SCHOOL OF MEDICINE & DENTISTRY
UNIVERSITY of ROCHESTER MEDICAL CENTER

BST402 Stochastic Processes (CRN: 90843)
Fall 2019

Room: SRB 1.402
Time: Tuesday and Thursday 11:00am -12:40pm
Instructor: David Oakes, PhD
Office: SRB 4.104
Office Hours: Generally Friday's from 10-12, starting Sept 6.
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Prerequisites: BST 401 or equivalent

Catalog Description
Markov chains; birth-death processes; random walks; renewal theory; Poisson processes; Brownian motion; branching processes; martingales; with applications.

Amplified Description

The course will provide a general introduction to theory of stochastic processes and their applications in everyday life, biological and medical research and statistical theory and practice. We will briefly describe the theoretical foundations but focus mainly on examples. There will be some use of computer simulation to illustrate the behavior of certain processes.

In formal terms a stochastic process is a collection of random variables {X(t)} say, where t belongs to an *index set* T and the X(t) take values in a *state space* $\mathcal{X}$. Often, the index set corresponds to time but it could also correspond to space, possibly multi-dimensional, or some more complicated set. A famous theorem of Kolmogorov asserts that a stochastic process always exists provided the joint distributions of all finite subsets of the X(t) are consistently specified, and that this process is unique if an additional condition of separability is imposed. However stochastic processes are usually defined constructively by specification of a probabilistic mechanism by which realizations of the process may be generated, or simulated. The type of mechanism depends on the nature of the index set and state space. The simplest case is when both are discrete (countable). This case includes simple random walks, branching processes, discrete renewal processes, finite-state and infinite-state Markov chains. The Markov property asserts that at any time the conditional distribution of the "future" of the process, given its *exact* present state and entire past history, is a function only of its present state.
We will briefly discuss Markov chains with continuous state space, including their application in computational Bayesian statistics – "Markov chain Monte Carlo". The simplest continuous time, discrete state stochastic process is the Poisson process, a model for complete randomness. Generalizations include birth-death processes, linear and non-linear, and processes specified by infinitesimal transition intensities. Processes with continuous time and continuous state space include the celebrated Wiener process, also known as Brownian motion, and generalizations including diffusion processes. We will give a brief introduction to stochastic differential equations. Some stochastic processes in discrete or

continuous time have the "martingale property", in essence that the conditional expectation of a future value given the present value and the entire history of previous values up to the present point (the "sample path") is, with probability one, equal to the present value. These processes are important in statistical inference, especially in survival analysis.

Course Policies and Expectations

Attendance and participation in class are expected. Whenever possible please let me know in advance if you are unable to attend a class. Please minimize distractions such as cell-phones and laptops. Always feel free to ask questions during class and point out anything I say or write that seems wrong or unclear before I move on.

You are encouraged to discuss homework problems among yourselves. However the final solutions should be your own. I can usually recognize when work has been directly copied from another student. No consultation (except with me) will be permitted on the final exam.

Materials and Access

I have listed one required text and two recommended:

Required, Karlin, S. and Taylor, H.M. A First Course in Stochastic Processes. Second Edition. Academic Press (1975).

Recommended, Ross, S.M. Stochastic Processes Second Edition, Wiley, 1996.
Dobrow, R.P. Introduction to Stochastic Processes with R, Wiley, 2016.

These are available in the bookstore. Karin has copies of Karlin and Taylor and of Ross. Dobrow is available as an e-book from the Carlson library. Dobrow also has a freely available web-site including simulation routines in R.

There are many other books on the subject. Notable are
Cox, D.R. and Miller, H.D. the Theory of Stochastic Processes, Methuen, 1965 and the two magnificent volumes of W. Feller, An Introduction to Probability Theory and its Applications, Wiley.

Detailed Schedule

Will be distributed separately. Note that there will be no class on Tuesday September 3, this class will be rescheduled later.

Assignments and Grading Procedures
The final grade is based on three components:

(1) Homework (60%). Homework will be distributed every week in class and is due one week later. Please discuss with me in advance if you anticipate any schedule conflicts that will prevent you completing work on time.

(2) Mid-Term. (10%). There will be a one hour closed book mid-term exam. You will be permitted to bring in a single page of your own notes, handwritten or typed in normal size font, to refer to during the exam.

(3) Final exam (30%). There will be a take home final exam, the time to be scheduled. It may involve some computer simulation.

Academic Integrity

Academic integrity is a core value of the University of Rochester. Students who violate the University of Rochester University Policy on Academic Honesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University. Since academic dishonesty harms the individual, other students, and the integrity of the University, policies on academic dishonesty are strictly enforced. For further information on the University of Rochester Policy on Academic Honesty, please visit the following website:
http://www.rochester.edu/college/honesty/docs/Academic_Honesty.pdf

Accommodations for Students with Disabilities

Students needing academic adjustments or accommodations because of a documented disability must contact the Disability Resource Coordinator for the school in which they are enrolled:
http://www.rochester.edu/eoc/DisabilityCoordinators.html