little interference from other parts of the program. The supervisor which knits the modules together, is also capable of rapid modification. It is therefore proposed to extend this experience by writing other command interpreter programs for other similar projects.

If the reader can now answer the question in Fig. 1, the letters of the correct choices will be found in the third word of this sentence.

Acknowledgements

The authors would like to thank the staff of University College London Computer Centre for their assistance. Mrs. D. Evans has been largely responsible for the recording of the Bank of nearly 6000 multiple choice questions onto cards. The authors are indebted to Dr. P. Samet, Director of the UCL Computer Centre for his advice in the preparation of this manuscript.

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Book Review

Artificial Intelligence through Simulated Evolution, by Lawrence J. Fogel, Alvin J. Owens, and Michael J. Walsh, 1966; 170+xii pages. (*New York, London, Sydney: John Wiley and Sons Ltd., £3.75*)

An ancient principle in the design of machines is to adopt or to adapt methods used by nature. Although obvious, the principle is important and often overlooked so that it merits a name, say the *Naturist Principle*. It is usually necessary to bring two or more ideas together: birds do not fly by rotating their beaks nor by jet propulsion. An aeroplane is a cross between a bird and a sycamore seed or perhaps a squid.

The naturist principle can be applied to the study of machine intelligence by trying to copy the tricks of language, of the nervous system, and of the evolution of intelligence including the principles of natural selection and mutation. A fair amount of work has been done using the first two of these three approaches, and the third (evolutionary) approach is also not entirely new; it was, for example, suggested, by Oliver Selfridge in the 1958 symposium on the mechanisation of thought processes at the National Physical Laboratory. But the present book gives an account of what were perhaps the first fairly extensive experiments based on the idea. The idea should of course not be confused with the machine simulation of evolution for the study of evolution itself. (See, for example, J. L. Crosby, *New Scientist*, 21st February 1963.)

The individual 'machines' simulated in the experiments are all small finite-state automata. The simulation on a general-purpose computer is almost essential for the experiments owing to the continual redesign of the automata. The tasks put to these automata are the prediction of the next elements in sequences of letters, and sometimes there is an element of control as well. The more successful automata are allowed to give birth to new automata, with slight modifications including additions. Some measure of success is achieved for prediction problems that are simple enough, for example, when the original sequence is periodic and when the problem has a simple approximate solution. Practical implications are not yet evident since evolutionary techniques are not necessary for such simple problems. Moreover the bare description of the experiments makes it difficult to see the wood for the trees. But a beginning has been made.

The experiments are relevant to the status of simplicity in the mechanical or mental construction of concepts since, in some of the experiments, automata were handicapped in accordance with their complexities. Any given simple hypothesis is more likely to be approximately true, and also, for a variety of methods of concept generation, more likely to be generated than any given more complicated hypothesis: *this is why life is possible*. This would usually be true irrespective of the precise definition of 'simplicity' and irrespective of the method of hypothesis generation, be it by linguistic transformation, by pseudorandom artificial or real neural networks (the human method) or by simulation of evolution. Once an approximately correct hypothesis is generated, then it will tend to be confirmed (and hence consolidated in an adaptive technique) in virtue of its correct predictions. The present work, partly in virtue of its title, will help to channel research in these directions.

The automata that occur in the experiments are much simpler than unicellular animalcules, so it is appropriate that sexual reproduction has not yet been simulated. But eventually it will need to be since it would give scope to the combination of the good features of both 'parents'. This would be a natural strategy for the design of a creative machine, since, as Arthur Koestler has emphasised, creativity always involves the bringing together of two distinct ideas.

In addition to the description of the experiments there is also some speculative discussion. When discussing hard science the style is cold and dry, but it gets warmer when the science gets softer. Examples of the two styles are: (i) 'It is also evident that the cost matrix which expresses the goal of comparison must embody the characteristics that are the basis for human judgments of similarity' and (ii) '. . . the scientific method was not invented, it was discovered. It existed long before man; in fact it gave rise to man. Natural evolution can be looked upon as a realisation of the scientific method'. (Cf. the quotation heading Chapter 1 of Warren Weaver's 'Lady Luck'.)

There is no name index. For this the publishers are more to blame than the authors, since the production of a name index is a routine job which the publishers should organise after the page proofs are available.

I. J. GOOD (Oxford and Blacksburg, Virginia)

[*Editor's Note:* There was an unfortunate delay in the preparation of this review for publication, which was in no way the reviewer's responsibility. We apologise to the authors for the delay.]