Construing Experience through Meaning: A Language-based Approach to Cognition

M. A. K. Halliday and Christian M. I. M. Matthiessen

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Reviewed by
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Michael Alexander Kirkwood Halliday has been actively analyzing and documenting the interactions between syntax and semantics for over forty years, and his systemic–functional theory has been a foundation for important work in computational linguistics for at least thirty years. The first major application of systemic theory was the SHRDLU system by Winograd (1972). The largest ongoing series of applications has been developed at the USC Information Sciences Institute: language generation (Mann 1982; Hovy 1988); discourse analysis and rhetorical structure (Mann and Thompson 1992); and the interface between the lexicon and world knowledge (Bateman et al. 1990; Matthiessen 1995).

In this book, Halliday and Matthiessen present a comprehensive survey of semantics and its relationships to syntax and cognition. Although they present their subject from a systemic–functional point of view, they show how their approach is related to a wide range of work in both computational and theoretical linguistics. One notable omission from their 23-page bibliography is Noam Chomsky, whose period of active research almost exactly coincides with Halliday's. They do, however, give a fair summary of semantic theories based on Chomsky's approach, ranging from the early work of Katz and Fodor to the more recent work by Jackendoff.

The book consists of 15 chapters organized in five parts. In Part I, the authors contrast the systemic approach with a view of knowledge representation as a "piecemeal accumulation" of concepts with "no overall organization." Instead of treating language "as a kind of code in which pre-existing conceptual structures are more or less distortedly expressed," they view language as a semiotic system that serves "as the foundation of human experience." The goal of systemic theory is to present a comprehensive view of how humans construe experience through language. Unlike Chomsky, they do not consider grammar as "autonomous" but as an integral part of the **lexicogrammar**, which *realizes* meaning in words, phrases, sentences, and paragraphs.

Part II, comprising Chapters 2 through 7, presents the **meaning base**, which corresponds to what many authors would call an ontology. The meaning base, however, represents categories of experience with a topmost node called **phenomenon** instead of categories of existence with a topmost node called **entity**. The first subdivision of phenomena is a three-way partitioning according to levels of complexity:

1. Elementary ideas or **elements** are realized by the lexicogrammar as words or short groups of words, such as *rain, from the west,* or *8 hard-boiled eggs*. Computationally, elements may be represented by slots in a frame, nodes in a graph, or typed variables in logic.

2. Configurations of elements or **figures** are realized by phrases or clauses, such as *rain ending from the west* or *chop finely*. Computationally, a figure may be represented by various data structures, such as a frame, list, or graph.

3. Complexes of figures or **sequences** are realized by complex sentences or paragraphs, such as *Take 8 hard-boiled eggs, chop finely, mash with 3 tablespoons of soft butter, and add salt and pepper*. Computationally, a sequence could be represented by a network of frames, a list of lists, a graph of graphs, or structures of objects in an object-oriented language.

Each of these categories is further divided and subdivided by various distinctions, some dyadic and some triadic. Elements are classified as participant, circumstance, or process. Figures are classified by another triad of relational (being or having), material (doing or happening), and mental (sensing or saying). These categories are further elaborated and illustrated with numerous examples. To demonstrate the generality of the approach, Chapter 7 shows how the semantic categories realized in English can also be realized in Chinese and other languages.

Part III consists of two chapters that show how the theory can be implemented in a computational system for language generation, with examples of weather reports and cooking recipes. Part IV consists of three chapters that compare the theoretical and descriptive techniques of systemic–functional theory to other approaches. The concluding Part V consists of three chapters that apply systemic theory to an analysis of how humans construe experience through language. Chapter 14 has an intriguing analysis of the evolution of linguistic expressions from folk theories to scientific theories. Instead of drawing a sharp dichotomy between commonsense and scientific ways of thinking, the authors show how the basic linguistic mechanisms of abstraction and metaphor are used to systematize and formalize scientific language. Metaphor is fundamental to both science and poetry. The primary difference is that poets constantly strive to create novel metaphors, while scientists recycle, perfect, and build on the most successful of their colleagues' metaphors.

In summary, this book makes a strong case for the systemic approach as a fruitful alternative to Chomsky's view of autonomous syntax. The authors demonstrate that semantics has important structures that are cross-linguistic and formalizable. Although they present their data with the terminology, notation, and viewpoint of the systemic–functional approach, their analyses, distinctions, and categories can be adapted to semantic theories based on other approaches.

The authors criticize the logic-based, model-theoretic approaches for their limited ontologies and neglect of important aspects of language, such as metaphor. Yet logicians recognize the need for richer ontologies, and many, if not most, would agree that semantics is the proper starting point for a study of natural language. The authors try to draw a sharp distinction between the deductive methods of logic and the method of inheritance used in frame-based systems. A logician, however, would reply that inheritance is the oldest of all rules of inference; it was introduced by Aristotle for syllogisms, and it is a derived rule in every modern system of logic. The methods of unification used in many logic-based systems implement inheritance in ways that are equivalent to or more general than frame systems. Rather than being a competitor, the systemic approach can be a valuable complement to the logic-based approaches.

The authors consider language as a semiotic system, but they only mention the dyadic version of semiotics developed by Saussure and linguists influenced by Saussure, such as Hjelmslev and Firth. Peirce analyzed the sign relation in greater depth

than Saussure and emphasized its irreducible triadic nature. Although Halliday and Mattheissen never mention Peirce, they have rediscovered many of Peirce's triads in their systemic analysis (Peirce 1991–1998). Their choice of phenomenon as the most general category is an unconscious endorsement of Peirce's point that his categories were primarily phenomenological rather than ontological. The systemic triad of being–having, doing–happening, and sensing–saying corresponds to Peirce's fundamental triad of Quality, Reaction, and Representation. Most of the other triads in the systemic meaning base also have a strong Peircean flavor, and a more conscious application of Peirce's version of semiotics might help clarify and refine many of the triadic distinctions in the systemic approach.

Perhaps the least attractive feature of the book is its formatting. The authors used a conventional word processor to print camera-ready copy on A4 paper, which the publisher reproduced without change. The result is a heavy, unwieldy tome with a great deal of wasted paper, a generally unfinished appearance, but a price tag of $102. With that price and format, the book is destined to sell very few copies, the authors will get little or nothing in royalties, the publisher's high price will seem to be justified, and a potentially important book will never be read by students who might profit from it. The book would get better distribution if the authors had simply put the electronic version on their Web site; better yet, professional societies such as the ACL should put books such as these on their Web sites.

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Computing Meaning, volume 1

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Manipulating meanings of natural language texts and utterances is one of the main objectives of any large-scale NLP system. However, at present there is no general theory that explains what natural language meanings precisely are, and how they are to be effectively computed for purposes of practical NLP. Moreover, in the first place there is not even an overall agreement as to a general notion of "meaning" that is computationally relevant. Two prominent approaches to the question can be recognized.

1. The machine learning approach: In this view, meanings should be defined according to whatever representation practical NLP systems find useful. For instance, if a system is to extract travel information from free text, then meanings in this context can be defined as records in a database containing fields such as "destination", "time of arrival", "means of transportation", etc. Such a representation has to be defined ad hoc for any relevant purpose, but the mapping from natural language to this formal representation is performed automatically using general learning algorithms.
2. The formal semantics approach: According to this line, meanings are logical objects and should be manipulated using logical tools. Work in the formal-semantic school that developed from Montague grammar specifies the logically relevant parts of meaning and how to derive them from a natural language input, while the field of computational semantics deals with the algorithmic realization of these formal techniques as NLP systems.

The volume under review is a collection of 16 articles that adopt the second view as their starting point. In a clear and instructive introduction, the editors present an overview of the formal approach to the computation of meaning, illustrate it using a small calculus, and discuss a number of general problems for this approach. Of special importance is the ambiguity problem: the spurious multiplicity of meanings that even the most sophisticated syntactic and semantic theories derive. The construction of underspecified representations of meaning, which is one of the prominent techniques

for tackling the ambiguity problem, is addressed from different angles by five of the articles in the volume. Another prominent issue in computational semantics is the dynamic nature of many natural language phenomena, especially those related to anaphora and presupposition. Six articles in this volume address dynamic semantics from different perspectives. The other articles in the book deal with different topics in semantics: compositionality, speech events, belief utterances, motion verbs, and the interpretation of German compounds.

These topics are vast and highly varied, and a fair description of even the core ideas in these papers is impossible within the space limits of this review. (A good overview of the articles in this volume can be found in the introduction.) Many of the works have important implications for formal semantics or theoretical linguistics, but those papers that are most relevant for computational linguistics are those that succeed in extending an existing computational framework to treat phenomena that it had not previously handled. One such contribution is the paper by Richter and Sailer, who develop an underspecified semantics in HPSG. Of similar significance is an interesting paper by Van Genabith and Crouch, who give a semantics of cross-sentential anaphora using LFG glue language semantics. Other papers would be of interest mainly to theoretical linguists or to logicians and philosophers of language. Good examples of works of the first kind are a paper by Ginzburg on ellipsis resolution and a paper by Stone and Hardt on the anaphoric properties of modals. Examples of more logically oriented papers are the contribution by Meyer Viol et al. on the use of epsilon terms for underspecified semantics and the paper by Asher and Fernando on underspecification using labeled representations. Although these works do not give algorithmic implementations of their ideas, they include enough formal details to make small but illustrative computer applications feasible. The book also contains two articles of a more programmatic nature: on underspecified semantics (by Pinkal) and on compositionality and minimum description length (by Zadrozny). These works and others would be of interest to any researcher occupied with problems of natural language semantics from a formal or computational perspective.

It is also important to make clear what the book does *not* include:

- It does not provide a unified framework. To understand many of the proposals in this book, the reader has to become familiar with a considerable number of notations, techniques, and theoretical standpoints, sometimes with no real justification for this variety.
- The book does not contain contributions that would be of direct relevance to the NLP engineer who is especially interested in the development of practical "real-world" applications.

In general, the editors did a good job in projecting a collection of works representing the state of the art in computational semantics. The book contains material that will be of value especially to experts in this field. However, most of the papers in the volume will also be relevant to researchers from other branches of computational linguistics who are interested in theoretical aspects of the computation of meaning in natural language.

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