Book Reviews

Gary A. Sod: *Numerical Methods in Fluid Dynamics, Initial and Initial Boundary-Value Problems*, Cambridge University Press, 1986, 446 pp., $44.50.

Text-books in the field of computational fluid dynamics (CFD) are white crows. This despite of the fact that CFD has received very broad and deep interest from researchers since the fifties. The large publishing gap between CFD papers and books is possibly due to the very rapid pace at which CFD has developed and still develops. What's good today might be obsolete next year. Writing a textbook on CFD is certainly not an easy task. Yet, sometimes there are attempts to write down some (possibly) classical learnings from CFD research. Sod's book is such an attempt.

Sod's book is the 'first book of a two-volume series on numerical fluid dynamics', it is 'concerned with finite difference methods for initial boundary-value problems', and it is 'intended to be a text directed at first-year graduate students in engineering and the physical sciences and as a reference to practitioners in the field'. In my opinion, the first group mentioned can really benefit from this book, the second group not so much.

Sod lays emphasis on classical techniques for analyzing finite difference methods for parabolic and hyperbolic problems. The presentation of these techniques is very clear; large steps are avoided almost everywhere. The finite difference methods considered are classical, but few. Though a real asset of Sod's book is that it clearly shows the 'how' of numerical analysis applied on finite difference methods, it does not tell much about the 'what for'. In my opinion, the book would have been even more clear, and particularly more lively, if the author had given a background for the numerical analysis techniques, i.e., at first a formulation of fluid dynamics problems, and next a formulation of numerical methods. (In its introduction, if you please, Sod's book teaches you the Lax equivalence theorem.) Perhaps the second volume ('which deals exclusively with the equations of fluid motion') will teach us more.

After the introduction, Sod presents a chapter for parabolic equations (Chapter 2), followed by a chapter for hyperbolic equations (Chapter 3). (A permutation of both chapters seems more natural to me.) In both chapters, Sod clearly describes classical techniques for analyzing finite difference methods. However, as finite difference methods for parabolic equations, he only considers fractional step and ADI methods. He mentions drawbacks of both methods, but simply closes the chapter without giving a survey of more and better finite difference methods already available. Approximate factorization, for instance, (which can be made unconditionally stable, which is second-order accurate in both 2D and 3D for problems without cross-derivatives, and which has found practical use in the famous Beam–Warming technique) is not even mentioned. A survey of other, more up-to-date finite difference methods might have taken only a few pages, but would have enriched this chapter a great deal. Other reasons for considering this chapter to be a little bit old-fashioned are, for instance, the use of Gauss elimination (p. 28) for the solution of diagonally dominant tridiagonal systems instead of the use of the Thomas algorithm, and particularly its list of mainly old references. The chapter about hyperbolic equations is more up-to-date, though still insufficient. Concerning the explicit finite-difference methods, for instance, only the Lax–Wendroff one- and two-step schemes are considered. Also here, a short survey could have been given of more up-to-date methods (two-step Richtmeyer, Burstein, MacCormack).

Chapter 4 ('Hyperbolic Conservation Laws') is in my opinion the best chapter of the book. It treats in a clear way the rather difficult topic of nonlinear convection problems. Given the state-of-the-art at the publishing date of the book, this chapter is practically up-to-date. (I only missed a discussion of nonlinear flux limiters for high-resolution schemes.)

The next chapter (Chapter 5: 'Stability in the Presence of Boundaries') forms a very interesting closure of the book. This chapter might probably be of real interest for those who are already 'practitioners in the field'.

Summarizing, the overall impression of the book is that it gives a clear description of classical techniques for analyzing finite difference methods. Therefore, it is well-suited for students. A drawback is the old-fashioned treatment of the parabolic and hyperbolic equations in Chapters 2 and 3. This drawback completely vanishes in the chapter dealing with hyperbolic conservation laws. The overall style of writing is clear but not very lively. The attraction of the book might have been enlarged by using numerical examples throughout the chapters (instead of only at the ends). Further, more and better figures should have been used. (Table 2.3 on p. 138 should have been a figure, and figure 1.3b on p. 3 should have been a real figure.) Last but not least, a better typographical form should have been used (text-processing, using several types of text-elements). Maybe the second volume will be more attractive.

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