Editorial for special A.I. issue

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The topic of Robotics – or, at least, the more sophisticated parts of it – is often introduced as a subdivision of Artificial Intelligence. According to this view, an issue of *Robotica* with the special theme of "Artificial Intelligence" should have *carte blanche* to roam through Robotics provided it keeps clear of anything tainted with pedestrianism.

In fact, the situation is rather different since a particular approach, or paradigm, has come to be associated with A.I., and it is important to consider its relevance to Robotics. The adoption of this paradigm for A.I. work is not vindicated by any formal demonstration that it subsumes all, or any, important aspects of natural intelligence. It is favoured in A.I. studies simply because it has been found to be productive. Of course, from a pragmatic point of view this is the best possible justification.

Some sceptics would deny that the Artificial Intelligence approach embodies any of the important characteristics of human thought. A strong dose of scepticism was delivered in the 1984 Reith lectures on B.B.C. television, by John Searle.[1] The other great sceptic is H.L. Dreyfus.[2,3] The view of the present author would probably be classed by Searle as falling within the "strong A.I. position", since it is that the programs developed in A.I. work have a non-trivial correspondence to some aspects of real biological thought. However, it has to be conceded, by even the most ardent defender of the strong A.I. position, that the part of human thought that has been simulated in programs is only a minute fraction, like the tip of an iceberg.

The relationship of A.I. to natural intelligence is explored in the next paper in this issue, by Yazdani and Whitby. One of the aims of the authors has clearly been to reply to Searle, with a more practical bias than that of the philosopher Pylyshyn,[4] who has also presented an opposing viewpoint (predating the Reith lectures). Yazdani and Whitby have chosen the rather whimsical subtitle "Building birds out of beer cans"; the relevance becomes apparent in their discussion.

The next two papers, one by Mowforth and Bratko and the other by Aleksander, give general reviews of the application of A.I. techniques in Robotics, that of Mowforth and Bratko going on to illustrate the general points by a description of work in progress in the Turing Institute in Glasgow.

Although advanced aspects of Robotics tend to be treated under the A.I. heading, it is only necessary to flick over the pages of the literature, for example the recent book by Brady and colleagues,[5] to see that the treatment has a different flavour from that of most of the A.I. literature. Problems have to be treated within the framework of three-dimensional geometry and Newtonian mechanics, rather than by pure logic.

Mowforth and Bratko acknowledge the difference of approach and stress the importance of proper integration of the various aspects. Aleksander discusses the impact of the "logical" paradigm of traditional A.I. on Robotics. A different point of view is presented by Andrew in the following paper (written before the one by Aleksander had been seen). It is argued there that the "logical" approach has deficiencies which will be made apparent by the demands of Robotics, and that this will have far-reaching effects on the character of A.I. itself.

From a practical point of view it is certainly important to examine the areas of mismatch between A.I. and Robotics. Despite what was said in the opening paragraph above, robots to be described as "intelligent" in a practical context are surprisingly slow in making their appearance. The great majority of industrial robots do not use sensory information in any sophisticated way. The difficulties in applying A.I. techniques are obviously greater than has been thought. Of course, the potential rewards for making the breakthrough are enormous.

Whatever form is taken by sophisticated robotic devices, and whatever control strategies are employed, the analysis of sensory information must play a crucial part. The sensory information can come from various modalities, but probably robots will resemble humans in relying heavily on vision. The last two papers are concerned with the analysis of sensory input data, usually referred to as "pattern recognition". That of Mudge, Turney and Volz presents a technique of wide applicability, with particular reference to automated manufacturing.

The term "pattern recognition" is somewhat ambiguous since it is not clear whether the word "pattern" denotes a particular input to be classified, or one of the classes. Where the former meaning is accepted, the term "pattern classification" is to be preferred. The necessary processing of the inputs can be seen as the extraction of some measure of pattern similarity such that a pair of patterns belonging to the same class scores higher than a pair belonging to distinct classes. Some methods of pattern classification explicitly produce numerical estim-

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ates of similarity, and any classification process can be represented in these terms. The similarity measure can be said to be a *metric* defined on the pattern space.

For the abstract treatment of classification in these terms, Emptoz and Lamure have found conventional topology to be too restrictive, and have turned instead to the variant which they and their compatriots have termed "pretopology". It is of course difficult to assess the ultimate significance of an abstract treatment, but this one warrants attention as it is intended to provide a unified framework for apparently diverse classification techniques.

A topic I have unfortunately not succeeded in including in this issue is that of just how logic programming methods, particularly the language *PROLOG,* can be applied to such practical tasks as the planning of robot movements. As has been mentioned, the relationship of logic programming to Robotics has been discussed from different viewpoints by both Aleksander and Andrew, but only with reference to a general paradigm which could be expressed in terms of *PROLOG* or in other programming environments. However, it is interesting to consider *PROLOG* since it is a current focus of attention, and it is intriguing to find that an essentially declarative language can be made to control sequential actions.

An introduction to *PROLOG* which makes some reference to the wider applications is given by Clocksin,[6] but I have not succeeded in obtaining amplification of them. Masoud Yazdani is working on relevant issues at the University of Exeter, and the outcome will be awaited with interest. Clocksin states:

"*PROLOG* programs are being used in industrial applications, especially in Hungary . . . where the industrial use of *PROLOG* has been encouraged by the government. Applications include: using knowledge about chemical interactions to design drugs, and about building codes and architectural practice to design buildings, and for software engineering. At present in Britain and Japan there is some investigation into the possibilities of employing *PROLOG* in production planning, industrial process control, and strategy control for flexible automation systems."

I hope the collection of diverse papers appearing here provides food for thought in this developing and controversial area.

References

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6. W.F. Clocksin "An introduction to *PROLOG*" **In:** *Artificial Intelligence: Tools, Techniques and Applications,* Tim O'Shea and Marc Eisenstadt (eds.) (Harper & Row, New York, 1984) pp. 1–21.