Book Review: *Cellular Automata Modeling of Physical Systems*

Cellular Automata Modeling of Physical Systems.
Bastien Chopard and Michel Droz, 341 pp., Cambridge University Press, 1998.

Cellular automata (CA) are captivating in the stark simplicity and economical elegance of their rules, astonishing in the intricate behavior which often results from the mechanical repetition of their basic algorithms. The recent, comprehensive book of Chopard and Droz, "Cellular Automata Modeling of Physical Systems", does a good job at conveying the excitement involved in their research.

The first two chapters review the history of CAs and introduce the reader to the most elementary concepts (update strategies, neighborhood, boundary conditions) in an enticing, playful way. The initial tone is passive, inviting one to experiment with the surprising properties that result from various rules, but the more important goal of understanding which aspects of the rules are relevant to a specific macroscopic behavior is well emphasized and remains clearly in sight. Chapter 3 deals with lattice gas models (FHP and lattice Boltzmann models) and is also used to introduce basic tools of analysis from Statistical Mechanics, such as limiting procedures and the Chapman-Enskog expansion. Diffusion is treated in Chapter 4, and serves as an introduction to the more advanced topics of reaction-diffusion processes and kinetic phase transitions (Chapters 5 and 6). The book concludes with an overview of applications of CAs in other physical problems, in Chapter 7. The first six chapters are followed by suggested exercises. Included is also a glossary of technical terms, and an index.

The book is intended for a wide audience, though I suspect that it is best suited for students and researchers working in statistical physics. The authors warn of the danger of coming to the point of view "that any numerical scheme with a discrete space and time can be regarded as a cellular automaton." Indeed, they take great pain in explaining the true purpose of CAs, as a tool for uncovering the basic ingredients relevant to a given kinetic phenomenon, and as an exceptionally accurate simulation technique (precisely because of the discrete space and time, and because of the *integer* degrees of freedom), and the examples in the book illustrate these ideas time and again. However, the book cuts a broad swath through statistical physics research, and fairly advanced techniques from that discipline are routinely used in most of the chapters. One often gets the impression that it is not the cellular automata, but rather the physics they represent, which is the real purpose of the book.

With that minor reservation in mind, the book remains an excellent introduction to cellular automata in general, and to many a subject in statistical physics. It is written in a highly pedagogic, self-contained fashion. The various methods taught are applied several times, and in full detail, to numerous examples. The exercises provide yet another opportunity for practicing, though it would have been helpful if answers to the more involved problems were included. The bibliography is adequate and not too excessive, and it thoughtfully includes the titles of the cited works. It is hard for me to judge the effectiveness of the glossary: statistical physicists would have little use of it, while I am not sure whether it could truly help students lacking the appropriate background. On the other hand, the titled references and the handsomely complete index afford the text great value as a reference guide. Perhaps one of the book's greatest appeals is its potential as an educational tool. In today's reality, when more and more students are interested in computers and computer science, cellular automata constitute a delightful way to attract them into the rigors of theoretical research.

Daniel ben-Avraham
Physics Department
Clarkson University
Potsdam, NY 13699-5820