Differential Equations and Linear Algebra

Gilbert Strang

Wellesley-Cambridge Press, Wellesley, MA, 2014
502 pp.,hardcover ISBN 978-0-9802327-9-0

http://math.mit.edu/dela/

There's no doubt that Gilbert Strang is a master teacher and an enthusiastic evangelist for his perceptive vision of where applied math should be headed. After a half century and ten editions of Boyce and DiPrima, there's a pile of reasons (and ways) to change the typical first course in differential equations. One good idea is to combine that course with one on linear algebra, which occurred quite some time ago to Kreider, Kuller, Ostberg, and Perkins and to Hirsch and Smale, among others. Now, however, we have MATLAB and Maple, the Singular Value Decomposition, and the fast Fourier transform! Some experimentation with technology and computing uncovers the practical importance of differential equations. Students tend to learn the method of Frobenius and about specific special functions later, perhaps encountering them in a course in engineering, biology, or finance. They ultimately also learn that nonlinearity must be faced. This is hinted at by the book's attractive cover illustration (by two artistic SIAM staff members), which relates pictures of the Lorenz attractor from a Portuguese grad student.

As you'd expect, the emphasis here is linear differential equations with constant coefficients. Honestly, there aren't many variable coefficient ODEs that we can handle analytically, though it is certainly fun to solve one. Numerical methods for initial value problems are, admittedly, very successful and the resulting portraits provide immediate understanding of solution behavior. Moreover, the powerful underlying A^TA philosophy employed carries over to using eigenvalues and eigenvectors to solve boundary value problems for Laplace's equation and other partial differential equations, analytically and via finite differences. Most sophomores would not have realized this without Strang's insistence. Using Fourier series and Fourier and Laplace transforms brings the focus successfully back to the classical syllabus. Meanwhile, however, one has figured out many matrix decompositions, how to use delta and transfer functions, and has understood critical ideas like stability and stiffness. The exercises, which include challenge problems, look interesting, and extensive backup resources from MIT websites are available.

As with Strang's linear algebra books, now in their fourth edition, this text is destined to have a big impact on differential equations courses and applied math education. Its conversational presentation, breadth, and provocative problems will even appeal to students, who typically read little of the book assigned. Those who teach differential equations should definitely give Strang's approach serious consideration. Once again, he's making us think!

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SIAM REVIEW VOL. 56, ISSUE 4 (DECEMBER 2014) PP. 721–22.