

transient wave equations, Cohen's extension of the Yee scheme is more efficient and accurate than the classical Lagrange finite elements. The improvements result from Cohen's use of a new class of elements, called edge elements, to ensure continuity at the elemental interfaces of the tangential components of the finite-element basis functions.

The book's last chapter (chapter 14), devoted to outflow boundary conditions, analyzes in detail the method of perfectly matched layers (PML). The chapter mentions other methods, but not in enough detail for the unfamiliar reader to compare their merits with those of PML.

Cohen's book should be useful, especially to new researchers, and could even be a reference in a course. I would not recommend it as a textbook, because it has no problem sets, is not self-contained, and does not treat other useful topics such as compact schemes, explicit and implicit filtering, and discontinuous Galerkin methods. However, I recommend the book for its clear and cogent coverage of the material selected by its author.

George Em Karniadakis

*Brown University
Providence, Rhode Island*

Nexus: Small Worlds and the Ground-breaking Science of Networks

Mark Buchanan

W. W. Norton, New York, 2002.

\$25.95 (235 pp.).

ISBN 0-393-04153-0

Linked: The New Science of Networks

Albert-László Barabási

Perseus, Cambridge, Mass., 2002.

\$26.00 (280 pp.).

ISBN 0-7382-0667-9

Complex networks pervade our world. A few familiar examples include the metabolic network in a tiny cell, neural networks in the brain, networks of friends and acquaintances in a society, collaboration networks in scientific communities, ecological networks, economic networks of international companies trading worldwide, the Internet, and the World Wide Web. Finding the laws that govern the formation, evolution, and function of complex networks has been a major concern in recent research.

Nexus, by Mark Buchanan, and *Linked*, by Albert-László Barabási, tell the fascinating story of physicists' and mathematicians' search for the laws of complex networks. Both books, clearly and elegantly written for a lay audience, make three main points. First, the reductionistic approach that dominated science in the last century will not help us to understand complex networks. The specific nature of the individual network elements is irrelevant to understanding the collective behavior of the network in much the same way as the detailed properties of a water molecule are irrelevant to understanding turbulence. As Barabási put it in the first chapter of *Linked*, "... here is a secret that never makes the headlines: We have taken apart the universe and have no idea how to put it back together."

Second, networks in nature do not have the kind of homogeneous random architectures that the eminent mathematicians Paul Erdős and Alfred Rényi analyzed in the mid-20th century. On the contrary, real networks such as the Web or the Internet, which were assembled through the collective action of millions of individuals acting separately and randomly, are far from random or homogeneous. (This is one reason they are called complex networks.) Using interesting and well documented examples, Buchanan and Barabási show that departure from randomness applies not only to informatics networks, but also to cellular, social, and ecological networks.

The third main point in *Nexus* and *Linked* is that a common architecture may be shared by such diverse systems as the metabolic network inside the cell, the Hollywood movie-actor network, and the network of sexual contacts in a human society.

Although *Nexus* and *Linked* overlap in many respects, on this third point they diverge in their emphasis.

Buchanan's *Nexus* emphasizes the small-world architecture, in which network elements connect mostly to their near neighbors and only infrequently to distant elements. The small-world architecture in a social network was made evident by the Harvard psychologist Stanley Milgram in 1967 and is popularly known as "six degrees of separation": Any two people in the world are separated, on average, by only six acquaintances.

On the other hand, Barabási's *Linked* emphasizes another architecture called scale-free topology, characterized by inhomogeneous connections.

ADVANCED BOOK PROGRAM

Advanced Solid State Physics

Philip Phillips

0-8133-4014-4, 400 pages, \$55.00, paperback
FRONTIERS IN PHYSICS #102

Statistical Thermodynamics of Surfaces, Interfaces, and Membranes

Samuel A. Safran

0-8133-4079-9, 284 pages, \$48.50, paperback
FRONTIERS IN PHYSICS #90

The Physics of Laser Plasma Interactions

William L. Kruer

0-8133-4083-7, 202 pages, \$43.00, paperback
FRONTIERS IN PHYSICS #73

Semiclassical Physics

Matthias Brack

Rajat K. Bhaduri

0-8133-4084-5, 476 pages, \$45.00, paperback
FRONTIERS IN PHYSICS #96

Veiled Reality

An Analysis of Present-Day

Quantum Mechanical Concepts

Bernard d'Espagnat

0-8133-4087-X, 494 pages, \$45.00, paperback
FRONTIERS IN PHYSICS #91

Solar Neutrinos

The First Thirty Years

John Bahcall, Raymond Davis, Jr.,

Peter Parker, Roger Ulrich, editors

08133-4037-3, 486 pages, \$50.00, paperback
FRONTIERS IN PHYSICS #92

An Introduction to Chaotic Dynamical Systems,

SECOND EDITION

Robert L. Devaney

0-8133-4085-3, 360 pages, \$40.00, paperback
STUDIES IN NONLINEARITY

Vectors and Tensors in Engineering and Physics,

SECOND EDITION

D. A. Danielson

0-8133-4080-2, 288 pages, \$40.00, paperback



Westview Press

A MEMBER OF THE PERSEUS BOOKS GROUP

www.westviewpress.com

To order, call 1-800-386-5656

Most elements are poorly connected, but a few are highly connected. The highly connected elements, or "hubs," are crucial in holding the network together. Barabási has made pioneering contributions to discovering and characterizing the scale-free architecture and writes enthusiastically about it. In *Linked*, he recounts in a personal and authoritative way the discoveries made by his group. He uses well-organized notes at the end of the book to credit several other scientists who also contributed to unraveling the properties of complex networks.

Both *Nexus* and *Linked* are full of anecdotes about network scientists and how they achieved their discoveries. These anecdotes add an enjoyable touch of wonder to the narrative. They also reinforce the ubiquity and importance of scale-free and small-world architectures.

Although *Nexus* and *Linked* taught me much and inspired me in my own research, there are a few things I did not like. For example, *Linked* contains few figures. The narrative is light and pleasant, but good figures could have made it even better. Two salient concepts, the scale-free topology and preferential attach-

ment, are poorly illustrated with bad quality figures.

More fundamentally, both authors overstate the scope of the new science of networks in an attempt to connect scientific disciplines and to unify the laws of networks. For instance, in *Nexus*, Buchanan states that "... the wiring of the human brain turns out to have the very same small-world structure as our social networks ..." (p. 197). The above is misleading and inaccurate. Social networks that have been analyzed exhibit a scale-free topology not found in the brain's neural connections (*Nature* **411**, 907, 2001; *Nature* **386**, 452, 1997).

When describing the 1997 economic crisis in Asia and its cascading worldwide effects, Barabási claims that "South America and Mexico had experienced similar cascading failures two years earlier. It is surely not the last either, despite all the measures banks and governments seem to have taken to avoid it." (p. 211). That is also inaccurate. It has been thoroughly argued that the 1994-1995 Mexican crisis resulted from avoidable internal political and economic mistakes, and not from an automatic cascade through a network. See for instance Sidney Weintraub's *Financial*

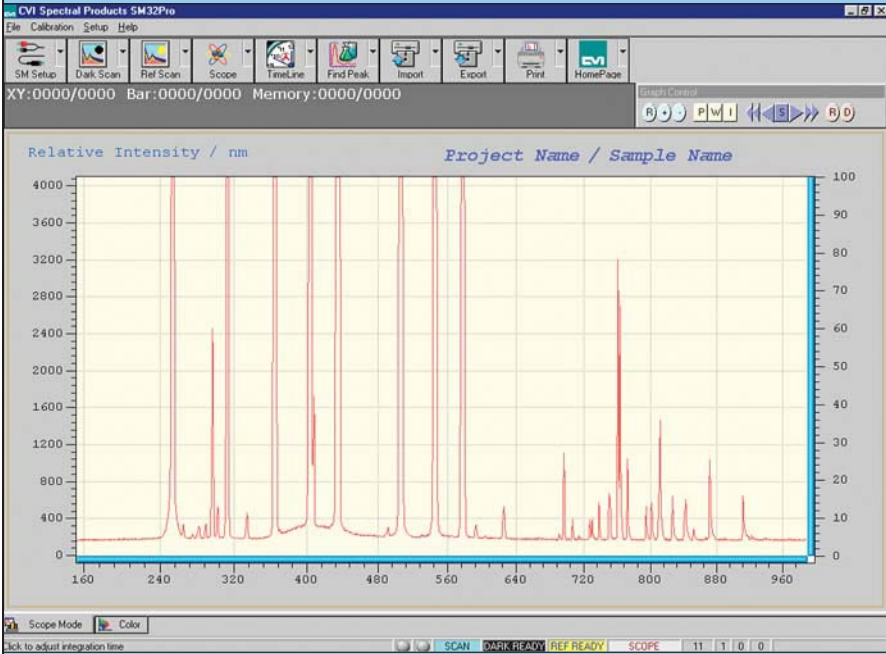
Decision-Making in Mexico: To Bet a Nation (U. of Pittsburgh Press, 2001).

Barabási also overemphasizes the importance of preferential attachment, an aggregation process he and his group proposed to account for the scale-free network topology. For example, Barabási argues that "preferential attachment is unquestionably present on the Internet. This was first demonstrated by Soon-Hyung Yook and Hawoong Jeong, both working in my group ..." (p. 152). Recent studies do not seem to support this statement (*Proc. Natl. Acad. Sci. USA* **99**, 2573, 2002). Although other mechanisms for the scale-free topology were proposed, Barabási does not mention them. See, for example, Bernardo A. Huberman's *The Laws of the Web: Patterns in the Ecology of Information* (MIT Press, 2001).

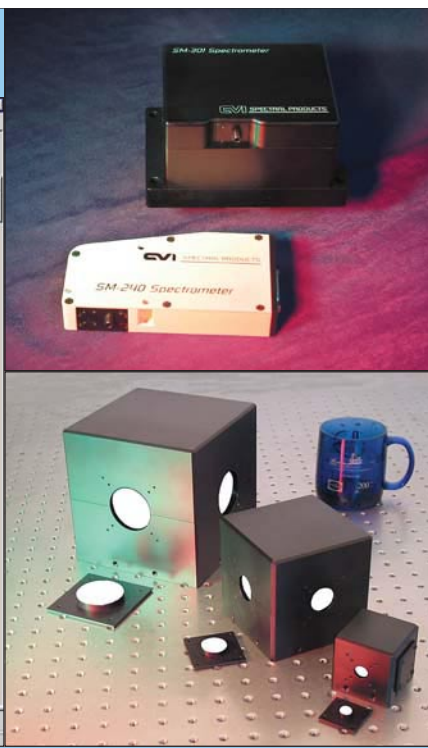
Despite their few flaws, which no doubt will be ironed out in subsequent editions, both books provide valuable insights on the complexity of our world and contribute substantially to the popular-science literature. I strongly recommend them.

Maximino Aldana-Gonzalez
University of Chicago
Chicago, Illinois

What light are you looking at?



SM32Pro Controlling and Acquisition software
 SM301 PbS NIR Spectrometer (1 μ m to 3 μ m)
 SM240 UV/VIS/NIR Spectrometer (200nm to 1050nm)
 High reflectivity integrating Qubes™



CVI Spectral Products
 Phone: (860) 928-5834
 Fax: (860) 928-2676
www.cvispectralproducts.com