GRADUATE RESEARCH DAY ABSTRACTS

Tamas Darvas

Title: Geometry of the space of Kahler metrics
Abstract: Suppose (X, ω) is a Kähler manifold. As noticed by Mabuchi, the space of all Kähler metrics on X in the same cohomology class as ω has a natural Riemannian structure. In this short talk I will explain how understanding the geometry of this space is helpful in understanding when a constant scalar curvature Kähler metric exists on X.

Agnid Banerjee

Title: Gradient bounds for degenerate elliptic systems in convex domains
Abstract: Let u be a weak solution to a p-harmonic system with vanishing Neumann data on a portion of the boundary of a domain which is convex. We show that sub-solution type arguments for some uniformly elliptic PDE's can be used to deduce that the gradient is bounded with constant which depends only on the Lipschitz character of the domain after appropriate rescaling. In this context, I would like to mention that classical results on the boundedness of the gradient require the domain to be $C^{1,Dini}$. However, in our case, since the domain is convex, one can make use of the fundamental inequality of Grisvard which can be thought of as an analogue of the use of the barriers for Dirichlet problems in convex domains. This is a joint work with Prof. John L. Lewis.

Arnold Yim

Title: Logarithmic vector fields along determinantal varieties
Abstract: Given a hypersurface in $\mathbb{C}^n$, one might ask: what kind of vector fields on $\mathbb{C}^n$ are tangent to that hypersurface? While this question is not so hard to answer for hyperplanes, it becomes more difficult when we consider a union of several different hyperplanes, and even more so for more general hypersurfaces. The collection of vector fields tangent to a particular hypersurface forms a module, and we are particularly interested in knowing when this module is free. In this talk, we introduce some basic definitions and theorems, then look at examples of hypersurfaces for which the module of logarithmic vector fields is/isn't free. In particular, we will look at

hypersurfaces defined by the vanishing of minors of a $2 \times n$ matrix of indeterminates.

Yiqiang Zheng

Title: Size-structured plant-herbivore models in presence of plant toxin defense

Abstract: Plant toxin defense is an important factor in the study of the plant and herbivore interaction. A class of mathematical models named toxin-determined functional response models (TDFRM) have been proposed and studied, and show a variety of applications to ecological problems, like plant invasion, herbivore and wolf control and fire regime, etc. The size structure of plants plays a key role in the regeneration of forest, new models are proposed to include the size structure of plants in this study. Dynamics of these models are studied, which shows new behaviors compared with the previous models in which the size structure is not considered. The new models have potential application to the invasion of Arctic Tundra by woody plants as one possible consequence of global warming.

Yingwei Wang

Title: Sparse grid methods for high-dimensional problems

Abstract: Many scientific and engineering applications require solving high-dimensional partial differential equations (PDEs). Current numerical methods for solving PDEs in multidimensions are usually based on classical tensor product, in which the convergence rate deteriorates rapidly as the dimension increases, leading to the so-called curse of dimensionality.

Sparse grids present a special case of a tensor product expansion for high-dimensional functions. They promise to circumvent the above-mentioned curse of dimensionality of a conventional discretization using full grids, at least to some extent.

In this talk, I will present the basic idea of sparse grids based on hyperbolic cross. Besides, emphasis will be laid on the application in solving the high-dimensional electronic Schrodinger equation, which plays a fundamental role in the theory of quantum mechanics and calculation of electronic structures.

Britain Cox

Title: Supercuspifragilisticexpialidocious
Abstract: When choosing a research area, nomenclature is key. A subject with the right sort of vernacular will grab the spotlight in any social interaction. Pursuit of ”supercuspidal representations of a p-adic reductive group” will bring many erroneous red squiggles throughout your .tex file. In this talk, we will explain what supercuspidal representations are, and why they are worth the headache.

Jieun Kim

Title: An approximate inverse recipe method for estimating the Phenylalanine content of composite foods
Abstract: Management of phenylalanine (Phe) daily intake is a dominant treatment in phenylketonuria (PKU). However, measuring Phe content of all foods requires expensive and time-consuming experiments. Instead, we suggest a method to automatically determine the amount of each ingredient that is used to prepare a commercial food by using the information provided on its label. The method applies when there is no loss of nutrients or fluid during the preparation process. We then apply our method to the problem of automatically anticipating Phe content of foods.

Erin Rizzie

Title: Multiple-valued functions
Abstract: In high school algebra, we all learned the vertical line test for functions, then we were quickly told that the inverses of some of our favorite functions, like the square root, fail the test. Later, we saw other ”non-function” functions like the complex logarithm. Of course, these *multiple-valued functions* really are useful, and they arise naturally as inverses of non-injective functions. We are led to wonder in what context they can be viewed as bona fide functions. In this talk, I’ll discuss such a context and some of my work with multiple-valued functions.
