Heat Equation and Reflected Brownian Motion in Time Dependent Domains

Krzysztof Burdzy, Univ. Washington

Abstract:

The talk will be focused on properties of heat equation solutions in one-dimensional time-dependent domains, with Neumann boundary conditions, i.e., with no flux through the boundary. Singularities and "heat atoms" in domains with rough boundaries will be discussed. Questions of existence and uniqueness of solutions to the heat equation and refected Brownian motion will be mentioned, if time permits. This is joint work with Z. Chen and J. Sylvester.

A Hybrid Approach for Solving Large Scale Crew Scheduling Problems

Cid Carvalho de Souza, UNICAMP

Abstract:

Autores: Tallys H. Yunes, Arnaldo V. Moura and Cid C. de Souza

We consider several strategies for computing optimal solutions to large scale crew scheduling problems. Provably optimal solutions for very large real instances of such problems were computed using a hybrid approach that integrates mathematical and constraint programming techniques. The declarative nature of the latter proved instrumental when modeling complex problem restrictions and, particularly, in efficiently searching the very large space of feasible solutions. The code was tested on real problem instances, containing an excess of 1.8x109 entries, which were solved to optimality in an acceptable running time when executing on a typical desktop PC.

Zero Temperature Dynamics of Two Spin Systems

Luiz Renato Fontes, IME/USP

Abstract:

We review recent and current work concerning zero temperature stochastic dynamics in which the speaker is involved. One of the models treated is the ordinary ferromagnetic Ising model in two and higher dimensions with product initial condition at high density, for which convergence to the "all plus" configuration is shown for almost every realization of the initial condition and dynamical variables. The argument uses renormalization. In two dimensions the convergence is shown to be subexponential.

For another model, the Voter model with random rates in one dimension, under a heavy "tail near zero" condition on the rate distribution, for almost every realization of the initial condition and rates, the dynamics does not converge. We call this phenomenon "chaotic time dependence", since it is related with the fact that the distribution of the process, as a function of the initial condition and the rates, has non vanishing fluctuations at arbitrarily large times. This is in turn related to the concentration of the distribution of the dual random walk with random rates. This can be established through the scaling limit of the latter process, a diffusion whose speed measure is discrete."

The Bispectral Problem

Alberto Grunbaum, Univ. California, Berkeley

Abstract:

Under the umbrella of "the bispectral problem" one can place a number of problems with connections to special functions, mathematical physics, harmonic analysis in symmetric

spaces, algebro-geometric aspects of rings of differential operators, isomonodromic deformations, integrable systems, etc.

I will attempt to give a completely introductory view of the problem and point in the direction of many open problems.

Counting Points of Bounded Rlative Height

Ana Meda Guardiola, UNAM, México

Abstract:

We prove Nummelin's conditional weak law of large numbers in different contexts, then apply large deviations techniques to identify the limit in terms of the so called dominating point, and obtain some applications to different weak laws as well as to the Gibbs conditioning principle. Now we are examining some rates of convergence to those limits.

L2 Notions of Rectafiability and Applications to Harmonic and Numerical Analysis

Plenary Lecture

Peter Jones (Yale Univ)

Abstract:

We discuss various multi-scale notions of L2 deviations from flatness for a set or measure in Rn. Roughly speaking, this amounts to a multi-scale notion of least squares in the statistical sense. This theory has provided a wealth of results in harmonic analysis where one relates some function theoretic problem to estimates in geometric measure theory. Recent work by Gilad Lerman shows how to effectively extend these notions to the study of large data sets with mixed dimensionality and noise.

Cauchy Transforms of Measures and Relations to Large Data Sets
Title for Harmonic Analysis/Operator Theory – session – UMALCA

Peter Jones (Yale Univ)

Abstract:

We use certain estimates related to Beta Numbers to prove that a planar continuum supports a nonzero measure with bounded Cauchy Transform. This old problem therefore fits into Melnikov's program for analytic capacity. We also discuss relations to the study of large data sets.

Geometric Structures Associated with Dynamics of Rational Maps

Mikhail Lyubich, SUNY at Stony Brook

Abstract:

To any rational endomorphism of the Riemann sphere one can naturally associate a two-dimensional affine lamination and a three-dimensional hyperbolic lamination. We will describe beautiful geometric structures carried by these laminations: conformal and harmonic measures, characteristic and Busemann cocycles, currents and harmonic functions... We anticipate an intimate relation between these structures and fractal geometry of the underlying dynamical objects.

Convergence to Equilibrium for Disordered Systems and Poincaré Inequalities

Pierre Mathieu,CNRS, Marseille, France / IME, USP, São Paulo

Abstract:

The aim of the talk is to illustrate the use of Poincaré, or generalized Poincaré inequalities in the context of disordered Markov chains. We shall present new results on the speed of convergence towards equilibrium for dynamical spin glasses and discuss spectral properties of random walks in a random environment.

The eta-invariant of Twisted Dirac Operators of S3/ Gamma

Jose Luis Cisneros Molina, U.N.A.M.

Abstract:

The aim of this talk is to explain how to compute the eta and xi invariants, defined by Atiyah-Patodi-Singer, for the Dirac operator of the quotient of the sphere S3 by a finite subgroup, twisted by a representation of its fundamental group.

The Minimal Entropy Problem for Simply Connected 5-Manifolds

Gabriel Paternain, Montevideo, CIMAT

Abstract:

Let M be a closed orientable manifold. Let h(M) be the infimum over all smooth Riemannian metrics g with volume one of the topological entropy of the geodesic flow of g. We say that the minimal entropy problem can be solved for M if there exists an entropy minimizing metric. Manifolds for which the minimal entropy problem can be solved seem to be rather special and so far there are only two classes of manifolds for which it is possible to show that the minimal entropy can be solved: surfaces and manifolds that admit a locally symmetric metric of negative curvature. This follows from results of Katok (for surfaces) and Besson, Courtois and Gallot.

We show that if M is simply connected and 5-dimensional then h(M)=0 the minimal entropy problem can be solved for M if and only if Mis diffeomorphic to S5, S3 x S2, the non-trivial S3-bundle over S2 or the Wu-manifold SU(3)/SO(3). This is joint work with Jimmy Petean.

Smoothness of the Self-diffusion Coefficient of Interacting Particle Systems

Claudio Landim, IMPA

Abstract:

We prove through a generalized duality method that the self-diffusion coefficient, given in general by a variational formula, is smooth. The method apply to the diffusion coefficient of non-gradient systems.

On the Geometry of Diffusion Operators and their Random Flows, and the Application to Viscous Fluids

Diego Rapoport, Univ. of Buenos Aires

Abstract:

We introduce a class of metric compatible connections which give rise to differential generators of diffusion processes of differential forms, on smooth manifolds. These connections (the so-called Riemann-Cartan-Weyl connections, RCW for short) have a tracefull torsion describing the drift. By introducing these connections as LeJan-Watanabe connections through their defining maps, we prove that the stochastic differential equations generated by the RCW connections, have a driftless Stratonovich representation, in dimension other than one. We extend these results to the diffusion of differential forms. We apply these constructions to the description of the vorticity of a viscous incompressible fluid on a smooth manifold, as well as the passive transport of a magnetic field on the fluid, and prove that the nonlinearity of these equations can be subsumed in a purely diffusive representation without drift.

Natural Variational Problems in the Grassmann Manifold of a C*-Algebra with Trace.

Lazaro Recht, Univ. Simon Bolivar, Venezuela

Abstract:

I consider a family of natural variational problems in the Grassmannian of a C*-Algebra with trace which can be considered as slightly degenerate Finsler metrics. I show that these problems have as solutions the standard geodesics, and that the short standard geodesics are absolute minima of the functionals restricted to a special class of curves.

These results are contained in a paper with the same title by C. Durán, L. E. Mata-Lorenzo and myself that will appear in Advances in Mathematics.

An Extension of Perron's Method and Some Existence Theorems of Constant Mean Curvature Surfaces with Boundary in Parallel Planes of R3

Jaime Ripoll, UFRGS

Abstract:

Our purpose with this lecture is twofold: we first present an extension of a well known technique used for proving the existence of solutions to the Dirichlet problem of certain PDE's, known as Perron's method. This extension allows us to apply this technique not just for functions but for surfaces as well. Secondly, we apply this extension in the proof of existence of compact minimal and constant mean curvature surfaces spanning two given convex curves in parallel planes of R3. Part of the results discussed in this lecture constitute a joint work with Pedro Fusieger.

Weakly Nonlinear Gas Dynamics in Semi-Open Tubes

Rodolfo R. Rosales, ETH

Abstract:

Joint work with Guillermo Goldsztein In this paper we study the long time behavior of acoustic waves in a semi--open narrow tube. We obtain the nonlinear boundary condition at open end and the equation describing the long time evolution of small but finite

amplitude waves. This asymptotic approximation is valid even for discontinuous solutions. In the long time asymptotic behavior shocks form in the solution. Due to the dissipation caused by these shocks, the acoustic wave amplitude decays as the inverse square root of time. This differs and it is much slower than the decay in closed tubes (where it is inversely proportional to time).

This is due to the fact that the shock waves in this case are not there all the time, but only during a fraction of each acoustic cycle -- the time it takes the waves to go back and forth along the tube. The asymptotic governing equations have a mathematical character that differs from that of the original equations. We explain here why this difference arises.

The Geometry of Bryant Surfaces in Hyperbolic 3-space

Harold Rosenberg, Univ. Paris VII

Abstract:

Bryant surfaces are immersed surfaces of mean curvature one in hyperbolic space. Bryant found a holomorphic parametrization of these surfaces and Bryant, Umehara-Yamada, and others, developed this subject. We will discuss the geometry of properly embedded Bryant surfaces in compact
hyperbolic 3-manifolds.

The M-matrix Problem: a Probabilistic Approach

Jaime San Martin, Univ. Chile

Abstract:

It is an important problem in the theory of matrices to characterize when a matrix with nonnegative coefficients is the inverse of a M-matrix. We shall prove, using probabilistic arguments, that an ultrametric matrix has this property and moreover its inverse is row and column diagonally dominant.

We consider also some generalizations and related problems. In particular we show that a necessary and sufficient condition for a matrix A to be the inverse of a M-matrix is that A, is proportional to and h-transform of the potential of a transient Markov chain. Some other related concepts, as for example Schur's decomposition, will be put in probabilistic perspective.

Interface Motion of a Two-Dimensional Ising Model at Zero-Temperature

Adilson Simonis, IME-USP

Abstract:

We derive the response of the interface motion to an uniform small external magnetic field of two-dimensional zero-temperature stochastic Ising model.

Dynamics of the Adiabatic Piston

Ya. Sinai, Princeton Univ.

Abstract

Dynamics of the adiabatic piston is one of the central problem of non-equilibrium statistical mechanic. Recently some progress was achieved in our joint paper with Lebowitz and Piasecki. Our method show that there can appear unusual oscillations.

On the Mathematical Foundations of Learning Theory

S. Smale, City Univ. of Hong Kong

Abstract:

We give a big emphasis to the relationship of approximation to learning and the primary role of sampling (inductive inference). We hope to emphasize relations of this subject to the mainstream of mathematics. In particular, there are large roles for probability theory, for algorithms such as {\em least squares}, and for tools and ideas from linear algebra and linear analysis. An advantage of doing this is that communication is facilitated and the power of core mathematics is more easily brought to bear.

Sobre os Epigrupos Monotéticos Localmente Compactos

Tanana B.P., Instituto Superior de Ciências e Tecnologia de Moçambique (ISCTEM)

Abstract:

Um semigrupo chama-se **epigrupo** se alguma potência de cada elemento pertence a um subgrupo. Consideram-se varias generalizações de noção de epigrupo para os semigrupos topologicos e demonstra-se que qualquer epigrupo monotético localmente compacto é compacto ou discreto.

On the Complexity of the Integral Closure

Wolmer Vasconcelos, Rutgers University

Abstract:

The availability of inexpensive processing power has allowed the tackling of several constructions in algebraic geometry. The determination of the integral closure of affine rings has been the focus of several modern algorithms. We will discuss the problem of estimating the number of generators the integral closure of an affine domain A may require. This number, and the degrees of the generators in the graded case, are major measures of costs of the computation. From joint work with Bernd Ulrich, we report on progress in this question for various kinds of algebras, particularly algebras with a small singular locus. At the worst, these estimates have the double exponential shape of Gröbner bases computations. We then turn to a different approach to the issue of complexity by developing a setting for analyzing the efficiency of algorithms that compute the integral closure of affine rings. It gives quadratic (cubic in the non-homogeneous case) multiplicity based but dimension independent bounds for the number

of passes the basic construction will make, thereby leading to the notion of astronomical unit of complexity

Three-dimensional Subgroups and Unitary Representations

D. Vogan, MIT

Abstract:

The simplest noncommutative compact Lie group is SU(2), the group of unit quaternions. If G* is a compact Lie group, write D(G*) for the set of conjugacy classes of homomorphisms of SU(2) into G*. Dynkin showed in the 1950s that D(G*) is a finite set, and calculated it in all cases. A fundamental unsolved problem is to parametrize the "purely real" unramified unitary representations of a split reductive group G. Such representations are parametrized by a compact polytope P(G). When G and G* are "Langlands dual" to each other, a conjecture of Arthur realizes D(G*) as a subset of P(G). I will discuss how the two problems illuminate each other.

Robust Estimates Based on Projections

Victor Yohai, Univ. de Buenos Aires and CONICET

Abstract:

Most of the classical statistical estimation procedures assume normal errors. However a small fraction of atypical observations (outliers) may have a large influence on these estimates. Estimates, that are not greatly influenced by outliers, are called robust

estimates. In this talk we will present a general procedure based on projections (projection estimates) for obtaining robust estimates for multivariate problems from their analogous univariate problems. We will derive projection estimates for linear regression, generalized linear models, multivariate location and covariance matrices. The robustness properties of these estimates will be discussed.

Finally we will present computing algorithms.