General Schedule

Wednesday, 28 January, 2015

19:00	Reception, City Top, City University, 9/F

Thursday, 29 January, 2015

	Room Y5403 Chairman: R. Wong
9:20–9:30	Welcoming words
9:30–10:20	**D. Leviatan** *Weighted D-T moduli revisited and applied*
10:30	Coffee Break
11:00–11:50	**D.-X. Zhou** *Approximation theory of some learning algorithms*
12:00	Lunch Break (City Chinese Restaurant, City University, 8/F)
	Room Y5403 Chairman: H.-H. Dai
14:00–14:50	**F. Cucker** *On the computation of eigenpairs*
15:00–15:50	**S. Schochet** *Pseudo-differential commutators for singularly-perturbed evolution equations involving variable-coefficient large operators*
16:00	Coffee Break
16:30–17:20	**N. Dyn** *Reconstruction of 3D objects from their 2D cross-sections by a subdivision scheme for sets*

Friday, 30 January, 2015

	Room Y5403 Chairman: N. Dyn
9:30–10:20	**D. Levin** *Between moving least-squares and moving least-ℓ_1*
10:30	Coffee Break
11:00–11:50	**H.H. Dai** *Series-asymptotic Solutions for Crease Formations in a Gel Layer*
12:00	Lunch Break (City Chinese Restaurant, City University, 8/F)
	Room Y5403 Chairman: D. Levin
14:00–14:50	**E. Farhi** *The metric derivative of set-valued functions*
15:00–15:50	**D. Amelunxen** *Beyond counting faces: Integral geometry of polyhedral cones*

Saturday, 31 January, 2015

10:00	Excursion

Sunday, 1st February, 2015

	Room Y5403 Chairman: F. Cucker
9:30–10:20	**N. Sochen** *The (Statistical) Mechanics of Wealth Distribution*
10:30	Coffee Break
11:00–11:50	**X. Zhuang** *Directional Tensor Product Complex Tight Framelets and Their Applications in Image/Video Processing*
12:00	Lunch Break (City Chinese Restaurant, City University, 8/F)
	Room Y5403 Chairman: D. Leviatan
14:00–14:50	**M. Zukerman** *Some Mathematical Problems in Internet Design*
15:00–15:50	**S. Dekel** *Harmonic analysis on manifolds*
16:00	Coffee Break
16:30–17:20	**D. Dai** *Critical Edge Behavior in the Singularly Perturbed Laguerre Unitary Ensemble*
18:30	Banquet

Abstracts

Dennis Amelunxen

Beyond counting faces: Integral geometry of polyhedral cones

Every polyhedral cone C possesses an associated f-vector, whose kth entry counts the k-dimensional faces of C. This talk is about certain weighted versions of the f-vector, which we call the u-vector and the v-vector (the kth entry of the v-vector is the kth intrinsic volume). Conic integral geometry is the theory of these vectors (and their localizations) for randomly formed cones. We will describe the algebraic foundations of this theory including characterization theorems and kinematic formulas. Surprisingly, it seems that the conic setting (as opposed to the better known Euclidean one) admits a very general kinematic formula, which might provide a real test for the notorious conic Hadwiger conjecture.

Felipe Cucker

On the computation of eigenpairs

We will describe both the shortcomings of the current algorithms for computation of eigenpairs (eigenvalue/eigenvector) and some recent theoretical advances to overcome these shortcomings.

Dan Dai

Critical Edge Behavior in the Singularly Perturbed Laguerre Unitary Ensemble

In this paper, we study the singularly perturbed Laguerre unitary ensemble

$$\frac{1}{Z_n}(\det M)^{\alpha} e^{-\operatorname{tr} V_t(M)} dM$$

with $V_t(x) = x + t/x$, $x \in (0, +\infty)$ and $t > 0$. Due to the effect of t/x for varying t, the eigenvalue correlation kernel has a new limit instead of the usual Bessel kernel at the hard edge 0. This limiting kernel involves ψ-functions associated with a special solution to a new third-order nonlinear differential equation, which is then shown equivalent to a particular Painlevé III equation. The transition of the limiting kernel to the Bessel and Airy kernels is also studied when the parameter t changes in a finite interval $(0, d]$. Our approach is based on the Deift-Zhou nonlinear steepest descent method for Riemann-Hilbert problems.

Hui-Hui Dai

Series-asymptotic Solutions for Crease Formations in a Gel Layer

An analytical study on crease formations in a swelling gel layer is conducted. By a method of coupled series-asymptotic expansions, we formulate a nonlinear eigenvalue problem of ordinary differential equations (ODEs), which are then solved analytically to obtain solutions for all the post-bifurcation branches. The results provide deep insights on crease formations, including the unveiling of three pathways to crease, determination of the bifurcation type, establishment of a lower bound for mode numbers

and two scaling laws. A number of experimental results are captured, whose interpretations are provided. It appears that the present work offers a comprehensive understanding on crease formation, a widely-spread phenomenon.

This is a joint work with Xiaoyi Chen.

Shai Dekel

Harmonic analysis on manifolds

We are concerned with developing representations and function spaces over manifolds whose local geometry is governed by a self-adjoint positive operator L [1,2,3]. Typical examples for the operator L are the Laplacian over R^n, The Laplace-Beltrami over a manifold (such as a sphere), the Jacobi operator over $[-1, 1]$, etc. Under some regularity assumptions on the associated heat kernel, it is possible to develop wavelet-type representations and analyze meaningful function spaces that are a natural generalization of their Euclidian counterparts.

[1] G. Kerkyacharian and P. Petrushev. Heat kernel based decomposition of spaces of distributions in the framework of Dirichlet spaces. Trans. Amer. Math. Soc. 367 (2015), 121-189.

[2] S. Dekel, G. Kerkyacharian, G. Kyriazis and P. Petrushev. Compactly supported frames for spaces of distributions associated with non-negative self-adjoint operators, submitted.

[3] S. Dekel, G. Kerkyacharian, G. Kyriazis and P. Petrushev. Hardy spaces associated with nonnagative self-adjoint operators, submitted.

Nira Dyn

Reconstruction of 3D objects from their 2D cross-sections by a subdivision scheme for sets

The talk will first introduce subdivision schemes for curves, with emphasis on two basic schemes: "Corner cutting" and the "Interpolatory 4-point scheme". Then basic properties of sets needed for the understanding of the reconstruction method will be presented. The last part of the talk will be devoted to the the adaptation of the 4-point scheme to sets, and several examples of reconstruction by this scheme will be shown.

Elza Farkhi

The metric derivative of set-valued functions

We look for differentiability conditions on a multifunction that guarantee higher error order for simple approximants such as certain local linear approximants.

The following features highlight the metric derivative among others:

1. When it exists, it is unique and explicitly constructed. It may be viewed as a concrete unique realization of the directives of Z. Artstein and the Euler approximation of M.S. Nikolskii which have intrinsic non-uniqueness.

2. It assigns to each point of the graph of the multifunction a minimal set of "metric" tangent vectors. In particular, the metric derivative of a constant map is zero at each point of its graph, which is not necessarily true for other set-valued derivatives.

We calculate the metric derivative in some examples and give a sufficient condition on a multifunction for $O(h^2)$ approximation by the metric piecewise-linear interpolant.

This is a joint work with Nira Dyn and Ron Goldman.

Dany Leviatan

Weighted D-T moduli revisited and applied

We introduce weighted moduli of smoothness for functions $f \in L_p[-1,1] \cap C^{r-1}(-1,1)$, $r > 1$, that have an $(r-1)$st absolutely continuous derivative in $(-1,1)$ and such that $\varphi^r f^{(r)} \in L_p[-1,1]$, where $\varphi(x) = (1-x^2)^{1/2}$. These moduli are equivalent to certain weighted D-T moduli, but our definition is more transparent and simpler. In addition, instead of applying these weighted moduli to weighted approximation, which was the purpose of the original D-T moduli, we apply these moduli to obtain Jackson-type estimates on the approximation of functions in $L_p[-1,1]$ (no weight), by means of algebraic polynomials. We also have inverse theorems that yield characterization of the behavior of the derivatives of the function by means of its degree of approximation.

Joint work with K. Kopotun and I.A. Shevchuk.

David Levin

Between moving least-squares and moving least-ℓ_1

Given function values at scattered points in $\mathbf{R}^d$, possibly with noise, one of the ways of generating approximation to the function is by the method of moving least-squares (MLS). The method consists of computing local polynomials which approximate the data in a locally weighted least-squares sense. The resulting approximation is smooth, and is well approximating if the underlying function is smooth. Yet, as any least-squares based method it is quite sensitive to outliers in the data. It is well known that least-ℓ_1 approximations are not sensitive to outliers. However, due to the nature of the ℓ_1 norm, using it in the framework of a "moving" approximation will not give a smooth, or even a continuous approximation. This paper suggests an error measure which is between the ℓ_1 and ℓ_2 norms, with the advantages of both. Namely, yielding smooth approximations which are not too sensitive to outliers. A fast iterative method for computing the approximation is demonstrated and analyzed. It is shown that for a scattered data taken from a smooth function, with few outliers, the new approximation gives an $O(h)$ approximation error to the function.

Steve Schochet

Pseudo-differential commutators for singularly-perturbed evolution equations involving variable-coefficient large operators

After reviewing the classical theory of singular limits for singularly-perturbed evolution equations with constant-coefficient large operators, I will discuss recent progress on equations with variable-coefficient large terms.

Nir Sochen

The (Statistical) Mechanics of Wealth Distribution

We will review new approaches for economic and social problems such as wealth distribution, cities

population and opinion formation by means of coupled stochastic equations for many-agent systems. The huge set of equations can't in general be solved yet the global behaviour can be extracted in some cases. Various numerical experiments show interesting behaviour of phase transition. We will elaborate on these issues, show preliminary results and point for open problems and directions for further research.

Ding-Xuan Zhou

Approximation theory of some learning algorithms

Methods and ideas from approximation theory have played an important role in learning theory. In this talk we provide approximation theory viewpoints of some learning algorithms: learning with functional data, randomized Kaczmarz algorithm, additive models, one-bit compressed sensing, and some other related methods.

Xiaosheng Zhuang

Directional Tensor Product Complex Tight Framelets and their Applications in Image/Video Processing

Real-valued separable wavelets and framelets are known to have some shortcomings, in particular, they lack directionality for high dimensional problems, e.g., image/video processing. In this talk, we show that directionality can be greatly improved by using complex-value tight framelets. We shall present a comprehensive theory and construction of directional tensor product complex tight framelets. Moreover, we shall show that mixed-rate directional filter banks associated with directional tensor product complex tight framelets can be constructed with extremely low-redundancy rate, which is crucial for high-dimensional problems. Then we shall explore several applications of directional tensor product complex tight framelets in the area of image processing such as image/video denoising or inpainting. We shall show that directional tensor product complex tight framelets have superior performance in image processing, compared with many other frame-based methods.

This is a joint work with Prof. Bin Han of University of Alberta.

Moshe Zukerman

Some Mathematical Problems in Internet Design

A range of mathematical problems applicable to design of telecommunications networks will be presented. These problems will cover key networking topics such as traffic modelling, queueing analysis, cost optimization, and network survivability. Heuristic solution approaches based on a combination of stochastic modeling, mathematical programming and optimization will be described.