Integrating Semantic Theories II

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(editors)

DYANA-2

Dynamic Interpretation of Natural Language
ESPRIT Basic Research Project 6852

Deliverable R2.1.B
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Dynamic Interpretation of Natural Language

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Contents

Introduction

1 DRSs as abstracts

Four papers are included here that present models of DRSs as abstracts:

- Dekker – "Predicate Logic with Anaphora"
- Fernando – "What is a DRS?"
- Ruhrberg – "A Simultaneous Abstraction Calculus and Theories of Semantics"
- Cooper – "The Attitudes in Discourse Representation Theory and Situation Semantics"

Cooper's paper is a development of an earlier proposal (in deliverable R2.1A) that DRS's should be considered as abstracts in situation theory to handle attitudes such as belief. The interest in bringing together these different proposals for modelling DRSs is that there has been a general move both within DYANA and elsewhere[1] for finding semantic objects that can be denoted by the DRS-expressions in a syntactic DRS language. Part of the motivation for this is the general program of bringing the various approaches to semantics into a form that makes them more easily comparable. The endeavour is also motivated by a consideration of providing a semantics for the attitudes where it seems desirable to analyze the object of the attitude in terms of a DRS. It seems dangerous to say that the object of the attitude is a syntactic object, since this seems to lead to a syntactic analysis of the attitudes with all its associated problems. Rather we would like to say that there is a semantic object corresponding to the syntactic object we call a DRS. The candidates that have been proposed for semantic objects corresponding to a DRS all seem to involve abstraction. Here we give a rough overview of the kinds of properties such objects have to have.

1.1 "Simultaneous" abstraction

In order to be able to model DRSs as abstracts the abstraction has to be over several variables (discourse referents) simultaneously in order to achieve the flat effect of the universe of a DRS as a set. This is achieved in Dekker's version by abstracting over tuples as in (1) corresponding to *a man owns a donkey*.

(1) $\{< x, y > \mid \mathrm{man}(x) \wedge \mathrm{donkey}(y) \wedge \mathrm{own}(x, y)\}$

In Fernando's version the simultaneity is achieved by abstracting over pairs of models and assignments to discourse referents as in (1).

(2) $\{< m, f > | m$ is a model and $f : \{X, Y\} \rightarrow$ universe of m such that $m \models \mathrm{man}(f(X))$, $m \models \mathrm{donkey}(f(Y))$ and $m \models \mathrm{own}(f(X), f(Y))\}$

This is in effect indexing part of the universe of models m with discourse referents. In Cooper's version Aczel-Lunnon abstraction is used which allows for simultaneity by regarding λ as an operation which applies to an indexed set of parameters and a parametric object, as in (1).

1. Muskens, R., 1994, "A compositional discourse representation theory". In: Proceedings of the Ninth Amsterdam Colloquium. ILLC, University of Amsterdam
Zeevat, H., 1989, "A compositional approach to discourse representation theory". Linguistics and Philosophy

(3) $\lambda\{i \to X, j \to Y\}(\text{man}(X) \wedge \text{donkey}(Y) \wedge \text{own}(X,Y))$

In Ruhrberg's version using his simultaneous abstraction calculus whose semantics is defined in terms of property theory and domain theory, the abstraction is over sets of variables which makes it syntactically look like Aczel-Lunnon abstraction. However, its semantics makes it look more like Fernando's version with abstraction over assignments to variables.

(4) a. *Syntax:* $\lambda\{X,Y\}(\text{man}(X) \wedge \text{donkey}(Y) \wedge \text{own}(X,Y))$
b. *Semantics:* $\{f \mid \text{man}(f(X)) \wedge \text{donkey}(f(Y)) \wedge \text{own}(f(X), f(Y))\}$

1.2 "Polymorphism"

The second requirement is a sort of polymorphism. DRSs of varying arity, i.e. with varying numbers of discourse referents in their universe, must count as the same sort or type of object. In Dekker's version the interpretation rules involve polymorphism explicitly. We will illustrate this below. In Fernando's version all DRSs are the same kind of object, sets of pairs of models and assignments to discourse referents, but the size of the domain of the assignments varies. In Cooper's version all DRSs are the same kind of object, although they are of varying arities and there is no need to regard operators that combine them as polymorphic. Ruhrberg's version is the same as Cooper's in this respect.

1.3 "Bound yet free"

If we are to regard DRSs as abstracts in the kind of way being proposed in all of these papers then what correspond to discourse referents will be bound within the abstract. This seems to contradict what is needed for DRT since it is important for discourse referents at the top level of the DRS to be available for anaphoric reference later in the discourse. Thus some way needs to be found of making the bound variables or parameters available external to the abstract while maintaining the insight that DRSs can be regarded as abstracts in a semantic domain. In Dekker's version this is achieved by importing a polymorphic version DMG-like technique for converting what follows in the discourse into the scope of the abstraction of the DRS. We illustrate this here by giving Dekker's polymorphic translation schema for *man*.

(5) *man* $\rightsquigarrow \lambda x \lambda s \lambda \vec{x}^n \;\; s(\vec{x}^n) \wedge \text{man}(x)$
where $s : \sigma^n$

This means that *man* receives all of the translations in (1).

(6) a. $\lambda x \lambda s \;\; s \wedge \text{man}(x)$ (for $s : \sigma^0$)
b. $\lambda x \lambda s \lambda y \;\; s(y) \wedge \text{man}(x)$ (for $s : \sigma^1$)
c. $\lambda x \lambda s \lambda y \lambda z \;\; s(y,z) \wedge \text{man}(x)$ (for $s : \sigma^2$)
...

In Fernando's version the discourse referents in the domain of the assignment functions remain free. In Cooper's version the role indices in Aczel-Lunnon abstracts remain free although the parameters are bound within the abstracts and there is α-equivalence with respect to the parameters. Thus the role indices can be used for achieving anaphoric relations. In Ruhrberg's version although the variables are bound there is no α-equivalence so the variables themselves serve as the indices.

1.4 DRSs as first class citizens

We take first class citizens to be predicates and arguments to predicates. When we begin to think of DRSs as semantic objects it becomes natural to think of DRSs as first class citizens in order to be able to model syntactic DRSs that contain embedded DRSs. Duplex conditions for conditionals and generalized quantifiers are possible examples depending on exactly how you do the semantics (e.g. whether you think of $\Rightarrow$ as a relation between two abstracts as Cooper does). A clearer example are DRS conditions of the form $e : K$ where the DRS K "classifies" the eventuality e and seems to being used as some kind of predicate. Finally, the use of embedded DRSs in the analysis of the attitudes is an important example of DRSs being used as arguments to predicates as discussed in Cooper's paper.

All the approaches presented in this paper share the advantage that they present DRSs as semantic objects which enables them to function as first class citizens. It is a separate issue whether what is needed to account for the intensionality involved in the analysis of event structure and the attitudes requires the kind of structured universes used in Cooper's and Ruhrberg's proposals as opposed to the set theoretic universes employed in Dekker's and Fernando's proposals.

2 The attitudes

The two papers on the attitudes presented here (Cooper – The Attitudes in Discourse Representation Theory and Situation Semantics, Cooper and Ginzburg – A Compositional Situation Semantics for Attitude Reports) address this issue. Cooper argues that the view of DRSs as abstracts in situation theory yields enough information structure to model the analysis of attitudes which Kamp has proposed within DRT and that this model is then a modern version of the original proposals for the treatment of the attitudes in situation semantics by Barwise and Perry. This suggests that the two approaches can contribute to each other. Cooper and Ginzburg show how this approach to the attitudes can be embedded in a Montague style compositional approach which preserves some of the original insights of Montague's approach to the attitudes as well as maintaining the advantages of the more structured approaches of situation semantics and DRT.

3 Update semantics

The remaining four papers (Groenendijk, Stokhof and Veltman 'This Might Be It', and 'An Update Semantics for Modal Predicate Logic'; Groeneveld and Veltman'Inference systems for Update Semantics'; Van Benthem 'Comments on "Inference systems for Update Semantics" ') concern issues in update semantics.

The papers by Groenendijk, Stokhof and Veltman are concerned with the integration of dynamic predicate logic, developed by the first two authors within DYANA1, and the update semantics for a propositional language with the epistemic modality *might*, developed by the third author, also within DYANA1. These two approaches shared the same overall philosophy, viz., that meaning should be viewed as information change potential, rather than as truth conditional content. Nevertheless, the semantics they proposed for the two different languages turned out to have different logical properties. As a result, combining the two into a single semantics for the language of modal predicate logic proved to be not a trivial matter. Whereas in Veltman's update semantics, as its name indicates, the interpretation of a sentence in an information state always results in an update of that state, in Groenendijk and Stokhof's dynamic semantics 'downdates' play an important role also.

The integration of the two systems was addressed within DYANA before, in Dekker's paper in deliverable R2.1A. The present paper builds heavily on that, but also differs from it in important respects. In both cases the strategy to solve the combination problem is to change the predicate logical part in such a way that all sentences do constitute updates. Dekker does so by making the reintroduction of a quantifier, which is what causes downdating, semantically anomalous. Groenendijk c.s. do allow for re-using quantifiers — which, after all, is common logical practice —, and solve the problem by adding a so-called 'referent system' to the information states.

Apart from this technical device — which brings along the conception of discourse information as a seperate component in information states —, there is another difference between Dekker's proposal and the present one. The existential quantifier is interpreted in a way that is slightly different from the way it was analyzed in dynamic predicate logic. Actually, the new interpretation makes no difference at all for the predicate logical fragment of the language. It only matters when modal operators are also involved. In those contexts it creates a difference between bound variables inside and outside the scope of the quantifier that binds it. It is argued in the paper that this different interpretation is needed to obtain the correct analysis of the interplay of quantifiers, modalities and identity.

The paper comes in two versions in this deliverable, the rather lengthy full paper is preceeded by a much shorter version that was written as an extended abstract. It was written later, and at some points improves on the presentation.

The paper by Groeneveld and Veltman presents sound and complete inference systems for Veltman's update semantics developed within DYANA1 for propositional languages with the modal epistemic *might*-operator, and for the *normally-presumably* system that was designed as an analysis of default reasoning. Van Benthem's comments are not just comments, they also offer a broader perspective on the research agenda of dynamic inference systems.

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Task 2.1, subtask 1

Dynamic Quantification and Update Semantics

Predicate Logic with Anaphora

Paul Dekker
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What is a DRS?

Tim Fernando
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Additional Contribution

A Simultaneous Abstraction Calculus

Peter Ruhrberg
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The Attitudes in DRT and Situation Semantics

Robin Cooper
(University of Edinburgh)

Task 2.1, subtask 4

The Attitudes in DRT and Situation Semantics

A Compositional Situation Semantics for Attitude Reports

Robin Cooper and Jonathan Ginzburg
(University of Edinburgh)

This Might Be It

Jeroen Groenendijk, Martin Stokhof and Frank Veltman
(Universiteit van Amsterdam)

Task 2.1, subtask 1

Dynamic Quantification and Update Semantics

Update Semantics for Modal Predicate Logic

Jeroen Groenendijk, Martin Stokhof and Frank Veltman
(Universiteit van Amsterdam)

Task 2.1, subtask 5

Inference Systems for Update Semantics

Inference Systems for Update Semantics

Willem Groeneveld and Frank Veltman
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Comments on "Inference Systems for Update Semantics"

Johan van Benthem
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A Note on *Inference Systems for Update Semantics* by Willem Groeneveld and Frank Veltman

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