arithmetic in the common 32 bit word were implemented as a 1 bit sign, a 9 bit binary exponent, and a 22 bit mantissa, one would have the same dynamic range as with the 7 bit hexadecimal exponent, but the precision would only vary between $\zeta_2 = 22$ ($\zeta_{10} = 6{\cdot}62$) and $\zeta_2 \lesssim 23$ ($\zeta_{10} = 6{\cdot}92$). The smaller variability of the precision corresponding to the range $6{\cdot}62 < \zeta_{10} < 6{\cdot}92$ is contained within the range of all 7-digit decimal numbers ($6{\cdot}30 < \zeta_{10} < 7{\cdot}30$). Also the assured (minimum) precision is one bit more ($\zeta_2 = 22$) than with the hexadecimal exponent format ($\zeta_2 = 21$). Such a 9-bit binary exponent is used in the ICL 1900 series computers. In these machines short format floating point numbers are contained in 48 bits, with an unsigned mantissa of 37 bits (one bit is not used). This corresponds to a precision range of $37 < \zeta_2 < 38$ ($11{\cdot}14 < \zeta_{10} < 11{\cdot}44$), which is contained within the precision range of 11 and 12 digit decimal numbers ($10{\cdot}30 < \zeta_{10} < 12{\cdot}30$). If the spare bit had been used to produce a 38 bit mantissa, then the precision range $38 < \zeta_2 < 39$ ($11{\cdot}44 < \zeta_{10} < 11{\cdot}74$) would have been a sub-range of all 12-digit decimal numbers ($11{\cdot}30 < \zeta_{10} < 12{\cdot}30$).

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Book review

Formal Aspects of Cognitive Processes, edited by Thomas Storer and David Winter, 1975; 214 pages. (*Springer-Verlag*, $9.50.)

This is vol. 22 of a series bearing the heading *Lecture Notes in Computer Science*, edited by G. Goos and J. Hartmanis. In the present instance the series title is somewhat misleading since the contents are in fact the proceedings of a symposium.

On the back cover it is explained that the series is intended to provide a means for rapid publication of material of various kinds reporting developments in computer science research and teaching. Previous volumes have contained proceedings of other important symposia. In view of the reference to rapid publication it is surprising to find that the symposium now being published was actually held in 1972.

The aim of the symposium was to bring together workers on cognition who are truly using formal methods to advance their work, as distinct from using them merely for effect when publishing. It appears to have been successful in this respect. The best way to indicate the coverage is probably to reproduce the table of contents and then to give some explanatory notes. The table is as follows:

(*a*) Theories of the brain; behaviour, the mind, robots and cognitive processes, respectively (J. T. Lamendella).
(*b*) Two classes of holographic process realisable in the neural realm (J. P. Cavanagh).
(*c*) Semantic memory retrieval: some data and a model (E. F. Loftus).
(*d*) Implication as an alternative to set inclusion as the semantic primitive (A. L. Glass).
(*e*) Structured-storage AFA (Abstract only; A. Gabrielian, S. Ginsburg).
(*f*) Predicate calculus feature generation (D. Rothenberg).
(*g*) A mathematical model for perception applied to the perception of pitch (D. Rothenberg).
(*h*) Models of speech production (C-W. Kim).
(*i*) Towards a theory of linguistic memory (T. J. Keeney).
(*j*) The grammar of relative adjectives and comparison) R. Bartsch, T. Vennemann).
(*k*) A simple hierarchial model of natural selection (D. J. Winter).
(*l*) On the notion of a rule (T. Olshewsky).
(*m*) Empirical restrictions on the power of transformational grammars (R. Skousen).

One of the points made in (*a*) is that Chomsky's introduction of the idea of transformational grammar brings language understanding firmly under the heading of cognition since the derivation of the deep structure from the surface structure requires much more than a parsing algorithm. Transformational grammar is treated in (*m*), and in (*l*) it is pointed out that there is an essential distinction, often overlooked, between the grammatical rules of a language and rules determining speaker and listener behaviour. Paper (*b*) discusses holographic theories of memory, with a useful preliminary discussion of information coding in the brain. Papers (*c*) and (*d*) discuss what can be inferred about the storage of items in memory from errors in recall and time needed for recall. They employ contrasting schemes to represent the relationships between remembered items. Paper (*i*) discusses the storage of material in linguistic form and ways in which it is disturbed by semantic confusions.

Paper (*e*) appears in abstract only, and is a very abstract treatment of formal languages and acceptors of information. No immediate relevance to biological studies is indicated. Paper (*h*) begins with the interesting observation that children who fail to learn to read English text can often learn fairly readily to read matter in a form in which Chinese-type characters represent whole words. Paper (*k*) begins by presenting fairly conventional genetics theory in a formal way well suited to computer simulation, but the final model has the special and unusual feature that the evolutionary process modifies the selection criteria as well as the genetic composition of the population. This presumably corresponds to the species changing its ecological niche.

Papers (*f*) and (*g*) introduce a formal approach to cognition, closely related to that of Banerji. In paper (*g*) the analysis is applied to the study of chords in the music of different cultures. Paper (*f*) is by far the longest of those presented, occupying one quarter of the book, and it is probably the most significant. Pattern recognition in any modality can reasonably be based on a set of logical predicates and it is shown that these can be automatically modified. An aim of the modification is to produce sets of rules which are, by a particular criterion, short. Deriving a short set of rules constitutes generalisation which may allow useful inductive inference (i.e. correct classification for patterns not in the training set). This is deep stuff and very important for the study of learning in animals or machines.

The papers all break new ground and it is impossible to judge their eventual value. What can certainly be said is that all of them give a refreshing impression of enthusiastic ongoing research. The useful-looking sets of references naturally end at 1972, but they were certainly bang up-to-date then, with at least half of them dated 1969 or later.

Anyone whose research interests adjoin any of the subject areas touched on here can almost certainly derive valuable stimulation from this book. It should be read by linguists, psychologists, neurophysiologists and particularly by the 'armchair' followers of these specialities who operate under the banners of Cybernetics or Artificial Intelligence.

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