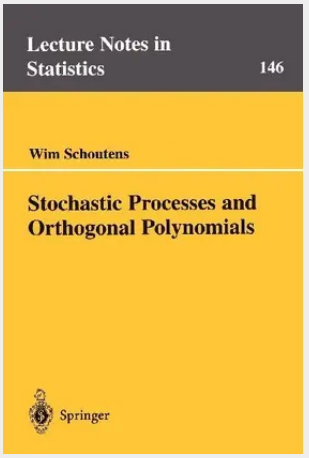
Schoutens

Stochastic Processes and Orthogonal Polynomials



It has been known for a long time that there is a close connection between stochastic processes and orthogonal polynomials. For example, N. Wiener [112] and K. Ito [56] knew that Hermite polynomials play an important role in the integration theory with respect to Brownian motion. In the 1950s D. G. Kendall [66], W. Ledermann and G. E. H. Reuter [67] [74], and S. Kar lin and J. L. McGregor [59] established another important connection. They expressed the transition probabilities of a birth and death process by means of a spectral representation, the so-called Karlin-McGregor representation, in terms of orthogonal polynomials. In the following years these relation ships were developed further. Many birth and death models were related to specific orthogonal polynomials. H. Ogura [87], in 1972, and D. D. En gel [45], in 1982, found an integral relation between the Poisson process and the Charlier polynomials. Some people clearly felt the potential im portance of orthogonal polynomials in probability theory. For example, P. Diaconis and S. Zabell [29] related Stein equations for some well-known distributions, including Pearson's class, with the corresponding orthogonal polynomials. The most important orthogonal polynomials are brought together in the so-called Askey scheme of orthogonal polynomials. This scheme classifies the hypergeometric orthogonal polynomials that satisfy some type of differ ential or difference equation and stresses the limit relations between them.

1 The Askey Scheme of Orthogonal Polynomials.- 2.1 Markov Processes.- 3 Birth and Death Processes, Random Walks, and Orthogonal Polynomials.- 4 Sheffer Systems.- 5 Orthogonal Polynomials in Stochastic Integration Theory.- Stein Approximation and Orthogonal Polynomials.- Conclusion.- A Distributions.- B Tables of Classical Orthogonal Polynomials.- B.1 Hermite Polynomials and the Normal Distribution.- B.2 Scaled Hermite Polynomials and the Standard Normal Distribution.- B.3 Hermite Polynomials with Parameter and the Normal Distribution.- B.4 Charlier Polynomials and the Poisson Distribution.- B.5 Laguerre Polynomials and the Gamma Distribution.- B.6 Meixner Polynomials and the Pascal Distribution.- B.7 Krawtchouk Polynomials and the Binomial Distribution.- B.8 Jacobi Polynomials and the Beta Kernel.- B.9 Hahn Polynomials and the Hypergeometric Distribution.- C Table of Duality Relations Between Classical Orthogonal Polynomials.- D Tables of Sheffer Systems.- D.1 Sheffer Polynomials and Their Generating Functions.- D.2 Sheffer Polynomials and Their Associated Distributions.- D.3 Martingale Relations with Sheffer Polynomials.- E Tables of Limit Relations Between Orthogonal Polynomials in the Askey Scheme.- References.

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