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[*See also:* Conversation analysis; Critical linguistics and critical discourse analysis; Prague school; Rhetoric; Stylistics; Text linguistics]

DISCOURSE REPRESENTATION THEORY

Hans Kamp

Discourse representation theory (nowadays also known under its acronym DRT) is in the first instance a theory of natural language (NL) semantics. Its main relevance for pragmatics is that the theory has prompted a reassessment of the relationship between semantics and pragmatics.

1. General outlook and underlying principles

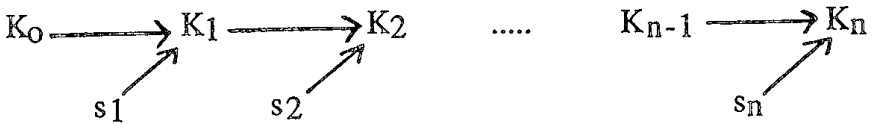
DRT developed out of the model-theoretic approach towards natural language semantics that is mostly associated with Montague grammar. According to this approach, the central tasks for a theory of the semantics of a natural language are (i) to analyze the conditions under which the sentences of the language are true and (ii) to characterize the logical relation of entailment (when does one sentence of the language follow logically from another). DRT shares these desiderata, but at the same time it is guided by a number of other principles, which earlier approaches to NL semantics denied or ignored. The interest of DRT arises (like that of file change semantics; see Heim 1982) largely from its endeavor to combine these different concerns.

The first of those other principles is that NL meaning cannot be separated from the process of language interpretation. There are many natural language expressions and constructions whose contribution to the meaning of the sentences in which they occur can only be understood in terms of the directives they embody for constructing an interpretation of the sentence as a whole. Examples (which played an important role in the early development of DRT) are tenses we find in certain languages such as, for instance, the *passé simple* (PS) and the *imparfait* (IMP) in French. It has often been observed that the PS expresses boundedness and/or punctuality, while the IMP conveys unboundedness and/or temporal extendedness. DRT has argued that these contrasts can be explained if the tenses are seen as expressing certain instructions for connecting the event or state described by the given tensed clause with the context in which the clause appears.

A second principle, closely related to the first, is that sentence interpretation nearly always involves reference to the context in which the sentence is used (the French tenses being only one example among many). More specifically, when the sentence occurs within a larger discourse,

interpretation tends to involve the context provided by the earlier parts of this discourse: in order to make sense of a discourse-internal sentence the interpreter must connect it with the interpretation he has assigned to the sentences preceding it. As a consequence, the interpretation he assigns to the new sentence takes the form of integrating its semantic contribution into the interpretation he already had. Thus assigning a meaning to a discourse or text which consists of sentences s1,...,sn takes the form of building a sequence of increasingly informative interpretations K1, K2, ..., Kn, where K1 is the result of integrating s1 into some context representation Ko, K2 is the result of integrating s2 into K1, etc. The final interpretation Kn represents the content of the entire discourse. The process is shown schematically in (1)

(1)



The interpretation structures Ki are called 'discourse representation structures', or 'DRSs'. Ko is a starting context which embodies the common ground shared by the producer of the discourse and his audience; in most of the examples found in papers on DRT one makes the simplifying assumption that Ko is empty. We follow this practice here.

2. DRSs and DRS-construction

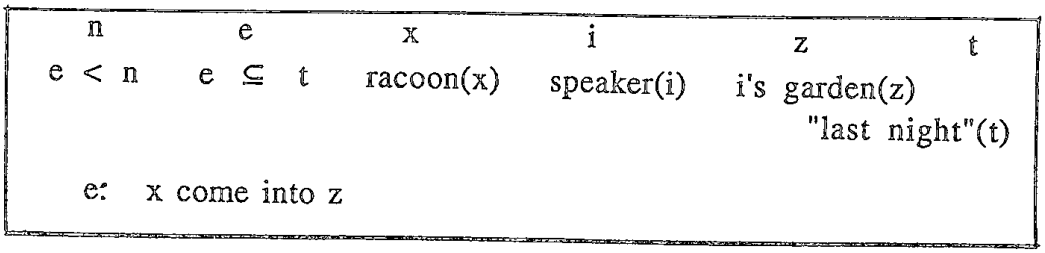
A theory such as DRT, which wants to do justice to the requirements mentioned so far, must at least accomplish two things. First, it must state rules which determine, on the basis of the syntactic structure of a sentence, how its interpretation is to be constructed (it must, to use the familiar DRT phrase, define a DRS construction algorithm). Second, it must provide an 'external' (e.g. model-theoretic) semantics for the DRSs which it postulates as NL representations; for only in this way can it secure a conceptually plausible analysis of truth conditions and of the relation of entailment, a commitment which DRT has taken over from formal semantics. Satisfying this commitment was unproblematic in the early phases of DRT, when DRSs were still comparatively simple and translational variants of formulas of the predicate calculus; this made it possible to adopt in essence the model-theory for predicate logic. For the DRSs used in subsequent applications, however — in particular those involving propositional attitudes and indirect discourse — the problem of finding a model-theoretic semantics has not yet been satisfactorily solved.

A third principle central to DRT pertains to the organization of linguistic information. With situation semantics (see Barwise & Perry 1983) DRT shares the persuasion that the typical NL clause describes an event, state or situation. Moreover, these descriptions typically take the form of presenting the descibed state or event in conjunction with other entities which enter into the event or state as actors or possibly in some other way. DRSs are structured in accordance with this persuasion. In the simplest case a DRS consists of a (typically small and finite) set of 'discourse referents' which represent the entities, together with 'conditions', which 'predicate' certain properties and relations of those discourse referents. An example should make this clearer. The DRS for the sentence

(2) A raccoon came into my garden last night.

has the form given in (3) (assuming that the context DRS Ko is empty):

(3)



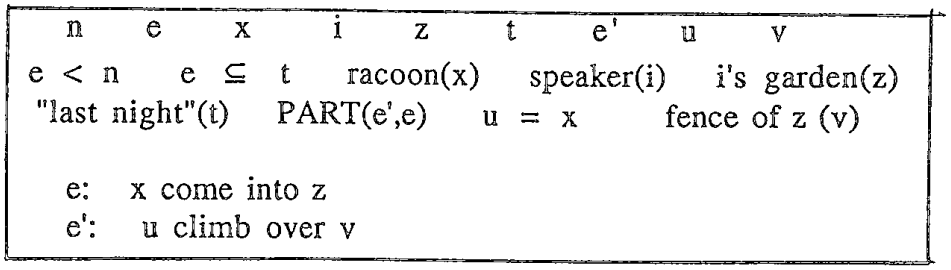
In (3) the discourse referent n represents the utterance time, i the speaker, t the night of the day immediately before the day of n, x some raccoon, z the speaker's garden and e the event of x coming into this garden; (3) exhibits the two-dimensional display of DRSs that is employed in much of the DRT literature.

Event or situation descriptions as in (3) can be expanded by adding further sentences. For instance, one could continue (2) with

(4) It climbed over the fence.

(4) is naturally interpreted as elaborating the event e introduced in (1). It does so by talking about an event e' that is a part of e. We consider the expansion (5) of (3) induced by (4). To construct this expansion it is necessary to link many of the discourse referents introduced by (4) to discourse referents in (3) — e' is to be represented as part of e, the discourse referent introduced by the pronoun 'it' must be represented as standing for the same individual as x, and the discourse referent introduced by the fence should surely be made to represent the fence of the garden represented by z. This leads to the following 'update' of (3):

(5)



The truth conditions represented by a DRS amount to there being objects corresponding to the discourse referents at the top of the DRS which satisfy all of the DRS's conditions. Thus (5) says essentially that there was a raccoon which came into the garden and (as part of this) climbed the fence. Note that these truth conditions cannot be decomposed into separate truth conditions for the constituent sentences (2) and (4). Here we come to a fourth point that is central to DRT, and which is one of the main reasons for its name: in general, the truth conditions of a coherent sequence of sentences cannot be analyzed as a conjunction of propositions which those sentences can be said to express in isolation. (Moreover, if, as many would hold, the links between the successive sentences of a discourse are a matter for pragmatics, it can no longer be maintained that truth-conditional semantics is independent of pragmatics).

3. Discourse linking and rhetorical relations

Sentence (2) could also have been continued with (6):

(6) It turned over a dust bin.

(6) would naturally be interpreted as telling us about the next significant element in the chain of events initiated by e. Thus the event e" introduced by (6) would be interpreted as following e and not as being included in it. The pragmatic problem of how we conclude that (4) is an elaboration of (3) but (6) is not — and therewith that e' is a part of e but that e" comes after e — is notoriously difficult. Evidently such judgements depend heavily on extra-linguistic information. This problem is among those for which DRT was not originally conceived. Nevertheless substantial progress has been made in this direction too (see Asher 1993).

4. Presupposition

As example (5) shows, an important part of DRS construction has to do with linking new discourse referents with old ones. Note that the DRS construction principles which are responsible for these links carry an element of presupposition: they require that the new discourse referent be linked to one already present in the context DRS; thus they presuppose that such a discourse referent is available. Indeed, from this perspective anaphora is a type of presupposition: an anaphoric expression is interpretable only when a suitable antecedent can be found, so it presuppposes the existence of an antecedent. Conversely, presupposition may be considered a species of anaphora: verifying that a certain presupposition holds in the given context is verifying that the context contains an element of a certain kind; this element may be a certain type of discourse referent, as in the case of anaphoric pronouns, or it may be some kind of proposition, as in most of the cases discussed in the presupposition literature. The framework of DRT is a natural setting to explore these parallels and to aim for a theory dealing with both phenomena at once. In recent years, the theory of presupposition has become one of DRT's most important areas of development.

5. Propositional attitudes, indirect discourse and the theory of communication.

From the start, DRS construction was conceived as an idealized version of the interpretation processes which occur in human recipients of written or spoken language. In line with this assumption, it was supposed that DRSs, the products of these processes, capture important aspects of the form in which we store and/or manipulate information. Thus it became natural to explore the possibility of using DRSs for the characterization of beliefs and other propositional attitudes and in particular to use DRS construction as a model for the formation and modification of attitudes under the influence of verbal input. This has lead on the one hand to DRT-based analyses of attitudinal verbs and indirect discourse verbs (*believe, desire, intend, say, ask*), and on the other to the outline of a DRT-based theory of communication.

6. Inference and the lexicon

The semantic representations of DRT are meant to be logically transparent. They must enable us to define when one sentence (on a given interpretation) follows from another. In keeping with this desideratum, DRT has endeavored to develop a proof theory for DRSs which makes it possible to formally deduce one DRS from another. A special concern in this area has been to

develop theorem provers capable of reproducing those inferences which are needed in the process of interpretation itself (viz. for the resolution of ambiguity). This last concern has prompted the investigation of two aspects of inference that lie beyond the traditional concerns of logic, non-monotonic inference and lexically based inferences. The lexical investigations inspired by these considerations have pointed at important connections between DRT-based work on presupposition and that on propositional attitudes and communication.

7. DRT and the relation between semantics and pragmatics

DRT questions the autonomy of semantics that has been a working hypothesis for many of those active in formal semantics and in pragmatics. While the theory still maintains a demarcation between 'semantics and pragmatics', this demarcation has shifted considerably in the direction of pragmatics in the sense that it has incorporated many aspects of language that were long regarded as part of pragmatics (by semanticists and pragmaticists alike) into the general process of computation and definition of meaning. Among those aspects we find, in particular, intersentential anaphora, rhetorical relations, ambiguity resolution through (non-monotonic) inference and communication-theoretic concepts.

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[*See also:* Game-theoretical semantics; Logical semantics; Situation semantics]

EPISTEMIC LOGIC

Gustaaf C. Cornelis

1. Definition

The main concern of epistemic logic is to formulate a formal system to deal with logical issues arising from an analysis of epistemological concepts such as knowledge, belief, and assertion. Instead of dealing with the essentially factual issues of alethic logic — i.e. what is actually, what must necessarily be the case or what can possibly be the case — it relates to what people know or believe or maintain or doubt to be the case. The concept 'epistemic' derives from the Greek word ἐπιστημη, which means 'scientifically supported knowledge' (Plato, *Phaedo* 96b).

Epistemic logic is formulated in terms of two dyadic operators, namely K and B. Their English readings are as follows: $K_a p$ means 'a knows that p', $B_a p$ means 'a believes that p'. Here 'a' is a name of a person or a personal pronoun, perhaps a definite description of a human being, and p is an independent proposition.

2. Historical overview

Epistemic logic emerged quite recently, although one of its main concerns is in effect an old epistemological riddle frequently discussed by philosophers, ancient as well as recent. This