Title: Modelling, mining, and searching networks.

Abstract: Complex networks arise in many diverse contexts, ranging from web pages and their links, protein-protein interaction networks, and on-line social networks such as Facebook and LinkedIn. The modelling and mining of these large-scale, self-organizing systems is a broad effort spanning many disciplines. A number of common properties have been observed in complex networks, such as power law degree distributions and the small world property. Stochastic graph models simulate these properties, while expanding our theoretical understanding of random graph models. Models for complex networks also give insight into their underlying properties.

We will give a brief overview of the properties observed in complex networks. We will then discuss a new geometric model that suggests a reverse engineering approach: given only the graph structure, use the model to help uncover the hidden reality of the network.

We finish by discussing network searching, which are certain two player games played on graphs. In network searching games, an intruder is loose on a network and agents try to capture him with while minimizing resources. We discuss a famous example of such game, Cops and Robbers, and discuss how it leads to some deep problems on networks.

Title: Population models of species, epidemic models, and dynamic models of finance

Kunquan Lan

Abstract

One of my research areas is to study population models for species. Population models for species are used to study the behaviors of the populations or the interaction of two or more species. One important topic is to determine under what circumstances the species either survive or go extinct. According to human needs, the exploitation of biological resources and the harvesting of populations are commonly practiced in fishery, forestry, and wildlife management. To predict whether species will become extinct and to obtain insight into the optimal management of renewable resources, one needs to consider models which incorporate harvesting rates. The aim is to determine a harvestable quantity of the species without having the population die out.

Mathematically, models of populations of species are often governed by one or more first order ordinary differential equations or by parabolic or elliptic partial differential equations including Laplacian boundary value problems. These models play an important role in modern applicable mathematics.

For example, the temporal behavior of population of one species which inhabits a strip of dimensionless width can be modeled by a reaction diffusion equation with suitable nonlinearities like logistic growth rates and harvesting rates. The essential problems are to determine the size of the patch and the ranges of harvesting rates under which the population survives or becomes extinct.

Second research area: In recent years, some realistic mathematical models for transmission dynamics of infectious diseases have been developed. The aim of developing such models is to understand observed epidemiological patterns and to predict the consequences of the introduction of public health interventions in order to control the spread of diseases. In most
epidemic models, the diseases will be eradicated under suitable conditions, but clinical observations and studies show that many infectious diseases such as measles, influenza and so on, have periodicity behaviors. This leads to a significant public health issue in preventing the spread of the disease and its severe complications. The purpose of research is to generalize and analyze some of epidemic models. Such analysis can show that whether the disease can be eradicated from the population and whether there are periodically high levels of incidence. **Third research area** is to study dynamic models of finance which describe the dynamical behaviors of interest rate, investment demand and price index. **Prerequisite**: Calculus, Linear Algebra, Differential Equations and/or PDEs. Knowing Maple or

Speaker: Dr. Silvana Ilie, Oct. 31st, 12:10-12:30 pm

**Title**: Research topics in Computational Biology

Abstract: Stochastic modelling is essential for an accurate description of the cellular dynamics. Biological processes at the level of a single cell may be viewed as systems of biochemical reactions. When some molecular species have low population numbers, the random fluctuation in the system may be significant. This is the case for gene regulatory networks. The network of interactions encountered in cellular systems is quite complex. Thus the need for refined mathematical models and powerful simulation tools to study such systems. My research is in the area of Computational and Systems Biology, with a focus on developing accurate and efficient methods for simulating stochastic mathematical models of biochemical systems at the level of a single cell. I shall give a brief introduction to the stochastic models of biochemical systems and I shall describe several research projects with important practical applications.

Speaker: Dr. Jean-Paul Pascal, Oct. 31st, 12:30-12:50 pm.

**Title**: TBA.

Speaker: Pawel Pralat, Oct. 31st, 12:50-1:10 pm.

**Title**: Modelling and Searching Complex Networks in the Big Data Era

Abstract: In the big data era, data is considered as the new fossil fuel. Every human-technology interaction, or sensor network, generates new data points that can be viewed, based on the type of interaction, as a self-organizing network. In these networks (for example, the Facebook online social network) nodes not only contain some useful information (such as user's profile, photos, tags) but are also internally connected to other nodes (relations based on friendship, similar user's behaviour, age, geographic location). Such networks are large-scale, self-organizing, decentralized, and evolve dynamically over time. Understanding the principles driving the organization and behaviour of complex networks as well as algorithms based on these networks is crucial for a broad range of fields, including information and social sciences, economics, biology, and neuroscience.
My main research interests lie in graph theory with applications to real-world self-organizing networks such as the web graph, social networks, or terrorism networks. I am interested in both modelling and searching of complex networks with emphasis on connections to Big Data research questions. Both topics have experienced tremendous growth in the last few years, with an increasing number of applications in other areas of mathematics and computer science. My research program is multidisciplinary in nature and as such requires a rather unique blend of knowledge, skills, and tools from at least three areas: mathematics, social science, and computer science (both theoretical and applied).

Speaker: Dr. Andrea Burgess, Oct. 31st, 1:10-1:30 pm.
Title: Combinatorial designs and graph decompositions

Abstract: The systematic study of combinatorial design theory traces much of its roots to applications in the design of statistical experiments, but has since found applications in areas such as coding theory, communications systems and software testing. In this talk, I will introduce several classes of designs, including cycle decompositions of graphs, and will highlight some research directions in these areas.

I understand that the presentation should be about my research program and myself (so that students know me better and understand better what I do---big picture rather than talking about one specific problem). If yes, then I propose something like this:

Speaker: Dr. Katrin Rohlf, Oct. 31st, 1:30-1:50 pm.
Title and abstract: TBA

Speaker: Dr. Dejan Delic, Nov 7th, 12:10-12:30 pm
Title and abstract: TBA

Speaker: Dr. Sebastian Ferrando, Nov 7th, 12:30-12:50 pm
Title: Financial Mathematics, Pricing, Hedging and Risk.

Abstract: I will describe my current research work in financial mathematics which investigates a hedging and pricing methodology involving dynamic optimization over a space of trajectories. It provides a new methodology to look for investment opportunities as well as hedging against future financial obligations. Another research area of research is the study of the risk brought to an investment portfolio by
external factors (such as exchange rates fluctuations). This requires the use of an assortment of financial notions (such as risk measures) as well as tools from mathematical analysis needed to decompose the portfolio for further risk analysis.

Speaker: Dr. Marcos Escobar, Nov 7th, 12:50-1:10 pm
Title: Modelling stocks and pricing derivatives: topics for M.Sc. students

Abstract: In this short talk, I will first give an overview of my research and interest. In a second part, several basic mathematical problems, designed for master level students, will be presented in the context of their applications to finance. Existing results as well as current and future developments will be briefly described.

Speaker: Dr. Peter Danziger, Nov 7th, 1:10-1:30 pm
Title and abstract: TBA

Speaker: Dr. Pablo Olivares, Nov. 7th, 1:30-1:50 pm.

Title: The Modeling of the Financial Markets

Abstract: Several mathematical models used to solve some problems in Finance, based on Stochastic Differential Equations with Jumps are discussed. In particular the pricing of financial derivatives is treated in details and some possible thesis problems are proposed.

Speaker: Steve Kanellis and Pablo Olivares, Nov 21st, 1:10-1:50 pm
Title: The use of LATEX in writing scientific papers.

Abstract: We discuss how to install LATEX and how to use it to write mathematics papers using it. Indication about your thesis specifications will be given.

Nov. 28th, 1:10-2:00 pm: Social gathering.