Applied Mathematics Session

Monday June 21st

1.30-2.00 PM	The Two-Envelope Problem - Derek Abbott
2.05-2.35 PM	A New Convolution Operator for The Linear Canonical Transform - Anabela Silva
2.40-3.10 PM	Stabilisation of a Viscoelastic Flexible Spacecraft System Under Unknown Spatiotemporally Varying Disturbance - Amirouche Berkani
3.15-3.45 PM	Break
3.50-4.20 PM	Optimal Control of Fractional-Stochastic Differential Equations - Mehmet Ali Akinlar
4.25-4.55 PM	Margin Based Angular Softmax on Handwritten Digit's Recognition - Jamshaid Ul Rahman
5.00-5.30 PM	Stochastic Delay Differential Equations of Epidemic Model for COVID-19: Case Study in the UAE - Hebatallah J. Alsakaji
5.35-6.05 PM	Dynamical Evolution of Entanglement in Disordered Oscillator Systems - Houssam Abdul Rahman

Session Chairs: Dr. Anwar and Dr. Eman

Virtual Room 1B

Applied Mathematics Session

Tuesday June 22nd

1.30-2.00 PM Extending the Douglas-Rachford Algorithm to Non-Linearly Related Constraint Sets - G.N. Newsam

2.05-2.35 PM A System of Local/Nonlocal p-Laplacians: The Eigenvalue Problem and Its Asymptotic Limit as p approaches infinity - S. Buccheri

2.40-3.10 PM Upper Bounds on The Energy of Graphs in Terms of Matching Number - Abdullah Alazemi

3.15-3.45 PM Break

3.50-4.20 PM Adaptive Boundary Stabilization of Nonlinear Axially Moving String - Abdelkarim Kelleche

4.25-4.55 PM On a Multigrid Solver for Stationary Navier-Stokes Velocity-Pressure tracking-type control problems - Muhammad Munir Butt

5.00-5.30 PM Deep Elastography: A Mathematical Framework - Abdul Wahab

Session Chairs: Dr. Anwar and Dr. Eman

Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Derek Abbott (derek.abbott@adelaide.edu.au)
The University of Adelaide Australia

The Two-Envelope Problem

The two-envelope problem is a question of choice between two states in the presence of uncertainty, and it has intrigued mathematicians for decades. The problem is interesting as it poses a number of open questions and there is little agreement over an approach or framework for its analysis. In this talk, we outline an approach that, in essence, makes a biased random choice where the bias is conditioned on the observed value of one of the states. We argue that the resulting symmetry breaking introduced by this process results in a gain counter to naive expectation. Finally, we discuss a number of open questions and new lines of inquiry that this approach opens up.

Dr. Anabela Silva (anabela.silva@ua.pt)
University of Aveiro

A new convolution operator for the linear canonical transform

The linear canonical transform plays an important role in engineering and many applied fields, as it is the case of optics and signal processing. In this talk, a new convolution for the linear canonical transform is proposed and a corresponding product theorem is deduced. Moreover, necessary and sufficient conditions are obtained for the solvability of a class of convolution type integral equations associated with the linear canonical transform.

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Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Amirouche Berkani (aberkanid@gmail.com)
Université Mohamed El Bachir El Ibrahimi de Bordj Bou Arréridj, Algeria

Stabilisation of a viscoelastic flexible spacecraft system under unknown spatiotemporally varying disturbance

In this work, we study the existence and asymptotic behaviour of solutions for a viscoelastic spacecraft with flexible appendage system. Using the generalised Hamilton's principle the dynamic of the problem is described by PDEs coupled with ODEs. Based on the standard Faedo-Galerkin method, we prove the well-posedness of the system. Under a suitable boundary control, we prove an arbitrary decay of the energy of the system for a large class of relaxation functions using the multiplier method.

Dr. Mehmet Ali Akinlar (mehmetaliakinlar@gmail.com)
Bandirma Onyedi Eylul University, Turkey

Optimal Control of Fractional-Stochastic Differential Equations

An equation formed with both fractional-order derivative/integral operators and a noise (uncertain, random) term is said to be a fractional-stochastic differential equation (FSDE). We are concerned with optimal control of at least two new classes of FSDEs. We solve the problems with some efficient optimization methods and present computational solutions of the resulting optimality system consisting of Euler-Lagrange equations. We are also interested in partial differential equation based optimization problems driven by fractional Brownian motion. Finally we will discuss the applications of these types of problems and open problems/challenges in these areas.

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Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Jamshaid UL Rahman (jamshaidrahman@gmail.com)
Abdus Salam School of Mathematical Sciences, GC University Lahore
PAKISTAN

Margin Based Angular Softmax On Handwritten Digit's Recognition

Deep Learning based systems have received increasing interests in recent years, recognitions structures including handwritten digits' recognition system is one of the hot topic in this area. A famous work on recognition system by using Angular Softmax Loss gain a significant importance and the margin based strategy in angular softmax is beneficial to learn discriminative image features where the adjustment of proper parameters and random selection of margin values is a big issue in additive angular margin and multiplicative angular margin. As a better solution in this matter, we present an alternative form of Angular Softmax as an extension of unit softmax by introducing a bit similar form of additive parameter that is originally introduced for face recognition and it have a capacity to adjust automatically with the corresponding margin values, trainable with large margin, stable to amend with gradient descent and appropriate to handle handwritten digits' recognition tasks. The Modified National Institute of Standards and Technology (MNIST) dataset is used to evaluate the results.

Dr. Hebatallah Alsakaji (heba.sakaji@uaeu.ac.ae)
UAE University

Stochastic Delay Differential Equations of Epidemic Model for COVID-19:Case Study in the UAE

Stochastic perturbation factors have a significant impact on the infection force of all types of virus diseases to humans. This work proposed a class of stochastic delay differential equations based on SIR model for the spread of COVID-19 among population. We investigate the global positive solution. Sufficient conditions of existence and uniqueness of an ergodic stationary distribution of the positive solution are provided, by constructing suitable Lyapunov functionals. Sufficient conditions for possible extinction of the disease are also obtained. The conditions are expressed in terms of threshold parameter $R"\#$ that relies on the environmental noise. Illustrative examples and numerical simulations, using Milstein's scheme, are carried out to illustrate the theoretical results. The research used the data of COVID-19 cases in the UAE for the numerical simulation which has been fitted to the model.

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Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Garry Newsam (garry.newsam@adelaide.edu.au)
School of Computer Science, University of Adelaide

Extending the Douglas-Rachford algorithm to non-linearly related constraint sets

The solutions to many problems in applied mathematics can be characterised as being the intersection of a collection of constraints. Moreover, while a point in this intersection may hard to determine directly, often points in the individual constraint sets, in particular the projections of a current iterate onto these sets, can be easily computed. Examples include linear or affine constraints, or balls around data points defined by noise levels. Problems with this property are amenable to solution algorithms that revolve round repeated projections of successive iterates on to the constraints. In recent years the Douglas-Rachford algorithm has become the method of choice within this broader family; in its canonical form it defines a procedure that can decide whether two convex sets have a non-empty intersection, and can find a point in this intersection if one exists. In this canonical form the two constraints are assumed to be naturally defined as sets in the same native space; in many problems, however, the constraints may be more naturally expressed as sets in two separate spaces, e.g. as one set of linear constraints on some variable together with another set of linear constraints on a nonlinear transform of this variable. The talk will give a brief description of the standard Douglas-Rachford algorithm and then present two possible extensions of it to the separate space setting. A stability analysis of the extensions will be given, and their potential utility illustrated by applying them to find roots of systems of polynomial equations.

Dr. Stefano Buccheri (stefano.buccheri@univie.ac.at)
University of Vienna

A SYSTEM OF LOCAL/NONLOCAL $p-$LAPLACIANS: THE EIGENVALUE PROBLEM AND ITS ASYMPTOTIC LIMIT AS $p \to \infty$

S. BUCCHERI

ABSTRACT. In this talk I am going to present some result recently obtained in collaboration with J.V. da Silva and L.H de Miranda. Given $p \in (1, \infty)$, we prove the existence and simplicity of the first eigenvalue λ_p and its corresponding eigenvector (u_p, v_p), for the following local/nonlocal PDE system

$$(0.1) \qquad \begin{cases} -\Delta_p u + (-\Delta)_p^r u &= \frac{2\alpha}{\alpha+\beta}\lambda |u|^{\alpha-2}|v|^{\beta} u & \text{in} & \Omega \\ -\Delta_p v + (-\Delta)_p^s v &= \frac{2\beta}{\alpha+\beta}\lambda |u|^{\alpha}|v|^{\beta-2} v & \text{in} & \Omega \\ u &= 0 & \text{on} & \mathbb{R}^N \setminus \Omega \\ v &= 0 & \text{on} & \mathbb{R}^N \setminus \Omega, \end{cases}$$

where $\Omega \subset \mathbb{R}^N$ is a bounded open domain, $0 < r, s < 1$ and $\alpha(p) + \beta(p) = p$. Moreover, we address the asymptotic limit as $p \to \infty$, proving the explicit geometric characterization of the corresponding first $\infty-$eigenvalue, namely λ_∞, and the uniformly convergence of the pair (u_p, v_p) to the $\infty-$eigenvector (u_∞, v_∞). Finally, the triple $(u_\infty, v_\infty, \lambda_\infty)$ verifies, in the viscosity sense, a limiting PDE system.

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Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Abdullah Alazemi (abdullah.alazemi@ku.edu.kw)
University of Kuwait

UPPER BOUNDS ON THE ENERGY OF GRAPHS IN TERMS OF MATCHING NUMBER

SAIEED AKBARI, ABDULLAH ALAZEMI, AND MILICA ANĐELIĆ

ABSTRACT

The energy of a graph G, $\mathcal{E}(G)$, is the sum of absolute values of the eigenvalues of its adjacency matrix. The matching number $\mu(G)$ is the number of edges in a maximum matching. In this paper, for a connected graph G of order n with largest vertex degree $\Delta \geq 6$ we present two new upper bounds for the energy of a graph: $\mathcal{E}(G) \leq (n-1)\sqrt{\Delta}$ and $\mathcal{E}(G) \leq 2\mu(G)\sqrt{\Delta}$. The latter one improves recently obtained bound

$$\mathcal{E}(G) \leq \begin{cases} 2\mu(G)\sqrt{2\Delta_e+1}, & \text{if } \Delta_e \text{ is even;} \\ \mu(G)(\sqrt{a+2\sqrt{a}}+\sqrt{a-2\sqrt{a}}), & \text{otherwise,} \end{cases}$$

where Δ_e stands for the largest edge degree and $a = 2(\Delta_e+1)$. We also present a short proof of this result and several open problems.

Dr. Abdelkarim Kelleche (a.kelleche@univ-dbkm.dz)
Faculty of sciences and technology, University Djilali Bounaama, Khemis Miliana, Algeria

Adaptive boundary stabilization of nonlinear axially moving string

In this work, we are interested in stabilizing a nonlinear axially moving string by an adaptive boundary control. The existence and the uniqueness of solution of the closed loop system is dealt with in the framework of the nonlinear semigroup theory by using a theorem due to CrandallLiggett. The control is constructed through a low-gain adaptive velocity feedback. It is shown that the formulated control is capable of stabilizing exponentially the closed loop system.

Applied Mathematics Session

Abstracts

Dr. Muhammad Munir Butt (munir.butt@kfupm.edu.sa)
King Fahd University of Petroleum and Minerals

On a multigrid solver for stationary Navier-Stokes velocity-pressure tracking-type control problems

In this talk, a multigrid solver for distributed optimal control problems governed by time-independent Navier-Stokes equations is presented. A mixed (velocity-pressure) tracking-type control problem is considered and first-order optimality conditions are discussed. We investigate a full multigrid method with coarsening by a factor-of-three strategy to stationary Navier-Stokes control problems. The potential advantage of multigrid with coarsening by a factor-of-three strategy is that it results in nested hierarchy of staggered grids and thus simplifies the inter-grid transfer operators, reduces the number of levels, and hence the CPU time. The construction of the multigrid algorithm for Stokes control problems of our earlier work gives us a natural extension but still significant challenges are rooted in the nonlinear part of the Navier-Stokes equations (constraints) and mixed (velocity-pressure) tracking-type control formulation. Numerical experiments are reported to show the behaviour and efficiency of the proposed multigrid algorithm for small Reynolds numbers and moderate values of regularization parameter.

Dr. Abdul Wahab (abdul.wahab@nu.edu.kz)
School of Science and Humanities, Nazarbayev University

Deep Elastography: A Mathematical Framework

In this talk, I will discuss an inverse elastic source problem with very sparse measurements. The problem is of great interest due to its applications in elastography wherein the acquisition of dense measurements conforming to the Nyquist sampling rate is difficult. Unfortunately, conventional source reconstruction algorithms do not perform well with sparse measurements. A ready-witted remedy is to invoke a regularization technique. However, classical regularization techniques offer only an insignificant improvement in the performance of the conventional algorithms in terms of structural similarity index and the peak signal-to-noise ratio. In this talk, I will discuss a generic mathematical framework that extends a low-dimensional manifold regularization in the conventional source reconstruction algorithms thereby enhancing their performance significantly with sparse data-sets. The proposed framework is equivalent to the so-called deep convolutional framelet expansion in machine learning literature for inverse problems.

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Virtual Room 1B

Applied Mathematics Session

Abstracts

Dr. Houssam Abdul Rahman (houssam.abdulrahman@nyu.edu)
NYU ABU DHABI

Dynamical Evolution of Entanglement in Disordered Oscillator Systems

We study the non-equilibrium dynamics of a disordered quantum system consisting of harmonic oscillators in a d-dimensional lattice. If the system is sufficiently localized, we show that, starting from a broad class of initial product states that are associated with a tiling (decomposition) of the d-dimensional lattice, the dynamical evolution of entanglement follows an area law in all times. Moreover, the entanglement bound reveals a dependency on how the subsystems are located within the lattice in $d\geq 2$ dimensions. In particular, the entanglement grows with the maximum degree of the dual graph associated with the lattice tiling. (Based on the preprint: Arxiv:2104.13825).

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