Essentials of Brownian Motion and Diffusion (Mathematical Surveys & Monographs)

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Essentials of Brownian Motion and Diffusion (**Mathematical Surveys & Monographs**) Frank B. Knight This work was first drafted five years ago at the invitation of the editors of the Encyclopedia of Mathematics and its Applications. However, it was found to contain insufficient physical applications for that series; hence, it has finally come to rest at the doorstep of the American Mathematical Society. The first half of the work is little changed from the original, a fact which may partly explain both the allusions to applications and the elementary approach. It was written to be understood by a reader having minimal familiarity with continuous time stochastic processes. The most advanced prerequisite is an understanding of discrete parameter martingale convergence theorem. General summary and outline: 0. Introduction. Some gratuitous generalities on scientific method as it relates to diffusion theory. 1. Brownian motion is defined by the characterization of P. Levy. Then it is constructed in three basic ways and these are proved to be equivalent in the appropriate sense. Uniqueness theorem. 2. Projective invariance and the Brownian bridge presented. Probabilistic and absolute properties are distinguished. Among the former: the distribution of the maximum, first passage time distributions, and fitting probabilities. Among the latter: law of created logarithm, quadratic variation, Holder continuity, non-recurrence for $rgeq 2$. 3. General methods of Markov processes adapted to diffusion. Analytic and probabilistic methods are distinguished. Among the former: transition functions, semigroups, generators, resolvents. Among the latter: Markov properties, stopping times, zero-or-one laws, Dynkin's formula, additive functionals. 4. Classical modifications of Brownian motion. Absorption and the Dirichlet problem. Space-time process and the heat equation. Killed processes, Green functions, and the distributions of additive sectionals. Time-change theorem (classical case), parabolic equations and their solution semigroups, some basic examples, distribution of passage times. 5. Local time: construction by random walk embedding. Local time processes. Trotter's theorem. The Brownian flow. Brownian excursions. The zero set and Levy's equivalence theorem. Local times of classical diffusions. Sample path properties. 6. Boundary conditions for Brownian motion. The general boundary conditions. Construction of the processes using local time. Green functions and eigenfunction expansions (compact case). 7. The chapter is a ``finale'' on nonsingular diffusion. The generators $(d/dm)(d^+/dx^+)$ are characterized. The diffusions on open intervals are constructed. The conservative boundary conditions are obtained and their diffusions are constructed. The general additive functionals and nonconservative diffusions are developed and expressed in terms of Brownian motions. The audience for this survey includes anyone who desires an introduction to Markov processes with continuous paths that is both coherent and elementary. The approach is from the particular to the general. Each method is first explained in the simplest case and supported by examples. Therefore, the book should be readily understandable to anyone with a first course in measure-theoretic probability.

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