

("neural networks"), which had been proposed, could be made to fit in with the requirements. Such a machine has been "taught" to distinguish between differently oriented straight lines, or between a few simple geometric forms, a few letters of the alphabet in a single fount or similar founts, but to construct such a machine to recognize up to 128 characters would require something almost the size of the hall in which they were sitting.

At Bull, the problem of learning-reading machines was considered in a rather different manner. There would probably be a special reader unit, which would carry out the optical analysis and the decoding into computer language as an attachment to a general-purpose computer. This attachment would not itself be capable of learning, but would have variable logic under the control of the computer it was feeding, so that the latter could contain the learning program proper (once we had learned how to code such a program). One could imagine the mode of operation would be to introduce a few pages of the text, containing the alphabet to be learned, into the computer simultaneously from keyboard and optically through the optical attachment. Then the machine could

read along on its own, stopping for instruction at each further unlearned character. A multi-program machine of the type of the Gamma-60 seemed indicated for such work.

Dr. D. A. Bell (*University of Birmingham*) said it always appeared easier to put information into the machine deliberately rather than wait for the machine to learn. There were some very ingenious devices for semi-permanent storage. Recently a store designed to work on that basis had been installed in a Manchester machine. That was easier than having an elaborate process enabling a machine to read a trial piece to produce the information from statistical analysis.

Although it was convenient to enter material in binary form from character-reading, each time one made a binary decision one was throwing away information. One should try to preserve the pattern in analogue form until the latest possible stage before making any kind of decision.

The Chairman said the morning's discussions had been interesting and fruitful. Everyone present would wish to express their appreciation to Dr. Clowes and the other speakers for addresses which had given rise to such interesting questions and comments.

Correspondence

To the Editor,
The Computer Journal.

Sir,

"Predicting Distributions of Staff," by Andrew Young and Gwen Almond.

The Model given in the paper by Young and Almond (Vol. 3, p. 246) has been given previously by Prais (4, 5). The results on the latent roots of non-negative matrices have been given by Wielandt (7) and Debreu and Herstein (1), and are well known in the theories of Markov chains (2) and Leontief models (3). The setting up of such as difference equations and the properties of the solutions are well known to mathematical economists (6). These models have often been used for short-term planning or prediction.

As far as the Leontief models are concerned the closed model is a prediction model and the open model is primarily a planning model. The model discussed by Young and Almond is purely a prediction model. If the probabilities are made to reflect alternative policies of promotion then the model can be converted to a planning model in the same way as the Leontief models generalize to linear programming. This might save the authors from feeling the need to infer periodic components of 53 and 79 years—an inference that would have been considered rash even by the most audacious writers on closed Leontief models.

Yours faithfully,
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The authors' reply

Our problem arose because the particular institution could see trouble ahead in a few years' time when many of the staff simultaneously reach the tops of their respective grades. We were not asked to gaze into a crystal ball for several decades ahead and, we think, it is clear from the paper that we do not expect accurate long-term forecasts. We therefore find it surprising that the letter-writers seem so concerned that we "rashly" drew attention to the periodic components of 53 and 79 years. Our point was that because the periods were long, no big oscillations in the numbers of staff in various statuses need be expected in the short run with the existing recruitment and promotion patterns.

It may be of interest to report that the predictions made for the institutions for this year have now been verified and have proved extremely accurate. This very fact will encourage the institution to amend its staffing policy and we cannot expect such accuracy in a few years' time when the probabilities are based on a changing staffing policy.