runs to two pages; there exist, of course, much brisker ad hoc demonstrations. Yet, in the main, the authors' strategy is very successful in relation to the material considered so far. Two chapters seem, however, to stand largely outdside the scheme. Chapter 8 is primarily concerned with the finite form of Ramsey's theorem. The consequences for graph theory of this outstanding result are touched on, but the discussion is not carried very far. In Chapter 11, questions of enumerative combinatorial analysis are treated, with the emphasis on two topics: the classical method of generating functions (which goes back to Euler), and Pólya's celebrated enumeration theorem (1937). It is not easy to see how the enumerative theory could comfortably fit into the framework chosen by the authors. The chapter, and the book, conclude with a very brief introduction to the Möbius function associated with partially ordered sets, a topic that seems to me to merit more extensive treatment.

Coding theory is conspicuously absent from the discussion, although (since it is closely allied to the theory of designs), it could conceivably be accommodated within the existing scheme. I am much less certain about extremal problems of graph theory and of finite set theory (nor are these problems discussed here at all). A feature of the text that caused me regret is the comparative isolation of Ramsey's theorem. No echo of the clamorous advance in Ramsey theory is heard in the book.

Yet, when the worst I can think of has been said, there remains the firm conviction that any shortcomings of the work of Graver and Watkins are trifling by comparison with its merits, its innovative character, and the writers' unflinching determination to meet head-on the principal difficulties of modern combinatorial mathematics. Although not every problem discussed by them forms an integral part of their grand design and although some fascinating topics are ignored or are only accorded a grudging welcome, nevertheless the book represents an achievement which I salute with stunned admiration. Graver and Watkins have deserved well of their fellow-combinatorialists and I judge that, all in all, while they have not produced a definitive treatise on combinatorics, they have assuredly brought nearer the day when such a treatise might be written.

L. MIRSKY

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A history of numerical analysis from the 16*th through the* 19*th century*, by Herman H. Goldstine, Studies in the History of Mathematics and Physical Sciences 2, Springer-Verlag, New York, Heidelberg, Berlin, 1977, xiv + 348 pp., $24.80.

"Let us now praise famous men and our fathers who begat us"

Ecclesiasticus XLIV

It has been said that numerical analysis is the last refuge of classical analysis in modern universities. Be that as it may the impressive volume under review will give the reader many a fresh insight into venerable parts of today's undergraduate curriculum in analysis. I was touched to learn, for example, that throughout his life one of the world's greatest thinkers kept trying to find a formula for $\Sigma(1/k)$ to n terms but the solution never came within his grasp (p. 118). I did not realize what a key problem that was, nor had I given thought to how the redoubtable Baron of Merchiston would actually go about computing his table of logarithmss although the task was made easier by his handy invention of the decimal point. Those long Scottish winters will drive men to the strangest pursuits.

Seriously, though, even a short excursion into this book fills one with admiration for the pioneers whose efforts Goldstine recreates in such salutary detail. It is not just the slow struggle to find the right concepts (we have all been told about that) but the awful notation with which they had to work–certainly until well into the 18th century. Goldstine presents a good number of original excerpts and explains the methods using both the original and modern terminology so that the reader can the more nearly share the thoughts of the inventor. This is a valuable contribution, giving the book real muscle, but taking it firmly out of the category of light reading.

The themes which run through the book will not come as surprises but a brief sketch of them will indicate its scope. Logarithms are the starting point and the need to find short cuts in making tables gradually led to the binomial theorem, series, and, of course, finite differences. The logarithm function and the connection with the area under $y = 1/x$ came later. The expansion of $\ln(1 + x)$ is apparently attributed to Mercator but seemed to occur to several people at about the same year (1668). During the time of Newton there was steady progress with summing series, finding interpolation formulas, and evaluating integrals. A highlight in this period is the Euler-Maclaurin formula which gives the remarkable expression for the error term in the trapezoidal rule. Its independent discovery by both authors is covered with great care. The virtuosity of Euler comes through loud and clear; e, trigonometric functions, Bernoulli polynomials, gamma functions, series of all sorts. Celestial mechanics continues to be a driving force in the development of mathematical tools to aid the increasingly complicated computing tasks set before mathematicians. We can follow Lagrange as he seeks hidden periodicities in Mayer's table of the so-called "Equation of time" as he develops continued fraction expansions of various functions.

Naturally there is considerable space devoted to Gauss. I shall mention only one remarkable item–Goldstine's discovery that Gauss clearly used the idea of the Fast Fourier Transform (on 12 points) in 1805 to find the equation of center for the asteroid Juno. This idea was rediscovered by Cooley and Tukey in 1965 and used recursively by them to revolutionize the use of finite Fourier Series.

The last chapter dwells mainly on the work of Jacobi and Cauchy, but does mention the remarkable astronomer/calculator Adams who approximated Euler's constant to 515 decimal places to balance his more celebrated development of multistep methods for solving ordinary differential equations.

This brief and inadequate outline is meant to stop mathematicians from instantly classifying this book as merely of interest to numerical analysts. It should be of value to anyone interested in the development of analysis. I was taught that mathematics was the art of avoiding computation but that adage would have seemed strange to any of the mathematicians mentioned above. Indeed the advent of the electronic digital computer has wrought such a profound change in numerical methods that today's numerical analysis does not seem to owe much to yesterday's efforts. The problems are different, the tools are different, and so are the goals (tables are out, pictures are in).

In any case the character of modern numerical analysis is irrelevant to the value of this book. We should all be grateful to Goldstine (and to IBM) for giving us the opportunity of seeing some great mathematicians at work.

B. N. PARLETT

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The economics of space and time, by Arnold M. Faden, The Iowa State University Press, Ames, Iowa, 1977, xiii + 703 pp., $39.95.

The major vehicle for scholarly activity these days seems to be the journal article. At least, this holds true for scientific work at major American universities. Most scientific books are concerned with surveying, expounding or systematizing work that has had its origin in journal articles.

This is probably an appropriate state of affairs. The fact that most journal articles are more or less carefully refereed helps to screen out uninteresting or erroneous contributions to scientific knowledge. Publication rights are generally guarded with some care by a jury of one's peers.

The publication of Faden's *The economics of space and time* is a distinct departure from the journal article paradigm in at least two respects. First, it is a massive volume (703 pages) of original research, the bulk of which is appearing in print for the first time. Second, this research was undertaken in "splendid isolation"–to use the author's own words–over a period of more than a decade.

This isolation was no doubt due to a large extent to the subject matter of the book: it attempts to apply the mathematics of measure theory to the economics of spatial location. Measure theorists are a subset of mathematicians, and location theorists are a (rather small) subset of economists. The intersection of these two sets is, if not a set of measure zero, at least as close as one can come for all practical purposes.

Despite the difficulties of working in such isolation, I would say that Faden has produced an interesting and readable book. Measure theorists can profitably examine the book for the novel applications of measure theory to economic problems, and spatial economists can examine the book for generalizations and extensions of classical results, as well as some interesting suggestions of new techniques for research in this area.

Faden states at the outset that "... the thesis of this book is that measure theory is the natural language of spatial economics and, indeed, for all social science." The last phrase should perhaps be excused as parental exaggeration,