$$\frac{x}{\log x - \frac{1}{2}} < \pi(x) < \frac{x}{\log x - \frac{3}{2}} \qquad (67 \leqq x),$$

$$n\,(\log n + \log\log n - \tfrac{3}{2}) < p_n < n\,(\log n + \log\log n - \tfrac{1}{2}) \qquad (20 \leqq x),$$

and

$$li(x) - li(\sqrt{x}) < \pi(x) < li(x) \qquad (11 \leqq x \leqq 10^8).$$

Table II is an excerpt from a table computed several years earlier by Rosser and R. J. Walker on an IBM 650. It lists the four functions, $\theta(x) = \sum_{p \leqq x} \log p$, $\sum_{p \leqq x} p^{-1}$, $\sum_{p \leqq x} p^{-1} \log p$, and $\prod_{p \leqq x} p/(p - 1)$ to 10D for $x = 500(500)16{,}000$. Here the sums and the product are taken over the primes not exceeding x. For larger values of x see [1].

Table III lists $\psi(n) - \theta(n)$ to 15D for each of the 84 values of n equal to a prime power, $p^a (a > 1)$, which is less than $50{,}653 = 37^3$. The function $\psi(x) - \theta(x)$ remains constant between such prime-powers, and at such numbers the function increases by a jump equal to $\log p$.

Table I (which, for convenience, we describe out of order) is concerned with bounds on $\psi(x)$. The table lists 120 pairs of numbers, ϵ and b, such that

$$(1 - \epsilon)x < \psi(x) < (1 + \epsilon)x \quad \text{for} \quad e^b < x.$$

For example, $\epsilon = 4.0977 \cdot 10^{-6}$ for $b = 4900$.

Finally, Table IV lists $-\zeta'(n)$, $-\zeta'(n)/\zeta(n)$, and $\sum_p p^{-n} \log p$ to 17D for $n = 2(1)29$. Here ζ is the Riemann zeta function. This table was computed with the Euler-Maclaurin formula on an electronic computer. The values obtained were checked by a different computation and agree with Walther's 7D table of $-\zeta'(n)/\zeta(n)$ [2], and Gauss's 10D value of $-\zeta'(2)$ [3]. The purpose in computing Table IV was to use it in evaluating the limit:

$$\sum_{p \leqq x} p^{-1} \log p - \log x \to -1.33258227573322087.$$

However, Table IV certainly has other uses; for example, the reviewer has recently used it in [4].

D. S.

1. KENNETH I. APPELAND J. BARKLEY ROSSER, *Table for Estimating Functions of Primes*, IDA-CRD Technical Report Number 4, 1961; reviewed in RMT **55**, *Math. Comp.* v. 16, 1962, p. 500–501.
2. A. WALTHER, "Anschauliches zur Riemannschen Zetafunktion," *Acta. Math.*, v. 48, 1926, p. 393–400.
3. C. F. GAUSS, *Recherches Arithmétiques*, Blanchard, Paris, 1953, p. 370.
4. DANIEL SHANKS, "The second-order term in the asymptotic expansion of $B(x)$," *Notices*, Amer. Math. Soc., v. 10, 1963, p. 261, Abstract 599–46. For errata see *ibid.*, p. 377.

41[F, G, X].—GABOR SZEGÖ ET AL, Editors, *Studies in Mathematical Analysis and Related Topics—Essays in Honor of George Pólya*, Stanford University Press, Stanford, 1962, xxi + 447 p., 25 cm. Price $10.00.

This substantial volume, consisting primarily of sixty new research papers by leading mathematicians, was published on December 13, 1962, Professor Pólya's seventy-fifth birthday. The topics are of a great variety and include analysis, topology, algebra, number theory, and applied mathematics. While many of the papers begin with an opening paragraph that mentions some related work of Pólya, they have no other common theme.

There is included a list of Pólya's 217 papers (up to 1961) and his six books. We learn that *How To Solve It* has been translated into Arabic, Croatian, French, German, Hebrew, Hungarian, Japanese, and Russian (so far).

Even the table of contents is too long to reproduce here, and we merely list the many authors. They form, to misuse a definition of Alexander Weinstein, a *distinguished sequence*: L. V. Ahlfors, N. C. Ankeny, H. Behnke, S. Bergman, A. S. Besicovitch, R. P. Boas, Jr., A. Brauer, R. Brauer, H. S. M. Coxeter, H. Cramér, H. Davenport, B. Eckmann, A. Edrei, A. Erdélyi, P. Erdös, W. H. J. Fuchs, T. Ganea, P. R. Garabedian, H. Hadwiger, W. K. Hayman, J. Hersch, E. Hille, P. J. Hilton, J. L. Hodges, Jr., A. Huber, A. E. Ingham, M. Kac, J. Karamata, S. Karlin, J. Korevaar, C. Lanczos, P. D. Lax, E. L. Lehmann, D. H. Lehmer, E. Lehmer, P. Lévy, J. E. Littlewood, C. Loewner, E. Makai, S. Mandelbrojt, N. Minorsky, Z. Nehari, J. Neyman, L. E. Payne, M. Plancherel, J. Popken, H. Rademacher, A. Rényi, J. Robinson, R. M. Robinson, W. W. Rogosinski, P. C. Rosenbloom, H. L. Royden, G. Scheja, M. Schiffer, I. J. Schoenberg, L. Schwartz, E. L. Scott, J. Siciak, D. C. Spencer, J. J. Stoker, J. Surányi, G. Szegö, E. C. Titchmarsh, P. Turán, J. G. Van der Corput, J. L. Walsh, H. F. Weinberger, A. Weinstein, and A. Zygmund.

D. S.

42[G].—L. E. Fuller, *Basic Matrix Theory*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1962, ix + 245 p., 23 cm. Price $9.45.

The preface addresses this book to the "person who needs to use matrices as a tool." The writing style is conversational but careful. Illustrative examples are given in unusual detail. Procedures are outlined in stepwise fashion, and potential pitfalls in the application of an algorithm are red-flagged.

The attitude toward rigor is suggested by the following: many definitions are stated formally; several properties are enunciated; but nowhere are there any so-called theorems. Nevertheless, in the casual style, much worthwhile information appears, information which other authors might label as theorems. Many of these propositions are proved or made convincingly plausible. Other results whose proof would be long and/or deep are simply asserted.

Considerable attention is paid to canonical forms. The algorithms for finding these are elaborately discussed. Deeper questions concerning whether the claimed canonical forms are really entitled to be accorded such a title are quietly suppressed —an action carefully designed to keep the mathematics at "as simple a level as possible."

The first four chapters develop basic notions about matrices, vectors, and determinants; elementary row or column transformations are emphasized. The next three chapters stress computational methods; techniques for finding characteristic roots and characteristic vectors are presented; methods discussed for matrix inversion or for solution of a system of equations include those of Crout, Doolittle and Gauss-Seidel, as well as partitioning, iteration, and relaxation. The final chapter is devoted to bilinear, quadratic, and Hermitian forms. Each chapter has exercises, mostly of a practice nature.

R. A. Good

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