Fall 2016

Mathematical Modeling: Probabilistic Models (4)

Course Catalog Description: Probabilistic mathematical modeling emphasizing models and tools used in the biological sciences. Topics include stochastic and Poisson processes, Markov models, estimation and Monte Carlo simulation. A computer lab is included.

Prerequisite:
Math 216, or Math 242, or Math 252A, or consent of instructor.

Topics for Math 305: Discrete random variables. Continuous random variables and the Central Limit Theorem. Joint probability distributions. Covariance and correlation. Maximum likelihood estimation. Regression and curve fitting. Random walk. Poisson and birth processes: linear differential equations, inter-event times. Examples of stochastic differential equations. Matrices. Genes, Hardy-Weinberg Law, Markov chain model of random mating in a finite population, temporally homogeneous Markov chains. Random genetic drift, Markov chains with absorbing states, absorption probabilities, mean time to absorption. Mutation, stationary distributions, approach to stationary distribution as $n \to \infty$.

Textbook: David Logan and William Wolesensky (2009), *Mathematical Methods in Biology*, Wiley; handout on population genetics and Markov chains.

Time: 150 minutes of lecture weekly, and 50 minutes of computer lab (which may be scheduled in the Math Department computer lab, or may be done independently by students on their own computers).

Lab: Students will study a programming language such as Matlab or R (determined by the Instructor). For approximately half of the semester students will work weekly exercises (either in the Math Lab or on their own). Afterwards they will work on a modeling project.

Student learning objectives

Upon successful completion of Math 305, the student will be able to use probability and stochastic processes to construct models for change in various scientific fields, and to mathematically analyze these models to predict behavior.

Program objectives

Math 305 is a junior level course in probabilistic modeling, which is an important subject in the application of mathematics to all fields of science. This course promotes our goal that our students learn, understand, and be able to apply several mathematical topics at

the junior and senior level, and that our students acquire the ability and skills to apply mathematics to other fields. The approach emphasizes computation and application over theory. The course material is geared for both math and science students, so fulfills a service role as well as part of our major program.