Fall 2011

MthSc 985:

Topics in discrete mathematical biology

Instructor: Matthew Macauley

COURSE DESCRIPTION:

The course represents an introduction to several active research areas involving discrete mathematics and biology. The two main but fairly distinct topics will be the combinatorics and analysis of RNA pseudoknot structures, and discrete models of biological networks. The former is a new and popular topic drawing from a wide variety of fields that has yielded a wealth of research problems. The latter is an active research area of several Clemson faculty members. This course is suitable for students who have a basic foundation at the undergraduate level in abstract algebra, complex analysis, differential equations, and probability theory. After successfully completing this course, a student will have knowledge of how discrete mathematical techniques have been applied to the field of biology, the challenges that still exist, and areas of active research. Class meetings will be a mixture of lecture, discussion, and presentations by teams of students on research papers and other course materials.

TOPICS:

The following is a tentative outline of topics. This is more than we could possibly cover in one semester, so how we decide to allocate time among these specific topics will depend on the students' interests and background.

I. RNA pseudoknot structures
   a. Combinatorics of k-noncrossing matchings
   b. Generating functions and singularity analysis
   c. Tangled diagrams
   d. Probabilistic analysis of RNA pseudoknot generation
   e. RNA folding algorithms
   f. Neutral networks

II. Systems biology and models of gene networks
   a. Polynomial dynamical systems
   b. Boolean networks and probabilistic Boolean networks
   c. Transcription networks

III. Special topics
   a. Phylogenetics
   b. Algebraic statistics and computational genomics
   c. Genome assembly and graph theory
   d. Food webs and graph theory

Prerequisites: A basic knowledge (undergraduate-level) of most of the following topics: Abstract algebra, complex analysis, differential equations, probability theory.

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