Second International Workshop on Matrix Analysis and Applications: Abstracts

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Title Matrix Diagonals, Retrospective and Prospective

ILAS Speaker Richard Brualdi (brualdi@math.wisc.edu), Department of Mathematics, University of Wisconsin, Madison, WI 53706

Abstract This talk will be centered around nonzero diagonals of square matrices with connections to the following topics: doubly stochastic matrices, simplices, isolated sets of diagonals, digraphs, permanent, Bruhat order, standard Young tableaux, ... [There will be very little overlap with the talk I gave at the ILAS meeting in Amsterdam in the summer of 2006.]

Title On the Group Automorphisms of the unitaries of $\mathbb{M}_n(\mathbb{C})$

Speaker Ahmed Al-Rawashdeh(rahmed72@just.edu.jo)
Department of Mathematics & Statistics, Jordan University of Science & Technology, JORDAN

Abstract The matrix algebra $\mathbb{M}_n(\mathbb{C})$ is a von Neumann factor of type I_n. Dye proved in the case of von Neumann factors not of type I_{2n} that the map θ_φ between the projections which is induced by automorphism φ on the group of the unitaries preserves the orthogonality of projections, in particular, for $\mathbb{M}_n(\mathbb{C})$ where n is odd. Afterwards, Al-Rawashdeh proved for a large class of simple unital C^*-algebras that the induced map θ_φ is an orthoisomorphism. Dye outlined an example of a unitary group automorphism of $\mathbb{M}_{2n}(\mathbb{C})$ where its induced map between the projections does not preserve orthogonaliy. In this paper we study the unitary group automorphism φ of $\mathbb{M}_n(\mathbb{C})$, and we give some characterizations for θ_φ to be an orthoisomorphism between the projections. Also, for all unitary group automorphisms of $\mathbb{M}_{2n}(\mathbb{C})$, we show that the set of their induced mappings which are orthoisomorphisms of the projections forms a group, as well as the set of all induced mappings which are not orthoisomorphisms, indeed we prove that these two groups are isomorphic.

Title Norm Compression Inequalities for Block Matrices

Speaker Koenraad M.R. Audenaert (k.audenaert@imperial.ac.uk)
Institute for Mathematical Sciences, Imperial College London, 53 Prince's Gate, London SW7 2PG, United Kingdom.

Abstract Given a block matrix $A = [A_{i,j}]$, its norm compression in any given norm can be defined as the matrix obtained by replacing each block by its norm: $C(A) := [|||A_{i,j}|||]$. One can then ask if and how knowledge of the norm compression yields useful information about the original matrix, under various constraints on the set of allowed matrices. More specifically, one can ask for upper and lower bounds on the norm of A solely in terms of the norm compression of A. I call these bounds norm compression inequalities.

In this talk I give an overview of existing inequalities that fall into this category — although they have not been known under this name before — and then move on to discuss a newly conjectured norm compression inequality that would have many important

consequences in Mathematics and Mathematical Physics. For example, one special case of this inequality is the generalisation of Hanner's inequality to matrices, conjectured by Ball, Carlen and Lieb. I present various other special cases for which a proof has been found.

Although norm compression inequalities can be envisaged for any kind of norm, in this talk I will only consider the Schatten p-norms, which are the non-commutative generalisations of the ℓ_p norms.

Title Matrix sub-additive inequality for concave functions and an arithmetic-geometric mean inequality

Speaker Jaspal Singh Aujla (aujlajs@nitj.ac.in)
Department of Applied Mathematics, National Institute of Technology, Jalandhar-144011, Punjab, INDIA

Abstract Let f be a nonnegative concave function on $[0, \infty)$ with $f(0) = 0$ and let A, B be $n \times n$ complex positive semidefinite matrices. We shall prove that

$$||f(A+B)|| \leq ||f(A) + f(B)||$$

for all symmetric norms $||\cdot||$. As an application of one of our results for log convex functions, we shall prove that

$$||\sqrt{|AB|}\,|| \leq \left|\left|\frac{A+B}{2}\right|\right|.$$

This settles affirmatively a conjecture by Bhatia and Kittaneh. Several related inequalities will be discussed.

Title A class of structured matrices related to boundary metric constrained interpolation

Speaker Vladimir Bolotnikov (vladi@math.wm.edu)
Department of Mathematics, College of William & Mary, VA 23185, USA

Abstract Let w be an analytic self-map of the open unit disk and let $t_0 \in \mathbb{T}$ be a boundary point. The Carthéodory-Julia theorem states that if $\liminf_{z\to t_0} \frac{1-|w(z)|^2}{1-|z|^2} < \infty$, then the nontangential boundary limits $w_0 = \lim_{z\to t_0} w(z)$ and $w_1 = \lim_{z\to t_0} w'(z)$ exist and $w_1 t_0 w_0^* \geq 0$. More generally, if $\liminf_{z\to t_0} \frac{\partial^{2n}}{\partial z^n \partial \bar{z}^n} \frac{1-|w(z)|^2}{1-|z|^2} < \infty$, then the nontangential boundary limits $w_j = \lim_{z\to t_0} \frac{w^{(j)}(z)}{j!}$ exist for $j = 0, \ldots, 2n+1$ and the structured matrix

$$P := \begin{bmatrix} w_1 & \cdots & w_{n+1} \\ \vdots & & \vdots \\ w_{n+1} & \cdots & w_{2n+1} \end{bmatrix} \mathbf{\Psi}_n(t_0) \begin{bmatrix} w_0^* & \ldots & w_n^* \\ & \ddots & \vdots \\ 0 & & {w_0}^* \end{bmatrix}$$

is positive semidefinite, where the first factor is a Hankel matrix, the third factor is an upper triangular Toeplitz matrix and where $\mathbf{\Psi}_n(t_0)$ is the upper triangular matrix with entries

$$\Psi_{j\ell} = \begin{cases} 0, & \text{if } \ j > \ell, \\ (-1)^\ell \binom{\ell}{j} t_0^{\ell+j+1}, & \text{if } \ j \leq \ell. \end{cases}$$

Some properties and characterizations of matrices of the above structure will be discussed.

Title : On the Norms of the Circulant Matrices with the Lucas Number

Speaker : Hacı Civciv (hacicivciv@selcuk.edu.tr)
Department of Mathematics, University of Selcuk, 42031, Konya, TURKEY

Co-author: Ramazan Türkmen (rturkmen@selcuk.edu.tr), University of Selcuk.

Abstract : A circulant matrix is a special kind of Toeplitz matrix where each row vector is rotated one element to the right relative to the preceding row vector. In numerical analysis circulant matrices are important because they can be quickly solved using the discrete Fourier transform. In this note, we first construct the $n \times n$ circulant and reciprocal circulant matrices with the Lucas number and then present lower and upper bounds for the Euclidean and spectral norms of these matrices and the addition of these matrices as a function of n and L_n, where L_n is nth Lucas number. Also, we give some examples to show the effectiveness of our bounds.

Title Minimum deviation, quasi-LU factorizations

Speaker Maria Isabel Bueno Cachadina (mbueno@math.ucsb.edu)
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Co-authors C. R. Johnson, (crjonhso@math.wm.edu)
Department of Mathematics, College of William & Mary, Williamsburg, VA 23185, USA.

Abstract Not all matrices enjoy the existence of an LU factorization. For those that do not, a number of "repairs" are possible. For nonsingular matrices we offer here a permutation-free repair in which the matrix is factored $\tilde{L}\tilde{U}$, with $\tilde{L}$ and $\tilde{U}$ collectively as near as possible to lower and upper triangular (in a natural sense defined herein). Such factorization is not generally unique in any sense. In the process, we investigate further the structure of matrices without LU factorization and permutations that produce an LU factorization.

Title The Kemeny Constant of an Ergodic Chain

Speaker Minnie Catral (mcatral@math.drexel.edu)
Department of Mathematics, Drexel University, Philadelphia, PA 19104.

Abstract For an n-state homogeneous ergodic Markov chain with states $\mathcal{S}_1, \cdots, \mathcal{S}_n$, whose stationary distribution vector is $\pi = [\pi_1, \cdots, \pi_n]^T$, and such that $m_{i,j}$ is the mean first passage time from state $\mathcal{S}_i$ to state $\mathcal{S}_j$, it is known that the expressions $\displaystyle\sum_{j=1}^{n} m_{i,j}\pi_j$, all have a common value independent of i. We define the common value K to be the Kemeny constant of the chain. In this talk, we will give a new formula for K in terms of group inverses and inverses of principal submatrices of an associated M-matrix. Practical interpretations of K will also be discussed.

Title Strong domination of certain means

Speaker Driss Drissi (drissi@mcs.sci.kuniv.edu.kw)
Department of Mathematics, Kuwait University

Abstract In this talk, using Bochner's theorem on Fourier transform and positive functions, comparison inequalities between certain means that interpolate between the geometric and the arithmetic are established. Examples are presentd to show their sharpness.

Title Periodic Three-Diagonal Matrices and Their Application to Spin Dynamics

Speaker Konstantin E. Feldman (k.feldman@dpmms.cam.ac.uk)
Department of Pure Mathematics and Mathematical Statistics, University of Cambridge, Wilberforce Road, Cambridge, CB3 0WB UK.

Abstract We discuss how to diagonalize explicitly quite a general class of large three-diagonal matricies with entries on all three diagonals repeating periodically with the same period k. As an application we consider problems of multiple quantum spin dynamics in inhomogeneous open linear spin chains and of quantum information theory.

Title On the convergence of Aluthge sequence

Speaker Huajun Huang (huanghu@auburn.edu)
Department of Mathematics and Statistics, Auburn University, Auburn, AL 36849, USA.

Co-authors Tin-Yau Tam (tamtiny@auburn.edu), Auburn University.

Abstract The Aluthge transform of a bounded operator X acting on a Hilbert space is $\Delta(X) := P^{1/2}UP^{1/2}$, where X has the polar decomposition $X = UP$ for $P := (X^*X)^{1/2}$ and U the corresponding partial isometry. It is generalized to the λ-Aluthge transform $\Delta_\lambda(X) := P^\lambda UP^{1-\lambda}$. The transform preserves several key properties of the original operator, and can be viewed as a kind of normalization process.

In operator theory/matrix theory, the convergence of the Aluthge sequence $\{\Delta_\lambda^m(X)\}_{m\in\mathbf{N}}$, where

$$\Delta_\lambda^0(X) := X, \qquad \Delta_\lambda^m(X) := \Delta_\lambda(\Delta_\lambda^{m-1}(X)),$$

has been studied extensively by several groups of mathematicians. In the joint works with T.Y. Tam, we survey and present some convergence results of the λ-Aluthge sequences in matrices. We show that if the nonzero eigenvalues of $X \in \mathbf{C}_{n\times n}$ have distinct eigenvalue moduli, then $\{\Delta_\lambda^m(X)\}_{m\in\mathbf{N}}$ converges to a normal matrix with the same eigenvalues as X.

Thereafter, we explore the λ-Aluthge transforms and sequences in the context of real semisimple Lie groups. Many good properties in matrices can be extended to those in semisimple Lie groups.

Title Normal and Commuting Completions

Speaker David Kimsey (dpk27@drexel.edu)
Department of Mathematics, Drexel University, Philadelphia, PA 19104, USA.

Co-author Hugo J. Woerdeman (hugo@math.drexel.edu), Drexel University.

Abstract Given $A \in \mathbb{C}^{n\times n}$. Can we find a normal matrix $A_{ext} := \begin{pmatrix} A & A_{12} \\ A_{21} & A_{22} \end{pmatrix}$, where $A_{12} \in \mathbb{C}^{n\times k}$, $A_{21} \in \mathbb{C}^{k\times n}$, and $A_{22} \in \mathbb{C}^{k\times k}$, of smallest possible size? We shall call the smallest number of rows and columns we need to add the *normal defect* of A and denote by $\mathrm{nd}(A)$. As it turns out, in certain situations, it is useful to make A_{ext} to be a nonzero

multiple of a unitary. The smallest possible k to do this shall be called the *unitary defect* of A. In this paper we provide a lower bound for $\mathrm{nd}(A)$, that for certain matrices is sharp. For the case when $\mathrm{nd}(A) = 1$ we also investigate what freedom one has in constructing A_{ext}.

In addition, we study the related question where $A \in \mathbb{C}^{n\times n}$ and $B \in \mathbb{C}^{n\times n}$ are given, and where we look for $A_{ext} := \begin{pmatrix} A & A_{12} \\ A_{21} & A_{22} \end{pmatrix}$ and $B_{ext} := \begin{pmatrix} B & B_{12} \\ B_{21} & B_{22} \end{pmatrix}$ such they commute and are of smallest possible size.

Title G-invariant norms and bicircular projections

Speaker Chi-Kwong Li (ckli@math.wm.edu)
Department of Mathematics, College of William & Mary, VA 23185, USA.

Co-authors: Maja Fošner (FL, University of Maribor, Slovenia) and
Dijana Ilišević (Department of Mathematics, University of Zagreb, Zagreb, Croatia)

Abstract It is shown that for many finite dimensional normed vector spaces $\mathbf{V}$ over $\mathbb{C}$, a linear projection $P : \mathbf{V} \to \mathbf{V}$ will have nice structure if $P + \lambda(I - P)$ is an isometry for some complex unit not equal to one. From these results, one can readily determine the structure of bicircular projections, i.e., those linear projections P such that $P + \mu(I - P)$ is a an isometry for every complex unit μ. The key ingredient in the proofs is the knowledge of the isometry group of the given norm. The proof techniques also apply to real vector spaces. In such cases, characterizations are given to linear projections P such that $P - (I - P) = 2P - I$ is an isometry.

Title HYPERBOLIC(or STABLE) POLYNOMIALS AND VAN der WAERDEN / SCHRIJVER-VALIANT LIKE CONJECTURES

Speaker Leonid Gurvits (gurvits@lanl.gov),
Los Alamos National Laboratory

Abstract The van der Waerden conjecture states that the permanent of n by n doubly stochastic matrix A satisfies the inequality $\mathrm{Per}(A) \geq n!/n^n$ (VDW bound) and was finally proven (independently) by D.I. Falikman and G.P. Egorychev in 1981 . Its worthy successor , the SCHRIJVER-VALIANT conjecture on the lower bound on the number of perfect matchings in k-regular bipartite graphs was posed in 1980 and resolved by A.Schrijver in 1998. The Schrijver's proof is one the most remarkable (and "highly complicated") results in the graph theory .

We introduce and prove a vast generalization of the VAN der WAERDEN conjecture as well SCHRIJVER-VALIANT conjecture . Our generalization not only affects the world of permanents, but also has important implications concerning PDEs, stability and control theory , complexity theory . Besides , our proof is much shorter and conceptually simpler than the original proofs ; it proves VAN der WAERDEN / SCHRIJVER-VALIANT conjectures in "one shot" . The main tool in our generalizations and proofs is a concept of hyperbolic polynomials . Hyperbolic polynomials were originally introduced and studied in the PDE theory. They are also closely related to the multivariate stable polynomials. VAN der WAERDEN / SCHRIJVER-VALIANT CONJECTURES correspond to the hyperbolic polynomials being products of linear forms. Our proof is relatively simple and "noncomputational" ; it actually

improves Schrijver's lower bound , provides a generalization for non-regular and weighted graphs, and uses very basic (more or less centered around Gauss-Lukas theorem) properties of hyperbolic polynomials .

The theory is fairly straightly generalized to lower bound the number of partial matchings (joint work with S. Friedland). One of the applications results in the best estimate of the 3-dimensional monomer-dimer entropy.

Time permit , I will describe my recent result on analogues of VAN der WAERDEN / SCHRIJVER-VALIANT CONJECTURES for the mixed volume of compact convex sets . This generalization goes beyond hyperbolic polynomials and results in a randomized poly-time algorithm to approximate the mixed volume of n convex compact subsets in R^n within a multiplicative factor e^n .

Title Quasiseparable matrices, quasiseparable polynomials, realted Vandermonde matrices and signal flow graphs.

Speaker Vadim Olshevsky (olshevsky@math.uconn.edu)
Department of Mathematics, University of Connecticut, Storrs, Connecticut.

Abstract In this talk we survey several recent algorithms that exploit properties of matrices having special quasiseparable structure. The latter class inludes several well-known classes of matrices whose relations to orthogonal polynomials is classical. Specifically, quasiseparable matrices include, e.g., tridiagonal matrices related to the real orthogonal polynomials, as well as unitary Hessenberg matrices that are related to the Szego polynomials. Hence, the polynomials associated with quesiseparable matrices generalize both classes of real orthogonal polynomials and Szego polynomials.

In this talk we focus on the efficiency of computations with the new general class of quasiseparable polynomials. In particular, several generalizations of the Bjorck-Pereyra and of the Traub algorithms for quasiseparable-Vandermonde matrices will be described. Some preliminary numerical illustrations will be presented. An interpretation of the new algorithms via signal flow graphs will be described.

Title Polynomial Numerical Hull

Speaker Abbas Salemi (axsale@wm.edu)
Department of Mathematics, SBU of Kerman, Iran.

Co-authors Chandler Davis, University of Toronto; Chi-Kwong Li, College of William & Mary,

Abstract : The notion of polynomial numerical hull was introduced by O. Nevanlinna in 1993. In this presentation we determine the polynomial numerical hulls of n-by-n normal matrices. Also, the relationship between polynomial numerical hulls and joint numerical range of matrices is considered.

Title Endomorphisms of matrix semigroups

Speaker Peter Šemrl (peter.semrl@fmf.uni-lj.si)
Department of Mathematics, University of Ljubljana, Jadranska 19, SI-1000 Ljubljana, Slovenia.

Abstract Let D be an arbitrary division ring and $M_n(D)$ the multiplicative semigroup of all $n \times n$ matrices over D. We describe the general form of endomorphisms of $M_n(D)$.

Title $\mathbb{Q}$ vs $\mathbb{R}$ and $\mathbb{R}$ vs $\mathbb{C}$

Speaker Bryan Shader (BShader@uwyo.edu)
Department of Mathematics, University of Wyoming, Laramie, WY 82071

Abstract Let F be a field and let A be an m by n $(0,1)$–matrix. The set of all m by n matrices over $\mathbb{F}$ with zero-nonzero pattern A is denoted by $\mathcal{Q}_{\mathbb{F}}(A)$, and the minimal rank of a matrix in $\mathcal{Q}_{\mathbb{F}}(A)$ is denoted by $\mathrm{mr}_{\mathbb{F}}(A)$. In this talk we present matrices A and B such that $\mathrm{mr}_{\mathbb{R}}(A) < \mathrm{mr}_{\mathbb{Q}}(A)$ and $\mathrm{mr}_{\mathbb{R}(\mathbb{A})} < \mathrm{mr}_{\mathbb{C}}(A)$.

Title Numerical Stability and Convergence of Finite-Difference Approximations to Some Fourth Order Linear Boundary Value Problems based on the Condition Number of a Five-Band Matrix

Speaker M. Shakil (mshakil@mdc.edu)
Department of Mathematics, Miami Dade College Hialeah, FL 33012, USA.

Co-authors J. N. Singh (jsingh@mail.barry.edu), Barry University.

Abstract Many applied problems can be formulated as a fourth order linear boundary value problem in ordinary differential equations. By using the finite-difference approximations, the solutions of the fourth order linear boundary value problems can be reduced to a set of difference equations. The resulting linear system of equations, when written in matrix notation, involves a five-band matrix. This paper discusses the numerical stability and convergence of finite-difference approximations to some fourth order linear boundary value problems in ordinary differential equations based on the condition number of a five-band matrix.

Title On Quasi-λ-Nuclearity

Speaker W. Shatanawi (swasfi@hu.edu.jo)
The Hashemite University, Zarqa-Jordan. (joint work with A. Tallafha)

Abstract The concept of p-quasi-nuclear map is introduced by Pitsich in 1967. While Dubinsiky introduced quasi-λ nuclear map. In 2005, Shatanawi introduced the concept of 2-quasi-λ-nuclear map. Here we introduce new type of maps between normed spaces, namely, p-quasi-λ-nuclear map. We prove that the composition of a q-quasi-λ-nuclear map $(0 < q \leq 1)$ with a p-quasi-λ-nuclear map $(0 < p \leq 1)$ is a pseudo-λ-nuclear map. Also we prove that for a nuclear G_∞-space a linear map T between normed spaces is p-quasi-λ-nuclear iff it is q-quasi-λ-nuclear.

Title Symmetric and Positive Semidefinite Matrices in Optimization and Modeling

Speaker J. N. Singh (jsingh@mail.barry.edu)
Department of Mathematics and Computer Science, Barry University, 11300 N. E. 2nd Ave., Miami Shores, FL 33161, USA

Co-author M. Shakil (mshakil@mdc.edu), Miami Dade College.

Abstract In this talk we discuss some applications of Symmetric and positive definite (PSD) matrices in Optimization and modeling.

Title Power dominance of positive definite matrices

Speaker Ilya M. Spitkovsky (ilya@math.wm.edu)
Department of Mathematics, College of William & Mary, Williamsburg, VA 23185, USA.

Co-authors C.R. Johnson, College of William & Mary, and B. T. Hoai, Duke University.

Abstract It is well known that the Lowner partial order $\geq$ is not preserved under taking powers bigger than one. We say that the matrix A *power dominates* B if $A^t \geq B^t$ for all $t > 0$, and characterize all pairs of positive definite matrices having this property. Moreover, we show that power dominance is not inherited by compressions (as opposed to the Lowner order) and give necessary and sufficient conditions under which any compression of A power dominates the respective compression of B.

Title A philatelic introduction to linear algebra and magic squares

Speaker George P. H. Styan (styan@math.mcgill.ca)
Department of Mathematics and Statistics,
McGill University, Montréal (Québec), Canada

Co-author Götz Trenkler (trenkler@amadeus.statistik.uni-dortmund.de), Universität Dortmund, Germany.

Abstract Among stamp collectors and philatelists who consider the rich and fascinating world of postage stamps to be "a mirror of civilization", William L. Schaaf in the preface to his 1978 book entitled *Mathematics and Science: An Adventure in Postage Stamps*, exemplified stamps reflecting "the impact of mathematics and science on society".

We agree and in this talk we look at stamps that are associated with scholars who have contributed to linear algebra and/or magic squares, and who have been recognized with a postage stamp. These scholars include: Tadeusz Banachiewicz, Giovanni Domenico Cassini, Augustin-Louis Cauchy, Charles Lutwidge Dodgson, Albrecht Dürer, Leonhard Euler, Benjamin Franklin, Carl Friedrich Gauß, Sir William Rowan Hamilton, Hua Luogeng, Athanasius Kircher, Aleksei Nikolaevich Krylov, Joseph-Louis Lagrange, Pierre-Simon Marquis de Laplace, Gottfried Wilhelm von Leibniz, Aleksandr Mikhailovich Lyapunov, John von Neumann, Jules Henri Poincaré, John William Strutt Third Baron Rayleigh, Takakazu Seki Kowa, and Anton (Friedrich Ernst) von Webern.

Title Asymptotic behavior, matrix decompositions, and Lie group

Speaker Tin-Yau Tam (tamtiny@auburn.edu)
Department of Mathematics, Auburn University, Auburn,AL 36849-5310, USA.

Co-authors Huajun Huang, Auburn University

Abstract We will discuss some well-known decompositions in matrix theory such as SVD, QR decomposition, Cholesky decomposition, QR iteration, and some asymptotic behaviors associated with those decompositions. Gelfand's theorem, Yamamoto's theorem and some recent results of Huang and Tam will be discussed. If time permits, we will mention their extensions in the context of Lie group.

Title Some Bounds for the Singular Values of Matrices

Speaker Ramazan Türkmen (rturkmen@selcuk.edu.tr)
Department of Mathematics, University of Selcuk, 42031, Konya, TURKEY

Co-author: Hacı Civciv (hacicivciv@selcuk.edu.tr), University of Selcuk.

Abstract We know that to estimate matrix singular values (especially the largest and the smallest ones) is an attractive topic in matrix theory and numerical analysis. In this note, we first provide a simple estimate for the smallest singular value $\sigma_n(A)$ of $n \times n$ positive definite matrix A. Secondly, we obtain some simple estimates for the smallest singular value $\sigma_n(A)$ and the largest singular value $\sigma_1(A)$ of any $n \times n$ complex matrix A, which is not necessarily positive definite. Finally, we get a simple estimate for the largest singular value $\sigma_1(A)$ of an $n \times n$ nonsingular complex matrix A. These estimates are presented as a function of the determinant and the Euclidean norm of A and n.

Title The asymptotic behavior of the spectral norm of Toeplitz matrices with Fisher-Hartwig singularities

Speaker J. A. Virtanen (jani.virtanen@helsinki.fi)
Department of Mathematics, University of Helsinki, Finland.

Co-authors A. Böttcher, Fakultät für Mathematik, TU Chemnitz, Germany.

Abstract We study the asymptotics of the spectral norm of finite Toeplitz matrices generated by symbols with Fisher-Hartwig singularities as the matrix dimension goes to infinity. For nonnegative symbols, our results provide the asymptotics of the largest eigenvalue of positive definite Toeplitz matrices, which is of interest in the analysis of time series with long memory.

Title Eigenspace decomposition of symmetric matrices using diffusion maps

Speaker Jianzhong Wang (MTH_JXW@shsu.edu)
Dept. of Math and Stat., Sam Houston State University, Huntsville, TX 77341

Abstract Diffusion processing occurs in many areas of physics, where a dynamical system gradually achieves a steady state as time develops. An important type of diffusion processing can be described by a symmetric, positive-definite matrix. In a diffusion processing, we are interested in the projection on the eigenspaces associated with larger eigenvalues. For high-dimensional matrices, efficient dimensionality reduction algorithms for eigenspace decomposition are desirable. By the aid of diffusion maps, the paper presents a fast dimensionality reduction algorithm for eigenspace decomposition of symmetric, positive-definite matrices.

Title The Fischer-Frobenius transformation and outer factorization

Speaker Hugo Woerdeman (hugo@math.drexel.edu)
Department of Mathematics, Drexel University, 3141 Chestnut Street, Philadelphia, PA 19104, USA.

Co-authors Yvan Hachez, Electrabel, Regentlaan/Bd. du Régent 8, B-1000, Brussels, Belgium

Abstract The notion of Schur complement for a positive semidefinite operator matrix is a fairly simple object. The Schur complement, however, has some very striking properties which, among others, allow it to give an elementary proof of Rosenblum's outer factorization result for positive definite operator valued trigonometric polynomials (see [DW]). In the present paper we study the Fischer-Frobenius transformation that gives a one-to-one correspondence between Toeplitz and Hankel matrices. We use the transformation to give an elementary proof of the outer factorization result for operator valued positive semidefinite polynomials of a real variable. In addition, a new maximization process is given to obtain the outer factor, which in finite dimension can be implemented using a standard semidefinite programming package. Finally, we briefly discuss the multivariable case as well.

[DW] Michael A. Dritschel and Hugo J. Woerdeman, *Outer factorizations in one and several variables*, Trans. Amer. Math. Soc. **357** (2005), no. 11, 4661–4679

Title Completely Positive matrices and block designs

Speaker Chang-Qing Xu (cqxuiit@yahoo.com)
Department of Mathematics, School of Science, Zhejiang Forestry University, Hangzhou 311300, China.

Co-authors Guang-Hui Xu (ghxu@zjfc.edu.cn), Zhejiang Forestry University.

Abstract We first generailze the concept of block designs on any subfiled of R, the field consisting of all the real numbers. The aim of this work is to investigate the relationship between completely positive matricesand the block designs.

Title On spectral properties of group circulant matrices

Speaker Peter Zizler (PZizler@mtroyal.ca)
Department of Mathematics, Physics and Engineering, Mount Royal College, Calgary, Alberta, Canada, T3E 6K6

Abstract Let G be a finite group (typically nonabelian) and let $l^2(G)$ be a finite dimensional Hilbert space of all complex valued functions (usual inner product) for which elements of G form the (standard) orthonormal basis. In our paper we study the group circulant matrices, $C = C_G(\psi)$, induced by the convolution operator by the function $\psi \in l^2(G)$ over the group G. Unlike the abelian case, nonabelian group circulant matrices are typically non-normal and possibly even non-diagonalizable. We prove results on geometric properties of eigenspace decompositions and diagonalizations (or Jordan decompositions) of group circulant matrices. These results set a numerical framework for nonabelian filtering. Results in this context are obtained for dihedral circulant matrices where the underlying group is the dihedral group D_{2n} where n is even.

Title A matrix model of fasting metabolism in northern elephant seal pups

Poster Presentation Edward O. Keith (edwardok@nova.edu)
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Abstract

A ten compartment model of metabolite flux in fasting northern elephant seal (*Mirounga angustirostris*) pups has been developed. These pups maintain a paradoxical fasting hyperglycemia while fasting 6-8 weeks after nursing 30 days. The hyperglycemia results from low rates of glucose utilization (due to low insulin) and high rates of glucose carbon recycling. Fatty acids are the major energy substrate during this time, with high rates of palmitate turnover and low ketone levels, as well as nitrogen conservation and low urea turnover. First order rate constants for the model were taken from the literature and entered into a source-destination matrix. Eigenvalues and eigenvectors of this matrix were determined. The initial conceptualization, where carbon atoms leaving the model entered the surroundings, yielded nonzero negative eigenvalues, indicating an open, stable system. Inclusion of a sink which accumulated carbon atoms and never lost any, yielded the same set of negative eigenvalues, and a zero eigenvalue, indicating that this system was closed and stable. The trace (β) of the matrix was a negative real number in both cases, while the determinant (γ) of the matrix was a negative real number in the first case (no sink), and zero in the second case (sink), indicating that the system lies near a stable saddle point in the dimensionless β-γ phase-plane. These results are difficult to reconcile with the biological reality of a fasting animal that cannot survive forever without nutrient inputs, and thus question the utility of eigenanalysis of the stability of complex biological systems.