

BOOK REVIEWS

NATURAL LANGUAGE UNDERSTANDING AND LOGIC PROGRAMMING, II: PROCEEDINGS OF THE SECOND INTERNATIONAL WORKSHOP

Veronica Dahl and Patrick Saint-Dizier (eds.)
(Simon Fraser University and IRISA, University of
Rennes 1)

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Reviewed by
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This volume contains 18 papers and the positions presented at two panel sessions. The papers are rather heterogeneous and the editors have not classified them in any way.

The collection shows clearly the fast proliferation of new logic grammars and Prolog dialects, which is perhaps a necessary stage for a relatively new domain. Some of the modifications are small enough to be fully described in short Prolog listings accompanying the papers, e.g., the functional logic grammar of Michel Boyer or the epistemic reasoning of Manny Rayner and Sverker Janson; in other cases we have quite large systems practically unavailable to other parties, e.g., the three parsers compared by Toshiyuki Okunishi and his colleagues. Some papers take a specific linguistic theory or formalism as a starting point, e.g., Government-Binding theory or Sowa's Conceptual Graphs, while others augment existing logic grammar or programming tools. A paper on morphological analysis of Italian is an example of the work where it is fully justified to use Prolog, but its use is of little relevance to the problem under consideration.

According to my understanding of logic programming, three papers are most representative of the domain. Patrick Saint-Dizier describes Contextual Discontinuous Grammars, which form the next step in the evolution of logic grammars started by Colmerauer's metamorphosis grammar. Secondly, Edward P. Stabler, Jr. reconstructs in logic a fragment of a linguistic theory, namely, Government-Binding theory, and transforms it by formally provable steps into a logic program for parsing. Last but not least, the paper by Annie Gal and Jack Minker on informative and cooperative answers in data bases shows the advantages of using the same formalism for representing database integrity constraints and natural language semantics.

As for the panels, I sympathize most with Miguel Filgueiras ("logic programming can only be seen as a

programming methodology and not as a formalism contributing to the study of natural language understanding") and Stan Szpakowicz ("the belief in Prolog as a perfect tool for natural language processing may sometimes mean putting the cart before the horse") but they seemed to be in a minority.

To summarize, the volume definitely proves the usefulness of the Prolog programming language for a wide range of natural language processing tasks. It gives the reader a fair account of the activities in the domain, but leaves also some doubts as to whether the domain is more coherent than, say, natural language understanding and Lisp programming.

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LANGUAGE AND SPATIAL COGNITION

Annette Herskovits
(Wellesley College)

Cambridge, England: Cambridge University Press,
1987, x + 208 pp.
(Studies in natural language processing)
ISBN 0-521-26690-4, \$34.50 (hb) [20% discount to
ACL members]

Reviewed by
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In this book, Herskovits proposes an analysis of locative expressions in English. Her goal is to position the study of linguistic expressions (in particular, spatial expressions) within a broader context of language usage and the conventions associated with communicating goals, beliefs, etc. Thus the work should be evaluated from the perspective of cognitive science as an interdisciplinary field, and not simply as a linguistic treatise on prepositions or a computational model of a subset of natural language.

The underlying semantic theory that Herskovits assumes differs from more traditional "classical" approaches to meaning (e.g., Tarski 1943) and is most similar to the positions argued for by Searle (1979) and Winograd (1980), and previously by Wittgenstein (1963). According to these authors, the view that meaning derives from the literal interpretation of the words in

an expression is inadequate, and that what is necessary to understand the polysemy of prepositions (and of all language) is a theory of background information and language usage. Herskovits incorporates these aspects of the anticlassical theory of meaning by introducing three notions: (1) the ideal meaning of a word; (2) the way that expressions formed from this word can vary due to convention; and (3) the pragmatic influences of tolerance on this meaning. She classifies these influences according to a series of use types that abstract these conventions and complete the mapping from the lexical meaning to usage.

Herskovits argues that the classical theory is inadequate and that we need to enrich our descriptive framework with pairings of phrase types together with interpretations of the central cases falling within a use type. Thus this view denies the standard interpretation of the compositionality thesis for language.

Another recurrent theme of the book is the distinction between computational and holistic approaches to intelligence. The computational metaphor states that a computer can be programmed to fully understand English and embody intelligence in general. The anticomputational position (i.e., holistic thinking), advocated by Dreyfus (1979) and Winograd and Flores (1986), argues that no algorithmic specification can be given to embody intelligence or linguistic abilities. This view states that the "background" conditions necessary to understand a sentence in context cannot be completely or exhaustively encoded into procedures that a machine can carry out. Furthermore, Winograd and Flores hold that a language user cannot possibly have a mental representation of the world that he or she perceives. Adopting a neo-Heideggerian position on mental activity, they deny that symbol manipulation plays a role in our understanding of the world and our use of language.

Herskovits adopts this position to some extent, albeit with some important exceptions. She agrees with many linguists and cognitive psychologists that constructional theory building is essential for revealing generalizations about the data and for a better understanding of the phenomena (cf. Goodman 1951, Carnap 1967, Schlick 1918). Furthermore, she adopts a strong "representational" view on the nature of lexical meaning (closer in spirit to Lakoff (1987) or Jackendoff (1983)), which is embedded within a nonrepresentational theory of pragmatics.

From a linguistic perspective, Herskovits makes the following theoretical claims:

1. Spatial prepositions (henceforth SPs) have ideal meanings associated with them in their lexical entries.
2. The ways in which this meaning is conventionally exploited—that is, the canonical usage types for a word—are also stored in the lexicon with the preposition.

There are two types of deviations from the ideal meaning of a term: convention-based shifting (resulting in polysemy), and pragmatic processes of tolerance, to allow something to be almost true.

From a computational perspective, we can evaluate the book in a slightly different way. There are three specific proposals made in the work, the first concerning representation, the other two concerning analysis and generation. Although largely programmatic, Herskovits's computational model amounts to a generate-and-test paradigm for semantic interpretation and a mixture of plan-based and lexical decomposition approaches to generation.

Finally, from a psychological point of view, the work can be seen as arguing in favor of a "prototype" theory of categorization (Rosch 1977), where Herskovits's notion of ideal meaning is close to a prototype, although she claims that there are important differences between the two concepts.

Turning to the details of her theory: Herskovits's study is organized into three parts. She first presents a descriptive framework for studying spatial prepositions. This is followed by a discussion of computer models for the data presented in the first section. Finally, she discusses four case studies, involving the prepositions *in*, *on*, *at*, and the projective prepositions (e.g., *behind*, *to the right*, etc.).

The basic view can be summarized as follows. There is an ideal meaning of a preposition, which is a geometrical idea. From this geometrical idea, all uses of that preposition are derived by means of operations involving adaptations and shifts in this meaning. The ideal meaning itself is defined as a relation between "ideal geometric objects" such as point, line, surface, etc. Together with this meaning is a set of constraints Herskovits calls the "normal situation type." This is the abovementioned set of central cases falling within the use type. Although it is left somewhat vague, these situation types appear to be associated with full expressions and not simply with individual lexical items.

There are two ways for the meaning of an expression to shift. Consider first what Herskovits calls sense shifts: Assume that *on* carries the meaning of "support and contiguity." This describes the situation in (1a) but not (1b).

1. a. the book on the table
b. the wrinkles on his forehead

Yet the situation in (1b) resembles the ideal meaning of *on* in some way, even though no support is involved. Such a resemblance is related by a sense shift. Another way that the ideal meaning can shift is by "tolerance." For example, consider the locative expression in (1a) again. This would not be strictly appropriate with the ideal meaning of *on* if there were a tablecloth between the table and the book. But we obviously allow such fuzziness in the description of situations. In such cases,

we say that the meaning of the expression has shifted due to tolerance.

The ideal meaning of a preposition does not itself map directly onto the world. Rather, Herskovits argues for an intermediate level of geometric conceptualization, where geometric description functions map locative descriptions onto objects. In other words, these geometric functions determine what the preposition contributes to the meaning of a particular situation. Very often this might be the space occupied by the object, its "place." Obviously, the way that an object relates to a space will depend on the object. *Table*, for example, identifies its space very differently from *water*. With the former, the space is bounded and definite, while the latter is unbounded and indefinite.

2. a. the lamp on the table
- b. the child in the water

It is this function that distinguishes between solid objects, liquid objects, geometric objects, holes, etc.

Herskovits describes six other geometric descriptive functions (cf. Talmy 1978) including:

3. a. parts (e.g., edges, bases, surfaces, 3-D parts, etc.)
- b. idealizations (approximations to a point, line, surface, or plane)
- c. good forms
- d. volumes
- e. axes
- f. projections

As an example, consider the interpretation of the expression in (4).

4. the bird in the tree

There is a function, *good-form*, that provides the Gestalt closure on *tree* such that a bird can be contained in the space occupied by that form. The resulting interpretation looks something like (5).

5. Included-in (Part (Place (Bird)),
 Interior (Outline
 (VisiblePart (Place (Tree))))))

The major claim Herskovits is making here is that a simple spatial interpretation of locative prepositions is inadequate for capturing the variety of meanings carried by these words. Instead, we need to talk in terms of how we conceptualize objects, in terms of their geometric and spatial extensions.

This view is related to that presented in some detail in Hayes's discussion (1985) of a naive physics for liquids. It is also similar in spirit to Moravcsik's (1981) interpretation of the "aitiae" associated with objects.

After presenting the framework for the representation of spatial prepositions, Herskovits turns to the two problems of decoding and encoding. The decoding problem can be stated as follows: Given a locative expression used in a particular situation, how can we predict what it conveys? The encoding problem is

similarly stated: Given a situation with two spatial objects, how can we best describe the spatial relation obtaining between the two objects? These are simply the problems of interpretation and generation of spatial expressions.

Most computational approaches to lexical disambiguation involved some mechanism of selection among alternative word senses. Discovering the associations between one sense of a word and the rest of the expression will help in the disambiguation of the overall expression. This can be accomplished in any number of ways, including marker passing (Charniak 1983, Hirst 1987), message passing (Rieger and Small 1979), preference semantics (Wilks 1975), and collative semantics (Fass 1986). Herskovits implicitly assumes that senses are generated and matched according to the context and situational constraints. However, she leaves the particular computational mechanisms for the decoding of spatial expressions underspecified and unclear. It would have been helpful to see how her procedure for obtaining a context-specific interpretation can be made more explicit, so that it can be compared to some of the approaches mentioned above. As a result, the reader is left intrigued but unsatisfied with the details of the computational aspects of the proposal.

The discussion of how locative expressions are encoded is also rather programmatic and unclear. The problems of text planning and lexical selection in the generation process have been actively addressed by many researchers (cf. McDonald (1987) for a review), yet there is little mention of this work. Therefore, much of her proposal seems unconnected to this line of research. Given her philosophical assumptions, for example, it is possible that Herskovits envisages a systemic-based formalism (Halliday 1985) for generating spatial descriptions. This, in fact, seems consistent with her discussion of the functional role of the different expressions and the way that they will affect the communicative act. Yet, she describes how Appelt's plan-based approach (1985) might be employed to handle the higher-level aspects of planning locative expressions. Perhaps these approaches are consistent, but it is not at all clear from her short treatment of the topic.

The book concludes with several fairly detailed case studies of how so many different expressions can be derived from the same preposition, due to adaptation and tolerance shifts. I found this discussion very enjoyable and the observations quite detailed for the prepositions that she covers. A comparison with Jackendoff's proposal (1983) for the representation of prepositions, however, seems in order. Herskovits generally dismisses Jackendoff's work as not accounting for the roles of motivation and convention for locative expressions. Yet few linguists have done as much as Jackendoff to link specific linguistic tokens and expressions in a language to the conceptual (i.e., geometric descriptive) representations underlying them.

In her book, Herskovits has attempted to provide an

interdisciplinary approach to the analysis of spatial prepositions. The result is an intriguing, sometimes incomplete, often speculative account of how language and space are related. Often the guiding philosophical maxims are contradicted by assumptions made later in the book. For example, the ideal meanings of words often appear to be Platonic objects, something obviously inconsistent with the tenets in the preface of the book. Elsewhere, the geometric description functions seem to embody mental representations, a view not comfortably condoned by a neo-Heideggerian analysis. In general, however, the work is an enjoyable and well-written foray into a very basic subset of language.

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THE FORM OF INFORMATION IN SCIENCE: ANALYSIS OF AN IMMUNOLOGY SUBLANGUAGE

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590 pp.
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There is wide agreement that domain knowledge plays an important role in natural language processing systems, and, at the same time, that acquisition of domain knowledge is an extremely difficult problem. The work under review offers a rigorous method for knowledge acquisition in scientific and technical domains, based on a formal analysis of the texts written by domain experts. The set of texts in a restricted domain is known as a **sublanguage**. The method, which may be termed **sublanguage analysis**, reveals a formal structure in the sentences of the texts, **sublanguage formulas**, which are similar to the formulas of logic, but with certain extensions (which will be described below).

The sublanguage formulas described by the authors constitute a form of knowledge representation, and suggest interesting possibilities for the design of flexible and expressive databases or knowledge bases. The strength of the sublanguage approach lies in basing the knowledge representation on the analysis of actual texts. The significance of this approach to computational linguistics is that the initial phase of sublanguage analysis establishes a direct relationship between surface sentence forms and the semantic representation (formulas). This mapping serves as a basic design for text processing algorithms.

A striking feature of the book is that the authors have carried out a thorough test of their technique on real data: 14 full-length research articles from the field of immunology, published in the period 1935–1970. The formulas obtained and the methods used in producing them are given in meticulous detail. (The appendices that give examples of the formulas actually exceed the length of the narrative portion of the book). The methods employed are founded on Operator Grammar (Harris 1982) and are carried out in a general theoretical