MATH 490/710C

Case Studies in Mathematical Biology

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Motivation

The biological and biomedical sciences will be a premier area of investigation in the 21st century. There has been an explosion of techniques and technologies to explore increasingly smaller scale biological events, and through this we have encountered ever more complex problems. The complexity of the biological organisms makes the use of mathematical models essential as the discipline becomes more quantitative. Mathematical/computational biology is a fast growing modern application of mathematics. Biology has given us new classes of problems to attack, and mathematical tools are becoming available to aid the quest for understanding function from form. In recent years the demand for cross-disciplinary researchers in mathematical biology has significantly increased.

Course Description

In is impossible to be comprehensive with this subject, so we can only focus on a number of case studies. The topics picked have intrinsic interest, do not need a lot of specialized background, and the mathematical techniques we use on them have wide applicability. In a sense the course is a mathematical modeling course with applications restricted to biological topics.

Course Description

An outline of the subject matter I am considering includes:

- a general discussion of different kinds of dynamical models and their role in biology
- matrix models and structural population dynamics
- neural signaling, ion channels, operation of small neural networks
- infectious and dynamic diseases
- biological pattern formation

This list may change a little between now and when the course begins, but it is a representative list of topics. Underlying these topics is determinism and dynamics, mainly because that is my interest. There are important issues with stochastic and combinatorial models, as well as with methodologies like control and probability, but a one semester course can be untenable if too many methods and problems are covered, forcing a shallowness of presentation.

We anticipate requiring students to do a project of relevance to the subject. Students should have a core background in mathematics, that is, in calculus, linear algebra, elementary differential equations, and some exposure to scientific programming since some homework will involve computation. For further information, contact me.