COMMUNICATING WITH DATABASES IN NATURAL
LANGUAGE
(Ellis Horwood series in artificial intelligence)

Mark Wallace

Chichester: Ellis Horwood, 1984, 170 pp.
ISBN 0-85312-639-9; $29.95
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ISBN 0-470-20105-3]

As a programming language for computational linguistics,
Prolog is a relative newcomer. Mark Wallace, however,
demonstrates very clearly in this timely book the value of
this important tool, especially as it relates to the building
of natural language front ends and interfaces to database
systems. He takes a very practical approach which should
appeal to anyone who has had to contend with the diffi-
culties of designing and implementing natural language
interfaces.

Wallace begins by providing some background on
natural language interfaces. He surveys most of the
conceptual issues, but generously intersperses concrete
references to major research papers and projects. Some
might find his survey too shallow and broad in certain
respects, but I personally found his treatment fair and
complete.

In subsequent chapters, Wallace introduces a formal
query language, called **D&Qs,** based on referring phrases
(Descriptions) and qualifying phrases (Qualifiers). He
then uses this formalism as a representational vehicle in
the development and Prolog implementation of a natural
language interface, called **QPROC.** D&Qs is based on
predicate calculus, suitably restricted to provide an
adequate relational query language. Queries in D&Qs
can either be cast into Prolog (as in his "pilot" version)
or converted by Prolog to an underlying query language.
In the Prolog version, each simple qualifier is handled
through facts, each relation maps into a predicate, and
each tuple of the relation ends up as a Prolog clause for
that predicate.

Although the parser is treated in a domain-indepen-
dent fashion, semantics adopts a fairly conventional
relation and attribute style, with verbs, of course, playing
the major roles. Some major issues of semantics are
clearly identified for the reader, including ambiguity,
several matters involving reference and qualification, and
ways to handle the verb *to be.*

The reader should not, however, view this book as
something it does not claim to be – namely, a book that
provides a thorough and adequate introduction to the
areas of database systems, natural language understand-
ing, or Prolog (although the latter is discussed at some
length in an appendix). Such readers will be disap-
pointed. A moderate level of competence in these areas is
certainly assumed. The interested reader should find the
extensive bibliography also very useful.

I recommend this book to those who feel competent
with Prolog, have a basic understanding of relational
database systems, and can reason through a modest
amount of predicate calculus.

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THE MENTAL REPRESENTATION OF GRAMMATICAL
RELATIONS
(MIT Press series on cognitive theory and mental repre-
sentation)

Joan Bresnan, Editor

Cambridge: The MIT Press, 1983, lii+874 pp.
ISBN 0-262-02158-7, $35.00

LEXICAL-FUNCTIONAL GRAMMAR
(Trends in linguistics, Studies and monographs 21)

George M. Horn

Berlin: Mouton Publishers, 1983, 394 pp.
ISBN 90-279-3169-0

One of the curiosities of practical linguistics has long
been the chasm between linguistics, as practiced by, for
example, computational linguists, and linguistic theory.
Lexical-functional grammar deserves some attention
from the practical linguist if only because it contains an
explicit attempt to bridge this chasm.

Lexical-functional grammar is firmly planted in
Chomskyan tradition. It builds on all the accepted
conclusions of that theory through X-bar theory. Bres-
nan began lexical-functional grammar in a 1978 publica-
tion, and she has continued it since then in a number of
publications. *The Mental Representation of Grammatical
Relations* brings together this work and the work of a
number of collaborators into a synthesis that includes
many interesting innovations. *Lexical-Functional Gram-
mar* is an individual work that is not "orthodox", in the
sense that it deviates from Bresnan's own theory in some
non-trivial ways. In this review, I will concentrate on
Bresnan's theory and discuss Horn's contributions only in
passing.

I will begin by trying to describe lexical-functional
grammar for the outsider. It will be necessary to squeeze
a lot into a few sentences, but the reader needs to under-
stand some of the machinery (for instance, the striking
up-arrow and down-arrow notation) to understand
anything about the theory.

Grammar is divided into several modules that function
independently of one another to process an utterance out
of the mind into speech, or in the other direction.
Theoreticians like to ignore the production of sentences
and move directly to a module, having no generally

agreed-upon name, which generates all possible constituent structures by exercising a context-free phrase structure grammar (or an equivalent such as a recursive transition network). This leads to a string of lexical categories. Then a lexical module takes the category string as input and fills each category with a choice from the lexicon. This leads to a string of (abstract) morphemes. Then a phonological module takes the morpheme string and converts it into an utterance. Various schools of thought have inserted transformational modules between the lexical and phonological modules or even between phrase structure and lexicon.

This model of speech has been criticized for leaving no place for meaning. Chomsky has defended it by insisting that it is a model of grammar and not a model of human thought; there is good reason to believe that he thinks that it is a tool, perhaps the only tool, for examining thought scientifically. But even government-and-binding theory has never really addressed this problem. The generative semanticists identified semantics with the phrase structure module; Chomsky explicitly rejected this idea and, probably, there are, nowadays, no actual generative semanticists left. Lexical-functional grammar is another attempt, quite different in spirit, to address the problem of meaning.

In lexical-functional grammar, the lexical module is expanded to produce a second output – a functional structure – as well as the constituent structure that it passes to the phonology. The functional structure is the input to a semantic module that determines the meaning. The process of producing an utterance remains shadowy, but it is very clear how understanding must be carried out. In order to drive the lexical functional processing, the phrase structure is enriched with a set of functional statements that parallel the category statements.

For example, the initial phrase-structure rule of English is expanded into:

$$S \rightarrow NP \quad VP$$
$$(\uparrow subj)=\downarrow \quad \uparrow=\downarrow$$

In this notation, the $\uparrow$ is a variable to be filled with the identifier of the node being expanded (here S) and the $\downarrow$ is a variable to be filled with the identifier of the new node (here NP or VP). An interesting effect of this particular rule is the equation S = VP, so that the VP is identified with the sentence and its parts become sentence parts. I presume that VP is retained in the analysis because it reappears elsewhere in the phrase structure, but it clearly has no separate part to play in the meaning.

Hence as an utterance leaves the phrase structure it has a conventional category string and a set of equations like these:

(f1 subj) = f2; f1 = f3

The lexical module adds more of these equations on the basis of the lexical items it inserts into the category string. For example:

(f2 pred) = *girl*

The entire set of equations is a functional description, and it must be solved to provide a functional structure.

The word "function" is not being used lightly here. It is the intent of the theory that all the unknowns, the various *f*s, are indeed functions in the technical sense of that word. That is, they are sets of ordered pairs of argument and value such that each argument occurs no more than once. The description has been solved when each unknown function has been worked out and the value corresponding to each argument determined. In general, this is not too hard if the sentence is well-formed. And a failure in the solution indicates that the sentence is not well-formed. Grammaticality is automatic.

What makes the functional structure interesting is that a value can be another function. For example, the entire sentence might be a function with four arguments, **subj, obj, tense, pred,** and the value of the argument **subj** might be a three-place function with arguments **spec, num, pred,** where the three values are *a*, **singular**, *girl*. This has advantages; in a reflexive sentence the same function can be the value for both of the arguments **subj** and **obj.** In more complex sentences the interrelationship can be quite complicated.

The claim made by lexical-functional grammar is that functional structure is an adequate representation of mental processes. This is a strong claim that will need a significant amount of testing before it can be accepted. Since a number of persons appear to already believe that thought is, in fact, based on a mixture of predicates and their arguments, this is not an outrageous claim. Lexical-functional grammar can support a clearly formulated version of predicate and argument logic. It can also support considerably more complicated structures unless, as all of our writers are careful to do, one argument of every function is a distinguished "predicate". This is not however required by any other part of lexical-functional grammar, and represents a separate claim.

Lexical-functional grammar has *no* transformations. This means that it must face the problems of anaphorical behavior that government and binding was developed to handle. Some of this is relatively easy because relationships that are distant in terms of phonological strings can easily turn up as immediate after the functional description is solved. But neither Bresnan nor Horn can solve all the problems in this way, and they have to fall back onto special devices. The reader need not be concerned about specific devices, because they are sure to be changed in each treatment of the subject. Some transformations may yet be re-introduced.

Another difficulty which is almost trivial but matters because it impacts on the name of the theory is that "function" is probably a misnomer. One situation Bresnan answers with a special device is the component, like an English temporal adjunct, which can occur an arbitrary number of times. The device used is to allow a

value to be a set of functions rather than just one. This is a rather transparent trick to avoid saying that "adjunct" occurs several times as an argument and the set of ordered pairs is not, in fact, a function. Either we have to do with something we might call a "near-function", or we have to reformulate the well-formedness rules.

Both of the books being reviewed are mainly devoted to proving that this framework does not fall apart when presented with certain standard problems. Horn's book is less rigorous and closer to conventional linguistic theory. The main difference in the two theories seems to be that Horn admits function predicates (that is, values of the argument "predicate") that are themselves functions rather than atomic logical predicates. This is interesting from the mental representation point of view and deserves more discussion from that point of view than it gets in either book.

Bresnan has collected a number of very competent co-workers, most notably Ronald M. Kaplan, and *Mental Representation* is a collection of different contributions with a rather thin thread of continuity. Bresnan is the author or co-author of six of the thirteen chapters. The material is not restricted to English, and there are chapters on French, Russian, Icelandic, and Malayalam. All of the work is intended to prove applicability of the theory, rather than present the results of complete implementations.

Part III of *Mental Representation* is entitled "Cognitive Processing of Grammatical Representations"; it contains three chapters. "A Theory of the Acquisition of Lexical Interpretive Grammars" by Steven Pinker discusses acquisition by children. This reviewer admits to no longer being able to understand articles in this increasingly specialized sub-field of linguistics. "A Competence-Based Theory of Syntactic Closure" by Marilyn Ford, Bresnan, and Kaplan is, to a computationally-oriented linguist, the high point of the book. It contains a theory, supported by experimental evidence, of how real people analyze real utterances; and it ends up with a perfectly feasible plan for computerization (in terms of Kaplan's (1981) General Syntactic Processor) of lexical-functional grammars. "Sentence Planning Units: Implications for the Speaker's Representation of Meaningful Relations Underlying Sentences" by Ford discusses production of utterances and presents some valuable experimental data.

It is not possible, of course, in a review to do anything like justice to the wealth of detail in either of these books. For example, Horn systematically compares his English analysis with a parallel analysis of Polish. In fact, all of the authors wrestle with the problem of free word order and seem to achieve victories. In a chapter on "Control and Complementation", Bresnan tackles word order and even worse problems with some success. The language-specific chapters contain much of value that cannot be discussed here; and so on.

Lexical-functional grammar appears to be flourishing, but it has not swept away all the other schools of thought. Still other alternatives can be visualized. For example, we might question the asymmetry between phonology and semantics, and change the model to place them on a common basis. We might use phrase structure and lexicon to generate something called "deep structure" and two sets of descriptions, one on each side, to be solved.

Horn tries to formulate the construction of functional structures with something very like transformations rather than the arrow formalism. It is true, in an empty way, that every mapping of this kind is a transformation. But the process of solving the description wreaks havoc with conventional simplicity metrics. It is not, of course, fashionable any longer to mention simplicity metrics, but a glance at the argumentation procedures of any theoretical linguist will disclose that they are alive and well, if never acknowledged. Theoretical linguists choose, continually, between models on the basis of what mathematicians call elegance. This is unobjectionable because it is simply another version of Occam's Razor; but mathematicians live in a world where anything, notationally speaking, goes. Linguists have been, generally speaking, captive to their notational devices. It may well be that the most valuable contribution of lexical-functional grammar is to introduce the implicit function theorem into linguistics.

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References

Bresnan, J. 1978 A realistic transformational grammar. In Halle, M., Bresnan, J., and Miller, G.A., Eds., *Linguistic Theory and Psychological Reality.* Cambridge, Massachusetts: The MIT Press.

Kaplan, R.M. 1981 Active chart parsing. Xerox Palo Alto Research Center.

BOOKS RECEIVED

The following books have been received.

Data Bases in the Humanities and Social Sciences 2
(Papers from the 1983 International Conference on Data Bases in the Humanities and Social Sciences)
  Robert F. Allen
  Osprey, Florida: Paradigm Press, 1985, 434 pp. [ISBN 0-931351-006 (paper) $41; (cloth) $64]

Language Sound Structure: Studies in Phonology
Presented to Morris Halle by his Teacher and Students
  Mark Aronoff and Richard T. Oehrle with Frances Kelley and Bonnie Stephens Wilker (Editors)
  The MIT Press, 1984 [$35.00]

Rationality and Intelligence
  Jonathan Baron
  Cambridge University Press, 1985, viii+299 pp. [ISBN 0-521-26717-X, $32.50]