we referred, we shall simply add that Vivanti did not follow Klein and Fricke in a slavish manner. On the contrary, the work before us gives a masterly independent presentation of some of the most fundamental parts of the theory of linear groups and their geometric interpretation. Many American readers will doubtless welcome this translation into a language with which they are more familiar than that with of the original work.

G. A. MILLER.

Wahrscheinlichkeitsrechnung. Von A. A. MARKOFF. Nach der zweiten Auflage des russischen Werkes übersetzt von H. LIEBMANN. Leipzig and Berlin, B. G. Teubner, 1912. viii+318 pp.

Le Calcul des Probabilités et ses Applications. Par E. CARVALLO. Paris, Gauthier-Villars, 1912. x+170 pp.

The Elements of Statistical Method. By WILFORD I. KING. New York, Macmillan, 1912. xvi+250 pp., price $1.50 net.

THE translation of Markoff's Wahrscheinlichkeitsrechnung will be a welcome companion to that of the same author's Differenzenrechnung. Its motive, as frankly stated in the preface, is to treat the theory simply as a deductive mathematical doctrine, aiming at precision in the analytic formulations, rigor in the proofs, and the determination of superior limits of error where approximate formulas are used. Axioms, definitions, and theorems are formulated explicitly as such, though not always with euclidean austerity of arrangement. The philosophy of the subject is disregarded, and the few special applications admitted receive a relative emphasis determined more by their availability as examples than by their intrinsic interest.

The first four chapters, half of the book, deal with discrete probabilities, elementary and cumulative, their representation by rational numbers, and the classical asymptotic expressions resulting from Stirling's formula. The examples here are entirely from games of chance. Especially noteworthy is the discussion of mathematical expectation.

The rest of the volume contains a short account of the occurrence of irrational numbers as limiting values, together with the notions of probability as applied to continuous sets, with a few of the standard geometric examples; a few pages

on testimony, mortality, and insurance, chiefly as commentary on Bayes' formula and hypothetical probabilities; and a fairly full treatment of the theoretical aspects of the method of least squares. The appendices contain reprints of three of the author's papers, and a compact six-place table of the probability integral.

To a reader whose interest in the subject concerns primarily some of the wide and constantly growing range of applications, the book may appear unnecessarily theoretical and so one-sided. But the choice of material is consistent with its avowed aim, achieved with distinct success, of giving a really logical treatment of the general discipline. It is to be highly commended for furnishing, in concise style and moderate compass, just the kind of treatment needed as antidote to the looseness of thought and expression all too common in statistical literature.

There is a short list of references at the end of each chapter.

Carvallo explains that his object was to provide, for readers of good general education but little technical mathematical training, a modernized and simplified substitute for the classic work of Cournot, which, though still a model of what is possible in the way of a semi-technical treatise, has proved to be not sufficiently accessible to them. The book is directed primarily toward meeting the needs of candidates for the French statistical service, but will hold the attention of any reader interested in the subject, by its vivacity of style, wealth of pungent comment, and the clearness of the verbal explanations which are often given in place of mathematical proofs.

The first chapter discusses the meaning of chance and its laws, the enumeration of elementary events, and the statistical distribution of deviations from a standard; leading to a descriptive treatment of the theorem of Bernoulli by means of numerical examples and the integral curve of error, which is used, no doubt wisely, instead of the more customary exponential frequency curve, its derivative. The second chapter, on statistical method, contains a few pages on mortality formulas and errors of measurement, but is occupied chiefly with a detailed study of the statistics of sex in offspring. The seemingly undue space devoted to this one topic may be explained by the fact of the author's relation to recent statistical inquiries under governmental auspices. This example

is worked through so as to illustrate the various features of the previous theory, as well as the many precautions necessary in sifting statistical data. To the reviewer it seems equally successful as an example of data too hopelessly tangled to leave a chance for faith in any conclusions derived. The third chapter, on the problem of adjustment, treats the method of least squares and the computation of differential corrections. The fourth and last is a collection of loosely related paragraphs on various topics.

The book is distinctly readable, even entertaining, and, in view of its announced purpose, perhaps as successful as could be hoped for. Its faults seem to be chiefly those of omission; for example, it seems to encourage the common but blinding error of supposing that the Bernoulli formula for the distribution of deviations is of universal application. To a reader of reasonable mathematical attainment it will seem like an appetizer rather than a normal meal.

Mr. King's book is intended primarily for students of the social sciences. In general make-up it may be characterized as a kind of condensed and simplified Bowley.

The first two parts, on the history, nature, and uses of statistics and the collection of material, need no comment here, being non-mathematical except for a few hints on arithmetic work. The third part, on the analysis of material, makes enough use of elementary mathematical concepts to be noticed briefly.

The three chapters on tables, diagrams, and graphs are satisfactory so far as they go, except for some peculiar remarks on the smoothing of curves. Of the remainder of the book, dealing with types and averages, dispersion, skewness, variation, and correlation, it may be said that it is no worse and no better than the usual standard of books of its class, and is to be criticized chiefly for certain objectionable features which are unfortunately rather common, and are especially misleading to students without experience in such work. The unfounded sweeping generalizations, the use of words in a technical way with no indication of their meaning, the show of mathematical precision in the treatment of concepts whose inherent vagueness makes it utterly fictitious, are strangely out of place in a book claiming to be a guide to scientific study.

A. C. LUNN.