learning problems (p.224). At this point the overall conception of the book becomes clear. For the author regards the theory of neural networks a priori as one of the five possible models of calculability (mathematical, logical-operational, machine = computer, cellular automatism, and biological = neural networks). As a biological model, artificial neural networks lay claim to being an alternative calculability paradigm capable of supplying those sophisticated solutions which a million years of evolution have producedby self-organization.

This claim is honored in this book first and foremost by the description of the self-organizing networks as designed by Kohonen (1982) and, particularly, by the description of the so-called genetic algorithms which simulate an evolution process in the computer. First, however, there follows, in the third part of the book, a highly detailed description of the recursive networks to which the learning process in associative memories according to Hebb's rule, as well as the Hopefield model with its variants (e.g. Boltzmann machines) belong.

The book closes with a survey of the hardware for neural networks. Deserving of special mention are the detailed bibliography, as well as the historical notes accompanying each chapter. They considerably contribute to the readability of the book, highly abstract-theoretical and brimming with mathematical formulae as it is otherwise. If one asks, in summing up, whether the author has achieved his purpose of not only describing the various models but also linking them together systematically, this question must be answered unreservedly in the affirmative. By looking at the host of different network topologies and learning strategies from the - admittedly highly abstract and formal - point of view of the calculability paradigm, the chaotic tangle they intitially presented has made way for a readily overseeable overall picture. The sober, maybe all too sober description thus achieved, which also consistently emphasizes the limitations of such artificial neural networks in comparison with the unsurpassable complexity and efficiency of natural neural networks, contributes to the demystification of the artificial ones. Therefore, over and beyond its intrinsic didactic function, this book can be recommended to all those seriously interested in the theoretical foundations of an information processing technology which has already succeeded in closing major gaps which conventional methods have so far been unable to fill. Erhard Oeser

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FUGMANN, Robert: **Subject Analysis and Indexing. Theoretical Foundation and Practical Advice.** Frankfurt/M: INDEKS Verlag 1993. XVI,250p., ISBN 3-88672-500-6 = Textbooks for Knowledge Organization, Vol.1

This work is a compilation of lectures given by the author in 1992 and 1993 at the School of Library and Information Science, Indiana University, Bloomington, Indiana, USA. These lectures were quite evidently based on the author's book "Theoretische Grundlagen der Indexierungspraxis", Frankfurt/M, 1992, likewise published by INDEKS Verlag. For the didactic purposes of the lectures, the English version was revised, shortened and partly also expanded. The core of Fugmann's theoretical foundation is formed by the so-called "five-axiom theory of indexing and information supply". This theory is found in the chapter on information storage and retrieval. The point of departure for these five axioms is to be seen in the survival power or endurance of information retrieval systems. We will briefly introduce the five axioms here:

1. *Axiom of Definability:* Every document collection needs to be ordered. This order must, however, be definable, on the one hand in the sense of undirected or unfocused information supply (serendipity effect in browsing) and on the other hand for focused or directed searching. From this demand the distinction between pertinence (subjective need) and relevance (objective need) is derived.

2. *Axiom of Order:* Order is defined by the author as the "meaningful proximity of the parts of a whole at a foreseeable place", thus rendering the compilation of information relevant to a given subject into an order-creating process. This axiom dominates the entire classification theory.

3. *Axiom of Sufficient Order:* This axiom pertains to the degree of order as depending on the size of the document collection, the frequency of searches and the specificity of the enquiries, as well as to the type of order, which should be both loss-avoiding and noise-avoiding.

4. *Axiom of Representational Predictability and of Loss-Avoiding Order:* The completeness of the information to be retrieved depends on the predictability of its description. The prerequisite for this property is a so-called index language (i.e. information retrieval language) whose lexics and syntax are, through standardization, better "predictable" than those of natural languages, with - in particular - synonymy needing to be excluded.

5. *Axiom of Representational Fidelity and of Noise-Avoiding Order:* An index language must be capable of representing concepts and concept connections in a semantically adequate and unambiguous fashion, this is what the author means by "representational fidelity".

When presented in coherence, these five axioms are trivial in themselves, but they constitute basic demands on information retrieval languages and thus on a classification type of pragmatic nature for the ordering of documents or subjects. Such information retrieval languages are artificial languages which, just like natural languages, must fulfill two basic functions - namely the cognitive function (language as carrier of objects of human cognition) and the communicative function, with this latter function needing to be interpreted both technologically and socially. In addition, however, information retrieval languages also must fulfill the following func-

tions, likewise basic to Fugmann's axioms:

- *Representational function:* The lexemes represent the subjects or information to be classified or retrieved.

- *Language standardization function:* Lexics and syntax are standardized by agreement in order to exclude the ambiguity of natural language.

- *Storage function:* The information retrieval language must also be able to store the subjects or information.

As the aforementioned axioms may, as it were, be regarded as the guiding theme for the entire work reviewed here, the statements on indexing may likewise be viewed as central object of the work and will therefore be briefly discussed here.

The author rightly divides indexing into two successive processes which are fundamentally different from each other:

1. Recognition of the essence, or the information contents, of a document.

2. Representation of this essence by means of an index language while maintaining adequate predictability and representational fidelity.

Terminologically one might object to Fugmann's making indexing superordinate to classification ("classing"), by which he means the assignment of notations in a hierarchical classification. In our opinion, however, it is classification which is the superordinate concept, specified by the subordinate concepts of (a) hierarchical classification ("classaurus", as Fugmann calls it!) and of (b) ahierarchical classification. The activities concerned in each case should be called accordingly, i.e. indexing by means of descriptors as a type of classification.

The author rightly stresses the advantages of the use of concept categories, both for the processes of indexing and for the structure of an index. language. As an example he introduces the following categories for the field of chemistry: matter, living entity, apparatus, and process. For the representation of the essence of documents, the following, carefully differentiated indexing procedures are named:

1. Extractive indexing uses keywords from the text or the document title (e.g. KWIC index). Attention is called to the well-known weaknesses of this procedure in retrieval.

2. Assignment indexing presupposes an index language with the aid of which descriptors are assigned.

The author furthermore distinguishes here between "indexing with a controlled vocabulary" and "mandatory indexing" in which a standardized vocabulary needs to be specifically prepared, hence ordered, for the indexing process. This differentiation, which is not quite easy to sympathise with, is contrasted by the author with "free indexing", in which the selection of the indexing term is wholly free, i.e. use may be made, for the indexing, both of preassigned descriptors and of descriptors or keywords ad hoc. In using this procedure the borderline to extractive indexing is crossed, so the so-called hybrid indexing may occur.

The indexing procedures defined by the author are then compared and evaluated, with the following criteria being made use of: disambiguation, predictability, filling-up the ellipses, paraphrase lexicalization, representation of non-textual information, synonym control, descriptor specificity, currentness, syntax, collection of descriptor candidates (see picture 14, p.101 of the book), machine time and storage space requirements, and indexing economy. In these comparisons, hybrid and mandatory indexing score best.

The author completes his chapter on indexing with remarks on abstracting, cataloging and book indexing, with the systematic index being presented model-wise in the book itself, as it were as an expanded table of contents. The same is true of a so-called basic index, which replaces the traditional alphabetic subject index. In this basic index, which is alphabetically arranged, the link between it and the systematic index is provided by coding, while in addition every index entry is supplied together with its superordinate and subordinate concepts, with the thesaurus structure evidently serving as the pattern for this arrangement. Of its alphabetical subject index the book contains only a sample page, with this complete index being available from the publisher at cost price - quite an unusual procedure!

Described here by us in some detail, this chapter on indexing is imbedded in observations on the survival power of information retrieval systems, on concept theory (semantic triangle of Ogden and Richards) and on vocabulary and syntax of index languages, as well as in relatively brief remarks on concept analysis. Quite useful, because of their pragmatic approach, are the ensuing remarks on the evaluation of indexing quality, with particular importance being ascribed to the pertinence criterion. In conclusion the author turns to the technological aspects of information supply, but these remarks remain too cursory and fragmentary to have any assertive value to speak of (e.g. two pages on expert systems, less than a page on weighting).

The work reviewed distinguishes itself by an outstanding structure and subdivision including excellent indexes, a high didactic quality and an abundance of knowledge displayed; it is suitable both for reference and for study purposes, with questions at the conclusion of each main chapter facilitating the mastery of the subject matter and permitting its review. The numerous examples in the text strike one as particularly instructive.

With this book the author has succeeded in conveying to the reader (and impressing him with) his profound knowledge of the subject matter and rich practical experience.

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