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Natural and Artificial Reasoning

An Exploration of Modelling Human Thinking

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Preface

When all come to the Great Game he must go alone—
alone, and at peril of his head
Rudyard Kipling (Kim, 1901)

Originally this book was going to be written as a joint effort between the late Professor David Gooding and myself. David Gooding was a Science Historian in Department of Psychology at the University of Bath and one of the world leaders in his field. Alas, David died from leukemia before we could start writing. Nevertheless, we did sketch out a possible book outline from which this one was eventually derived. I thank his wife, Sandy Gooding, for allowing me to use some of his unpublished material that relates to our work together.

David and I first met in Dubrovnik, Yugoslavia, during the summer of 1989 at the Philosophy of Science Conference (Inter-University Centre). Originally, what got us talking was his work on the '*Visualization of the Research Process*' and my wife Jan's and my work on the '*Visualization of Computation*' (see '**Drawing Programs**' published by Springer 2010). We spent all our time at the conference walking round the castle wall (you could then), talking through our ideas on visualization.

The discussion led to funded joint research from the MRC and the SERC in 1991. This then allowed David, Jan, Simon Grey (an expert systems engineer from the University of Bath) and myself to form a small research team to implement a computer program that would model the discovery process. This was to be a model that was founded on evidence drawn from the historical records of past scientists. Our main model was Michael Faraday FRS (22nd September 1792 to 25th August 1867) and we were particularly interested in his investigations into electro-magnetic forces. David at that time had already reproduced and used much of Faraday's original equipment.

The model of research we developed was founded on the records that showed the thinking processes and behavior of scientists actively researching. These records were historical documents, such as original laboratory notes and diaries. Our observations were thus drawn from history and our work on developing a computer model was supported by such observations.

This book describes our work and explains the design of the computer model. The actual 'belief system' can be downloaded from my website, www.clarity-support.co.uk, and played with. I am not including such code within the book other than to explain the principles by which it was developed.

The term 'belief' here relates to the belief a scientist has in a theory. The process of modeling is equivalent to a scientific theory and so our model should produce results that can be tested against history. The modeling of the way a typical scientist believes in a set of theories is based upon their experimental results, and also talking to other scientists. This 'belief' leads the scientists, along with their experimental results and discussions with other scientists, to new beliefs and further experiments. All of these interactions have been simulated, run and compared with historical records.

In a very minor sense this book is also my memoirs: it is a summary of my professional work and my 'take' on the computer modeling of people. The use of the word 'I' (or 'we'), normally avoided in scientific writing, was intended to maintain the use of active rather than passive sentences, to keep the sentences shorter for easy reading and to spell out that certain elements of the book also have a personal origin.

Also the term 'Wisdom' is used in a very technical sense. In particular it was prefixed by 'Machine' to make clear it is not being used in the normal human sense. The term 'Wisdom' here means that the machine intelligence program is modified by itself in response to its experience (the learning process).

The examples of intelligence given early in the book include the natural theory of evolution (Charles Darwin FRS, 1871). This is included to show how evolution falls within the framework of an intelligent system; it is just an example of a mechanism that has all the properties of intelligent behavior as defined here. No suggestion is made that such a system may be 'conscious'. It is there simply to show that evolution describes a 'problem solving' process.

The schematic programming language Clarity is referenced (see Drawing Programs) because that was the language in which these systems were implemented. Any other functional language, such as ML, FPL, Miranda or LISP, could do the same job. The source code of Clarity is written in C++ and is available to download free from my website.

The other reason for using Clarity diagrams is that they are also a flow chart (a schematic) showing how a program works. These schematics are converted into a functional language similar to any functional language (actually a variation of ML). Because the schematic is converted automatically into a running and tested functional program, I am therefore absolutely certain that the description is both correct and sufficient. This is a guarantee of accuracy and completion.

Since programming languages are transient and ephemeral, adding a specific language would limit the time in which such representation could be fully understood. As I am not writing a software specification, I do not need to refer to any particular computer language. It has always been the case that software developers will mostly use the language with which they are familiar and it was not in my remit to suggest a different one. My aim is to explore some philosophical questions and to write about the ideas behind systems that behave intelligently. This book investigates the limitations of computer models and asks the question, *"Why do we still not have a working model of people that is recognizably human?*"

I would like to thank my colleagues of the Artificial Intelligence Reading Group in the Department of Information Science at Reading University for their patience in going through some of the early investigations with me. They helped ensure that these

ideas are at least coherent. I would also like to thank Drs. David Anderson, David Rotheram and Greg Leonard as well as Dr. David Salt for his detailed statistical analysis of the correlations between the musical extract raw score discussed in Chap. 13. Dr. David Billinge did most of the experimental work described in Chap. 13 and also provided the in-depth understanding of classical music. The results of his research into music were both surprising and enlightening.

In particular, I am very grateful to Professor Max Bramer of Portsmouth University, who has given me good advice on how to present these ideas. Further, the hard work and professional expertise as a technical writer of Meredith Tanner, my daughter in-law, has greatly improved the intelligibility of my presentation.

My gratitude is particularly given to my good friend and colleague, the late Prof David Gooding (University of Bath), for directing me to the ideas of metaphor and for his work with me on the belief system. Most of all I would like to thank my wife, my love and my colleague Jan Addis for her support, the construction of the Clarity programs that illustrate the ideas and for never complaining while I indulge myself in these pursuits.

Any errors in this book are mine.

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