# Abstract and Contribution to the Discussion

## Rethinking the Statistics-Probability Textbook in the Computer Era

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Traditional courses in statistical methods and probability modelling devote a large amount of time and effort to the derivation of explicit analytic results for typically highly simplified problems. Most students may develop some analytic skills, but this is often at the expense of the ability to model correctly and of the understanding required for a correct qualitative interpretation of both analytic and numerical results.

Statistical software packages available today allow for the instantaneous implementation of formal and numerical procedures typically far beyond those learned in the standard courses. Similarly, in courses on probability models, typical examples are structurally so simple that there is little challenge in numerical computation and subsequent interpretation of the results for the models studied.

We presented a few examples of problems we have successfully used in courses in these subject areas, to develop structural reasoning, algorithmic implementation and qualitative interpretation. Few, if any, current textbooks adequately stress these points and appropriate exercises are essentially non-existent. Our presentation was therefore also a plea and suggestions for a collective rethinking of textbook material appropriate to the era of the computer.

## Invited Discussion

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It was a pleasure to have a chance to study the three excellent papers "Statistics and the Computer" by Professor Råde, "Statistical Trends in Industry and in the Social Sector" by Professor Barnett, and "Statistical Directions in the 1990s" by Professor Gani, as well as Professor Neuts' Abstract. I would like to express my hearty thanks to Professor Gani for giving me this chance.

First, summaries of each paper and my instant comments are given. Then my point of view is explained, and some comments on the session as a whole are given.

*Lennart Råde:* Professor Råde discusses the relation between statistics and the computer. He says "The close relationship between statistics and computing implies that when one changes the other will also change". He then discusses the use of computers in teaching. He thinks that existing packages are useful in classrooms, but the tempo of their introduction is slow. The effect of an interactive computer environment, graphical methods, and symbolic calculation on statistics are also discussed. He concludes his paper by stating that the computer will be our daily working environment both in theoretical and practical work.

Some comments are, first, there is no doubt that the fitting of realistic models to a large amount of data has been made possible only by the recent development of computing technology. For example, the maximum likelihood method which used to be essentially a theoretical justification of some analytical estimators, became a practical method for parameter estimation with the powerful support provided by fast computers and numerical optimisation procedures.

I think that a good tool for research is a good tool for education, and vice versa.

*Vic Barnett:* The paper by Professor Barnett dwells on the relation between statistics and society. He says "We are getting closer to social acceptance of statistics" and points out that the proliferation is particularly rapid in the media, sociological and societal studies, government planning, and industry. In the last half of his paper, he gives interesting examples of statistical analysis from the fields of sport and recreation, social attitude and local government responsibilities, statistical process control and clinical trials.

He also gives thought to three approaches for providing the necessary statistical manpower.

Certainly, I feel that the relation between theory and application in statistics is different from that in the other sciences. This follows from the fact that statistics is the science of methodology. Professor Barnett's examples give vivid pictures of this aspect. His emphasis is placed on the cooperation between industry, or the social sector and statistics. From my point of view, we should pay more attention to cooperation between other branches of science such as, for example, astronomy and statistics.

*Joe Gani:* At first Professor Gani shows that in both statistics and probability theory, stochastic processes are gaining much attention. He then picks up robust estimation as a typical example of a recent development in statistics. To illustrate trends in probabilistic modelling, he presents a time series model and a random field model. He points out that these approaches are facilitated by the development of computing technology. The final section of his paper is devoted to forecasting. He thinks that computers, especially PCs, will be extensively used for the analysis of natural phenomena. Time series analysis and random field data analysis will be the important subjects in future.

He warns that a shortage of manpower in these fields is likely, if some precautions are not taken.

*My point of view:* The spectrum covered by the three authors is wide and excellently balanced. We get a birds'-eye view of the relation between statistics, the computer and society, and its future. However, it is possible to point out some missing issues.

*Problem-solving:* Typical steps in statistical problem-solving are as follows:

(i) *Model building:* Models are built to be used by people who are not statisticians.
(ii) *Model fitting:* Numerical model fitting technique is now established as a practical method. The analytical approach to model fitting is now playing a secondary role.
(iii) *Model evaluation/selection:* This is the most important step.
(iv) *Interpretation of the results:* To interpret results, graphical methods are indispensable. Computers are also useful in this aspect.

*Does a computer-for-statisticians exist?* Can we conceive of a specific architecture or hardware for statistical computing? If we can extract the essence of computer-intensive methods, we might be able to have our own made-to-order machines.

*Why not academic society?* Statistics can be useful in every corner of human activity. Science is one of the most important of our activities. It seems to me that more weight should be placed on the cooperation between statistics and other branches of science.

*Why not statistical testing?* Could the absence of reference to statistical testing be only a careless omission? Evaluation of the goodness of models fitted to a set of data is one important role of statistics. Though I myself prefer to use the information criterion approach to this problem, I cannot neglect the important role of statistical testing so far, and am interested in its future.

*Why not design of experiments?* Another area no one mentioned is the design of experiments. It should be an important area of interest. Without the design of experiments, we will remain somewhat passive elements in our society.

## References

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