

been held to hinge on whether the X-bar structure (corresponding to $NP \rightarrow Det\ Nom$ rather than $NP \rightarrow Det\ A\ N\ PP$) is correct in the constituent structure \bar{c} laims it makes. P also states that the categories \bar{N} , \bar{V} , \bar{A} , and \bar{P} "correspond to words that are two-place predicates" (p. 178), which cannot be right, since one-place verbs like *elapse* and three-place verbs like *give* also appear in \bar{V} constituents.

The language of P's chapters is full of impressionistic turns of phrase; "we can think of X as Y ", " X acts as Y ", and " X functions as Y " occur frequently. Differentiating GB from transformational grammar, P asserts: "In GB, the logical form (or semantics) of a sentence is considered to be just as important as the surface structure of a sentence (the words that we actually hear)" (p. 188). This appears to suggest that a crucial difference between GB and transformational grammar lies in a value judgment, namely how "important" logical form is held to be. It also manages to confuse logical form (which is syntactic) with semantics, s-structure with PF, and sentences with utterances.

Yet these distinctions are highly germane to the material discussed. For example, if surface structure contains "the words that we actually hear", it is not clear that there is any coherent interpretation of P's long excursus (pp. 155–159) on that old chestnut of theoretical syntax, the putative blocking of the rule

want to \rightarrow *wanna*

by *wh*-movement traces. P relies on a distinction between two kinds of empty string: e "is an empty category, in the sense that we can't hear it spoken" (p. 157), but it is not the empty string λ introduced by MAK on page 3, because, crucially, $\lambda \neq e$ (p. 158). The perceptive student will ask what the formal distinction is between $[_{NP}\lambda]$ and $[_{NP}e]$, and will find no answer. (Linguistically, there is published evidence that the explanation P seeks to present is not adequate anyway; see Postal and Pullum (1982).)

On page 195, P talks of "a notion of 'closeness' based not on distance in a contiguous string, but on the nearness in a tree". He then offers this definition of such a "closeness" relation:

C-command: Node α c-commands node β if the first branching node dominating α also dominates β .

This is extraordinarily vague for a definition in a textbook on formal language theory. The *if* should be *iff*; *first* is not defined; *branching node* is not defined; *dominates* is not defined (or used anywhere else in the book, as far as I could determine: typically, P has not checked whether MAK use the notion of a dominance relation when talking about trees); and it is not made clear whether α and β have to be distinct nodes, or whether one can dominate the other. In addition, the reference to "closeness" remains obscure: there is no limit to how far a c-commanding node may be from a c-commanded node, either in paths through the tree or symbols in the string (α may be indefinitely far down a

chain of unit productions, and β may be embedded anywhere in an arbitrarily complex structure). Whatever else c-command may be useful for, it does not guarantee "closeness" between α and β .

The foregoing are just a few of a very large number of examples that could be cited of inadequacies in the natural language portion of this book. The casual exposition of basic natural language syntax presented in the last two chapters ill befits a text on how to study languages and grammars with mathematical precision.

It is vital for the future of computational linguistics that linguists' study of languages and grammars should not remain at this level of informality and confusion. We need a textbook that deals with the grammars and properties of natural languages and programming languages with equal seriousness. This one does not satisfy that description.

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ATTRIBUTE-VALUE LOGIC AND THE THEORY OF GRAMMAR

Mark Johnson

(Brown University, Providence RI)

Stanford, CA: Center for the Study of Language and Information, 1988, xi+162 pp. (CSLI lecture notes 16)

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In *Attribute-Value Logic and the Theory of Grammar*, Mark Johnson has written an important work in the area of formal syntax. Johnson's underlying thesis that attribute-value-based grammars can be viewed as systems of logic permits a detailed analysis of their formal, computational, and linguistic properties. Although this book does not propose a specific linguistic theory, it does have direct implications for research into attribute-value grammars, which represent a major trend in contemporary grammatical theory.

After an introductory chapter that includes a brief history of attribute-value grammars and the notion of unification, the next three chapters develop the formal analyses. Chapter 2, the foundation of the book, is carefully presented, starting with the fundamental properties of attribute-value structures together with a language *A* in which the properties are expressible. Since the structures as defined are too general, in that they may admit illegitimate linguistic constructs, three plausible restrictions are proposed in order to constrain the class of attribute-value structures with respect to their linguistic expressiveness. Axioms and rules of inference are stated, thereby characterizing a logic called Attribute-Value Logic. The next several sections prove the completeness, soundness, and compactness of the axiomatization as well as decidability results concerning the validity and satisfiability of well-formed formulae (wffs) of the language *A*. By mapping the wffs of *A* into quantifier-free first-order logic with equality and function symbols, the satisfiability problem of the wffs of *A* is shown to be NP-complete. Finally, aspects of the attribute-value structures being investigated are contrasted with the unification formulations such as those of Karttunen (1984), Kasper and Rounds (1986), and Moshier and Rounds (1987).

With Chapter 2 as a basis, Chapter 3 focuses on attribute-value structures and natural language processing. One major theorem is the undecidability of the universal recognition problem for attribute-value grammars. The Off-line Parsability Constraint is then introduced; this disallows unbounded nonbranching (unary) dominance relations and empty strings appearing as terminal nodes. Under this constraint, the universal recognition problem is proven to be decidable for attribute-value grammars. Moreover, assuming the Off-line Parsability Constraint, an algorithm for deriving or producing the syntactic structure from a given string is specified, thus providing a solution to the universal parsing problem for attribute-value grammars.

Chapter 4 shifts attention from computational issues to linguistic questions. It is acknowledged that while the formal mechanisms that have been developed do restrict some types of grammatical analyses, others remained undetermined, such as the representation of grammatical relations. The discussion centers on direct encoding (Bresnan 1982) versus hierarchical encoding (Karttunen 1986; Pollard and Sag 1987) of grammatical relations and their differing analyses of the Dutch double infinitive construction. It is also shown that the following three properties are mutually inconsistent (p. 103):

- (i) A 'direct encoding' of the grammatical relations,
- (ii) An analysis of the double infinitive construction in Dutch based on the analysis of Bresnan et al (1982), and
- (iii) The Off-line Parsability Constraint.

As noted in the book, this result has direct consequences for current versions of LFG.

The final chapter is an extended conclusion that not only summarizes the major results of the book but also suggests specific research proposals.

The book is well structured and the arguments and proofs are well written. The work is not reliant on any particular form of attribute-value grammar, in that the definition of attribute-value structure is sufficiently broad. This abstractness is necessary, of course, in order to achieve general results across a universe of grammars that have an attribute-value framework in common. As a result, the book presupposes a working knowledge of logic, model theory, and complexity theory. However, there are many helpful examples illustrating the basic concept or notion underlying a definition or construction. These examples are judiciously based on LFG rather than on other forms of attribute-value grammars that may be less familiar.

There are several editorial errors; e.g., incorrect subscript in equation (iv) (p. 72), missing '<' in an index of another equation (p. 86), and misspellings or missing words (pp. 67, 93, and 104); however, none are serious or troublesome.

It is rare for a work to be of interest to mathematical, computational, and theoretical linguists but *Attribute-Value Logic and the Theory of Grammar* is one such book, in that it examines problems that impact the research of each type of linguist. For the mathematical linguist, it shows how classical logic can be employed for grammatical analyses in a way that is abstracted away from specific linguistic realizations and claims. Logic then provides the framework for obtaining completeness, soundness, compactness, and decidability results.

Much of the material in the book is relevant to computational linguists, albeit on an abstract level. The discussion, proofs, and algorithm pertaining to the universal recognition and parsing problems are particularly important for research into natural language processing.

Formal syntacticians should find interest in Johnson's discussion of the representation issues of grammatical relations and their implications for the double infinitive construction in Dutch. More generally, the ways that substantive analyses of grammatical processes may be crucially dependent upon formalization of attribute-value structures should help linguists in their search for deeper explanatory principles of linguistic phenomena.

Beyond the specific formalisms and analyses that are developed and discussed, there is a broader importance of this book to mathematical, computational, and theoretical linguists. Although there are sections that are of special interest to each type of linguist, the book as a whole clearly illustrates that problems investigated from a mathematical, computational, and theoretical framework share a common foundation. A study that formally characterizes the relationships and interdependencies of the logical, processing, and syntactic aspects of gram-

mar is not only of interest to all but should also serve as a model for similar research programs not only into attribute-value structures but alternative grammatical frameworks as well.

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NEW DIRECTIONS IN MACHINE TRANSLATION (PROCEEDINGS OF THE CONFERENCE, BUDAPEST, AUGUST 1988)

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(editors)
(BSO Research, Utrecht)

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Machine Translation (MT) research is thriving, and papers on this and related topics nowadays often account for many of the papers read at meetings on computational linguistics. The book reviewed here consists of 16 papers on MT (plus an additional short paper that summarizes some of the results of the conference) presented at a gathering held in Budapest in August 1988. The theme of the conference, as stated by one of the editors, was to "attempt to highlight some new approaches and viewpoints against the background of an up-to-date worldwide overview". The 16 papers are the following:

- W. J. Hutchins, 'Recent Developments in Machine Translation'
- I. Vámos, 'Language and the Computer Society'
- I. Oubine and B. Tikhomirov, 'The State of the Art in Machine Translation in the USSR'
- D. Zhen Dong, 'MT Research in China'
- C. Boitet, 'Pros and Cons of the Pivot and Transfer Approaches in Multilingual Machine Translation'
- M. Kosaka, V. Teller, and R. Grishman, 'A Sublanguage Approach to Japanese-English Machine Translation'
- I. Guzmán de Rojas, 'ATAMARI: Interlingual MT Using the Aymara Language'
- K. Schubert, 'The Architecture of DLT—Interlingual or Double Direct?'
- C. Hauenschild, 'Discourse Structure—Some Implications for Machine Translation'
- J. Tsujii, 'What is a Cross-Linguistically Valid Interpretation of Discourse?'
- C. Galinski, 'Advanced Terminology Banks Supporting Knowledge-Based MT'
- W. Blanke, 'Terminologia Esperanto-Centro—Efforts for Terminological Standardization in the Planned Language'
- D. Weidmann, 'Universal Applicability of Dependency Grammar'
- B. Sigurd, 'Translating to and from Swedish by SWETRA—a Multilingual Translation System'
- G. Prószéky, 'Hungarian—A Special Challenge to Machine Translation?'
- C. Piron, 'Learning from Translation Mistakes'

Against the background of the conference title, "New Directions in Machine Translation" (which gives the book its title), of the 16 papers, 4 seem to be irrelevant to the topic (Vámos, Piron, Weidmann, Blanke); of the 12 papers left, 3 report the state of various systems (Zhen Dong, Oubine, Hutchins). That leaves only 9 papers original enough to be directly relevant to the conference topic (Boitet, Kosaka, Guzmán de Rojas, Schubert, Hauenschild, Tsujii, Galinski, Sigurd, Prószéky).

The 16 papers discuss the following topics; note that most of them discuss more than one topic, but they all put emphasis on one central topic:

- (i) Language and the computer society (Vámos)
- (ii) State-of-the-art reports (Oubine, Zhen Dong, Guzmán de Rojas, Sigurd, Hutchins)
- (iii) The transfer/interlingua debate (Boitet, Guzmán de Rojas, Schubert, Kosaka, Tsujii, Hauenschild)
- (iv) Terminology data banks (Blanke, Galinski)
- (v) Linguistic designs/grammars (Guzmán de Rojas, Prószéky, Sigurd, Weidmann, Kosaka)
- (vi) MT and discourse (Kosaka, Hauenschild, Tsujii)
- (vii) MT history (Hutchins)
- (viii) Translation problems (Piron)

The isolated papers of Vámos in (i) and Piron in (viii) above discuss the computer and translation from both ends of the MT dimension. Vámos, a computer scien-