

# Structured Nominal and Modal Reference

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## Dynamic Semantics

"Consider a device designed to read a text in some natural language, interpret it and store the content in some manner, say, for the purpose of being able to answer questions about it. To accomplish this task, the machine will have to fulfill at least the following basic requirement. It has to be able to build a file that consists of records of all the individuals [...] mentioned in the text and, for each individual, record whatever is said about it."

The above exhortation, which is the very beginning of Karttunen's seminal paper on *Discourse Referents*, characterizes in a nutshell the dynamic turn in natural language semantics: interpreting a text crucially involves a notion of discourse reference which mediates between linguistic expressions and their reference (i.e. semantic value) in the classical (static) sense. The abstract text interpreter incrementally builds a file that contains records of the objects mentioned in the text. At any given point, the file encodes the current information state of the interpreter – and we refer to objects (i.e. individuals, times, possibilities etc.), their properties and how they are related to each other only via (i.e. as a function of) this information state.

## Dissertation Overview

My dissertation argues that discourse reference involves two equally important components with essentially the same interpretive dynamics, namely reference to *values*, i.e. (non-singleton) sets of objects (individuals and possible worlds), and reference to *structure*, i.e. the correlation / dependency between such sets, which is introduced and incrementally elaborated upon in discourse.

To define and investigate structured discourse reference, a new dynamic system couched in classical (many-sorted) type logic is introduced which extends Compositional DRT (Muskens 1996) with plural information states, i.e. information states are modeled as sets of variable assignments (following van den Berg 1996), which can be represented as matrices with assignments (sequences) as rows – as shown in the table below. A plural info state encodes both values (the columns of the matrix store sets of objects) and structure (each row of the matrix encodes a correlation / dependency between the objects stored in it). Given the underlying type logic, compositionality at sub-clausal level follows automatically and standard techniques from Montague semantics (e.g. type shifting) become available.

Plural Info State $I$	...	$u$ (discourse referent for individuals)	$u'$	$p$ (discourse referent for possible worlds)	$p'$	...
$i_1$	...	$x_1$	$y_1$	$w_1$	$v_1$	...
$i_2$	...	$x_2$	$y_2$	$w_2$	$v_2$	...
$i_3$	...	$x_3$	$y_3$	$w_3$	$v_3$	...
...	...	...	...	...	...	...

**Values (sets of individuals or worlds):**  $\{x_1, x_2, \dots\}, \{y_1, y_2, \dots\}, \{w_1, w_2, \dots\}$  etc.  
**Structure (relations between individuals and / or worlds):**  $\{\langle x_1, y_1 \rangle, \langle x_2, y_2 \rangle, \dots\}, \{\langle x_1, y_1, w_1 \rangle, \dots\}, \{\langle w_1, v_1 \rangle, \dots\}$  etc.

In Plural Compositional DRT (PCDRT), sentences denote relations between an input and an output plural info state. Indefinites and conditional antecedents non-deterministically introduce both values and structure, i.e. they introduce structured sets of individuals and possible worlds respectively; pronouns, verbal moods and modal verbs are anaphoric to such structured sets. Quantification over individual and over possible worlds is defined in terms of matrices instead of single assignments and the semantics of the non-quantificational part becomes rules for how to fill out a matrix. PCDRT enables us to account for a variety of phenomena, including:

1. the novel mixed reading (weak & strong) relative-clause donkey sentence *Every person who buys a<sup>u</sup> computer and has a<sup>u</sup> credit card uses it<sub>u</sub> to pay for it<sub>u</sub>*, which is interpreted as: for any person that is a computer buyer and credit card owner, for *every* (strong) computer s/he buys, s/he uses *some* (weak) credit card of her/his to pay for the computer; note in particular that the weak indefinite *a<sup>u</sup> credit card* co-varies with, i.e. is dependent on, the strong indefinite *a<sup>u</sup> computer* (I can buy my Dell desktop with a MasterCard and my Toshiba laptop with a Visa despite the fact that the two indefinites are syntactically trapped in their respective VP-conjuncts);
2. quantificational subordination, in particular the contrast between the interpretations of the following two discourses (from Karttunen 1976): *Harvey courts a<sup>u</sup> girl at every convention. She<sub>u</sub> is very pretty* vs. *Harvey courts a<sup>u</sup> girl at every convention. She<sub>u</sub> always comes to the banquet with him*; the initial sentence is ambiguous between two quantifier scopings: Harvey courts the same girl vs. a possibly different girl at every convention. The first discourse as a whole allows only for the "same girl" reading, while the second discourse is compatible with both readings;
3. naturally-occurring discourses exhibiting interactions between entailment particles (i.e. *therefore*), modal anaphora and (multiply embedded) modal subordination: *[A] man cannot live without joy. Therefore, when he is deprived of true spiritual joys, it is necessary that he become addicted to carnal pleasures* (Thomas Aquinas). The interaction is more transparent in the intuitively equivalent discourse *If<sup>p</sup> a<sup>u</sup> man is alive, he<sub>u</sub> must<sub>p</sub> find something pleasurable. Therefore, if<sup>p</sup> he<sub>u</sub> doesn't have any spiritual pleasure, he<sub>u</sub> must<sub>p</sub> have a carnal pleasure*.

## **Two Research Programs: Framework Unification & Cross-Domain Parallels**

My dissertation and my research in general is located at the intersection of two major research programs in semantics that have gained substantial momentum in the last fifteen years: the unification of different semantic frameworks and the investigation of the semantic parallels across the individual, temporal and modal domains.

One of the upshots of bringing together these two research programs is a novel compositional account of non-local (modal and individual-level) quantificational dependencies as *anaphora to structure*.

### **Unifying Different Semantic Frameworks**

The unification of different semantics frameworks, in particular Montague semantics, situation semantics and dynamic semantics (see Janssen 1986, Groenendijk & Stokhof 1990, Muskens 1995a, 1995b, 1996 among others) enables us to incorporate the generally complementary strengths of these different frameworks and allows for an easy cross-framework comparison of alternative analyses of the same phenomenon.

Plural Compositional DRT (PCDRT) unifies dynamic semantics and the compositional analysis of selective generalized quantification in Montague semantics and Intensional PCDRT unifies – in

classical type logic – the static Lewis (1973) / Kratzer (1981) analysis of modal quantification and van den Berg's Dynamic Plural Logic.

Within the framework unification program, my research brings further support to the idea that the dynamic turn in natural language semantics initiated by Karttunen's work (among others) does not entail that we have to abandon the classical approach to meaning and reference. Dynamic semantics is a development and refinement of static semantics. In particular, my research is shaped by the idea that the Montagovian solution to the problem of *compositionality* and the underlying logic of Montague semantics, namely classical type logic, are compatible with a dynamic approach.

Furthermore, I show that the classical notion of truth-conditional *content* (as opposed to *meaning*, which I take to be context-change potential) can be recovered within a dynamic approach. This enables us to analyze the entailment particle *therefore* as involving structured discourse reference to (propositional) contents, contributed by the premise(s) and the conclusion of an argument. This brings us to the second research program.

### **Anaphoric and Quantificational Parallels across Domains**

The anaphoric and quantificational parallels between the individual and temporal domains have been noticed at least since Partee (1973, 1984). My research focuses on the extension to the modal domain within a dynamic framework with explicit modal quantification initiated by Stone (1997, 1999) and further pursued by Bittner (2001, 2006) and Schlenker (2003, 2005b) among others.

Intensional PCDRT enables us to provide a point-for-point parallel account of quantificational subordination (e.g. *Harvey courts a<sub>i</sub> girl at every convention. She<sub>i</sub> always comes to the banquet with him*, Karttunen 1976) and modal subordination (e.g. *A<sub>i</sub> wolf might come in. It<sub>i</sub> would attack Harvey first*, based on Roberts 1989), thus bringing further support to the conjecture that our semantic competence is domain neutral.

### **Brief Comparison with Other Dynamic Approaches**

PCDRT differs from most previous dynamic approaches in at least three respects. The first difference is conceptual: PCDRT captures the idea that reference to structure is as important as reference to value and that the two should be treated in parallel (contra van den Berg 1996 among others).

The second difference is empirical: the motivation for plural information states is provided by *singular* and *intra-sentential* donkey anaphora, in contrast to the previous literature which relies on *plural* and *cross-sentential* anaphora (see van den Berg 1996, Krifka 1996 and Nouwen 2003 among others).

Finally, from a formal point of view, PCDRT accomplishes two non-trivial goals for the first time. On the one hand, it is not obvious how to recast van den Berg's Dynamic Plural Logic in classical type logic, given that, among other things, the former logic is partial and it conflates discourse-level plurality (i.e. the use of plural information states) and domain-level plurality (i.e. non-atomic individuals). On the other hand, previous dynamic reformulations of the analysis of modal quantification in Lewis (1973) / Kratzer (1981), e.g. the ones in Geurts (1995/1999), Frank (1996) and Stone (1999), are not satisfactory insofar as they fail to associate modal quantifications with *contents* (i.e. the propositions such quantifications express in a particular context) and cannot account for the fact that the entailment particle *therefore* can relate such contents as, for example, in the Aquinas discourse in (3) above.