by arranging the students in ranking order according to the marks gained and then, for each question, counting the students in the top third and in the bottom third who obtained a correct answer. The "discrimination" is then given by the difference of the proportion of students in each group. A discrimination of $+1$ means that all the students in the top third obtained a correct answer, but no students in the bottom third. This clearly discriminates well between the more able and less able students. A value of -1 conversely means that all the less able students were correct but none of the better ones! Such a value is of course highly unlikely but questions having negative discriminations must always be carefully examined since they almost certainly will contain errors or confusing information of some sort. Questions with low positive discriminations might be avoided in actual examinations but should not necessarily be avoided in regular tests since this could lead to the weaker students becoming discouraged.

Conclusions

The program has proved to be very useful in checking the progress of students, particularly those in large classes. It rapidly provides a great deal of information would could otherwise be obtained only with a great deal of effort. Its value is, however, completely dependent on the quality of the questionnaires, and no amount of ingenious programming will produce significant information if these are carelessly prepared.

The program was originally written for use with a large class of part-time students taking a Higher National Certificate in Chemistry course. It has subsequently been used successfully with a first year Chemistry Honours Degree course and has also been used for marking a first year examination in Botany and Zoology.

If the questionnaires are carefully written they can help to *teach* as well as to *test*; the author has found it very useful to follow up the tests by the issue of duplicated sheets of notes which discuss the various alternative answers. These, for maximum effect, should be given out immediately after the completion of the test so that students can straight away check their answers. There is considerable evidence that rapid access to correct answers results in significant reinforcement and contributes materially to the process of learning. This, of course, is one of the principles upon which teaching machines (and other forms of programmed learning) are based.

It is clear that the program could be developed and improved in various ways. It might for example prove very useful to assign the questions in the questionnaires to various categories according to what is required in their answering (factual knowledge, understanding a set of concepts, correlation with other branches of knowledge, imagination etc.). Cumulative scores, in these categories, especially if kept over the several years of a student's course, might well provide some extremely interesting and valuable information both on individual students and on groups. Such information could contribute considerably to the development of teaching techniques.

Various mechanical improvements could be made. For example, it would speed up the running of the program if magnetic tape were used for the record instead of paper tape. Preprinted cards on which students' answers could be recorded and then punched would probably be an advantage over paper tape. A card reader which would directly read hand marked cards would be very valuable.

A print-out of the program is available from the author as is also a set of operating instructions for its use on the Elliott 803.

Book Review

The Mathematical Approach to Biology and Medicine, by N. T. J. Bailey, 1967; 296 pages. (New York; *John Wiley & Sons*, 57s.)

This book is in two parts of roughly equal size. In the first part the author discusses mathematics and statistics within his given context, and follows this with chapters on model-building, operational research, and computing, ending with one on "teams, projects, and organizations". The second part treats five special topics where mathematics have been applied to biology. These are numerical taxonomy, population growth and ecology, the theory of epidemics, genetic linkage and chromosome maps, and mathematical methods of medical diagnosis. A final chapter deals with operational research in medicine. To cover all this ground in less than 300 pages must inevitably mean that only an outline can be given of the subjects in view.

I feel that the two parts are likely to appeal to rather different classes of reader. Many biologists will appreciate Dr. Bailey's clear expositions in the first part, but many will find the second part hard going unless their mathematics is fairly strong. Those in the field of statistics, O.R., or computing will get from the second part a good conspectus of what biomathematics is about, but they will inevitably be dissatisfied by the level of exposition in their own field. Thus readers of this *Journal* who have done large-scale editing of data on a computer may feel less enthusiastic than the author about his statement that "both languages (FORTRAN and ALGOL) are highly suitable for scientific computing".

To sum up, Dr. Bailey has taken on the difficult job of writing a book surveying diverse but inter-connecting disciplines where inter-communication is often poor or non-existent. If he can get even some biologists and mathematicians to talk intelligibly to each other, this will be a great step forward.
                                            J. A. NELDER (Wellesbourne)