Journal of Statistical Physics, Vol. 106, Nos. 3/4, February 2002 (© 2002)

Book Review: *A Guide to First-Passage Processes*

A Guide to First-Passage Processes. Sidney Redner. Cambridge University Press, United Kingdom, 2001.

First-passage problems have a long history, and are discussed in such classic works as Feller's *Introduction to probability theory and its applications*, as well as many other books on probability theory and statistical mechanics. In these works first-passage problems usually arise as examples of techniques in solving, say, the Fokker–Planck equation with absorbing boundary conditions. What distinguishes Redner's book is that it is entirely devoted to first-passage problems. This enables him to develop a coherent and unified set of techniques, of rather general utility, that are well adapted to problems of this type. One such is the connection to electrostatics, which is widely exploited.

The first chapter introduces some of the main concepts and techniques through a study of the one-dimensional random walk. The generalization to higher dimensions leads to the concepts of recurrent and transient processes, and for the probabilities that the walker has not returned to the origin up to time t. For a random walker in a bounded domain, the mapping to electrostatics elegantly determines the probability for first contact at a particular boundary point. Chapters two and three develop these ideas further in the context of one-dimensional random walks in finite (Chapter 2) and semi-infinite (Chapter 3) domains. The latter case leads to a discussion of the image method, with extensions which include biased diffusion and imperfect absorption.

Subsequent chapters study first-passage problems for a diffusing particle on fractal or non-fractal networks, and in higher dimensional systems including those with spherical symmetry and wedge geometry. In each case the chosen examples introduce new technical points or tricks, some of which were new to me. The final chapter deals with applications to some reaction-diffusion problems, making contact with some recent developments with which the author and his collaborators, among others, have been involved. Although the study of first-passage processes has a long

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history, various aspects are still very much at the forefront of research activity, experimental as well as theoretical, notably in the area of so-called "persistence phenomena" in coarsening problems.

The book is too specialized to be used as a textbook on stochastic processes, though it would be a useful adjunct to more standard texts. It's appeal lies, I suspect, mainly to practitioners in the field of first-passage problems, and to students entering the field (indeed, two of my students were very keen have a look at my own copy, and not too ready to relinquish it!). To these groups I can recommend it strongly. It is clearly written, and the organisation and presentation of the material are excellent. It serves as a useful repository of standard and not-so-standard techniques which anyone working in the area of stochastic processes in general, and first-passage problems in particular, will want to have on their shelves.

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