3:30-4:50 Tu, Th, SIG 226

Course Website: http://www.amath.washington.edu/courses/423-winter-2009/

Key Referenece

Taylor, H.M. and Karlin, S. An Introduction to Stochastic Modeling. 3rd Edition, Academic Press, Inc., 1998.

Tentative Course Outline

Introduction to Stochastic Models: Probabilistic and deterministic models; Statistical analysis and stochastic modeling.

Review of Basics of Probability: Discrete and continuous random variables (RVs); Probability mass function (pmf) $p_X(x_i)$; Probability density function (pdf) $f_X(x)$; Cumulative distribution function (cdf) $F_X(x)$; Expectated value (EV), variance, and moments; Joint and marginal distribution, and conditional probability; Function of random variable(s); Probability generating function; Characteristic function; Convolution and sum of random variables; Random sum of RVs.

Markov Chain: Markov processes and Markov chain; Discrete time, finite state homogeneous Markov process; Transition probability matrix; Matrix eigenvalues and matrix powers.

Behavior of Markov Chains: Classification of states; Transient properties; Long time behavior; Recurrence and first return time.

Markov Chains with Absorbing States:

One-Dimensional Random Walks: Symmetric random walk; Asymmetric random walk; Gambler's ruin problem;

Branching Process: Probability generating functions revisited; Survival probability; Bellman-Harris process; Renewal equation.

Poisson Process: Radioactive decay; Exponential distribution; Poisson counting process and Gamma distribution.

Continuous Time Markov Process: Transition rate (Q-) matrix; Discrete state continuous time Markov process; Differential equations and Markov chains.

Applications: Linear chemical reaction systems. Reversible reactions and stationary fluctuations; Irreversible reactions and time of absorption;

Birth and Death Process: The chemical master equation; Stochastic nonlinear chemical reactions; Michaelis-Menten kinetics revisited, flux versus time; Phosphorylation-dephosphorylation cycle revisited; Dynamic cooperativity.

Brownian Motion and Diffusion: Definition; Random walks; Brownian motion with a constant drift; White noise; Stochastic differential equations.

Applications: Brownian motion and diffusion in biology.

General Reference Books

1. L.J.S. Allen (2003) *An Introduction to Stochastic Processes with Applications to Biology.* Pearson Prentice Hall.
2. N.T.J. Bailey (1964) *The Elements of Stochastic Processes with Application to the Natural Sciences.* Wiley.
3. D.J. Bartholomew (1967) *Stochastic Models for Social Processes.* 2nd Ed., Wiley.
4. A.T. Bharucha-Reid (1960) *Elements of the Theory of Markov Processes and Their Applications.* McGraw-Hill.
5. D.R. Cox (1962) *Renewal Theory.* Methuen.
6. G.R. Grimmett and D.R. Stirzaker (1992) *Probability and Random Processes.* 2nd Ed., Clarendon Oxford University Press.
7. S. Karlin and H.M. Taylor (1975) *A First Course in Stochastic Processes.* 2nd Ed., Academic Press.
8. K. Lange (2004) *Applied Probability.* Springer.
9. D.A. McQuarrie (1968) *Stochastic Approach to Chemical Kinetics.* Methuen.
10. A. Papoulis (1991) *Probability, Random Variables, and Stochastic Processes.* McGraw-Hill.
11. H.C. Tijms (2003) *A First Course in Stochastic Models.* Wiley.

Biological Stochastic Modeling Reference Books

1. H.C. Berg (1993) *Random Walks in Biology.* Princeton University Press.
2. D. Brown and P. Rothery (1993) *Models in Biology: Mathematics, Statistics and Computing.* John Wiley & Sons.
3. F. Hoppensteadt (1975) *Mathematical Theories of Populations: Demographics, Genetics, and Epidemics.* SIAM, Philadelphia, PA.
4. P. Jagers (1975) *Branching Processes with Biological Applications.* John Wiley & Sons.
5. M. Kimmel and D.E. Axelrod (2002) *Branching Processes in Biology.* Springer-Verlag.
6. K. Lange (1997) *Mathematical and Statistical Methods for Genetic Analysis.* Springer.
7. D. Ludwig (1974) *Stochastic Population Theories.* VI, Vol 3, Springer-Verlag.
8. R.M. May (1973) *Stability and Complexity of Model Ecosystems.* Princeton, NJ.
9. J.K. Percus (2002) *Mathematics of Genome Analysis.* Cambridge University Press, New York.
10. J. Schnakenberg (1981) *Thermodynamic Network Analysis of Biological Systems.* 2nd Ed., Springer-Verlag, New York.
11. M.S. Waterman (1995) *Introduction to Computational Biology: Maps, Sequences and Genomes.* Chapman & Hall/CRC.
12. N. Wax (1954) *Noise and Stochastic Processes.* Dover Pub.
13. D.J. Wilkinson (2006) *Stochastic Modelling for Systems Biology.* Chapman & Hall/CRC.