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Book reviews

Collected works of A. M. Turing: Volume 1: Pure mathematics by J. L. Britton (Ed.), North Holland, Amsterdam, 1992, pp 288, Dfl, 175.00, ISBN 0-444-88059-3; **Volume 2: Mechanical intelligence** by D. C. Ince (Ed.), North Holland, Amsterdam, 1992, pp 226, Dfl 160.00, ISBN 0-444-88058-5; **Volume 3: Morphogenesis** by P. T. Saunders (Ed.), North Holland, Amsterdam, 1993, pp 160, Dfl 170.00, ISBN 0-444-88486-6.*

"The development of any organism, and *above all a complex one such as a human being*, is a truly remarkable process." These words are found in the introduction to the volume on Morphogenesis, and refer to the subject matter of Turing's paper on "The Chemical Basis of Morphogenesis". The italics are mine; this seems an appropriate thought when contemplating the complex human being whose work is collected in these four volumes.

Andrew Hodges' (1992) very fine biography really did a great deal to raise the public consciousness of this, one of Britain's greatest mathematicians. But there is perhaps still something a little awry about the way we classify the man. Formerly castigated for his homosexuality and non-conformist lifestyle, these aspects of his personality are now greeted with greater understanding and sympathy. In fact, for many, his reaction to his middle class family background and conventional academic life make him a figurehead for a more free thinking academic movement. "A magnificent book which comes out of the gay movement, . . ." does seem a fair assessment of Hodges' book (quoted on the back cover of the Viking paperback edition, from a review by David Fernbach in *Gay's The Word Newsletter*). The worry is that although *Alan Turing: The Enigma* does provide a very well balanced study of the man and of his scientific achievements, it is Alan Turing as "The Enigma" which is becoming embedded in the public consciousness, perhaps to the detriment of Alan Turing "The Achiever".

Maybe it is just reflecting my own interests, but I still find it is the depth and beauty of his scientific work that is above all the fascination of the man. Time and again, imagination and insight go straight to the heart of a problem. Often with stunning simplicity, as with the invention of the Turing Machine to tackle a fundamental problem in the foundations of mathematics. Yet as much as his private life was at odds with the conventions of the time, but open and honest, so his intellectual life was often at odds with the mainstream, and equally honest and true. As a mathematician excited by the potential contributions to his subject by computer power, or as a computer scientist who saw mathematics as fundamental to his subject, Turing was constantly frustrated by a general reluctance to cast a vision across disciplines. Now computer results have been used as an integral component of mathematical proofs, exemplifying the former. As an example of the latter, Turing's 1949 paper, "Checking a Large Routine", describes the first use of mathematics to specify the functionality of a computer program, and goes on to prove properties of that program. Even now there is still widespread scepticism in the use of mathematics to engineer computer programs, although people are beginning to accept it has a value in specialised, safety-critical, applications.

A particularly interesting example of Turing's vision being far ahead of its time is in the design of computer architectures. Turing's relationship with the National Physical Laboratory was far from happy. But just to gain a little idea of what might have been the state of the British computer industry if Turing had been placed in an environment which better suited him, read this from Darel Ince's Introduction to the volume on Mechanical Intelligence. Enumerating the reasons for the

*R. O. Gandy and C. Yates (Eds), **Collected works of A. M. Turing – Volume 4: Mathematical logic** was unavailable at the time of reviewing.

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