INTERNATIONAL CONFERENCE ON APPLIED AND PURE MATHEMATICS

IAŞI, ROMANIA

NOVEMBER 9 – 12, 2023

SCIENTIFIC PROGRAMME & ABSTRACTS

"Alexandru Ioan Cuza" University of Iaşi

"Gheorghe Asachi" Technical University of Iaşi

Romanian Academy Iași Branch

http://math.etti.tuiasi.ro/apm2023/

SCIENTIFIC PROGRAMME

Thursday, 9^{th} of November

08:00 – 09:30 Registration

Opening Ceremony
"Carmen Sylva" Aula Magna[1]

09:30 – 10:00 Opening Ceremony

Plenary session
"Carmen Sylva" Aula Magna

Chairman: Dorel FETCU (Iaşi, Romania)

10:00 – 10:50 Liviu ORNEA (Bucureşti, Romania)
Hopf manifolds and an old result by Poincaré

10:50 – 11:20 Coffee Break

11:20 – 12:10 Zoltán MUZSNAY (Debrecen, Hungary)
Tangent algebra of a diffeomorphism group and its application

12:10 – 13:00 Christiane TAMMER (Halle, Germany)
Variational principles and optimality conditions for optimization problems with variable domination structures

13:00 – 14:30 Lunch

[1]Faculty of Electronics, Telecommunications and Information Technology, Technical University, Carol I Blvd., no. 11

Afternoon Session I - Applied Mathematics

"Carmen Sylva" Aula Magna

Chairman: Cătălin LEFTER (Iaşi, Romania)

14:30 – 14:55 Paul GEORGESCU (Iaşi, Romania)
Facultative mutualisms: conditions for stable coexistence

14:55 – 15:20 Iulian STOLERIU (Iaşi, Romania)
An artificial neural network model for enzyme kinetics

15:20 – 15:45 Cristian LĂZUREANU (Timişoara, Romania)
Some properties of Hamilton-Poisson jerk systems

15:45 – 16:10 Bianca SATCO (Suceava, Romania)
A Filippov-type lemma for Stieltjes differential inclusions

16:10 – 16:40 Coffee Break

Afternoon Session I - Pure Mathematics

Amphitheatre III.46[2]

Chairman: Marcel ROMAN (Iaşi, Romania)

14:30 – 14:55 Adrian SANDOVICI (Iaşi, Romania)
A generalized Von Neumann's theorem

14:55 – 15:20 Iulia-Cătălina PLEŞCA (Iaşi, Romania)
Number Theory Concepts in Group Theory

15:20 – 15:45 Georgiana FASOLĂ (Iaşi, Romania)
On the Chermak-Delgado measure of a finite group

15:45 – 16:10 Nicuşor MINCULETE (Braşov, Romania)
On several new results related to Richard's inequality

16:10 – 16:40 Coffee Break

[2]Faculty of Electronics, Telecommunications and Information Technology, Technical University, Carol I Blvd., no. 11

Afternoon Session II - Applied Mathematics

"Carmen Sylva" Aula Magna

Chairman: Bianca SATCO (Suceava, Romania)

16:40 – 17:05 Gabriela LIŢCANU (Iaşi, Romania)
Dynamics of front propagation in a biomathematical model

17:05 – 17:30 Bogdan SEBACHER (Bucureşti, Romania)
Conditioning facies probability fields to soft data with a regularized element-free Galerkin (EFG) method

17:30 – 17:55 Carmen Oana TĂRNICERIU (Iaşi, Romania)
Oscillations in a Fully Connected Network of Leaky Integrate-and-Fire Neurons with a Poisson Spiking Mechanism

17:55 – 18:20 Alexandra Elena MELNIG (Iaşi, Romania)
Inverse problems of estimating the source in parabolic systems

Afternoon Session II - Pure Mathematics

Amphitheatre III.46

Chairman: Cezar ONICIUC (Iaşi, Romania)

16:40 – 17:05 Ştefan ANDRONIC (Iaşi, Romania)
Biharmonic hypersurfaces with three distinct principal curvatures in space forms

17:05 – 17:30 Gamze ALKAYA (Ankara, Türkiye)
A Study on $\mathcal{W}_8-$ Curvature Tensor with respect to a Normal Complex Contact Space Form

17:30 – 17:55 Simona Luiza ROMANIUC (Iaşi, Romania)
α-structures parallel with respect to the Schouten-Van Kampen connection on the tangent bundle

Friday, 10^{th} of November

Plenary session

"Carmen Sylva" Aula Magna

Chairman: Răzvan LIŢCANU (Iaşi, Romania)

09:30 – 10:20 Lucian BEZNEA (Bucureşti, Romania)
Nonlinear Dirichlet forms associated with quasiregular mappings

10:20 – 10:50 Coffee Break

10:50 – 11:40 Marcos CAVALCANTE (Maceió, Alagoas, Brazil)
New Solutions to the Serrin Problem on Riemannian Manifolds

11:40 – 12:30 Daniel BELTIŢĂ (Bucureşti, Romania)
Holomorphic extension of one-parameter operator groups with applications to Lie group representations

12:30 – 14:00 Lunch

Afternoon Session I - Special Workshop

"Carmen Sylva" Aula Magna

Chairman: Marius DUREA (Iaşi, Romania)

14:00 – 14:25 Sjur Didrik FLÅM (Bergen, Norway)
Mathematical Programmers in Markets

14:25 – 14:50 Bahareh KHAZAYEL (Halle, Germany)
Generalized conic scalarization in vector optimization in real locally convex spaces

14:50 – 15:15 Daniela LUPU (Bucureşti, Romania)
Efficiency of higher order optimization methods

15:15 – 15:40 Elena-Andreea FLOREA (Iaşi, Romania)
Conic cancellation laws and some applications in set optimization

15:40 – 16:10 Coffee Break

Afternoon Session I - Pure Mathematics

Amphitheatre III.46

Chairman: Liviu ORNEA (Bucureşti, Romania)

14:00 – 14:25 Ioan BUCATARU (Iaşi, Romania)
Finsler metrizabilities and geodesic invariance

14:25 – 14:50 Ivaldo NUNES (São Luís, Maranhão, Brazil)
On static manifolds with boundary

14:50 – 15:15 Radu PETER (Cluj-Napoca, Romania)
Hardy type inequalitites and the impact of the curvature of the boundary

15:15 – 15:40 Vlad MARCHIDANU (Bucureşti, Romania)
Complex structures on the product of two Sasakian manifolds

15:40 – 16:10 Coffee Break

Afternoon Session II - Special Workshop

"Carmen Sylva" Aula Magna

Chairman: Radu STRUGARIU (Iaşi, Romania)

16:10 – 16:35 Sorin-Mihai GRAD (Paris, France)
Beyond the Fermat Optimality Rules

16:35 – 17:00 Markus Arthur KÖBIS (Gjøvik, Norway)
Analysis and testing of a proximal gradient method in multiobjective optimization

17:00 – 17:25 Christian GÜNTHER (Hannover, Germany)
Proper efficiency in vector optimization: A fresh look at an old topic

17:25 – 17:50 Nitesh Kumar SINGH (Bucureşti, Romania)
Stochastic first order methods for convex optimization with functional constraints

Afternoon Session II - Pure Mathematics
Amphitheatre III.46

Chairman: Ioan BUCATARU (Iaşi, Romania)

16:10 – 16:35 Cristina HREŢCANU (Suceava, Romania)
Submanifolds in (α, p)-Golden Metric Manifolds

16:35 – 17:00 Rareş-Mircea AMBROSIE (Iaşi, Romania)
Some classification results of the biharmonic quadratic maps between spheres

17:00 – 17:25 Vasile POP (Cluj-Napoca, Romania)
On some properties of Sylvester matrix rank functions

Saturday, 11^{th} of November

Plenary session
"Carmen Sylva" Aula Magna

Chairman: Constantin ZĂLINESCU (Iaşi, Romania)

09:30 – 10:20 Boris MORDUKHOVICH (Detroit, Michigan, USA)
Optimal control of sweeping processes with applications

10:20 – 10:50 Coffee Break

10:50 – 11:40 Liviu MARIN (Bucureşti, Romania)
Numerical approach to some inverse problems in anisotropic heat conduction

11:40 – 12:30 Ion NECOARĂ (Bucureşti, Romania)
Higher order methods: recent advances and open questions

12:30 – 13:30 Lunch

13:30 – 14:30 Visit to the Palace of Culture

14:30 – 17:00 Excursion to Hermeziu Winery (wine tasting)

17:00 – 21:00 Festive Dinner

ABSTRACTS

PLENARY SPEAKERS

Holomorphic extension of one-parameter operator groups with applications to Lie group representations

Daniel BELTIŢĂ
"Simion Stoilow" Institute of Mathematics of the Romanian Academy, Bucharest, Romania
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We plan to discuss one-parameter operator groups on locally convex spaces, specifically holomorphic extensions with respect to the parameter, from the real line to suitable horizontal strips in the complex plane, as well as Kubo–Martin–Schwinger (KMS) boundary conditions.

For one-parameter unitary groups on Hilbert spaces, we recover the complex powers of the positive operator defined as the exponential of the infinitesimal generator.

This Hilbert space setting is however too special for the applications to certain constructions of nets of standard subspaces in the framework of Lie group representations, as they appear in Algebraic Quantum Field Theory.

The constructions of this type are our main motivation.

They require one-parameter operator groups on spaces of distribution vectors of unitary representations of Lie groups and will be briefly discussed as well.

This is a joint work with Karl-Hermann Neeb (Friedrich-Alexander-Universität Erlangen-Nürnberg).

Nonlinear Dirichlet forms associated with quasiregular mappings

Lucian BEZNEA
Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucharest, Romania,
and National University of Science and Technology Politehnica Bucharest
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We present a general procedure of constructing nonlinear Dirichlet forms in the sense introduced by Petra van Beusekom, starting from a strongly local, regular, Dirichlet form, admitting a carré du champ operator. As a particular case, we shall describe the nonlinear form associated with a quasiregular mapping.

New Solutions to the Serrin Problem on Riemannian Manifolds

Marcos Petrúcio CAVALCANTE
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The Serrin problem is an overdetermined elliptic problem that shares many analogies with constant mean curvature surfaces.

In this talk, we will revisit some known results related to the existence and classification of solutions to the Serrin problem on certain Riemannian manifolds.

Motivated by these works, we will use bifurcation theory to demonstrate the existence of non-trivial domains that admit solutions to the Serrin problem on cohomogeneity one Riemannian manifolds.

This is a joint work with Renato Bettiol (CUNY).

Numerical approach to some inverse problems in anisotropic heat conduction

Liviu MARIN

University of Bucharest and Gheorghe Mihoc – Caius Iacob Institute of Mathematical Statistics and Applied Mathematics of the Romanian Academy, Romania

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We investigate, from both the theoretical and the numerical viewpoints, two iterative procedures for the accurate, convergent, stable, and efficient approximation of the solutions to two inverse problems in steady-state anisotropic heat conduction.

The first inverse problem deals with the numerical reconstruction of the missing boundary data (both the temperature and the normal heat flux) and the solution (the temperature) in a domain occupied by an anisotropic solid from the knowledge of Cauchy data on the remaining and accessible boundary. The iterative algorithms of Kozlov, Mazya and Fomin (Comput. Math. Math. Phys., 1991) are studied from the computational point of view and improved accordingly by employing a relaxation parameter. For exact Cauchy data, this inverse problem is transformed into an equivalent fixed-point problem for an associated operator that is defined on and takes values in a suitable function space, and accounts for the relaxation parameter. This results in determining the admissible range for the relaxation parameter along with a criterion for selecting its optimal value at each iteration. The numerical implementation is realised for both 2D and 3D homogeneous anisotropic solids via the meshless method of fundamental solutions (MFS) and confirms a significant reduction in the number of iterations and hence the CPU time required for the relaxation algorithms to attain convergence.

The second inverse problem is concerned with the numerical reconstruction of the unknown inner boundary, in a 2D anisotropic solid from homogeneous Dirichlet data available on the entire boundary of and an additional measurement of the Neumann data on the outer boundary assumed to be known. This so-called inverse geometric problem is tackled by defining an operator that maps an admissible inner boundary belonging to the space of 2π-periodic and twice continuously differentiable functions into the Neumann data on the outer boundary assumed to be continuous. It is proved that this operator is differentiable and hence a gradient based algorithm that uses the anisotropic single layer representation of the solution to a mixed problem for the 2D anisotropic heat conduction is developed for approximating the unknown inner boundary. The numerical implementation is realised for both exact and perturbed Neumann data on the outer boundary and employs a quadratic finite element method (FEM) and a suitable quadrature for the anisotropic single layer representation of the solution, and shows the convergence and stability of the proposed method.

Optimal control of sweeping processes with applications

Boris MORDUKHOVICH
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This talk is devoted to a novel class of optimal control problems governed by the so-called sweeping (or Moreau) processes that are described by discontinuous dissipative differential inclusions. Although such dynamical processes, strongly motivated by applications, have appeared in 1970s, optimal control problems for them have been formulated quite recently and occurred to be rather complicated from the viewpoint of developing control theory. Their study and applications require advanced tools of variational analysis and generalized differentiation, which will be presented in the lectures. Combining this machinery with the method of discrete approximations leads us deriving new necessary optimality conditions and their applications to practical models in elastoplasticity, traffic equilibria, robotics, etc.

Tangent algebra of a diffeomorphism group and its application

Zoltán MUZSNAY
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In this talk the notion of the tangent algebra of a (not necessarily smooth) subgroup of the diffeomorphism group $Diff(M)$ of a compact manifold M is introduced. We prove that this tangent algebra is a Lie subalgebra of the Lie algebra of smooth vector fields on M. The construction can be generalized to subgroups of any (finite or infinite dimensional) Lie groups. The tangent Lie algebra introduced this way is a generalization of the classical Lie algebra in the smooth case. As a working example, we discuss in detail the tangent structure of the holonomy group of Finsler manifolds.

Higher order methods: recent advances and open questions

Ion NECOARĂ
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Composite minimization involves a collection of functions which are aggregated in a nonsmooth manner. It covers, as particular cases, nonlinear least-squares, smooth approximation of minimax games, minimization of max-type functions, minimization problems with functional constraints and simple composite minimization problems, where the objective function has a nonsmooth component. We present a higher-order majorization-minimization algorithmic framework for such composite problems (possibly nonconvex). This framework replaces each component in the composite model with a higher-order surrogate such that the corresponding error function has a higher-order Lipschitz continuous derivative. Our algorithmic framework encompasses tensor methods, higher-order proximal methods and even higher-order Gauss-Newton type methods as particular algorithms. We present convergence guarantees (including rates) for these higher-order majorization-minimization algorithms in both convex and non-convex settings. Besides providing a general framework for the design and analysis of composite higher-order methods, in special cases, where complexity bounds are known for some particular (first-order) algorithms, our convergence results recover the existing bounds. Applications to nonlinear least-squares (including phase retrieval) and functional constrained minimization are presented. Finally, some open questions related to higher-order minimization are discussed.

Hopf manifolds and an old result by Poincaré

Liviu ORNEA
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Hopf manifolds are quotients of $\mathbb{C}^n \setminus \{0\}$ by the cyclic group generated by a holomorphic, invertible contraction of $\mathbb{C}^n$ at 0. Their complex geometry depends on the properties of this contraction. I shall investigate holomorphic vector bundles on Hopf manifolds and holomorphic connections in these vector bundles, aiming to classification results. On the way, as a byproduct, we shall find a condition, in geometric terms, for the contraction to be linear. This will be a geometric proof of a theorem from 1889 by Poincaré, in the realm of dynamical systems, concerning normal forms of vector fields.

Variational principles and optimality conditions for optimization problems with variable domination structures

Christiane TAMMER

Martin-Luther-University Halle-Wittenberg, Faculty of Natural Sciences II, Institute of Mathematics, D-06099 Halle (Saale), Germany

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In this talk, we are dealing with vector optimization problems in infinite-dimensional spaces where the solution concept is given by variable domination structures. Vector optimization with variable domination structures is a growing up and expanding field of applied mathematics that deals with optimization problems where the domination structure is given by a set-valued map. Interesting and important applications of vector optimization with variable domination structure arise in economics, behavioral sciences, in portfolio management, location theory and radiotherapy treatment in medicine. We introduce several concepts for (approximate) solutions to vector optimization problems with variable domination structures and show several variational principles in this setting. Furthermore, we derive necessary conditions for approximate solutions using techniques from variational analysis. These results are useful for further research on the field of vector optimization with variable domination structure, especially, for deriving numerical procedures.

This is a joint work with Truong Q. Bao, Boris S. Mordukhovich and Antoine Soubeyran.

CONTRIBUTED TALKS
PURE MATHEMATICS

A Study on $\mathcal{W}_8$- Curvature Tensor with respect to a Normal Complex Contact Space Form

Gamze ALKAYA
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In this paper includes information about the subject of $\mathcal{W}_8$ curvature tensors on a complex contact space form. The conditions for a complex contact space form to be $\xi-\mathcal{W}_8-$ flat, $\mathcal{GH}-\mathcal{W}_8-$ semi-symmetric, $\mathcal{W}_8\mathcal{Q}=0$ and $\mathcal{W}_8(\xi,\mathcal{C}_1)\mathcal{S}=0$ were investigated.

Some classification results of the biharmonic quadratic maps between spheres

Rareş-Mircea AMBROSIE
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In this paper we first prove a characterization formula for biharmonic maps in Euclidean spheres. Then, for the special case of maps between spheres whose components are given by homogeneous polynomials of the same degree, we find a more specific form for their bitension field. We apply this formula to the case when the degree is 2 and we prove that a quadratic form from $\mathbb{S}^m$ to $\mathbb{S}^n$ is non-harmonic biharmonic if and only if it has constant energy density $(m+1)/2$. Further, we obtain a rigidity result concerning the structure of non-harmonic biharmonic quadratic forms which allows us to obtain several classification results.

Biharmonic hypersurfaces with three distinct principal curvatures in space forms

Ştefan ANDRONIC
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In 2015 Yu Fu proved that any biharmonic hypersurface with at most three distinct principal curvatures in space forms has constant mean curvature. In this paper we point out that there is at least one case when the final argument in that paper is invalid and therefore the proof is not complete. We introduce a new method, involving algebraic tools and Mathematica, to solve this problem. We manage to find all cases that the original proof missed and showed that all hypersurafaces of this type have constant mean curvature.

Finsler metrizabilities and geodesic invariance

Ioan BUCATARU
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We prove that various Finsler metrizability problems for sprays can be reformulated in terms of the geodesic invariance of two tensors (metric and angular). We show that the class of gyroscopic sprays is the the largest class of sprays with geodesic invariant angular metric. Scalar functions associated to these geodesically invariant tensors will be invariant as well and therefore will provide first integrals for the given spray.

On the Chermak-Delgado lattice of a finite group

Georgiana FASOLĂ
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In this talk, I present some recent results on the Chermak-Delgado lattice associated to a finite group. More precisely, I classify the finite groups with a small number of subgroups not in the Chermak-Delgano lattice. I also study the subgroups of minimum Chermak-Delgado measure.

Submanifolds in (α, p)-Golden Metric Manifolds

Cristina HREŢCANU
Ştefan cel Mare University of Suceava, Romania
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The aim of the present paper is to investigate the properties of a Riemannian manifold endowed by a generalization of the golden structure, called the almost (α, p)-golden structure. Also, we obtain a characterization of the structure induced on a submanifold by the almost (α, p)-golden structure and we find some properties of the invariant, anti-invariant and respectively, slant submanifolds in this type of manifold.

Complex structures on the product of two Sasakian manifolds

Vlad MARCHIDANU
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A Sasakian manifold is a Riemannian manifold whose metric cone admits a certain Kähler structure which behaves well under homotheties. In this talk, we consider the product of two compact Sasakian manifolds and show that it admits a family of complex structures indexed by a complex nonreal parameter, none of whose members admits any compatible locally conformally Kähler metrics if both Sasakian manifolds are of dimension greater than 1. We compare this family with another family of complex structures which has been studied in the literature. We also give a description of the Dolbeault cohomology groups of these products of compact Sasakian manifolds in terms of their basic cohomologies.

On several new results related to Richard's inequality

Nicuşor MINCULETE
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The main study of this article is the characterization of Richard's inequality, because it is closely related to Buzano's inequality. Finally, we present a new approach for Richard's inequality, where we use the Selberg operator.

This is a joint work with Cristian Conde (Instituto de Ciencias, Universidad Nacional de General Sarmiento and Consejo Nacional de Investigaciones Cientıficas Tecnicas, Argentina).

On static manifolds with boundary

Ivaldo NUNES
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In this talk, we consider static manifolds M with nonempty boundary. In this case, we suppose that the static potential V of M also satisfies an overdetermined Robin type condition on the boundary of M. We prove prove a rigidity result for the closed unit ball in the three-dimensional Euclidean space. More precisely, we give a sharp upper bound for the area of the zero set of V, in the case it is connected and intersects the boundary of M. We also consider the case where the zero set of V does not intersect the boundary of M.

This is a joint work with Tiarlos Cruz (Federal University of Alagoas, Brazil).

Hardy type inequalitites and the impact of the curvature of the boundary

Radu PETER
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We present some Hardy type inequalities on domaines in Minkowski spaces with focus on the impact of the curvature of the domain in the inequalities. Also some applications to existence and unicity problems in PDE are provided.

Number Theory Concepts in Group Theory

Iulia Cătălina PLEŞCA
Alexandru Ioan Cuza University, Iaşi, Romania
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In recent times, a plethora of concepts from number theory have been adapted to group theory. We do a summary of the most important results and introduce some new ones regarding groups that have integer harmonic mean of element orders.

This is a joint work with Marius Tărnăuceanu (UAIC).

On some properties of Sylvester matrix rank functions

Vasile POP
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We investigate, using elementary methods, some properties of Sylvester matrix rank functions [P. Malcolmson, 1980]. In the main result we show that the sum of Sylvester matrix rank functions of two matrix polynomials is the same as the sum of the Sylvester matrix rank function of the matrix obtained by applying greatest common divisor, with the Sylvester matrix rank function of the matrix obtained by applying lowest common multiple.

This is a joint work with Constantin-Cosmin Todea (UTCluj).

α-structures parallel with respect to the Schouten-Van Kampen connection on the tangent bundle

Simona-Luiza ROMANIUC
Gheorghe Asachi Technical University of Iaşi, Romania
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We determine the Schouten-Van Kampen connection associated to the Levi-Civita connection of a general natural metric on the total space TM of the tangent bundle of a Riemannian manifold. We provide the necessary and sufficient conditions for the obtained Schouten-Van Kampen connection to be torsion free and then to coincide with the Levi-Civita connection. We characterize the general natural α-structures on TM, which are parallel with respect to the torsion free Schouten-Van Kampen connection. Finally, we obtain the (para-)ähler structures of general natural lift type on TM, for which the α-structure is parallel with respect to both Levi-Civita and Schouten-Van Kampen connection.

A generalized Von Neumann's theorem

Adrian SANDOVICI
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Assume that X is a real or complex Hilbert space, T a linear relation in X and B a bounded linear operator in X. It is shown that if some four linear relations generated by T and B are selfadjoint in X, then T must be a closed linear relation.

CONTRIBUTED TALKS
APPLIED MATHEMATICS

Facultative mutualisms: conditions for stable coexistence

Paul GEORGESCU
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Continuing earlier investigations on programmatic boundedness conditions for n-species models of facultative mutualism, we now provide sufficient conditions for the global stability of coexistence equilibria. These conditions involve inequalities in terms of reproductive ratios computed at high population densities, together with either sublinearity of monotonicity assumptions, building on a certain trichotomy perspective on the asymptotic behavior of cooperative dynamical systems.

Some properties of Hamilton-Poisson jerk systems

Cristian LĂZUREANU
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In this paper we construct a family of Hamilton-Poisson jerk systems. Particularly, we consider an one-parameter such system and we study stability and some special orbits. Moreover, we point out some properties of the energy-Casimir mapping associated to this system.

Dynamics of front propagation in a biomathematical model

Gabriela LIŢCANU
Octav Mayer Institute of Mathematics of the Romanian Academy, Iași, Romania
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Propagation phenomena occur in many biological processes such as the spread of epidemics, formation of skin pigment of the animals, bacterial chemotactic aggregation. We focus on the existence, asymptotic decay rates and stability of traveling wave solutions of a reaction-diffusion-convection system.

Inverse problems of estimating the source in parabolic systems

Elena-Alexandra MELNIG
Alexandru Ioan Cuza University, Iaşi, Romania
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We consider coupled parabolic systems and establish estimates for the sources in terms of the solutions on a subdomain or on a part of the boundary. The main tool is a family of Carleman inequalities with general weights.

A Filippov-type lemma for Stieltjes differential inclusions

Bianca SATCO
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Recently, in collaboration with G. Smyrlis (Set-Valued and Variational Analysis, 2023), the author obtained a viability result for differential inclusions involving the Stieltjes derivative with respect to a left-continuous non-decreasing function, with time dependent state constraints.

Classical viability results (for usual differential inclusions) were thus generalized and, moreover, the gate to new viability results for difference inclusions, impulsive differential inclusions or dynamic inclusions on time scales was open.

As a consequence, in the particular case where $K(t)$ is a tube, a Filippov-type lemma is deduced for the general setting of differential problems driven by Stieltjes derivatives.

A comparison with another Filippov-type result (A. Fryszkowski, J. Sadowski, Math. Nachr. 2021) available for the same framework is made.

Conditioning facies probability fields to soft data with a regularized element-free Galerkin (EFG) method

Bogdan SEBACHER
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A facies represents a body of rock with specified characteristics (grain size, petrophysical characteristics), which formed under certain sedimentation conditions. The best prior knowledge about the spatial distribution of the facies in a hydrocarbon reservoir is essential due to its high importance in the setting of any reliable field development planning. One piece of information related to facies is its probability field, which mainly comes from seismic data inversion. Another one is the data obtained after analyzing the cores extracted at the exploration wells. Usually, the pieces of rocks that come from the underground extraction are non-homogeneous in terms of facies types, which makes a hard decision when it comes to specifying the type of facies that occur there. A solution is to assess the cores and assign the facies type with the higher possibility of occurrence, obtaining the so-called "hard data" or facies observations at the wells. In this paper, we explore a different solution by assigning at each well a discrete distribution that models the occurrence of facies types (i.e. soft data). This uncertain data is further used for conditioning the probability field of each facies type. The conditioning methodology is developed in a modified element-free-Galerkin framework that takes into account both the observations and the prior. The EFG optimization function is defined with a Tikhonov regularization term that accounts for the prior probability field of facies. The methodology is applied for a synthetic case, where three facies types occur in a bi-dimensional reservoir. The conditioned/updated probability fields of facies respect the probability theory rules. In each grid cell, the updated values are between 0 and 1, and the sum of all updated probability fields equals 1 everywhere. This result is ensured by using proper values for the Tikhonov parameter.

This is a joint work with Silvia Marzavan ("Ferdinand I" MTA) and Roxana Dobre ("Ferdinand I" MTA).

An artificial neural network model for enzyme kinetics

Iulian STOLERIU
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We build an artificial neural network model to approximate the solutions of a system of nonlinear differential equations. This system describes the evolution of the reactant concentrations in a Michaelis-Menten type model for enzyme kinetics. Our method is based on a mixture of feed-forward artificial neural networks and optimization techniques. We perform several numerical experiments to show the efficiency of our method. We also compare our result with the numerical solution obtained via the classical Runge-Kutta method.

Oscillations in a Fully Connected Network of Leaky Integrate-and-Fire Neurons with a Poisson Spiking Mechanism

Carmen Oana TĂRNICERIU
Gheorghe Asachi Technical University of Iaşi, Romania
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Understanding the mechanisms that lead to oscillatory activity in the brain is an ongoing challenge in Computational Neuroscience. We address this issue by considering a network of excitatory neurons with Poisson spiking mechanism. In the mean-field formalism, the network's dynamics can be successfully rendered by a non-linear dynamical system. The stationary state of the system is computed and a perturbation analysis is performed to obtain an analytical characterisation for the occurrence of instabilities. Taking into account two parameters of the neural network, namely, synaptic coupling and synaptic delay, we obtain numerically the bifurcation line separating the non-oscillatory from the oscillatory regime.

SPECIAL WORKSHOP

NEW TRENDS IN NONLINEAR OPTIMIZATION

Mathematical Programmers in Markets

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Each agent considered is a mathematical programmer, constrained by bounded inputs. He values own margins by Lagrange multipliers, seen and serving as his *endogenous* prices. Comparing these with *exogenous* prices, quoted in markets by other programmers, he wonders whether some input trade be worthwhile.

Present several such programmers, in case nobody sees attractive deals, then, which state prevails in the market?

The talk paper attempts to shed some light on these matters. It touches upon *Lagrangian relaxation*, *constraint qualifications*, *bounded multipliers*, *bid-ask spreads* and *competitive equilibrium*.

Conic cancellation laws and some applications in set optimization

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To obtain his renowned embedding theorem, Hans Rådström demonstrated the so-called cancellation law, which subsequently proved to be a fundamental tool in various fields. In this talk, we discuss, another version of Rådström cancellation law on infinite dimensional spaces. Then, we explore a conic variant of Rådström cancellation law and also, of the new version of Rådström cancellation law mentioned above, and we call our results conic cancellation laws since they involve the presence of an ordering cone on the underlying space. Several adaptations to this context of some topological properties of sets are studied and some applications in set optimization problems are given.

Beyond the Fermat Optimality Rules

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We propose a general framework for analyzing the behavior at its extrema of an extended real-valued function that might lack convexity or differentiability, and for which the classical Fermat rules of optimality may fail to apply. To this end, we employ the notions of sup-subdifferential (see [1]), and partial sup-subdifferentials. The sup-subdifferential is a nonempty enlargement of the Moreau-Rockafellar subdifferential, satisfying most of its fundamental properties and enjoying certain calculus rules. The partial sup-subdifferentials are obtained by breaking down the sup-subdifferential into one-dimensional components through the elements of a Hamel basis and play the same role as the partial derivatives in the Fermat optimality rules.

Joint work with Malek Abbasi (University of Isfahan) and Michel Théra (University of Limoges).

[1] M. Abbasi, A.K. Kruger, M. Théra, Enlargements of the Moreau-Rockafellar subdifferential, Set-Valued Var Anal 29(3):701-719, 2021

Proper efficiency in vector optimization: A fresh look at an old topic

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Over the last 70 years, various solution concepts of proper efficiency in vector optimization have been proposed (e.g., by Benson, Borwein, Geoffrion, Henig, Hurwicz, Kuhn/-Tucker) and their relationships studied. It is generally accepted that properly efficient solutions (as specific efficient solutions) are useful in practice. On closer examination, certain concepts of proper efficiency (e.g., in the sense of Benson, Borwein, Hurwicz) have the following structure: A point x is properly efficient if it is efficient and the cone given as the image value at x under a cone-valued map has only the zero point in common with the negative of the ordering cone of the image space.

For certain choices of the cone-valued map, any Henig properly efficient solution is properly efficient in the above sense. In our talk, we propose a new concept of proper efficiency involving a cone-valued map. The advantage is that our new concept can be easily related to the two well-known concepts mentioned above (using recent strict cone separation results based on Bishop-Phelps cones), and thus offers new insights into the relationships between the different known concepts of proper efficiency.

Generalized conic scalarization in vector optimization in real locally convex spaces

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It is well known that scalarization techniques (e.g., in the sense of Gerstewitz; Kasimbeyli; Pascoletti/Serafini; Zaffaroni) are useful for finding efficient solutions of vector optimization problems. One recognized approach is the conic scalarization method proposed by Kasimbeyli (2010, 2013), which is based on augmented dual cones and Bishop-Phelps type (norm-linear) scalarization functions. In this talk, we propose a generalized version of the conic scalarization method and derive new scalarization results for different types of proper efficiency concepts (e.g., in the sense of Benson; Borwein; Henig). To derive our new results, we use some recent strict cone separation theorems by Günther, Khazayel and Tammer (SIOPT, 2023) and recent scalarization results by Jahn (JANO, 2023).

Analysis and testing of a proximal gradient method in multiobjective optimization

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We propose a proximal gradient method for unconstrained multiobjective optimization problems, where the objective function is possibly nondifferentiable, but can be written as the sum of a continuously differentiable function and a proper lower semicontinuous convex function as they regularly appear, for example, in approximation theory.

The analysis shows Pareto stationarity of accumulation points in the general case and convergence towards at least weak Pareto optimal points if certain additional convexity assumptions are imposed on the smooth part of the objective. The analysis reveals further concrete convergence rates which will be illustrated by means of some small-scale numerical examples where we also discuss certain acceleration strategies. The presented results were obtained in a collaboration with X.-P. Zhao, X.-L- Qin, Chr. Tammer and J.-C. Yao.

Efficiency of higher order optimization methods

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Majorization-minimization algorithms consist of successively minimizing a sequence of upper bounds of the objective function so that along the iterations the objective function decreases. Such a simple principle allows to solve a large class of optimization problems, even nonconvex and nonsmooth. We propose a general higher-order majorization-minimization algorithmic framework for minimizing an objective function that admits an approximation (surrogate) such that the corresponding error function has a higher-order Lipschitz continuous derivative. We present convergence guarantees for our new method for general optimization problems with (non)convex and/or (non)smooth objective function. For convex (possibly nonsmooth) problems we provide global sublinear convergence rates, while for problems with uniformly convex objective function we obtain locally faster superlinear convergence rates. We also prove global stationary point guarantees for general nonconvex (possibly nonsmooth) problems and under Kurdyka-Lojasiewicz property of the objective function we derive local convergence rates ranging from sublinear to superlinear for our majorization-minimization algorithm. Moreover, for unconstrained nonconvex problems we derive convergence rates in terms of first- and second-order optimality conditions.

Stochastic first order methods for convex optimization with functional constraints

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In this work, we consider optimization problems with stochastic composite objective functions subject to (possibly) infinite intersection of constraints. The objective function is expressed in terms of expectation operator over a sum of two terms satisfying a stochastic bounded gradient condition, with or without strong convexity type properties. In contrast to the classical approach, where the constraints are usually represented as intersection of simple sets, in this work, we consider that each constraint set is given as the level set of a convex but not necessarily differentiable function. Based on the flexibility offered by our general optimization model we consider a stochastic subgradient method with random feasibility updates. At each iteration, our algorithm takes a stochastic proximal (sub)gradient step aimed at minimizing the objective function and then a subsequent subgradient step minimizing the feasibility violation of the observed random constraint. We analyze the convergence behavior of the proposed algorithm for diminishing stepsizes. We prove sublinear convergence rates for this stochastic subgradient algorithm, which are known to be optimal for subgradient methods on this class of problems.