Concept Decomposition

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ABSTRACT

Historically, perhaps the most general paradigm for scientists has been decomposition — as with, e.g., 'elements' in chemistry, and the basic structures/processes of theoretical physics. Knowledge representation research is encouraging a somewhat comparable activity in computer science, by way of the study of knowledge representation structures and knowledge represetation systems. Symbol sets, rules of usage (including divergent inferencing engines), and conceptual primitives are among the entities involved in this process of decomposition.

Years of association with research in the history of science have eventuated in a conspectual overview of the character of science at large and in a perceived sense of science's Grand Design — including concept decomposition as well as other distinctive properties (Sedelow & Sedelow, 1978; 1979). Despite traditional associations for the term design, that Grand Design is not an individual invention, but, rather a 'social invention' (Ogburn and Thomas, 1922). It is not the work of any one individual, nor even in its entirety the fully conscious plan of a set of such, but, rather, the only partially intended, accreted result of a process Koestler (1959) spoke of tropically as in some respects even sonambulistic. To a computer scientist, in that perspective science itself may be 'ultimately' decomposable into the behavior of a Turing Machine (Sedelow, 1980), or a Bavel Power Tier Automation (Bavel, 1988). Thus, although conventionally there is an ascription of conscious intent, much of the detail of science, both in the large and in fine, does not require a positing of consciousness (Gregory, 1987) and of deliberate intent to account for patterns we find/invent in the output of the scientific enterprise; some indication of that approach is to be found in the published papers already cited on the formalization of historiography and the analysis of science as discourse, especially with reference to the highest level in the scientificity hierarchy.

Aside from the major scientific achievements in China in earlier centuries (Needham, 1954) as well as the notable achievements of early Islamic science, and taking science as at least predominantly an Occidental enterprise — and in the longer perspective of world history perhaps the Occident's primary accomplishment — it does seem apparent that the most general scientific paradigm (in Kuhn's, 1970, earlier view of the role of paradigms) has been decomposition. That emphasis on decomposition in the Grand Design of science is evident both by way of the examination of the history of the individual sciences and also by way of the study of the contrastive possibility of an emphasis on systemic understanding.

Efforts to enhance the intellectual and technical power of computer science as an academic discipline (Sedelow, 1989) encounter numerous adamantine obstacles, many of them consequences of the pay-off matrix in computer applications — which is so loaded as to reward short-term, purely technique, trivia at the expense of scientific depth. Even in a computer science specialty so necessarily concerned with 'ideas' as expert systems, and artificial intelligence, that scientifically disadvantages condition has obtained. Nonetheless there are those like John McCarthy who, while indubitably making shorter-term 'practical' contributions (e.g., the language LISP), have persisted in an effort to achieve such generality of results (e.g., on the predicate calculus, as presented in his Turing Lecture, 1987) as contribute to that cumulativeness crucial to the growth of science.

In the domain of human language computing, and more specifically expert systems, there is in the Little Rock division of the University of Arkansas system an on-going effort — which has been aided by grants from The National Science Foundation, the Office of Naval Research, the U.S. Air Force, and The Exxon Educational Research Foundation — to contribute to that depth of result which distinguishes science from technology, as well as to accord with that grand design in science which fosters decomposition. More specifically, and as also developed by S. Sedelow (in press), some of that effort is directed to the study of whole 'natural' languages as knowledge representation structures employable on the computer.

In the aftermath of the consensual recognition of the non-productivity of the General Problem Solver (GPS) of Simon, Newell, and Company (on the Computer Science faculty at Carnegie-Mellon University), there developed an enthusiasm for specific problem solvers highly engineered to accommodate massive informational pump-priming, so that a minimum of learning (contra Rosenblatt and Bloch's 'Perceptron') by the computer-based system was required. Unfortunately for the development of computer science, and for the development of science generally, a domain-specificity/generic-reasoning contrast was not problematicized, with the result that now more than a generation of computer science students have been professionally enculturated with the notion that in building cognitively robotic (Sedelow, 1988) or artificially intelligent systems one has to opt for domainal narrowness in order to avoid a dead-end in an impoverished and barren abstractness. But now we can begin to see our way clear to attaining the advantages of that breadth of scope sought by the builders of the General Problem Solver at the same time that — through modelling the semantic structure of a decomposed whole human language — we can engage in the specific human language transforms which are at the core of expert systems and numerous cognitive robotic applications (Marr, 1982).

At the moment the expert systems of AI might more accurately be described as artificial idiots savants. While to build an artificial idiot savant is a considerable accomplishment — after all, an idiot savant specialized to playing chess is demonstrating considerable skill, no matter what may be his/her limitations otherwise — nonetheless it does not demonstrate that capacity for general-purpose symbol manipulation that we speak of as a manifestation of at least verbal and logico-mathematical intelligence.

In the process of building expert systems numerous types of decomposition are employed, irrespective of whether the systems in question are domain-narrow or domain-transcendent (Sedelow and Sedelow, 1988). Among the types of entities which knowledge representation specialists examine are symbol sets (such as an alphabet or a number system). There also is decomposition into rules of usage governing what constitutes an acceptable string of items made up from a symbol set, as well as decomposition into well-formed formulas, inferencing engines, etc. It is now also possible to decompose the meaning space — in the sense of a mathematical space — created by a human language at any given stage of its evolution. If, as in type-token mathematics, a distinction is made between types and tokens, the types as gathered together for a language and then sorted alphabetically comprise a dictionary's main entries.

The word types used in the definitional components of that dictionary could be regarded as a set of primitives (Sedelow and Sedelow, in press). Now if, one way or another — whether in trees, in semi-rings, or with some other discrete mathematical structure (webs, for example), perhaps not yet invented — an effort is made at least partially to order that set of primitives, the result is a semantic space structure for the language as a whole which also provides a basis for comparing one language with another (Sedelow, 1988), even if those comparisons have to be made with the aid of a supra-binary (multi-valued) logic, such as rough sets (Grzymala-Busse and Sedelow, 1988).

Many years of research stand behind the formalized symbolic processes (necesarily only glancingly) referred to here, and in Sally Yeates Sedelow's paper in this Proceedings. Perhaps the best single introduc-

tion to further knowledge of this work would be by Sedelow and Sedelow (1986); Sedelow and Sedelow (1987); and Sedelow and Sedelow (in press).

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