used to introduce the results of a treatment or examination). For vocabulary fields S for Symptoms, T for Topographies, E for Etiology, TR for Treatments and R for Results, the basic clinical sentence in this language is

$$S < T > E * TR = R.$$

Logical operators can be used, and further operators (e.g., for "between" and "qualified by") have been defined, so that relatively complex clinical statements can be expressed. Also a means for including time data is included. This artificial language is sufficiently close to the syntactic form of simple, straightforward natural language sentences expressing the same information that it would seem feasible to automate the coding process directly from natural language input, although this possibility is not discussed in the paper.

Taken as a whole, this volume shows the existence of an area of interest between the processing of medical information and the analysis and processing of language.

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Linguistic Structures Processing - Studies in Linguistics, Computational Linguistics, and Artificial Intelligence

Antonio Zampolli, Editor

North-Holland Publishing Co., New York, 1977, 586 pp., $48.00, ISBN 0-444-85017-1.

This book is a collection of good articles. It is not, however, a good collection of articles. The only connection between them is that their authors all lectured at the International Summer School on Computational and Mathematical Linguistics at Pisa in 1974. Each lecturer was asked to contribute a chapter to the book; some of the contributions were specifically written for it, while others are papers that the authors had published elsewhere. Although each article is good by itself, the book as a whole lacks a common theme, a logical progression from one article to another, and a common level of background knowledge expected of the reader.

Three of the articles taken together make a good survey of computational linguistics: *On natural language based computer systems* by Stanley Petrick, *Natural language understanding systems within the AI paradigm* by Yorick Wilks, and *Five lectures on artificial intelligence* by Terry Winograd. Although the articles are three to five years old, the issues they discuss are still among the most active research topics today. One strength is the variety of viewpoints on many of the same systems and issues. One weakness is the skimpy treatment of semantic networks and related graphs: Winograd, for example, devotes two pages to them out of 123, while using eleven pages to reproduce the same SHRDLU dialog that he has been quoting for the past eight years. One absurdity is the placement of these introductory articles near the end of the book because the chapters are listed alphabetically by their authors' last names.

Three tutorials on techniques are *Synthesis of speech from unrestricted text* by Jonathan Allen, *Morphological and syntactic analysis* by Martin Kay, and *Lunar rocks in natural English* by William Woods. Allen's article is a short survey of the state of the art and current issues in speech synthesis. Woods describes the various phases of the LUNAR system; he doesn't give enough detail to enable a beginner to build his own system, but he gives enough motivation and references to show someone where to go for further information. Kay, however, buries the reader in detail, including 21 pages of traces from his parser. Such detail is acceptable in a technical report, but an article of this sort should put more emphasis on the reasons for these techniques. Some comparisons with the parsing methods of Petrick, Wilks, Winograd, and Woods would be especially useful since they are discussed elsewhere in the same book.

Two articles that relate computational questions to more general issues in linguistics and psychology are *Scenes-and-frames semantics* by Charles Fillmore and *Cognition: The linguistic approach* by David Hays. Fillmore's article meanders for seventeen untitled sections: he presents a wealth of observations that a semantic theory must account for, but he never attempts to systematize his observations or present a tentative theory of his own. Hays, on the other hand, has a short, tightly organized discussion of the psychological implications of cognitive networks. But his article is so vague and devoid of examples that it is hardly more than an extended abstract.

Four other papers, *'The position of embedding transformations in a grammar' revisited* by Emmon Bach, *Focus and negation* by Eva Hajičová, *Some observations concerning the differences between sentence and text* by Ferenc Kiefer, and *John is easy to please* by Barbara Partee, treat theoretical points in linguistics that are also important computationally. Yet none of the authors cite any computational or AI work in their bibliographies or make any attempt to relate their issues to computational methods. These four articles illustrate a frequent failing of interdisciplinary conferences: the speakers talk past one another without ever reconciling their vocabularies or coming to grips with common issues. (In their more recent work, Bach and Partee and their graduate students have been combining Montague grammar and purely linguistic theory with parsing techniques; it is a pity that their articles in this book make no suggestion of such a combination.)

In summary, this book is not systematic enough for an introductory text, and it surveys too much familiar work for a research collection. Although the book is not suitable as a primary textbook, parts of it would make good supplementary reading for a course in AI or computational linguistics.

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Automated Theorem Proving: A Logical Basis

D.W. Loveland

North-Holland Publishing Co., New York, 1978, 432 pp., $43.50, ISBN 0-7204-0499-1.

To determine whether someone understands a text, such as a story, essay, or poem, he is asked questions that require him to draw inferences from what he has read. Since the text, questions, and answers are all in natural language, a theory of natural language understanding is not satisfactory if it cannot support a model of how questions are answered. When linguists propose explanations for natural language, therefore, they must consider the inference procedures that will be needed to extract information from the representations in their theories.

The inference process associated with the answering of questions can be formally characterized as theorem proving, the subject of Loveland's book. Loveland presents mostly various methods of theorem proving by resolution, but the most attractive method he presents is a non-resolution approach that extends the problem reduction method in artificial intelligence. In the problem reduction method, a question Q is reduced to a set of subquestions P1, P2, ..., Pn by application of the assertion

$$P1 \ \& \ P2 \ \& \ \ldots \ \& \ Pn \supset Q$$

which is called an implication. The terms Pi and Q are atomic statements or their negations. Loveland points out that the problem reduction method is not complete, i.e., that it cannot always answer answerable questions. From the assertions

$$P \supset Q, \quad {\sim}P \supset Q$$

for example, the question Q cannot be answered yes (shown to be a theorem) even though that is logically implied. (The incompleteness comes from the fact that negation is a primitive in first order logic. See Black [1] and Smullyan [3] for systems that do not have negation as a primitive and for which problem reduction is complete.)

Loveland's extension to the problem reduction method, named the MESON format (called a format because many design choices are left to the implementer), adds several rules to the problem reduction method which make it complete. These rules do not complicate the method very much; the most important new rule, for instance, states that when answering a question Q, if one of the resulting subquestions is ~Q, then that subquestion is considered to be successfully answered in the affirmative. (This rule is essentially proof by contradiction.) The MESON format is partially described elsewhere (Loveland and Stickel [2]), but this book is the source for a full description and a proof of its completeness.

The book is divided into six chapters. The first two chapters review the basic concepts of first order logic and explain the basic resolution procedure. Chapter 3 presents several refinements of resolution, including unit preference, set-of-support, linear refinements, and model elimination. Chapter 4 discusses subsumption, a technique that removes redundant expressions from further consideration. Chapter 5 adds paramodulation, the inference rule that handles equality in the context of a resolution-based theorem proving system. The last chapter is devoted to the MESON format. In a sense Chapter 6 is the climax of the book because the MESON format is justified on the basis of theorems about resolution in the preceding five chapters.

This book is a well organized and well written reference for mechanical theorem proving methods presented at the algorithmic level. More than this should not be expected. It assumes that the reader has an acquaintance with formal logic. It proves rigorously nearly every theorem presented, and there are many. Many technical terms are defined throughout the book, as is typical of mathematical treatments. Although theorem proving consists of two parts, a mechanism that defines a search space and a control that guides the search in that space, the techniques described in the book are only the space defining mechanisms. Details of the guiding controls are still the subject of research.

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