Red Deer College Conference and North/South Dialog in Mathematics

Section on Mathematical Biology (May 01, 2009)

Organizer - Thomas Hillen (University of Alberta)

10:00 - 10:30
Marc Roussel (University of Lethbridge)
Time-scale-based reduction of the chemical master equation

The chemical master equation (CME) gives the time rate of change of the probability distribution for the vector of chemical species numbers in a well-mixed reactive system. While the CME is an important theoretical tool, it is rarely used directly because it takes the form of a very large set of stiff linear ODEs. It is however possible to eliminate fast time scales from the CME, resulting in an equation that can be solved at modest cost using standard ODE solvers. The mathematics involved integrates ideas from the basic theory of ODEs, numerical linear algebra, and classical optimization methods, and is accessible to undergraduate students with appropriate preparatory coursework.

10:30 – 11:00
Burton Voorhese (Athabasca University)
The Value of Toy Models for Complex Systems Theorizing

This paper discusses the way that toy models, that is, models that are intentionally constructed using highly simplified assumptions, can contribute to understanding in studies of complex systems. After comparison of modeling in classical physics and in modern complex systems theorizing several well-known models are briefly described. Following this two toy models are discussed in detail. The first of these examines the trade-off between stability and flexibility in an environment subject to random fluctuations while the second makes a comparison between response strategies in cases of potential risk and reward.

1:30 – 2:00
Adriana Dawes (University of Alberta)
Initiation of polarization in the early C. elegans embryo

Cell polarization, where cells establish biochemically distinct domains, is

required for many important biological processes including wound healing and embryonic development. Embryos of the nematode worm C. elegans are an ideal model system for studying polarization as they establish complementary domains shortly after fertilization and maintain those domains through first division, producing distinct daughter cells. In this talk, I will discuss recent theoretical and experimental work that investigates possible mechanisms responsible for breaking symmetry and initiating polarization of the early embryo, and I will discuss the significance of these results for understanding polarization in other cell types.

1:30 - 2:00
Elena Braverman (University of Calgary)
On Various Harvesting Models: Continuous, Discrete, Spatially Distributed

We consider models described by ordinary differential equations with continuous (a negative term involved in the equation) and short-time (described by impulsive conditions) harvesting. It is demonstrated that, generally, the impulsive model cannot outperform its continuous counterpart, unless there is some constant harm involved in the harvesting event. In the case when the model is spatially distributed, we discuss the diffusion term involved in the equation. Optimal harvesting results are presented for several growth laws (logistic, Gilpin-Ayala, Gompertz). This is a joint work with L. Braverman and my graduate students R. Mamdani and L. Korobenko.

2:00 – 2:30
Jiafen Gong (University of Alberta)
Optimization of Radiation Treatment Schedules

In this talk I will present several mathematical methods to optimize radiation dose delivery for cancer treatment. I will discuss the expected treatment success under minimization of side effects.

Section on Mathematical Finance (May 01, 2009)

Organizer – Professor A. Melnikov (University of Alberta)

2:30 – 3:00

Change of Time Method for Multi-Factor Levy Models in Finance,
Anatoliy Swishchuk, University of Calgary

We apply the change of time method to Levy-based multi-factor models in finance. As applications of this method we consider many Levy-based stochastic differential equations and models in financial and energy markets including Heston, SABR/LIBOR and Schwartz models.

3:00 - 3:30

Stock Market self-organization in extreme conditions. Traders' network synchronization dynamics - Quantitative Model,
Rossitsa Yalamova, University of Lethbridge

Stock markets have been shown to exhibit complex dynamics with increased correlation between stocks in extreme events. Statistical models may not be appropriate to reflect the dynamics of self-organization that lead to crashes, therefore they may be useful to plan successful intervention strategies. Recently attempts have been made to adapt network topology modeling for use with finance markets and institutions. This paper proposes a method to add dynamic analysis into this promising research direction.

4:00 – 4:30
On mathematical methods in option pricing,
Vladislav Krasin and Alexander Melnikov, University of Alberta

This presentation is devoted to problem of option pricing in modern financial mathematics. It demonstrates how such areas of mathematics as partial differential equations, various numerical methods and optimization theory are used in practice for this purpose. Along with description of existing methods the work proposes two new approaches, based on market completions and stochastic comparisons.

4:30 – 5:00
Dynamic hedging of Conditional Value of Risk,
Alexander Melnikov and Ivan Smirnov, University of Alberta

The talk studies partial hedging by constructing hedging strategies that minimize Conditional Value at Risk (CVaR). Two aspects of the problem are considered: minimization of CVaR with initial capital bounded above, and minimization of hedging costs subject to a CVaR constraint. The approach is based on the Neyman-Pearson

fundamental lemma. The results are derived in the form of semi-explicit solutions and illustrated in the framework of the Black-Scholes model and the telegraph market model.

Plenary Talk

5:15 – 6:00 Arno Berger (University of Alberta)
Digits, dynamics, and distortion - A tour of Benford's Law

Benford's Law, a notorious gem of mathematics folklore, asserts that leading digits of numerical data are usually not equidistributed, as might be expected, but rather follow one particular logarithmic distribution. Since first recorded by Newcomb, this apparently counter-intuitive phenomenon has attracted much interest from scientists and mathematicians. This talk will provide a friendly introduction to some of the intriguing aspects of Benford's Law, relating them in particular to problems in number and probability theory and, above all, dynamics.

College session

3:00 – 3:30: Gerda de Vries (University of Alberta)
Science 100 at the University of Alberta: A Unique First-Year Learning Experience

Science 100 is a complete program for a small cohort of first-year science students at the University of Alberta. Science 100 integrates core first-year material from each of the seven departments in the Faculty of Science into a single, intense year-long course. Students successfully completing Science 100 have the prerequisites to enter almost any second-year science program offered by the Faculty of Science at the University of Alberta. In this talk, I will give an overview of the Science 100 program, and describe my experience teaching the calculus component of Science 100. I will focus on the interaction between calculus and the other science disciplines.