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Book Reviews

Edited by Robert E. O'Malley, Jr.

Featured Review: The Emergence of Numerical Weather Prediction: Richardson's Dream. *By Peter Lynch.* Cambridge University Press, Cambridge, UK, 2006. $75.00. xii+279 pp., hardcover. ISBN 978-0-521-85729-1.

Lewis Fry Richardson, FRS (1881–1953) may now be best remembered in connection with Richardson extrapolation (or deferred approach to the limit (1927)) rather than his 1922 book, *Weather Prediction by Numerical Process* (WPNP) [6]. The Richardson number he defined in 1920, related to the onset of turbulence, is still often used, though it's less compelling than his rhyme (from WPNP): "Big whirls have little whirls that feed on their velocity, and little whirls have lesser whirls and so on to viscosity." Richardson's dream, "to advance the computations faster than the weather advances," provides the good excuse for this fascinating history of numerical weather prediction. It's not a traditional personal biography, like Ashford [1]. Instead, it provides a reconstruction of Richardson's catastropic three-hour European forecast for May 20, 1910, with a critical reanalysis of the data that establishes WPNP as a nearly up-to-date forerunner of current practice!

Peter Lynch is a professor in the School of Mathematical Sciences and the director of the Meteorology and Climate Center at University College Dublin. Previously, he worked for Met Eirann, the Irish Meteorological Service, in many scientific and administrative capacities. He's an expert on initialization and has repeated and extended Richardson's original computations, including his barotropic forecast, and those done by von Neumann and Charney on the ENIAC at Aberdeen, Maryland, in 1950. Besides Richardson, the book's heroes naturally include Bjerknes, Dines, von Neumann, Charney, and Lorenz.

Richardson began working on weather forecasting in 1911, and was employed by the British Met Office just before and after the First World War. He served as a driver in the Friends' Ambulance Unit during the war, carrying out much of his extensive computations in the field. The working copy of his manuscipt was actually lost in the battle of Champagne and was luckily rediscovered under a heap of coal. The 1922 book appeared, after subsidy, with a 750-copy print run. It was reprinted by Dover in 1965, and a second edition, with an introduction by Lynch, recently appeared in 2007. Richardson, as a pacifist, felt compelled to resign in 1920 when the Met Office was placed under the Air Ministry, and he spent most of his later career teaching and working on peace studies (cf. Korner [2]).

Most would expect that Richardson's (precomputer) problems in finite differencing would have come from violating the Courant–Friedrichs–Levy stability condition (from 1928), but Lynch shows that the culprit is spurious noise. Lynch explains the underlying slow manifold concept of Leith [3], resulting from filtering fast variables and using only the the balanced fast part that is reexpressed as a function of the slow

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variables. Richardson, himself, had known that his data needed some sort of initialization, blaming errors on initial winds and discussing this critical issue in WPNP and its revision file that he maintained until 1951.

Lynch carefully describes the basic equations required. He's more willing to approximate than Richardson. Moreover, he converts Richardson's quite idiosyncratic descriptions into computational algorithms, supplanting the computing forms that supplemented WPNP. Indeed, he also describes Richardson's concept of a forecast factory, which might employ thousands of cleverly organized human computers. If the atmosphere is indeed chaotic, like the Lorenz attractor of 1963 [4], we have to anticipate ongoing challenges due to the limits to predictability.

This well-written history clearly displays the success and practical importance of applied mathematics. Thanks, Peter, for demonstating that the swinging spring [5] isn't just for fun.

REFERENCES

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[5] P. Lynch, *The swinging spring: A simple model for atmospheric balance*, in Large-Scale Atmosphere-Ocean Dynamics: Vol. 2, Geometric Methods and Models, J. Norbury and I. Roulstone, eds., Cambridge University Press, Cambridge, UK, 2002, pp. 64–108.
[6] L. F. Richardson, *Weather Prediction by Numerical Process*, 2nd ed., Cambridge University Press, Cambridge, UK, 2007.

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Computational Methods of Linear Algebra. Second Edition. *By Granville Sewell.* Wiley-Interscience, Hoboken, NJ, 2005. $111.50. x+268 pp., hardcover. ISBN 0-471-73579-5.

One could fill a book discussing applications of computational linear algebra. While Granville Sewell has not enumerated such an extensive list, his textbook *Computational Methods of Linear Algebra* establishes a strong foundation for upper-level undergraduate and graduate students interested in this field. The book establishes a strong theoretical basis for its content while repeatedly ensuring that the reader thoroughly understands many underlying computational issues. A student studying this text would undoubtedly be exposed to the diverse demands of computational linear algebra—theoretical development, algorithmic analysis, and application of such methods to real-world problems.

The first chapter of this text provides a brief primer on important results from linear algebra. For students lacking or rusty in such topics, a supplemental source would be needed. The following four chapters, "in short, attack everything that begins with the word 'linear'." These chapters discuss and analyze direct and indirect methods for the solution of linear systems of equations, linear least squares problems, linear eigenvalue problems, and linear programming. The next chapter presents the fast Fourier transform, which is a topic often omitted from comparable resources. The final chapter introduces topics in programming for vector and parallel supercomputers.

This textbook offers a diversity of perspectives on computational linear algebra that should increase its usefulness in a va-