in the previous section can be easily solved if we adopt the indexing system and related principles of Dynamic Discourse Representation Theory (henceforth, DDRT) proposed in Chung (2008). We will first briefly review the basic principles of DDRT, and then discuss how they could be applied to structures like (1).

3.1 Basic assumptions and rules of DDRT

To resolve several theoretical problems of the current Discourse Representation Theory with respect to anaphoric resolution, Chung (2004, 2008a, 2008b, 2009) proposes a more dynamic version of discourse representation theory, Dynamic Discourse Representation Theory. Among the basic principles and construction rules which differentiate Chung's DDRT from other versions of DRT, the most important ones are given below.

(5) Principles

a. Every element is processed in the order of occurrence.

b. Operators in non-sentence (or clause)-initial positions cause the ongoing DRS to split into two DRSs with the same index.

c. DRSs with the same indexes are regarded as one and the same one in terms of accessibility.

d. Non-identity rules: A discourse referent *x* for a pronoun α in DRS K_i cannot be identified with a discourse referent *y* for a non-pronoun β such that *y* is introduced to DRS K_i later than *x*, (unless *y* is for a definite description and there is *z* such that *z* immediately embeds *x* and does not embed *y*).

(6) Construction Rules

a. If K_1 and K_2 are DRSs, then $K_1 \Rightarrow K_1$ is a condition.

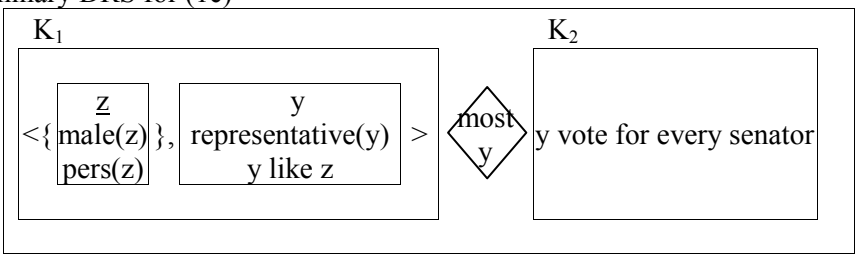
b. If K_1 is a DRS, then $K_{1/2} \Rightarrow K_{1/1}$ is a condition.

c. If K_1 is a DRS, then $K_{1/2} \diamond K_{1/1}$ is a condition.

d. If $K_1 \diamond K_2$ is a condition, then $K_{1\&2/2} \diamond K_{1\&2/1}$ is a condition, where $K_{1\&2/1}$ is $K_1 \diamond K_2$.

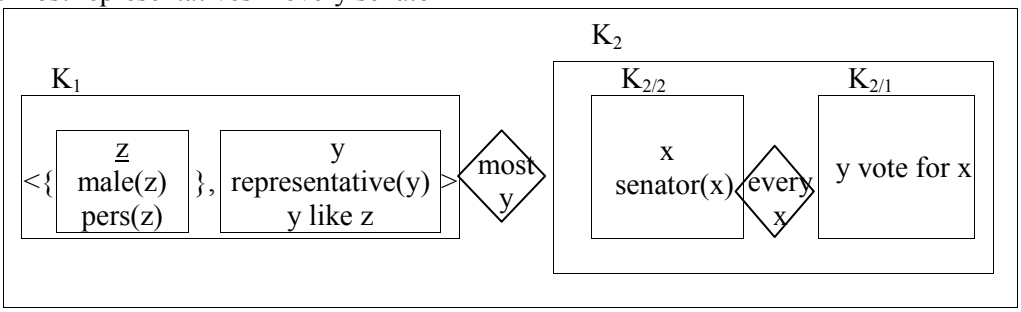
Following the principles and rules in (5) and (6), (1c) will generate a preliminary DRS (7).

(7) Preliminary DRS for (1c)

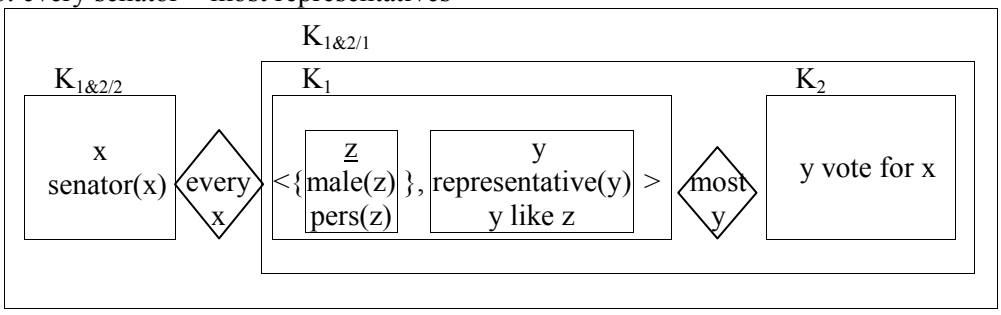


From DRS (7), two different DRSs can be derived, depending on which quantifier phrase has wider scope. DRS (8a) would be derived when *most representatives* has scope over *every senator*. On the other hand, if *every senator* has wider scope, DRS (8b) would be derived.

(8) a. most representatives > every senator



b. every senator > most representatives



Neither of the DRSs above can be further developed into a DRS in which the coreferential reading between the pronoun *he* and the universal quantifier phrase *every senator* is allowed. In (8a), the discourse referent introduced by the universal quantifier phrase, *x,* is not accessible from the discourse referent introduced by the pronoun, *z*. In (8b), *x* is accessible to *z*, but the identification of *x* with *z* is prevented by the Non-Identity Rule. Thus, the construction rules of DDRT successfully account for why the intended coreferential reading in (1c) is not allowed, no matter whether *every senator* has scope over *most representatives* or not.

3.2 Expansion of DDRT

In this section, we add two more construction rules to explain the grammaticality of structures like (2c), which we have discussed in section 2.

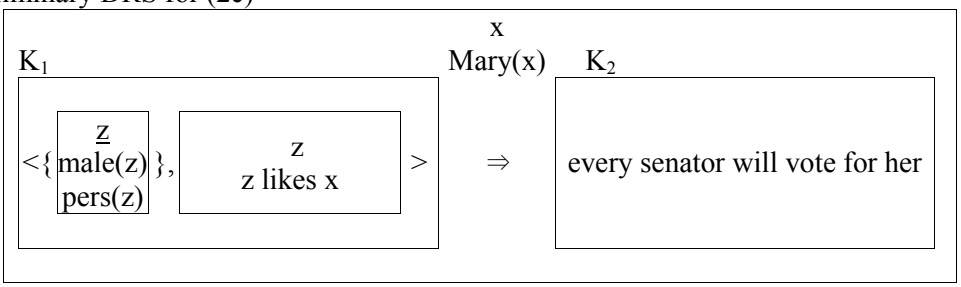
(6) Construction Rules

e. If $K_1 \Rightarrow K_2$ is a condition, then $K_{1\&2/2} \Diamond K_{1\&2/1}$ is a condition, where $K_{1\&2/1}$ is $K_1 \Rightarrow K_2$.

f. If $K_1 \Diamond K_2$ is a condition, then $K_{1\&2/2} \Rightarrow K_{1\&2/1}$ is a condition, where $K_{1\&2/1}$ is $K_1 \Diamond K_2$.

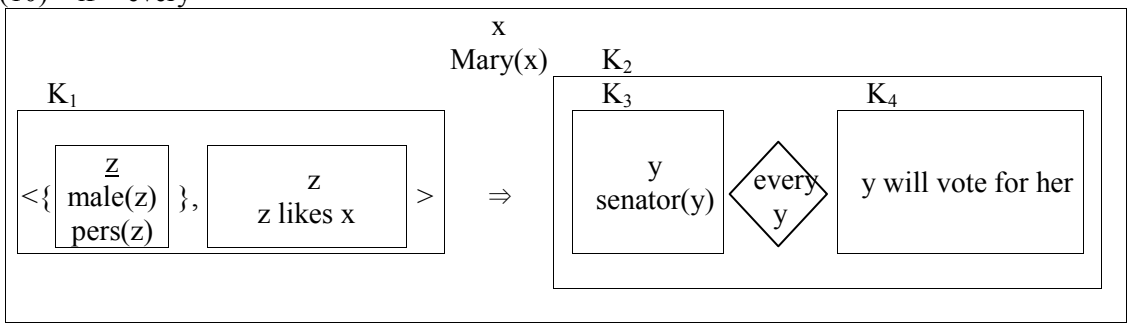
Following the principles and rules in (5) and (6), the preliminary DRS for (2c) will be (9) below.

(9) Preliminary DRS for (2c)



DRS (9) is exactly the same as DRS (3) in section 2, except the indexes given to the sub-DRSs. Just as in the case of DRS (3), DRS (9) can be further developed into two different intermediate DRSs, depending on the relative scope of the universal quantifier phrase *every senator* with respect to the conditional operator *if*. First, if the quantifier has a narrow scope, DRS (10) would be derived.

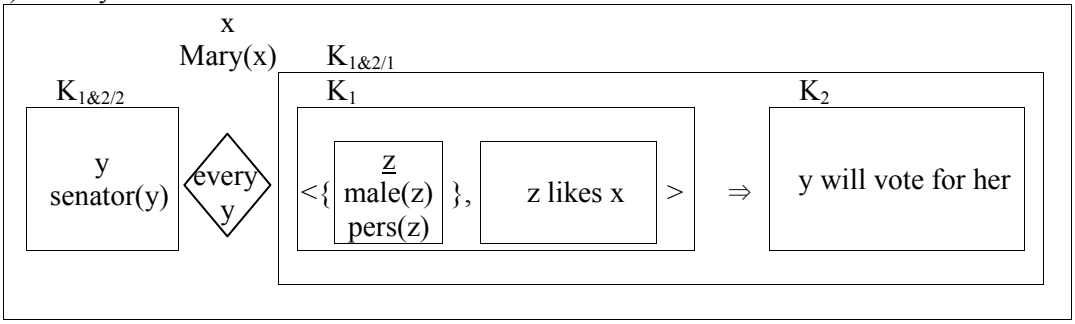
(10) if > every



In DRS (10), the discourse referent introduced by the quantifier, *y*, is not accessible from the discourse referent introduced by the pronoun, *z*. The coreferential reading of *he* with *every senator*, therefore, is not allowed.

Second, if the universal quantifier phrase has wider scope than the conditional operator, DRS (11) would be the one to be derived.

(11) every > if



In DRS (11), the discourse referent y seems to be accessible from the discourse referent z, but the identification of those two referents are blocked by the Non-Identity Rule in (5d). This shows that the principles of DDRT can be successfully applied to an analysis of anaphoric resolutions in structures like (2c).

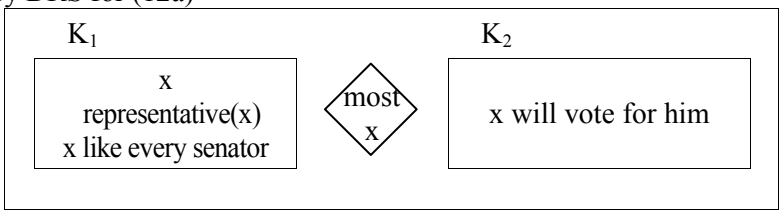
4 Restrictors as barriers

The construction rules of Dynamic Discourse Representation Theory we have discussed in the previous section are somewhat too strong to rule out the ungrammatical coreferential readings in (2a) and (2b), which are repeated below as (12a) and (12b) for the sake of convenience.

(12) a. *Most representatives who like every senator$_1$ will vote for him$_1$.
b. *If every senator$_1$ likes Mary, he$_1$ will vote for her.

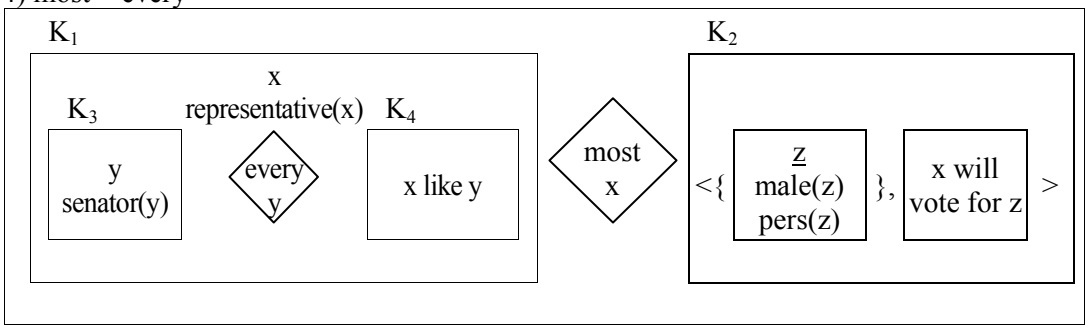
The preliminary DRS for (12a) would be like (13).

(13) Preliminary DRS for (12a)



If we follow the mechanism we have discussed in the previous sections, the universal quantifier phrase would be able to introduce a duplex condition into the ongoing DRS in two different fashions. First, the duplex condition could be embedded in the restrictor DRS of the quantifier phrase *most representatives*, as shown in (14).

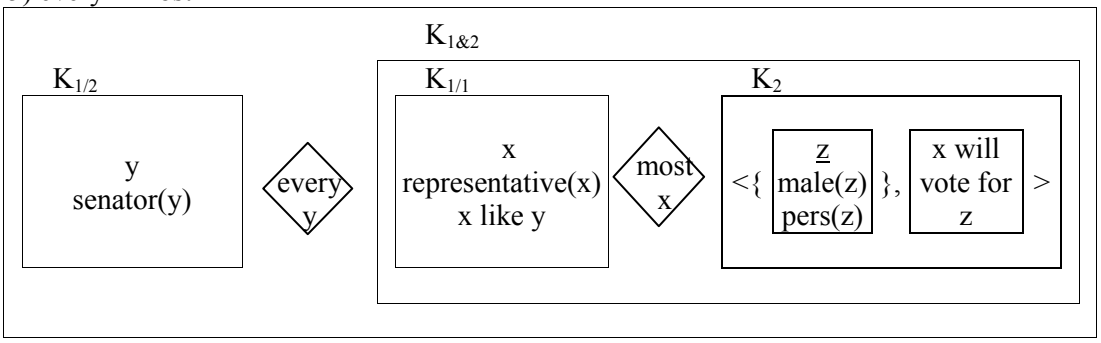
(14) most > every



In (14), where the quantifier *most* has scope over the universal quantifier *every*, the discourse referent introduced by the universal quantification phrase *every senator* is not accessible from the discourse referent introduced by the pronoun *him*. Therefore, the coreferential reading between *every senator* and *him* is not allowed, as is compatible with our intuition.

Second, the universal quantifier phrase may introduce its restrictor DRS out of the duplex condition introduced by the quantifier phrase *most representatives*, as shown below.

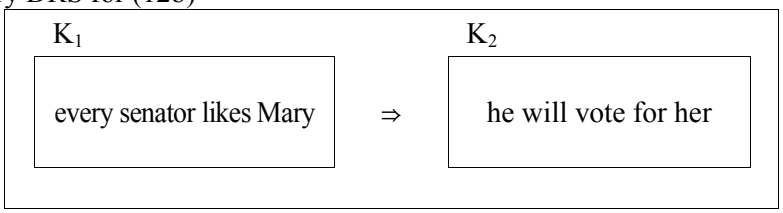
(15) every > most



In (15), where the universal quantifier *every* has scope over the quantifier *most*, the discourse referent introduced by *every senator* is accessible from the discourse referent introduced by the pronoun *him* in discourse representation structure K_2. DRS (15), thus, turns out not to be a correct intermediate DRS for (12a). The question now is what blocks the derivation from (13) to (15).

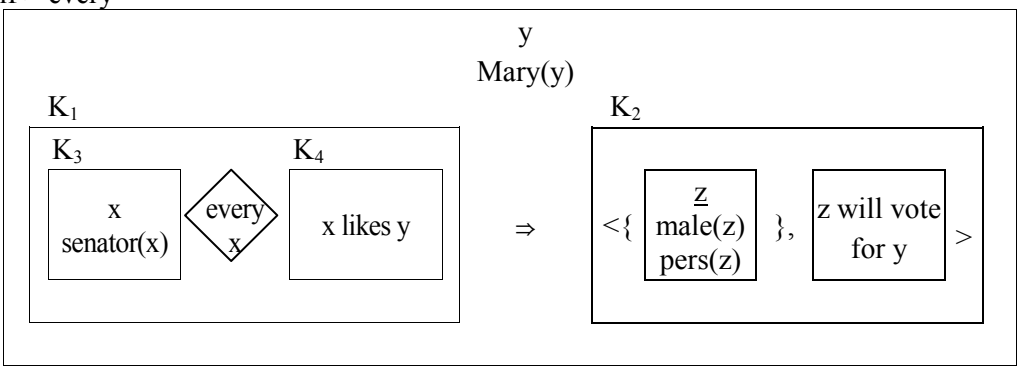
Example (12b) raises the same problem for Dynamic Discourse Representation Theory. Its preliminary DRS would be (16).

(16) Preliminary DRS for (12b)



Just as in the case of the preliminary DRS (13), this DRS (16) can be developed further into two different DRSs. First, the universal quantifier phrase can introduce its duplex condition inside DRS K_1, as suggested in Kamp and Reyel (1993: 117).

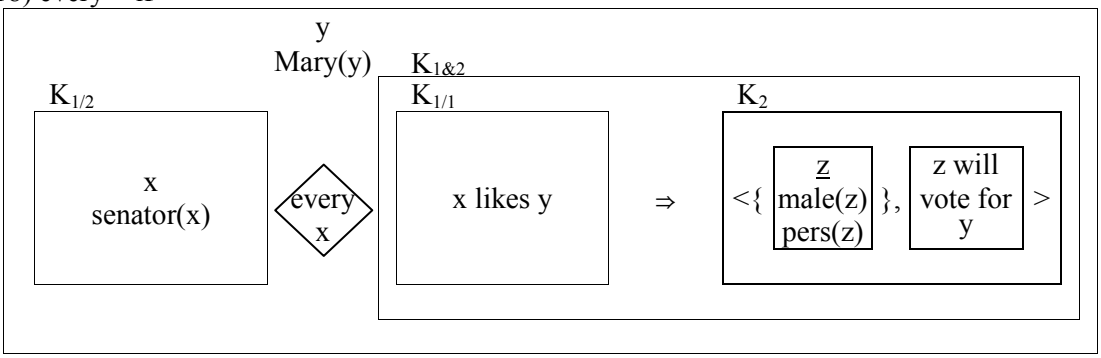
(17) if > every



As discussed in the case of (14), DRS (17) does not allow the coreferential reading between the universal quantified phrase *every senator* and the pronoun *he* since the discourse referent *x* is not accessible from the discourse referent *z*.

Second, the universal quantifier phrase may introduce its restrictor DRS out of the duplex condition introduced by the conditional operator, as shown below.

(18) every > if



In DRS (18), where the universal quantifier has wide scope over the conditional operator, the coreferential reading between *every senator* and *he* seems to be possible, just as in the case of

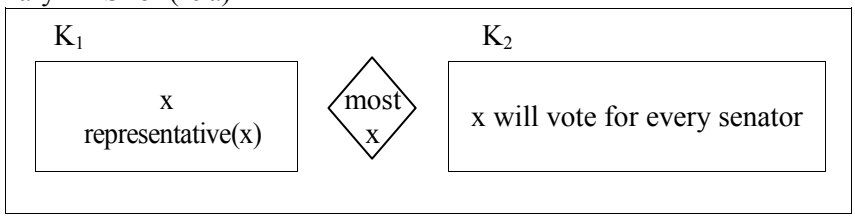
DRS (15). Therefore, here again, we need to come up with a way to block the derivation from (16) to (18).

To better understand why the universal quantifier phrase *every senator* cannot have scope over the other quantifier phrase *most representatives* in (12a) and the conditional operator in (12b), let's compare those two sentences with the examples in (19) below.

(19) a. Most representatives will vote for every senator.
b. If a boy likes Mary, every senator votes for her.

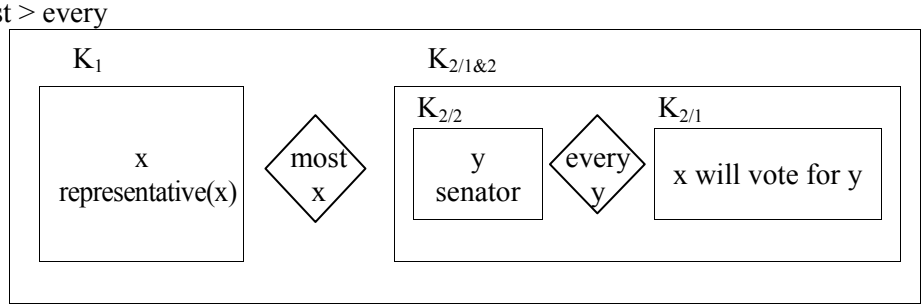
In the two examples of (19), the universal quantifier phrase can have scope over the other quantifier phrase in (19a) and over the conditional operator in (19b). A comparison of the preliminary DRSs for these two sentences with those for (12a) and (12b) reveals a very interesting aspect. For the sake of space, we will examine the difference by comparing just one of the preliminary DRSs for (19) with (16). DRS (20) below would be the preliminary DRS for (19a).

(20) Preliminary DRS for (19a)

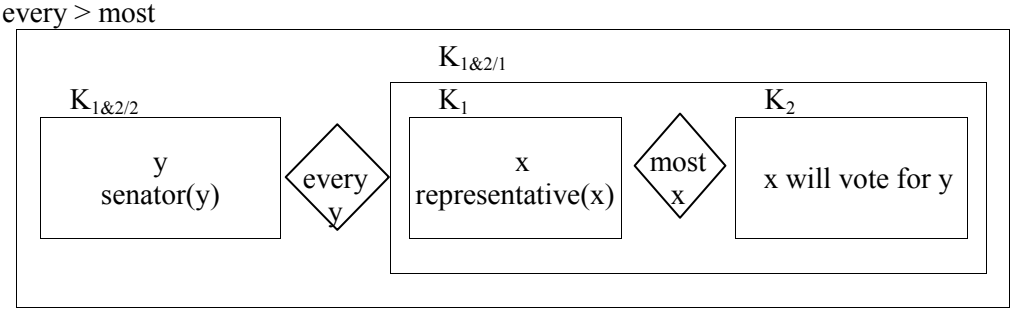


DRS (20) can be further developed into (21) or (22), depending on which quantifier phrase of *every senator* and *most representatives* has wider scope.

(21) most > every



(22) every > most



In DRS (22), the universal quantifier phrase *every senator* is allowed to have scope over the other quantifier phrase *most representatives*. This scope interaction fits the intuition of native English speakers. What to be noted here is that the universal quantifier phrase is allowed to introduce its own restrictor DRS outside the scope of the restrictor DRS of the other quantifier phrase when the first occurred in the scope DRS of the latter. On the other hand, if the universal

quantifier occurred inside the restrictor DRS of another quantifier, as in (13) and (16), it must be blocked from introducing its own restrictor DRS out of it. That is, the restrictor DRS of a quantifier or conditional operator must play the role of a barrier which blocks a quantifier phrase in it from introducing its restrictor DRS out of it.

From the observation we have made above, we can postulate a constraint on the construction rules of DDRT.

(23) Restrictor DRSs as a Barrier:

> A restrictor DRS of an (quantification or conditional) operator is a barrier which blocks any operators occurring inside it from introducing their own restrictor DRS out of it.

5 Ending remarks

We have discussed that the indexing system and principles of Dynamic Discourse Representation Theory proposed in Chung (2008a, 2008b, 2009) or a similar mechanism are needed to account for the grammaticality of the coreferential readings between pronouns and quantification phrases in quantificational and conditional structures such as (1) and (2). We also have suggested that restrictor DRSs of quantificational or conditional operators play the role of a barrier, out of which any quantificational operator is prohibited from introducing its own restrictor DRS. This means that a quantifier phrase cannot have scope over any other quantifier or conditional operator which dominates it.

The findings we have made in this paper, we speculate, can be applied to other quantificational or conditional structures, as well as other conjunctional structures we were not be able to discuss here for the sake of space. We, however, leave the burden of proving it to be a further research topic.

References

Asher, Nicholas and Hajime Wada. 1989. A Computational Account of Syntactic, Semantic and Discourse Principles for Anaphora Resolution. *Journal of Semantics* 6: 309-344.

Chung, So-Woo. 2004. Untangling Anaphoric Threads. *Language and Information* 8.2: 1-25.

Chung, So-Woo. 2008a. A Dynamic Approach to Anaphoric Resolution. *Language and Information* 12.1: 1-26.

Chung, So-Woo. 2008b. Anaphoric Resolution in Conjunction and Quantificational Structures in Discourse Representation Theory. *Proceedings of the Thirty Eighth Western Conference on Linguistics*, pp. 12-23.

Chung, So-Woo. 2009. Anaphoric Links in Quantificational Structures. *Korean Journal of English Language and Linguistics* 9.2: 351-370.

Kamp, Hans. 1984. A Theory of Truth and Semantic Representation. In Groenendijk et al.(ed.), *Truth, Interpretation and Information.* Amsterdam: Foris Publications. pp. 1-41.

Kamp, Hans and Uwe Reyle. 1993. *From Discourse to Logic.* Kluwer Academic Publishers.

Kamp, Hans, Josef van Genabith, and Uwe Reyle. Forthcoming. *Discourse Representation Theory, Handbook of Philosophical Logic.* Kluwer: Dordrecht. (Draft from http://www.ims.uni-stuttggart.de/~hans/ research.html).

Roberts, Craige. 1987. *Modal subordination, anaphora, and distributivity. Ph.D. dissertation.* University of Massachussetts

van Deemter, Kees. 1990. Forward references in natural language. *Journal of Semantics* 7: 281-300.