I. The Computational Treatment of Natural Language

I.1 Introductory Remarks

A novelty in the roughly 30 year old history of natural language processing (or computational linguistics) is without doubt that many if not most current research programs integrate theories and methods from both linguistics and computer science in a previously unparalleled manner. More specifically, we mean the following: on the one hand one can observe that many researchers active in natural language processing are "at home" so to speak in both (if not more disciplines!) and are thus able to choose the most appropriate methods and techniques available in linguistics and computer science for pursuing their research goals. On the other hand - and this is certainly a consequence of what was just said - we observe that the integration of problems and methods from the two disciplines gives rise to the formulation of new problems, which even if raised in connection with issues related specifically to natural language processing quite often have remarkable consequences both for theoretical linguistics and computer science.

Examples of this kind of fruitful interaction are still rare but they have accompanied the interaction between the two disciplines from their very beginnings. Just to mention two of the most prominent ones: work in the area of automatic translation in the late sixties led Alain Colmerauer to introduce the notion of unification and the concept of declarative programming into computational linguistics. As we know today these innovations have given rise to a host of developments both in computer science and theoretical linguistics. Recent work in unification theory, in logic programming, in automatic theorem proving, in formal semantics and in knowledge representation is quite often directly inspired by problems on the borderline between linguistics and computer science. Similarly productive was Noam Chomsky's work on the formal aspects of grammatical theories in the fifties, which has formed the basis of much work in computational linguistics and in formal language and automata theory in computer science.
The goals of computational linguistics are manifold - in fact much too manifold to be surveyed or even mentioned adequately here. Instead of trying to cover the broad spectrum of research activities in this field, let us instead draw attention to what we take to be the basic common task of these activities, namely, to render linguistic theories computational. Another way of formulating this goal is to say that one of the central interests that are pursued on the border line of linguistics and computer science is to enumerate certain fundamental relations.

This goal is by no means a new one. The founders of important currents in modern syntax and semantics, Noam Chomsky and Richard Montague, neither of which we can count among the computational linguists by any standard, were of the conviction that progress in linguistics could only be obtained on the basis of a precise formulation of interesting fragments of natural language. As a result of their work several basic notions, like for instance the concept of grammaticality or the concept of truth, became part of the scientific adequacy criteria of these linguistic sub-disciplines and more recently also of various computational accounts of language.

1.2 Sentence vs. Discourse Understanding

In addition to the just mentioned adequacy criteria for the syntactic and semantic sub-components of an integrated linguistic theory, a further distinction has played an important theoretical and methodological role in recent linguistic and especially in recent computational linguistic thinking: namely the question whether semantic interpretation and more generally the nature of understanding is to be investigated primarily at the sentence or at the discourse level. The central question here is of course how the in the meantime well-understood syntactic and semantic adequacy criteria could be applied at all at the level of discourse and what further criteria of a similar import we need to take into consideration if we want to obtain similarly significant results beyond the level of the sentence.

Since my intention here is to formulate some of the principal differences between approaches to sentence and discourse analysis from a computational perspective, I would like to begin with a sketchy account of why the "limitation" to the description of syntactic, semantic and pragmatic properties of sentences has played a significant positive role in both theoretical as well as practical undertakings in computational linguistics. This will be followed by a discussion of the necessity of taking into consideration properties of language observable essentially at the discourse level. I