the missing data paradigm, and the EM algorithm.

The book is well organized; the flow of topics follows a logical development. The writing is generally clear, although the author has an annoying habit of omitting articles.

The level of the book is that of advanced undergraduate courses in probability and in mathematical statistics. According to the preface, the author sees three types of audience for the book: researchers studying Monte Carlo methods, scientists using Monte Carlo, and graduate students in statistics and some other areas. The book would be very useful for people in any of these groups, especially the first two. The coverage is up-to-date and comprehensive, and so the book is a good resource for people conducting research on Monte Carlo methods. Although there is no focus on any specific application area, the book should be accessible to a scientist using Monte Carlo in any area, and the wealth of examples would help to guide the application of the methods to the problem being studied. As a textbook, however, the book may be somewhat terse, and the exercises, which are included with only eight of the thirteen chapters, would need to be supplemented. The exercises tend to be rather straightforward. The book would be an excellent supplementary text for a course in scientific computing, after the basic numerical methods have been covered.

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Introduction to Numerical Analysis. *By Arnold Neumaier.* Cambridge University Press, Cambridge, UK, 2001. $34.95. viii+356 pp., hardcover. ISBN 0-521-33610-4.

The appearance of a new textbook for a first course on numerical analysis is a regular event and not usually the cause of much excitement among those who lecture in the subject. Among the very many existing texts are some outstanding examples, including classics that have existed for 20 or 30 years, and it is becoming increasingly hard for an author to produce something original in this field. Neumaier's new text is notable because it is refreshing in its choice and treatment of topics, it integrates a substantial amount of material on interval analysis, and it bucks the trend to aim for a lower level of understanding of the subject.

The book begins with a chapter on errors. This air of conventionality disappears almost immediately with a 5-page treatment of automatic differentiation starting on page 3. After some more standard material on floating point arithmetic, numerical stability, and condition, the chapter ends with a 16-page section on interval arithmetic. While not bedtime reading for the average undergraduate, with sups and infs, mids (midpoints) and rads (radiuses) appearing straight away, this is perhaps the best textbook introduction to interval arithmetic you will find. Having been introduced, interval analysis is picked up later in the book in the context of linear systems (the interval Krawczyk method) and nonlinear systems (the interval Newton method). Due reference is also made to Rump's INTLAB toolbox, which makes interval arithmetic available in MATLAB.

This book is probably worth having for the exercises alone. A novel exercise on the focusing of a camera lens brings in interval analysis to estimate the zone of sharp focus. Another on finding the bucket with the greatest volume for a given surface area leads to a pair of nonlinear equations and gives the opportunity to use Newton's method to solve a "practical" problem. The excellent index makes it easy to locate material within the book.

Other things that caught my attention were

- a graphical explanation, with shaded boxes representing numbers, of why iterative refinement works for linear systems,
- an insightful explanation of forward and reverse automatic differentiation in terms of lower and upper triangular systems,
- an original and elegant treatment of the divided difference form of the interpolating polynomial, and
- a thorough treatment of nonlinear systems via fixed point theorems and Newton's method.

Other topics covered are spline interpolation, numerical differentiation, Gaussian elimination, scalar nonlinear equations, quadrature, and initial value problems for ordinary differential equations.

I do have some criticisms. The exercises are not rated for difficulty, yet the level varies greatly, with some being very challenging. I found several places where explanations were unclear and a minor rewrite is needed. For example, on page 94, with no prior mention of "ε": "In a finite dimensional vector space, all norms are equivalent, in the sense that any ε-neighborhood contains a suitable ε'-neighborhood and is contained in a suitable ε''-neighborhood." On page 20 the convention is introduced that $x^2/2y$ means $x^2/(2y)$, which strikes me as an unnecessary possible source of confusion (it is not clear whether the convention applies only to this section, but I did not see it in use elsewhere). In a number of sections I felt that the material could benefit from some reordering, such as in the treatment of polynomial interpolation, where the recurrence for divided differences first appears five pages after the introduction of divided differences. The definition of approximation order of a quadrature rule does not ask for the maximal order, and so Simpson's rule, for example, is of order 0, 1, 2, and 3 according to the definition.

In 356 pages Neumaier covers the material briskly and at a relatively high degree of sophistication. This is not a book I could use as a main text for an introductory undergraduate course on numerical analysis, but I do see it being useful for advanced undergraduate and graduate level courses and I will certainly use it for reference. It would also be an excellent guide for a student doing a project on interval arithmetic.

In summary, this book contains enough original material and ideas to pique the interest of anyone involved in numerical analysis. While its sophisticated approach will not suit all courses, it is a very welcome and distinctive addition to the crowded market of numerical analysis textbooks.

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Path Integrals in Physics, Volume I: Stochastic Processes and Qauntum Mechanics. *By M. Chaichian and A. Demichev.* Institute of Physics Publishing, Bristol, UK, 2001. $82.50. x+336 pp., hardcover. ISBN 0-7503-0801-X.

Path Integrals in Physics, Volume II: Quantum Field Theory, Statistical Physics and other Modern Applications. *By M. Chaichian and A. Demichev.* Institute of Physics Publishing, Bristol, UK, 2001. $82.50. x+345 pp., hardcover. ISBN 0-7503-0802-8.

Path integrals, as the name is intended to imply, are integrals whose elements are paths, namely, functions, rather than points in a finite-dimensional space, as is the subject of elementary calculus. Needless to say, while some of the ideas of elementary integration carry over to path integrals, there is far more to the subject than can be seen at first glance.

The work under review consists of two volumes: the first devoted to finitely many degrees of freedom and the second devoted to infinitely many degrees of freedom or, stated otherwise, in the latter case, to fields. It is true that the known mathematical facts in the case of finitely many degrees of freedom are rather vast, while in the case of infinitely many degrees of freedom the known mathematical facts are comparatively few. Nevertheless, the importance of functional integrals dealing with any number of variables is so basic that many workers, especially physicists, are often willing to forego a variety of mathematical niceties in the interest of securing an answer to some problem, however formal or ill defined that answer may be. Such arguments have their place in the scheme of things, and in the absence of proper mathematical arguments that lead to the same conclusion, these arguments ought to be taken as reasonably well-motivated conjectures.

The scope of the two volumes is remarkably broad and a surprising number of topics are considered. However, whenever this is the case it is almost inevitable that some topics receive a better treatment than other topics.

Volume 1 contains just two long chapters. Broadly speaking, the first chapter is