Colloquium, Academic Year 17-18

Thursdays 4:10 pm in 5211 Stevenson Center, unless otherwise noted
Tea at 3:33 pm in 1425 Stevenson Center
Colloquium Chair (2017-2018): Ioana Suvaina

September 14, 2017 (Thursday), 4:10 pm

Applied Random Matrix Theory

Joel A. Tropp, California Institute of Technology
Location: Stevenson 5211
Random matrices now play a role in many areas of theoretical, applied, and computational mathematics. Therefore, it is desirable to have tools for studying random matrices that are flexible, easy to use, and powerful. Over the last fifteen years, researchers have developed a remarkable family of results, called matrix concentration inequalities, that balance these criteria. This talk offers an invitation to the field of matrix concentration inequalities and their applications. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Akram Aldroubi)

September 21, 2017 (Thursday), 4:10 pm

Calibrations, Potential Theories and the Dirichlet Problem

Blaine H. Lawson, Stony Brook University
Location: Stevenson 5211
I will begin by explaining the theory of calibrations and present some important examples. These examples are cases where one has large families of minimal (in fact, homologically volume minimizing) varieties. The basic case is K\”ahler geometry, where the varieties are the complex analytic ones. Now for a general calibrated manifold there is no analogue of the holomorphic functions. However, it turns out that there is always a complete analogue of the plurisubharmonic functions (those which are subharmonic on complex curves), and many of the results from several complex variables carry over. These functions are, in a sense, dual to the subvarieties. Furthermore, the inequality defining general plurisubharmonic functions also gives an equality, that is, a nonlinear partial differential equation. These associated equations are generalizations of the complex Monge-Amp\`ere equation in the K\”ahler case. We now have a good understanding of how to solve the Dirichlet Problem for solutions to these equations. An example some people may like concerns symplectic manifolds equipped with a Gromov metric. The associated plurisubharmonic functions are those whose Hessian has non-negative trace on every Lagrangian plane. The corresponding differential operator is a polynomial in tr$(D^2 u)$ and the skew-Hermitian part of $D^2 u$. Tea at 3:30 pm in Stevenson 1425. (Contact Person: Ioana Suvaina)

September 28, 2017 (Thursday), 4:10 pm

Random Graphs and Applications to Geometric Group Theory

Jason Behrstock, CUNY Graduate Center
Location: Stevenson 5211
Erdos and Renyi introduced a model for studying random graphs of a given “density” and proved that there is a sharp threshold at which lower density random graphs are disconnected and higher density ones are connected. Motivated by ideas in geometric group theory we will survey connections between this field and graph theory and describe new threshold theorems for random graphs and applications to the geometry of Coxeter groups. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Denis Osin)

October 5, 2017 (Thursday), 4:10 pm

Perturbations of Operators and Commutants Mod Normed Ideals

Dan-Virgil Voiculescu, University of California, Berkeley
Location: Stevenson 5211
Normed ideals of compact operators are the infinitesimals of Alain Connes’ noncommutative geometry. In the study of operators modulo perturbations from these ideals a numerical invariant plays often a key role. Recently more structure is appearing in these questions from the commutant modulo the normed ideal. Connections with dynamical entropy, K-theory of operator algebras, supramenable groups and Banach space duality aspects will also be discussed. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Dietmar Bisch)

October 19, 2017 (Thursday), 4:10 pm

Rigidity for Group von Neumann Algebras

Adrian Ioana, University of California at San Diego
Location: Stevenson 5211
Any countable group Γ gives rise to a von Neumann algebra $L(\Gamma)$. The classification of these group von Neumann algebras is a central theme in operator algebras. I will survey recent rigidity results which provide instances when various algebraic properties of groups, such as the existence or absence of a direct product decomposition, are remembered by their von Neumann algebras. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Jesse Peterson)

October 26, 2017 (Thursday), 6:10 pm

Algebraic Methods in Numerical Computations

Lek-Heng Lim, University of Chicago
Location: Stevenson 5211
We show that in many instances, at the heart of a problem in numerical computation sits a special 3-tensor, the structure tensor of the problem that uniquely determines its underlying algebraic structure. For example, the Grothendieck constant, which plays an important role in unique games conjecture and SDP relaxations of NP-hard problems, arises as the spectral norm of such a structure tensor. In matrix computations, a decomposition of the structure tensor into rank-1 terms gives an explicit algorithm for solving the problem, its tensor rank gives the speed of the fastest possible algorithm, and its nuclear norm gives the numerical stability of the stablest algorithm. As an explicit example, we determine the fastest algorithms for the basic operation underlying Krylov subspace methods — the structured matrix-vector products for sparse, banded, triangular, symmetric, circulant, Toeplitz, Hankel, Toeplitz-plus-Hankel, BTTB matrices — by analyzing their structure tensors. Our method is a generalization of the Cohn–Umans method, allowing for arbitrary bilinear operations in place of matrix-matrix product, and arbitrary algebras (e.g., coordinate rings of schemes, cohomology rings of manifolds, PI algebras) in place of group algebras. The second part is joint work with Ke Ye. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Mike Neamtu)

November 2, 2017 (Thursday), 4:10 pm

Vaught's Conjecture in Computability Theory

Antonio Montalbán, University of California, Berkeley
Location: Stevenson 5211
We'll describe Vaught's conjecture, which is one of the most well-known and longest-standing open questions in mathematical logic. The conjecture essentially says that the continuum hypothesis holds when restricted to counting the number of models of a theory. We'll mention the author's result that this conjecture is equivalent to a computability-theoretic statement. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Costas Tsinakis)

November 9, 2017 (Thursday), 4:10 pm

Connes' Character Rigidity Conjecture for Lattices in Higher Rank Groups

Jesse Peterson, Vanderbilt University
Location: Stevenson 5211
A character on a group is a class function of positive type. For finite groups, the classification of characters is closely related to the representation theory of the group and plays a key role in the classification of finite simple groups. Based on the rigidity results of Mostow, Margulis, and Zimmer, it was conjectured by Connes that for lattices in higher rank simple Lie groups, the space of characters should be completely determined by their finite dimensional representations. In this talk, I will discuss the solution to this conjecture, and I will discuss its relationship to ergodic theory, invariant random subgroups, and von Neumann algebras. Tea at 3:33 pm in Stevenson 1425.

November 16, 2017 (Thursday), 4:10 pm

Isogeometric Analysis

Thomas J.R. Hughes, University of Texas at Austin
Location: Stevenson 5211
The vision of Isogeometric Analysis was first presented in a paper published October 1, 2005 [1]. Since then it has become a focus of research within both the fields of Finite Element Analysis (FEA) and Computer Aided Design (CAD) and is rapidly becoming a mainstream analysis methodology and a new paradigm for geometric design [2]. The key concept utilized in the technical approach is the development of a new foundation for FEA, based on rich geometric descriptions originating in CAD, resulting in a single geometric model that serves as a basis for both design and analysis. In this overview, I will describe some areas in which progress has been made in developing improved Computational Mathematics methodologies to efficiently solve problems that have been at the very least difficult, if not impossible, within traditional FEA. I will also describe current areas of intense activity and areas where problems remain open, representing both challenges and opportunities for future research (see, e.g., [3,4]).
REFERENCES:[1] T.J.R. Hughes, J.A. Cottrell and Y. Bazilevs, Isogeometric Analysis: CAD, Finite Elements, NURBS, Exact Geometry and Mesh Refinement, Computer Methods in Applied Mechanics and Engineering, 194, (2005) 4135-4195.[2] J.A. Cottrell, T.J.R. Hughes and Y. Bazilevs, Isogeometric Analysis: Toward Integration of CAD and FEA, Wiley, Chichester, U.K., 2009.[3] Special Issue on Isogeometric Analysis, (eds. T.J.R. Hughes, J.T. Oden and M. Papadrakakis), Computer Methods in Applied Mechanics and Engineering, 284, (1 February 2015), 1-1182.[4] Special Issue on Isogeometric Analysis: Progress and Challenges, (eds. T.J.R. Hughes, J.T. Oden and M. Papadrakakis), Computer Methods in Applied Mechanics and Engineering, 316, (1 April 2017), 1-1270.Tea at 3:33 pm in SC 1425. (Contact Person: Mike Neamtu)

November 27, 2017 (Monday), 4:10 pm

Special Colloquium

Location: Stevenson 1206
Tea at 3:33 pm in SC 1425

November 29, 2017 (Wednesday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

November 30, 2017 (Thursday), 4:10 pm

Word-Hyperbolic Surface Bundles

Christhoper Leininger, University of Urbana, Champaign
Location: Stevenson 5211
In the late 70's and early 80's, Thurston's approach to studying 3-manifolds revolutionized the theory, showing that hyperbolic geometry provided a framework to more systematically study these manifolds. Specifically, he conjectured (and proved in many cases) that 3-manifolds could be canonically decomposed into geometric pieces, with hyperbolic geometry being the richest and most interesting geometric structure arising. Based on earlier work by Dehn, the key features of hyperbolic geometry were abstracted by Gromov to study more general spaces (most famously, finitely generated groups), and he has asked whether the analogue of the "hyperbolic parts" of Thurston's geometrization hold in a more general setting. In this talk, I will describe a particular instance of Gromov's "hyperbolization question", motivated by Thurston's approach, and explain some partial results in this direction. This is joint work with Bestvina, Bromberg, and Kent. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Mark Sapir)

December 6, 2017 (Wednesday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

December 7, 2017 (Thursday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

January 9, 2018 (Tuesday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

January 11, 2018 (Thursday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

January 16, 2018 (Tuesday), 4:10 pm

Special Colloquium

Location: Stevenson 5211
Tea at 3:33 pm in SC 1425

February 8, 2018 (Thursday), 4:10 pm

Topological Vistas in Neuroscience

Kathryn Hess Bellwald, EPFL (École Polytechnique Fédérale de Lausanne)
Location: Stevenson 5211
I will describe results obtained in collaboration with the Blue Brain Project on the topological analysis of the structure and function of digitally reconstructed microcircuits of neurons in the rat cortex and outline our on-going work on topology and synaptic plasticity. The talk will include an overview of the Blue Brain Project and a brief introduction to the topological tools that we use. If time allows, I will also briefly sketch other collaborations with neuroscientists in which my group is involved. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Anna Marie Bohmann)

February 15, 2018 (Thursday), 4:10 pm

A Geometric Approach to Artin Groups

Ruth Charney, Brandeis University
Location: Stevenson 5211
Artin groups arise naturally as fundamental groups of hyperplane complements. They form a large and diverse collection of groups which include braid groups, free groups, free abelian groups and many more. While some classes of Artin groups are well understood, many remain mysterious, with even very basic questions unanswered. In this talk we will review what is known and not known, then discuss some old and some new geometric techniques for studying these groups. (No prior familiarity with Artin groups will be assumed.) Tea at 3:33 pm in Stevenson 1425. (Contact Person: Spencer Dowdall)

February 22, 2018 (Thursday), 4:10 pm

Distortion of Surfaces in 3-manifolds

Chris Hruska, University of Wisconsin-Milwaukee
Location: Stevenson 5211
A finitely generated group G admits a natural word metric that has been popularized by Gromov. A finitely generated subgroup H<G has its own intrinsic word metric, as well as the metric induced by G. Distortion is a function measuring the degree of difference between these two metrics. In the setting of compact 3-manifolds and their surface subgroups, distortion is often closely connected with other geometric or topological properties. I will discuss one such connection between distortion and virtual embedding. An immersed surface in a 3-manifold M is virtually embedded if the immersion lifts to an embedding in a finite cover of M. In the setting of 3-dimensional graph manifolds and horizontal surfaces, we show that a surface has quadratic distortion if it is virtually embedded and has exponential distortion if it is not virtually embedded. This is joint work with Hoang Thanh Nguyen. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Matthew Haulmark)

March 1, 2018 (Thursday), 4:10 pm

Compressed Sensing for the Real World: Closing the Gap Between Theory and Practice

Bernhard G. Bodmann, University of Houston
Location: Stevenson 5211
The theory of compressed sensing promises to revolutionize remote sensing, biomedical imaging and perhaps even digital photography. Mathematically, this theory is appealing because of the interplay of elements from random matrix theory, optimization theory and analysis. However, the randomized sensing model and the grid-based sparsity assumption central to many results are somewhat disconnected from typical signal spaces and sensor architectures used in engineering. This talk explores recent trends in narrowing the gap between theory and practice. Instead of sparsity in an orthonormal basis, we define a notion of sparsity in reproducing kernel spaces. The signal space is permitted to be infinite-dimensional while obtaining recovery from a finite number of measured quantities. The recovery procedure is based on optimization of a total variation norm. This work, in collaboration with Gitta Kutyniok and Axel Flinth, extends results by Candes and Fernandez-Granda as well Recht et al. This talk is intended for a general mathematics audience. Despite the claims made in the title, little knowledge of the real world will be assumed.Tea at 3:33 pm in Stevenson 1425. (Contact Person: Akram Aldroubi)

March 15, 2018 (Thursday), 4:00 pm

Emerging Scholars in Arts & Science Lecture Series: Local Geometry of Neuronal Activity in Mice

Gal Mishne, Yale University
Location: Kissam C210
Gal Mishne, Gibbs Assistant Professor of Applied Mathematics at Yale University, will present this lecture as part of the Emerging Scholars in Arts & Science series. This lecture series, co-sponsored by the College of Arts & Science and the Office of the Vice Provost for Inclusive Excellence, is intended to spark new conversations within the Vanderbilt community through guest presentations by early-career scholars from traditionally underrepresented backgrounds whose innovative research promises to make significant and lasting contributions to their fields of study. The series features three speakers each year: one each from the humanities, natural sciences, and social sciences.
Abstract: Experimental advances in neuroscience enable the acquisition of increasingly large-scale, high-dimensional and high-resolution neuronal and behavioral datasets, yet addressing the full spatiotemporal complexity of these datasets poses significant challenges for data analysis and modeling. I present a new geometric analysis framework, and demonstrate its application to the analysis of calcium imaging from the primary motor cortex in a learning mammal. To extract neuronal regions of interest, we develop Local Selective Spectral Clustering, a new method for identifying high-dimensional overlapping clusters while disregarding noisy clutter. We demonstrate the capability of this method to extract hundreds of detailed neurons with demixed and denoised time-traces. Next, we propose to represent and analyze the extracted time-traces as a rank-3 tensor of neurons, time-frames and trials. We introduce a data-driven method for tensor analysis and organization, which infers the coupled multi-scale structure of the data. In analyzing neuronal activity from the motor cortex we identify in an unsupervised manner: functional subsets of neurons, activity patterns associated with particular behaviors, and long-term temporal trends.
A reception will follow the lecture.

March 22, 2018 (Thursday), 4:10 pm

The Many Faces of Dispersive Equations

Gigliola Staffilani, Massachusetts Institute of Technology
Location: Stevenson 5211
In recent years great progress has been made in the study of dispersive and wave equations. Over the years the toolbox used in order to attack highly nontrivial problems related to these equations has developed to include a variety of techniques including Fourier and harmonic analysis, analytic number theory, math physics, dynamical systems, probability and symplectic geometry. In this talk I will introduce a variety of problems connected with dispersive and wave equations, such as the derivation of a certain nonlinear Schrodinger equation from a quantum many-particles system, periodic Strichartz estimates, the concept of energy transfer, the invariance of a Gibbs measure associated to an infinite dimension Hamiltonian system and, if time permits, non-squeezing theorems for such systems when they also enjoy a symplectic structure. Tea at 3:33 pm in Stevenson 1425. (Contact Person: Giusy Mazzone)

March 29, 2018 (Thursday), 4:10 pm

Riccati Equations and Nonlinear PDE

Lawrence Craig Evans, University of California, Berkeley
Location: Stevenson 5211
In this expository lecture I will first explain some PDE theory analogs of Riccati equation tricks from ODE theory. I will then discuss recent progress (and conjectures) concerning weak KAM theory and distinguished solutions of related Riccati matrix equations.Tea at 3:33 pm in Stevenson 1425. (Contact Person: Vaughan Jones)

April 19, 2018 (Thursday), 4:10 pm

Special Colloquium: Samir Aldroubi and Amira Azhari Award Winner

Samir Aldroubi and Amira Azhari Award Winner
Location: Stevenson 5211
Winner of the Samir Aldroubi and Amira Azhari Award, will be announced at the 2018 Award Ceremony on April 18. The recipient is invited to deliver a mathematics colloquium reflecting his or her research interests. Tea at 3:33 pm in SC 1425. (Contact person: math department)

» Past Colloquia