

to the area integral, and the traverse is complete when the starting point is reached. The initial routine for finding the starting point consists of searching in the $+y$ direction from the position of the light pen until an occupied test point is found.

This method as it stands cannot find the area of an obstructed space such as a courtyard containing a free-standing structure. However, because the program is continuously scanning in the $+y$ direction from the position of the light pen, the user can "present" these

obstructions to the program by moving the pen beneath them. Their area is then automatically subtracted from the displayed total.

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References

- WILLIAMS, A. (1965). "IBIS Development Project," *Architect and Building News*, Vol. 227, p. 156.
SUTHERLAND, I. E. (1963). "Sketchpad: A Man-Machine Graphical Communication System," *AFIPS Conf. Proc.*, Vol. 23, p. 329.
STOTZ, R. (1963). "Man-Machine Console Facilities for Computer-Aided Design," *AFIPS Conf. Proc.*, Vol. 23, p. 323.
COMFORT, W. T. (1964). "Multiword List Items," *Comm. Assoc. Comp. Mach.*, Vol. 7, p. 357.

Book Review

Learning Machines, by Nils J. Nilsson, 1965; 132 pages. (Maidenhead: McGraw-Hill Publishing Company, Ltd., 80s.)

The scope of this book is more restricted than the title suggests, since (a) only machines for pattern classification are treated and (b) even within this, detailed consideration is given only to that part of the classification task which remains when the coordinates of the pattern space have already been chosen. Restriction (a) does not seriously reduce the range of application of the treatment, since learnable tasks other than pattern classification can usually be decomposed in such a way that pattern classification plays a part. Restriction (b) is more serious, and is partially acknowledged in a section headed "The problem of what to measure".

The problem of choosing suitable pattern-space coordinates is not just that of deciding what to measure, however, at least in the case of machines using relatively simple types of discriminant function. The detailed mathematical treatment in the book is restricted to these. Such machines can only be successful if the representations of equivalent patterns are reasonably well clumped together in the pattern space. In most non-trivial applications it will therefore be necessary to process the input data before presenting it to the learning machine.

In the case of more complex machines, such as one consisting of more than two layers of adjustable elements, it is conceivable that useful learned behaviour could be achieved using the raw data as input. Part of the machine (e.g. those

layers nearest the entry points of the input pathways) might learn to perform appropriate coordinate transformations. What training algorithms would be useful in such a machine is still an open question, though it is the faith of most workers under the banner of "Cybernetics" that suitable ones can be found. The difficulty of finding them is emphasized by the present book where, even in the case of two-layer machines, the only training algorithm given is one which modifies only one of the layers.

The restrictions on the scope have been emphasized because they are not implicit in the title, and because restriction (b) is often underemphasized in the literature on pattern-classifying devices. The book is useful in spite of them and is an admirable review of a body of very sound mathematical work which has been stimulated by studies of perceptrons and related devices. A variety of types of discriminant function is treated, as well as training algorithms and their respective convergence proofs.

One chapter is devoted to layered machines. Since the study of these, particularly where the number of layers is large, is presumably the key to further progress, it is useful to have this summary of what has been achieved. It turns out to be remarkably little.

The book presents a large amount of useful information in a clear and readable way. It is well produced, as it should be at the price, and will be valuable to anyone interested in machine learning or pattern recognition.

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