Saying that a delta function is "supposed to be ∞ at 0" is mathematical nonsense. A suitable defining feature is that the δ returns 1 when integrated over any open interval containing 0. To not mark this unit integral as the height of the delta function is a substantial disservice to readers. For example, on page 373 the Fourier transform of $\cos(9\pi t/2)$ is shown as two spikes with unmarked heights. I don't know how one is supposed to differentiate this diagram from the transforms of $2\cos(9\pi t/2)$ or $20\cos(9\pi t/2)$.

Many fabulous texts, and courses, derive formulas for the DFT, FFT, and Nyquist's sampling theorem, as well as the implications of finite-time measurement, exactly, succinctly, and intuitively by using accurately scaled and annotated graphical methods. This text does not support any of these desirable methods or teaching outcomes.

In Summary. After reading this book I have learned that the author worked in the dean's office, he plays the trombone, his friend Randy plays the trumpet, the author does not know why orchestras tune to an oboe playing an A, and many more anecdotes. Honestly, I don't want to know any of these things.

There is solid and well-written material in this text that can also be found in other texts. However, this text mixes that material in equal measure with material that you would need to avoid or correct.

A colleague from Stanford confirmed that EE261 is a graduate-level course. I cannot imagine that this text (and course) is intended for graduate students in EE who might progress; at least, it would be a great disservice to impose this text on such students.

I recommend that you look elsewhere for a text on Fourier transforms.

REFERENCES

[1] R. Sottek, *Modelle zur Signalverarbeitung im menschlichen Gehör*, Dissertation, RWTH Aachen, Germany, 1993.

[2] L. Schwartz, *Théorie des distributions*, Hermann, Paris, 1966 (reprinted 1978).

[3] G. R. Grimmett and D. Stirzaker, *Probability and Random Processes*, Oxford University Press, 2001.

Colin Fox
University of Otago

Numerical Methods for Conservation Laws: From Analysis to Algorithms. *By Jan Hesthaven.* SIAM, Philadelphia, 2018. $89.00. xvi+555 pp., softcover. ISBN 978-1-611975-09-3. https://doi.org/10.1137/1.9781611975109.

The book *Numerical Methods for Conservation Laws* by Jan Hesthaven deals with hyperbolic conservation laws,

$$U_t + \nabla \cdot F(U) = G(U),$$

where F and G are given functions of the unknown function $U = U(t, x)$ with $t \in R^+$ and $x \in R^d$, where $d = 1, 2$, or 3.

Classical examples of these equations are

- the Euler equations of compressible, inviscid gas dynamics (possibly with a gravitational source term G);
- the equations of ideal magnetohydrodynamics.

The subject of numerical methods for these partial differential equations was propelled into life by von Neumann's endeavor during the Manhattan project in the early 1940s, and ten years later later by Godunov, when he wanted to compute the flow around a reentry space vehicle in order to transport humans into space and back.

In contrast to computing elliptic partial differential equations, where numerics (finite elements) could mimic the theoretical development (Hilbert spaces) that came before, the same was not possible for hyperbolic conservation laws. Glimm (in 1965) had been able to prove convergence of a variant of Godunov's numerical method, providing a proof of existence in one space dimension, but nothing of that sort has yet been possible in two or three space dimensions. A multidimensional existence theory even for the compressible Euler equations still eludes us today. This means that the subject of the numerics of conservation laws had to take off on its own, and it did so from the late 1970s onward.

Thus, it makes sense that in those heady times after 1980, when new numerical methods for conservation laws were being developed, textbooks on the subject of numerics were published. In the 1990s there were books by Godlewski and Raviart [3], [4], Randy LeVeque [7], [8], and Dietmar Kröner [6] on finite volume methods, and in the first decade of the 21st century there came a book by Hesthaven and Warburton [5] on discontinuous Galerkin methods.

It should be noted that numerical methods of conservation laws were and still are quite sought after by practitioners, who are constantly on the prowl for ever better methods for their particular applications. Some of their legacy codes are based on the philosophy of these books, and Randy LeVeque's two books in particular have been quite influential. If they wanted something more recent than the publication of these textbooks, they had to contend with review articles (like [9]) or simply read the newest developments in original articles.

Thus, it is high time for a new book. The book at hand by Jan Hesthaven is highly welcome, especially since it attempts to give a comprehensive overview of the subject up to the present day and thus fills a gap. It differs from previous textbooks on numerical conservation laws in covering a broader range of numerical methods. In particular, it discusses

- finite difference methods,
- finite volume methods,
- high order finite volume methods,
- discontinuous Galerkin methods,
- spectral methods.

Possibly the author had the excellent treatises of LeVeque in mind, because there is emphasis in Hesthaven's book on aspects that are not covered in LeVeque's books. An example is the thorough treatment given to higher order methods, an area that has been developed extensively in the 21st century, and thus was not so well developed at the time Randy LeVeque wrote his books. Hesthaven's book spends one third of its almost 600 pages on a thorough treatment of high order finite volume methods.

The emphasis of this book is on numerical methods rather than numerical analysis, so should be quite useful for practitioners. The book also has classroom use in mind, albeit at an advanced graduate level. The many MATLAB routines it contains will come in quite handy there.

That this text is deeply rooted in the achievements of the past literature can be gauged from its emphasis on problems in one space dimension. The extension to two or three dimensions can in some cases be achieved in a straightforward way, however, there are also new things yet to be discovered in computing multidimensional compressible flow. Notions like vorticity do not exist in one space dimension, and thus warrant multidimensional schemes. Examples of multidimensional schemes are Phil Roe's active flux scheme [2] or residual distribution schemes [1], but these are outside the scope of this book.

In summary, this book is a welcome addition to the literature, providing a comprehensive and up-to-date view of the subject of numerics for conservation laws.

REFERENCES

[1] R. Abgrall, *The notion of conservation for residual distribution schemes (or fluctuation splitting schemes), with some applications*, Commun. Appl. Math. Comput. (2019), https://doi.org/10.1007/s42967-019-00029-6.

[2] W. Barsukow, J. Hohm, C. Klingenberg, and P. L. Roe, *The active flux scheme on Cartesian grids and its low Mach number limit*, J. Sci. Comput., 81 (2019), pp. 594–622.

[3] E. Godlewski and P.-A. Raviart, *Hyperbolic Systems of Conservation Laws*, Math. Appl. (Paris) 3/4, Ellipses, Paris, 1991.

[4] E. Godlewski and P.-A. Raviart, *Numerical Approximation of Hyperbolic Systems of Conservation Laws*, Appl. Math. Sci. 118, Springer, 1996.

[5] J. S. Hesthaven and T. Warburton, *Nodal Discontinuous Galerkin Methods: Algorithms, Analysis, and Applications*, Texts Appl. Math. 54, Springer, 2008.

[6] D. Kröner, *Numerical Schemes for Conservation Laws*, Wiley, 1997.

[7] R. J. LeVeque, *Numerical Methods for Conservation Laws*, Birkhäuser-Verlag, 1992.

[8] R. J. LeVeque, *Finite Volume Methods for Hyperbolic Problems*, Cambridge Texts Appl. Math. 31, Cambridge University Press, 2002.

[9] C.-W. Shu, *Discontinuous Galerkin methods: General approach and stability*, in Numerical Solutions of Partial Differential Equations, S. Bertoluzza, S. Falletta, G. Russo, and C.-W. Shu, eds., Advanced Courses in Mathematics–CRM Barcelona, Birkhäuser, Basel, 2009, pp.149–201.

Christian Klingenberg
Würzburg University

Applications of the Topological Derivative Method. *By Antonio André Novotny, Jan Sokolowski, and Antoni Zochowski.* Springer, Cham, 2019. $159.99. xiv+212 pp., hardcover. ISBN 978-3-030-05431-1.

The book combines a theoretical overview of topology optimization with solution procedures for a variety of applications. The theoretical part focuses on singularly perturbed domains and introduces asymptotic expansion and the Steklov–Poincaré operator as important tools. It is worth mentioning that, although the adjoint approach is described as beneficial to topology optimization several times with more convenient expressions arising, the main goal of the book seems to be the derivation of a closed form expression for the topological derivative via asymptotic analysis, in particular, of the governing PDE.

To this end, the first half of the book develops the foundations for topology optimization based on asymptotic expansion and singularly perturbed domains. The second half, beginning with Chapter 6, is based around several different application problems and their respective topological derivatives. A welcome exception is the Navier–Stokes problem discussed in section 6.3.2 and the accompanying paper [1], where the Lebesgue differentiation theorem coupled to a Darcy permeability law gives rise to a topological asymptotic expansion without the usual asymptotic analysis of the PDE solution, while still being based on singularly perturbed domains and not a material density approach. Thus, problems with gray scale densities are prevented. The book concludes with Newton-type methods for topology optimization.

To make the most out of the book, I would recommend previous experience with asymptotic analysis. Indeed, the character of the book is closer to a presentation of cutting edge research and each chapter is more like a research paper with less textbook character, giving each chapter a high degree of independence. Indeed, to utilize each chapter to the fullest, I can only recommend also following the respective accompanying papers. By doing so, the book will provide a well-rounded impression of the current state of the art of topology optimization for a variety of applications.

REFERENCE

[1] L. F. N. Sá, R. C. R. Amigo, A. A. Novotny, and E. C. N. Silva, *Topological derivatives applied to fluid flow channel design optimization problems*, Struct. Multidisc. Optim., 54 (2016), pp. 249–264.

Stephan Schmidt
Paderborn University

500 Examples and Problems of Applied Differential Equations. *By Ravi O. Agarwal, Simon Hodis, and Donald O'Regan.* Springer, Cham, 2019. $51.99. xiv+432 pp., hardcover. ISBN 978-3-030-26383-6.

As a mathematician active in the vast field of differential equations, one always strives to enrich one's lectures with practical examples to keep students engaged. Of course, these examples should illustrate certain effects discussed in the lecture to increase motivation. Whether or not the book under consideration here actually proves to enrich the teaching depends strongly on the direct style of the lecture: analytic, numerical, with modeling emphasis, etc.

Ideally this book should complement lectures on the theory and analytical solution of ordinary and partial differential equations. According to the preface it is also intended as a "supplement to some of" the authors' "previous books published