importance of the 1945 report Proposals for the *Development in the Mathematics Division of an Automatic Computing Engine (ACE)*, he says:

> The first is Turing's insistence that the computer has a hardware system that would be as simple as possible. Turing's philosophy being that the main functionality of the ACE computer would be achieved by programming rather than complex electronic circuitry. The trend in computer architectures since the publication of this report has been towards more and more complex hardware. However, the inevitable result of this has been the computer becoming increasingly baroque and inefficient. This has resulted in a new generation of very powerful Reduced Instruction Set Computers which, while not exactly matching Turing's Spartan hardware design, are conceptually much nearer to it than the vast majority of the computer architectures that have been designed over the last three decades.

Herein lies the essence of Alan Turing's approach: think about the problem; choose the tools appropriate for the problem; solve the problem. Without prejudice or preconception, with honesty and courage, he analysed, designed and effected solutions to a wide range of problems. From pure mathematics, through statistics and applied mathematics to theoretical biology, his contributions still stand as inspiration and enlightenment.

Nobody could teach Turing mathematics. Therein lies the real enigma. From the stuff of life developed a wonderfully creative, driven human being. These volumes capture the very essence of the man. Each one carries an introductory summary of the import and impact of the papers included in it. Some papers, especially in Pure Mathematics, are technically demanding. But very many would repay careful reading by a wide, scientifically literate, audience. A fitting tribute which can profitably be read in conjunction with Andrew Hodges' biography.

(All four volumes are available in the U.S. from Elsevier Science Publishing Co. Inc., P.O. Box 945, Madison Square Station, New York, NY 10159.)

Reference

Hodges A, 1992. *Alan Turing: The Enigma*. Viking: London.

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Integrating rules and connectionism for robust commonsense reasoning by Ron Sun, John Wiley & Sons, New York, 1994, pp 273, £49.50, ISBN 0-471-59324-9.

A standard criticism of symbolic rule-based systems is their inflexibility or brittleness. When faced with inputs that deviate slightly from the expected, symbolic rule-based systems are apt to fail. In this book, Ron Sun presents a novel solution to this inflexibility problem based on similarity matching of distributed representations within a hybrid symbolic/connectionist architecture. Sun's reasoning system consists of two coupled networks. One network represents "concepts" locally or holistically (i.e., one node per concept) with weighted connections between the nodes encoding probabilistic symbolic rules directly. The second network mirrors the first, but with distributed, feature-based, representations. Concept nodes in the first network and their component feature nodes in the second network are linked with bi-directional connections. Reasoning within the system consists of the propagation of activation within and between the networks. Propagation within the localist network effects standard rule-based reasoning (within a continuous-valued logic). The links to the distributed network give flexibility to the rules, allowing them to apply (with reduced strength) to objects of categories which share features with those explicitly specified in the rules.

The book, based on Sun's PhD research, begins with an analysis of a number of typical instances of "common-sense" reasoning which are problematic under standard rule-based approaches. The examples involve reasoning based on incomplete or uncertain premises, as well as generalisation and specialisation. This is followed by a presentation of the architecture which, with its tightly

coupled dual representations, has much to commend it. It is consistent with, for example, research in cognitive science which may be taken to suggest that people frequently employ multiple representations. Arguing further in the system's favour is a chapter devoted to evaluation, in which Sun demonstrates how reasoning based on simple rules, analogies, default inheritance, and exceptions to inheritance, can be performed within the system. Issues of scaling are partially addressed with the presentation of results obtained from a moderate-sized rule base of geographical knowledge (though the precise number of rules employed is not mentioned).

Less convincing is Sun's attempt in the following chapter to present the coupled networks as a faithful implementation of Fuzzy Evidential Logic (FEL) a mathematico-logical theory of reasoning based on "fuzzifying" Shoham's causal theory. It is far from clear just what it should mean for a statement such as "necessarily" to have truth value of 0.1, or a statement such as "possibly q" to have a truth value of 0.9. Two further dubious chapters follow. In the first Sun considers issues arising from the interaction of the two subsystems. Inheritance in its many guises comes in here, and whilst much of the discussion is not problematic, the equation of intensionality, feature-based representations and semantics (and the equation of the complementary concepts, extensionality, holistic local representations, and syntax), is, from a formal perspective, disturbing. The incorporation of variables and variable binding considered in the following chapter is equally off-putting. In brief the proposed technique involves nodes within each network corresponding to distinct variables, with the activation values of those nodes mapping to instances. Thus, when the activation of a variable node is 0.41 that node might represent John, whereas when the activation of the node is 0.42 it might represent Mary. The difficulty with this approach is that the representation of an instance when it is bound to a variable bears no relation to, for example, the distributed representation of that instance as it occurs elsewhere in the system.

In the final chapters Sun attempts to review FEL and his reasoning system, placing them in relation to other work in reasoning. Special emphasis is given to the way that FEL treats all forms of inexactness in a uniform way. Whilst uniformity does have its advantages, it is far from clear that, for example, uncertain knowledge and incomplete knowledge should be treated in the same way. In the end, whether one is convinced by Sun's approach may well reduce to ones willingness to accept the uniform treatment.

To summarise, Sun's introduction of coupled networks with dual, interacting, representations may well be a profitable area, both within the field of reasoning and beyond. However, my personal impression is that Sun attempts to oversell his system. The treatment of several issues (such as the mathematical foundations of the system, and variable binding) is not convincing, and this leaves me with a number of reservations. Nevertheless, I do recommend the earlier chapters of the book to practitioners of Artificial Intelligence involved in the research and development of rule-based systems, and to cognitive scientists interested in the interface between distributed and localised representations.

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Cooperation in industrial multi-agent systems by Nick Jennings, World Scientific, Singapore, 1994, pp 177, £28, ISBN 981-02-1652-1.

This book describes the development of multi-agent systems for industrial applications, using a DAI shell that is based on a novel theoretical framework for cooperation and coordination in dynamic and unpredictable environments.

The introductory chapter explains various issues involved in coordination, such as global coherence, computational cost and communication bandwidth. Agent autonomy and partiality are considered to contribute to difficulties in coordinating social actions. Well-known coordination techniques are then introduced, including organisational structure, meta-level information