Book Reviews

Mathematical methods of statistics. Harald Cramèr. Princeton, N. J.: Princeton Univ. Press, 1946. Pp. xvi + 575. (Illustrated.) $6.00.

The modern development of statistics has brought with it the use of mathematical techniques which have in the past been confined to the repertory of professional mathematicians. Unfortunately for nonmathematicians, the theory of probability, which is essential as a background to statistics, involves the use of advanced measure and integration theory, and the concomitant general apparatus of the theory of functions of real variables. Cramér's book is doubly welcome in that it contains both a remarkably complete treatment of the mathematical background to statistics and a treatment of statistical methodology itself, a combination not previously available.

The book is divided into three parts. The first part is devoted almost wholly to measure and integration. The second part gives the basic knowledge of probability required for statistics. The author's general point of view makes this part a study of random variables; games, permutations, combinations, etc., so dear to the hearts of probability textbook writers, are omitted, except as implicit in the binomial distribution. The development is carried through the central limit theorem (on the approximation to normality of the sum of a large number of independent random variables) and the law of large numbers. The problem of measure in infinitely many dimensions is avoided; probably for this reason the concept of convergence with probability 1 is omitted, and the function theoretic significance of the concept of convergence in probability (convergence in measure) is not explained. The third part of the book, comprising somewhat less than half, is devoted to statistical inference, subdivided into sampling distributions, tests of significance, and the theory of estimation. Periodogram analysis and the related theoretical problems of random processes are not treated because of lack of space.

The text presupposes a knowledge of calculus and familiarity with limiting processes. The writing, although almost always mathematically rigorous, does not sacrifice space to rigor. It is frankly a mathematics text, however, in spite of the numerous statistical examples, and as such is not for casual reading by outsiders. The full bibliography simplifies more extended study.

Both probability and statistics have been completely revolutionized in the 20th Century. The first has been put on a firm mathematical foundation, as rigorous as any other branch of analysis; the second, basing itself on probability, has been enabled to develop the delicate and elaborate techniques which give it its present importance. The author has succeeded admirably in his stated purpose of writing an exposition of the two fields, in their interrelations, from the modern point of view.

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Synthetic Penicillin

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References

1. The synthesis of *d*-penicillamine hydrochloride was first described by E. P. Abraham, E. Chain, W. Baker, J. W. Cornforth, R. H. Cornforth, and R. Robinson in a report dated 4 October 1943.

2. The synthesis of several compounds of this type was announced by the investigators of Merck and Company, Inc., in a report dated 31 January 1944; the details of the preparation of 2-benzyl-4-methoxymethylene-5(4)-oxazolone were described in a report dated 17 March 1944. The synthesis of 2-phenyl-4-ethoxymethylene-5(4)-oxazolone was described by J. P. Wilson, J. B. Jepson, G. M. Robinson, E. P. Abraham, W. Baker, E. Chain, and R. Robinson in a reported dated 14 March 1944.

3. Merck and Company, Inc., report dated 31 January 1944. In a report dated 29 February 1944 the details of the synthesis of a product possessing antibiotic activity (1 unit/mg.) were described by the Merck group. In this procedure *d*-penicillamine and 2-benzyl-4-methoxymethylene-5(4)-oxazolone were heated in pyridine at 75° for 1½ hours.

4. G. M. Robinson, E. P. Abraham, W. Baker, E. Chain, and R. Robinson, report dated 27 March 1944. In consequence of the appreciable time lag in the exchange of technical information in the international collaboration, the Merck report dated 31 January 1944 (*3*) arrived in England after the submission of the report by the Oxford group.

5. Merck and Company, Inc., report dated 30 September 1944.

6. Department of Biochemistry, Cornell University Medical College, report dated 1 March 1945.

7. Department of Biochemistry, Cornell University Medical College, report dated 1 November 1945.

8. E. P. Abraham, W. Baker, E. Chain, and R. Robinson, report dated 26 November 1945.

9. The Upjohn Company, report dated 30 November 1945.

10. L. C. Craig. *J. biol. Chem.*, 1944, **155**, 519; L. C. Craig, C. Golumbic, H. Mighton, and E. Titus. *J. biol. Chem.*, 1945, **161**, 321.

11. Department of Biochemistry, Cornell University Medical College, report dated 15 December 1945.

12. The use of triethylamine to prepare a crystalline salt of natural benzylpenicillin was first described by the investigators of the Heyden Chemical Corporation in a report dated 22 May 1944.

13. Some other 5(4)-oxazolones which have been reported to give activity in this reaction are: 2-phenyl-4-ethoxymethylene (J. P. Wilson, J. B. Jepson, G. M. Robinson, E. P. Abraham, W. Baker, E. Chain, and R. Robinson, 14 March 1944); 2-propyl-4-hydroxymethylene and 2-amyl-4-hydroxymethylene (J. Cornforth, R. H. Cornforth, E. P. Abraham, W. Baker, E. Chain, and R. Robinson, 1–2 May 1944); 2-*p*-nitrostyryl-4-ethoxymethylene and 2-*p*-nitrophenyl-4-hydroxymethylene (F. C. Copp, W. M. Duffin, S. Smith, and S. Wilkinson, 29 November 1944); 2-*p*-nitrobenzyl-4-ethoxymethylene and 2-methyl-4-ethoxymethylene (Department of Biochemistry, Cornell University Medical College, 2 July 1945); 2-*n*-amyl-4-methoxymethylene (Merck and Company, Inc., 31 August 1945); 2-β-phenylethyl-4-methoxymethylene, 2-phenyl-4-thiolmethylene, and 2-phenyl-4-N-acetylanilinomethylene (G. M. Robinson, E. P. Abraham, W. Baker, E. Chain, and R. Robinson, 26 November 1945); 2-phenyl-5-chloro-oxazole-4-aldehyde also gives rise to penicillin-like activity when condensed with *d*-penicillamine (L. J. Goldsworthy, R. Robinson, E. P. Abraham, W. Baker, and E. Chain, 26 November 1945).

14. Department of Biochemistry, Cornell University Medical College, reports dated 1 March and 1 December 1945; Merck and Company, Inc., report dated 28 September 1945.