Winter 2005

2005 (Winter)

University of Dayton. Department of Mathematics

Abstracts of the Colloquium Talks: Winter 2005
Department of Mathematics

An Introduction to Discrete Fractional Calculus
Dr. Paul Eloe
Abstract: We study a discrete analogue of the Riemann-Liouville fractional calculus. Definitions are motivated, elementary formulas are derived. Extensions to fractional differential and fractional difference equations are motivated. The work continues some initial work due to Kenneth S. Miller and Bertram Ross.

Boundedness in Nonlinear Functional Differential Equations with Applications to Totally Nonlinear Volterra Integro-Differential Equations
Dr.Youssef Raffoul
Abstract: In this talk, we make use of non-negative definite Lyapunov functions and obtain sufficient conditions that guarantee the boundedness of all solutions of the system of functional differential equations

$$x\,0\,(t)\;=\;G(t,x(s);\;0\;\leq\;s\;\leq\;t)\;def\;=\;G(t,x(\cdot))$$

where $x\;\in\;R\,n\,,G:\;R\;+\times\;R\,n\;\rightarrow\;R\,n$ is a given nonlinear continuous function in t and x.

We will apply our results to totally nonlinear Volterra Integro-differential equations of the form

$$x\,0\,(t)\;=\;A(t)g(x(t))\;+\;Z\;t\;0\;B(t,s)f(x(s))ds$$

where $f(x)\;=\;x\,n\;and\;g(x)\;=\;x\,k$ such that n and k are positive and rational.

At the end of the talk, we will discuss the possibilities of extending this talk to functional equations with finite or infinite delays and posing some new problems.

Perspectives on Fractional Domination
Dr. Matthew Walsh
Abstract: The practice of fractional graph theory involves finding and analyzing real-valued analogues of familiar (integer-valued) graph parameters. In this talk we will explore some domination-type problems and their fractional versions, with particular attention being paid to the uses of linear programming techniques and theory.

Using WebCT in the Math Classroom
Dr. Darren Parker
Abstract: WebCT is a software package that enables an instructor to put part of his or her course(s) on the web. In its simplest form, it can be a course web page where one can post course content to be downloaded or viewed by students (syllabus, homework assignments, etc.). It has some additional functions as well that I have found to be quite helpful. For example, it provides a password-protected environment, so that material can be posted that only the students in the class see. The talk will focus on posting grades and scores, the calendar function, and threaded discussions. If there is time, I will talk about some of the nuts and bolts of designing a course web page.

Disease containment by progressive vaccination on trees and grids
Dr. Stephen Hartke

Abstract: We consider a deterministic discrete-time model of disease spread on graphs, where the disease spreads to adjacent vertices at each time step. A limited number of vertices can be vaccinated at each time step. Which vertices should be vaccinated to minimize the total number of infected vertices? This model is equivalent to a model of fire spread introduced by Hartnell, where firefighters fill the role of vaccination. We consider the question of minimizing the number of infected or burnt vertices for finite trees and for infinite d-dimensional square grids.

Wiener indices of trees

Dr. Gang Yu

Abstract: The Wiener index is one of the main descriptors that correlate a chemical compound's molecular graph with experimentally gathered data regarding the compound's characteristics. A long standing conjecture on the Wiener index states that, for any positive integer $\$n\$$ (except numbers from a given $\$49\$$ element set), one can find a tree with Wiener index $\$n\$$. In this talk, I will prove that every integer $\$n > 10\^8\$$ is the Wiener index of some short caterpillar tree with at most six non-leaf vertices. The Wiener index conjecture for trees then follows from this and the computational results that other people have obtained. I will also show that, with finitely many exceptions, every positive integer is the Wiener index of a caterpillar tree of maximal degree $\$\leq 3\$$. These trees imitate the exact molecular structures of many chemical compounds.

Multidecomposition of the Complete Graph with Various Leaves

Mr. Christian Hampson

Abstract: A graph-pair of order $\$t\$$ is two non-isomorphic graphs $\$G\$$ and $\$H\$$ on $\$t\$$ non-isolated vertices for which $\$G \cup H \cong K_t\$$ for some integer $\$t \geq 4\$$. Given a graph-pair $\$(G, H)\$$, we say $\$(G, H)\$$ divides some graph $\$K\$$ if the edges of $\$K\$$ can be partitioned into copies of $\$G\$$ and $\$H\$$ with at least one copy of $\$G\$$ and at least one copy of $\$H\$$. We will refer to this partition as a $\{it\ \$(G, H)\$ - multidecomposition\}$ of $\$K\$$. In this talk, we consider the existence of multidecompositions of $\$K_m - F\$$ for the graph-pairs of order 5 where $\$F\$$ is a Hamiltonian cycle or a 1-factor graph. For those graph-pairs, we will also look for maximum multipackings and minimum multicoverings of $\$K_m - F\$$.

A Qualitative Study of the Line Search Method and Surrogate Optimizations

Mr. Chunlei Zhang

Abstract: Explorations of the latest numerical optimization methods, in particular the line search methods and surrogate procedures, are carried out in this study. Applications to engineering dynamic systems are introduced. A real time optimization framework, in which a line search strategy associated with linear dynamic systems, is analyzed. The controllability of the linear systems and the robustness of the line search methods are discussed. Numerical demonstrations are given to illustrate the effectiveness the optimization algorithms developed.

A class of the surrogate optimization procedures for unconstrained optimization is studied for practical applications. The global convergence of the optimization sequence to first order stationary points following Strawman's design is considered. An algorithmic approach has been implemented to demonstrate the surrogate optimization procedure under Strawman's principals. Further applications of the surrogate methods in mobile agent cooperative search problems is given.

Boundedness and Stability for Nonlinear Delay Difference Equations Employing Fixed Point Theory

Mr. Chunlei Zhang

Abstract: We study boundedness and stability of the nonlinear difference equation

$$x(t+1) = a(t)x(t) + c(t)\Delta x\big(t - g(t)\big) + q(x(t), x(t - g(t))$$

In particular we study equi-boundedness of solutions and the stability of the zero solution of this equation. Fixed point theorems are used in the analysis

Curriculum Guidelines for Bachelor Degrees in Statistical Science

Dr. Thaddeus Tarpey

Abstract: The American Statistical Association (ASA) recently adopted guidelines for Bachelor degrees in statistical science. In this talk I will discuss the background and motivation for these guidelines and discuss the recommendations in the guidelines for undergraduate degrees in statistics. I will also discuss recommendations for minors in statistics.

Modeling Traffic Flow Through a Toll Plaza

Patrick Coate, Matthew Kocoloski, and Jeremy Lynch

Abstract: Our team recently participated in the 2005 Mathematical Contest in Modeling. The problem selected by our team was to consider the optimal number of tollbooths that should be deployed along highways, such as the Garden State Parkway and Interstate 95. In this problem, we defined "optimal" as the greatest flow of cars through the toll plaza, where flow is defined as the density of cars times the average velocity of the cars. We wanted to maximize flow in order to process as many cars as possible through the tollbooth lanes, thus decreasing the wait time and annoyance of the drivers.

After considering the possible congestion on both sides of the toll plaza, our team decided to focus solely on the area strictly before the plaza, since we concluded that there would not be any traffic problems in the area immediately after the tollbooths. If anything, the time that each car is required to wait at the tollbooth would decrease the flow on the exit side of the plaza. And, because we assumed that there was minimal congestion as the cars initially approached the toll plaza from the highway, there would be negligible congestion as they were leaving as well. Therefore, our solution essentially involved equating the flow into the plaza with the flow out of the plaza, and then determining how many tollbooths should be deployed based on estimates of incoming vehicle flow and average time spent waiting per tollbooth. We concluded that, for a four lane, one-way highway, 12 tollbooths would be sufficient to create a free flow of traffic, even during periods of heavy traffic. Our model is fairly simple due to our assumptions and simplifications, as well as our decision to consider traffic as a continuous flow rather than considering individual vehicles.