Macedonian Society
of Graph Theorists

8th Macedonian Workshop on Graph Theory
and Applied Mathematics

Ohrid, August 9–13, 2024

Book of Abstracts

Editor:
Vesna Andova

Publisher:
Macedonian Society of
Graph Theorists

Scientific committee :
Riste Škrekovski, Slovenia
Pavel Dimovski, Macedonia
Martin Knor, Slovakia
Snježana Majstorovic, Croatia
Jelena Sedlar, Croatia
Vesna Andova, Macedonia
Mirko Petruševski, Macedonia

Local organizing committee :
Vesna Andova
Mirko Petruševski
Pavel Dimovski

Technical support :
Vesna Andova
Mirko Petruševski

Sponsors :
Ss. Cyril and Methodius University in Skopje,
Faculty of Electrical Engineering and Information Technologies, UKIM,
Faculty of Technology and Metallurgy, UKIM,

Contents

Invited talks

Symmetry Properties of Nut Graphs

Nino Bašič

University of Primorska,
Koper, Slovenia
nino.basic@famnit.upr.si

Joint work with Patrick W. Fowler and Tomaž Pisanski.

Abstract

A nut graph is a simple graph for which the adjacency matrix has a single zero eigenvalue such that all nonzero kernel eigenvectors have no zero entry. Nut graphs have seven or more vertices; they are all connected, non-bipartite, and leafless. Nut graphs were introduced in 1998 by Sciriha and Gutman. However, only recently important chemical applications involving this class of graphs were uncovered, which makes them quite attractive for further investigation and research.

In this talk, we first present some symmetry properties of nut graphs. We show that a nut graph G always has at least one more edge orbit than it has vertex orbits. In particular, edge-transitive nut graphs do not exist. Then we give infinite families of vertex-transitive nut graphs with two orbits

of edges, and infinite families of nut graphs with two orbits of vertices and three of edges.

Next, we show by construction that every finite group can be represented as the group of automorphisms of infinitely many nut graphs. It is also shown that these graphs may be required to be regular; the cases where the degree is required to be 8, 12, 16, 20 or 24 are realised explicitly.

Symmetry Equiinncidence of Natural Orbitals

Jerzy Cioslowski

Institute of Physics,
University of Szczecin
Szczecin, Poland
jerzy.cioslowski@usz.edu.pl

Abstract

The symmetry equiincidence principle quantifies the apportionment of the natural orbitals (NOs), ordered according to their nonascending occupation numbers, among the irreducible representations (irreps) of the point group pertaining to the underlying on-top two-electron density. This principle, which is rigorously proven for the resolvable C_s, C_{2v}, C_{3v}, C_{4v}, C_{6v}, D_{2h}, D_{3h}, D_{4h}, D_{6h}, and O_h point groups, states that the symmetry incidences, i.e. the asymptotic probabilities with which the NOs belonging to different irreps occur, are proportional to the squares of irreps' dimensions. Since its proof hinges upon a sufficient number of planes of symmetry among the elements of a given point group, it yields only linear combinations of the symmetry incidences for the quasiresolvable groups with too few such planes and fails for the unresolvable C_1, C_i, C_n, D_n, S_{2n}, T, O, and I groups whose nontrivial elements comprise only symmetry axes and/or the center of inversion.

Characterization of Polymer of Polymer Matrix Composites Reinforced with Carbon Nanostructures

Aleksandar Dimitrov

Faculty of Technology and Metallurgy,
Ss Cyril and Methodius Univ.
Skopje, North Macedonia
aco@tmf.ukim.edu.mk

Joint work with Beti Andonovic[1]

Abstract

The main goal of this research is synthesis of carbon nanostructures: MWCNTs (multi-walled carbon nanotubes) and Graphene. These carbon nanostructures were synthesized by electrolysis in molten salt, under potentiostatic condition using nonstationary current regimes. Furthermore, production and characterizing of conductive nanocomposites using PMMA (Poly(methyl methacrylate)) and PVDF (Poly(vinylidene fluoride)) matrices reinforced with graphene, MWCNTs, and a hybrid mix of graphene, MWCNTs, and fullerenes. These nanocomposites are created as thin films via the solvent casting method. Carbon nanostructures are mixed with PMMA or PVDF solutions using ultrasonication. PMMA is dissolved in chloroform, and PVDF in N-dimethylacetamide, with solvent evaporation taking about 72 hours. The carbon-based nanostructures (CNs) are dispersed in weight fractions of 5functionalized by acid treatment with HNO3 and X-ray irradiation. Non-functionalized reinforcements are used for comparison. The

[1]Faculty of Technology and Metallurgy, "Ss. Cyril and Methodius" University in Skopje, Republic of North Macedonia

effects of functionalization on the conductive properties of graphene, MWCNTs, and the hybrid mix are evaluated. Physical characterization includes Raman spectroscopy, TEM, SEM, and TGA. Conductivity is measured using a four-point probe method. Chemical analysis of graphene and carbon nanotubes is conducted with ICP-OES.

Key words: nanocomposites, PMMA, graphene, MWCNTs, PVDF.

References

[1] A. K. Geim , K. S. Novoselov, Nat. Mater., **6** (2007) 183–191.

[2] S. Mishra, K.T. Kumaran, R. Sivakumaran, S. Paul Pandian, S. Kundu, Synthesis of PVDF/CNT and their functionalized composites for studying their electrical properties to analyze their applicability in actuation and sensing, **509** (2016) 684–696.

[3] Z. Jia, Z. Wang, C. Xu, J. Liang, B. Wei, D. Wu, S. Zhu, Study on poly(methyl methacrylate)/carbon nanotube composites, **271** (1999) 395–400.

[4] C. Schwandt, A. T. Dimitrov, D. J. Fray, High-yield synthesis of multiwalled carbo nanotubes from graphite by molten salt electrolysis, Carbon, **50** (2012) 1311–1315.

[5] A. T. Dimitrov, A. Ademi, A. Grozdanov, P. Paunović, Production and Characterization of MWCNTs Produced by Non Stationary Current Regimes in Molten LiCl, Applied Mechanics and Materials, **328** (2013) 772–777.

[6] A.T. Dimitrov, G.Z. Chen, I.A. Kinloch and D.J. Fray, A Feasibility study of Scaling-up the Electrolytic Production of Carbon Nanotubes in Molten Salt, Electrochimica Acta **48** (2002) 91–102.

Strong edge-coloring of graphs

Roman Soták

PF UPJŠ – Pavol Jozef Šafárik University in Košice,
Faculty of Science,
Košice, Slovakia
roman.sotak@upjs.sk

Abstract

A strong edge-coloring of a graph is an edge-coloring in which every color class is an induced matching. It is well known that for a strong edge coloring of a k-regular graph at least $2k-1$ colors are needed. We present a characterization of all k-regular graphs which admit a strong edge coloring with $2k-1$ colors. In particular, a cubic graph is strongly 5-edge-colorable whenever it covers the Petersen graph.

We also consider the list version of the strong edge-coloring. Dai et al. (Strong list-chromatic index of subcubic graphs, Discrete Math., 341(12) (2018), 3434-3440) proved that every subcubic graph admits a strong list-chromatic index at most 11. We improve this result and give a tight upper bound for the strong list-chromatic index of subcubic graphs.In the proof, we use Combinatorial Nullstellesatz for non-colored edges of the shortest cycle with pendant edges.

In the end, we will discuss the relation between the strong chromatic index and the strong list-chromatic index of graphs, and present an infinite class of cubic graphs where these two indices differ.

Some Developments on the Wiener-Ikehara Theorem

Jasson Vindas

Department of Mathematics: Analysis, Logic and Discrete Mathematics
Ghent University
Krijgslaan 281
B 9000 Ghent
Belgium
jasson.vindas@ugent.be

Abstract

The Wiener-Ikehara theorem is one of the cornerstones of complex Tauberian theory for Laplace transforms. This useful result has found many applications in diverse areas of mathematics such as number theory and spectral theory. In this talk we will survey some developments on the Wiener-Ikehara theorem from the last decade. Among others, we will discuss minimal assumptions on the boundary behavior of the Laplace transform, exact forms of the theorem, absence of reminders, and some quantified versions of it.

Variety of mutual-visibility problems in graph theory

Ismael Gonzalez Yero

University of Cádiz,
Cádiz, Spain
ismael.gonzalez@uca.es

Abstract

Let G be a connected simple graph. Given a set $S \subset V(G)$, it is said that two vertices $x, y \in V(G)$ are S-visible, if there exists a shortest x, y-path P in G satisfying that $P \cap S \subseteq \{x, y\}$. The set S is known as a *mutual-visibility set* of the graph G if any two vertices of S are S-visible, and the cardinality of a largest possible mutual-visibility set of G is the *mutual-visibility number* of G. This concept was recently introduced in [3]. Some variations of the concept are known as follows. A given set $S \subset V(G)$ is:

- a *total mutual-visibility set*, if every $u, v \in V(G)$ are S-visible, or
- an *outer mutual-visibility set*, if every $u, v \in S$ are S-visible, and every $u \in S$, $v \in \overline{S}$ are S-visible, or
- a *dual mutual-visibility set*, if every $u, v \in S$ are S-visible, and every $u, v \in \overline{S}$ are S-visible.

In this talk, there will be given several contributions concerning the variety of the mutual-visibility problem in graphs. The results of the talk are part of the articles [1, 2].

Acknowledgement: The speaker thanks the Spanish Ministry of Science and Innovation, ref. PID2019-105824GB-I00.

References

[1] S. Cicerone, G. Di Stefano, S. Klavžar, I. G. Yero, Mutual-visibility problems on graphs of diameter two. Manuscript, arXiv:2401.02373 [math.CO], (2024).

[2] S. Cicerone, G. Di Stefano, S. Klavžar, I.G. Yero, Variety of mutual-visibility problems in graphs, Theoretical Computer Science 974 (2023) 114096.

[3] G. Di Stefano, Mutual visibility in graphs, Applied Mathematics and Computation 419 (2022) 126850.

Contributed talks

Diameter of Nanotori

Vesna Andova

Faculty of Electrical Engineering and Information Technologies,
Ss Cyril and Methodius Univ. in Skopje,
Ruger Boskovik 18, 1000 Skopje, Macedonia
vesna.andova@gmail.com, vesnaa@feit.ukim.edu.mk

Joint work with Pavel Dimovski, Martin Knor and Riste Škrekovski.

Abstract

A cubic graph which has only hexagonal faces, and can be embedded into a torus is known as generalized honeycomb torus or honeycomb toroidal graph, abbreviated as nanotorus. This graph is determined by three parameters a, b, and c, and denoted by $G_{a,b,c}$. Recently, B. Alpspach dedicated a survey paper to nanotori, wherein a number of open problems are suggested. In this article we deal with one of the problems given in the survey, i.e. we determine the diameter of nanotorus $G_{a,b,c}$ as a function of the parameters a, b, and c. We obtain that the diameter of $G_{a,b,c}$ for $b \leq a$ is just a. For the case $a < b$, we distinguish two subcases: $a \leq c < b$ and $c < a < b$. In both subcases we determine the diameter for b big enough.

Detecting Communities Under Constraints in Directed Acyclic Networks

Suzana Antunović

Faculty of Science,
University of Split, Croatia
suzana.antunovic264@gmail.com

Abstract

Community detection in complex networks theory is an outstanding area of research with applications in many different branches of science. Many available algorithms for community detection in directed acyclic networks do not include analysis of the resulting set of communities, and those that do, mostly focus on factors like the number of communities and community stability, not on relations between communities. Here, we present an algorithm that, given the topological ordering of a directed acyclic network, produces an optimal division (in terms of modularity) for that ordering which allows the establishment of an ordering on the resulting set of communities. The algorithm is based on recursively placing of the vertices into appropriate communities, thus respecting the order of the vertices, and resulting in division with optimal modularity.

Asymptotic Analysis of Some Fractional Transforms on Distribution Spaces

Sanja Atanasova

Faculty of Electrical Engineering and Information Technologies,
Ss Cyril and Methodius Univ. in Skopje,
Ruger Boskovik 18, 1000 Skopje, Macedonia
ksanja@feit.ukim.edu.mk

Abstract

In this talk, Abelian and Tauberian type results that intricately link the quasi-asymptotic behavior of distributions to the corresponding asymptotic properties of certain fractional transforms will be presented. In all cases, we quantified the scaling asymptotic properties of distributions by asymptotic comparisons with Karamata regularly varying functions.

Wave Front Sets with Respect to Banach Spaces of Ultradistributions

Pavel Dimovski

Faculty of Technology and Metallurgy, Ss Cyril and Methodius Univ.
Skopje, North Macedonia
dimovski.pavel@gmail.com

Abstract

We define ultradistributional wave front sets with respect to translation-modulation invariant Banach spaces of ultradistributions having solid Fourier images. The main result is their characterisation by the short-time Fourier transform.

Some Spectral Characterizations of Graphs with Self-loops

Irena Jovanović

School of Computing,
Union University,
Belgrade, Serbia
irenaire@gmail.com

Joint work with Saieed Akbari and Johnny Lim.

Abstract

Let G be a finite simple n-vertex graph with the set of vertices $V(G)$, and let $S \subseteq V(G)$, where $|S| = \sigma$ and $0 \leq \sigma \leq n$. The graph G_S obtained by attaching a self-loop at each vertex from the set S is a *self-loop graph* of G. The *adjacency matrix* $A(G_S)$ of G_S is of the form $A(G_S) = A(G) + \mathfrak{I}_S$, where $A(G)$ is the adjacency matrix of G, while $\mathfrak{I}_S$ is the "almost" identity matrix, with exactly σ ones on the main diagonal corresponding to S and all other entries equal to zero. The adjacency eigenvalues $\lambda_i(G_S)$, $1 \leq i \leq n$, of G_S are the eigenvalues of its adjacency matrix. Recently, Gutman et al. [4] introduced the *energy* $\mathcal{E}(G_S)$ of a self-loop graph G_S as follows: $\mathcal{E}(G_S) = \sum_{i=1}^{n} \left|\lambda_i(G_S) - \frac{\sigma}{n}\right|$, and conjectured that for any set S, such that $1 \leq \sigma \leq n-1$, $\mathcal{E}(G_S) > \mathcal{E}(G)$, where $\mathcal{E}(G)$ is the (ordinary) energy of G. The conjecture was disproved in [5], and its modified version was posed in [1]. In that way, graphs with self-loops have become interesting for research again.

Similarly as in the case of a simple graph, the *incidence matrix* of a self-loop graph is introduced, and certain relations based on this matrix and its transpose are established in order to define and discuss some *unary graph operations* on self-loop graphs. It is shown that the eigenvalues of the *line graph* $L(G_S)$ of a self-loop graph G_S of a given graph G are not less than -2, as well as that the multiplicity of the eigenvalue -2 in the spectrum of $L(G_S)$ is equal to the multiplicity of the same eigenvalue in the spectrum of the line graph $L(G)$ of the graph G. As a consequence of a slightly general statement, it follows that for a graph G with at least two vertices and a non-empty set S, $\mathcal{E}(L(G)) < \mathcal{E}(L(G_S))$ holds.

The characteristic polynomials of some particular self-loop graphs of the subdivision graph $S(G)$ of an regular graph G are determined, as well as the characteristic polynomial of the *subdivision graph* $S(G_S)$ of a self-loop graph G_S of G. The nullity of a graph $SP(G)$ which is obtained from the subdivision graph $S(G)$ of an arbitrary graph G by attaching pendant edges at vertices from the set S is computed by relating such a graph with a certain multiple-loop graph. Due to this result, a class of bipartite graphs with pendant edges and of small nullity can be easily generated.

The talk will be concluded by presenting some bounds for the energy of self-loop graphs based on proposed inequalities for their eigenvalues.

References

[1] Akbari S., Menderj H. Al, Ang M. H., Lim J., Ng Z. C., *Some results on spectrum and energy of graphs with loops*, Bull. Malays. Math. Sci. Soc. 46, 94 (2023).

[2] Akbari S., Jovanović I. M., Lim J., *Line graphs and Nordhaus-Gaddum-type bounds for self-loop graphs*, under review

[3] Akbari S., Jovanović I. M., Lim J., *Some unary graph operations on self-loop graphs and beyond*, in preparation

[4] Gutman I., Redžepović I., Furtula B., Sahal A. M., *Energy of graphs with self-loops*, MATCH Commun. Math. Comput. Chem. 87 (2022), 645–652.

[5] Jovanović I. M., Zogić E., Glogić E., *On the conjecture related to the energy of graphs with self-loops*, MATCH Commun. Math. Comput. Chem., Vol. 89, No. 2 (2023), 479–488.

On Šoltés Vertices in Regular Graphs

Martin Knor

Slovak University of Technology in Bratislava
Bratislava, Slovakia
knor@math.sk

Joint work with Nino Bašič and Riste Škrekovski.

Abstract

Let G be a graph. By $W(G)$ we denote its Wiener index, that is the sum of distances in G. If $v \in V(G)$, then in general $W(G \setminus v) \neq W(G)$. However if $W(G \setminus v) = W(G)$, then v is a Šoltés vertex. There are many graphs with at least one Šoltés vertex, but at the moment there is known only one graph which has only Šoltés vertices. In the talk we report a current progress in regular graphs. We present a construction showing that the nuber of Šoltés vertices is not bounded in cubic graphs.

This research was supported by the APVV Research Grants 19-0308 and 22-0005 and the VEGA Research Grants 1/0567/22 and 1/0069/23.

Complexity of Graph Algebraic Expressions: Recent Findings

Mark Korenblit

School of Computer Science
Holon Institute of Technology
Holon, Israel
korenblit@hit.ac.il

Joint work with Vadim E. Levit[2].

Abstract

We define the sum of edge label products corresponding to all possible spanning paths in an edge-labeled *st-dag* (two-terminal directed acyclic graph) G as the *canonical expression* of G. An algebraic expression is called an *st-dag expression* if it is algebraically equivalent to the canonical expression of an st-dag. We define the total number of labels in an algebraic expression as its *complexity*. An *optimal representation of the algebraic expression* F is an expression of minimum complexity algebraically equivalent to F.

The focus of our studies is to explore the relationship between algebraic expressions and graphs for simplifying st-dag expressions. The ultimate goal is to reduce an st-dag expression to its optimal representation or, at least, to the expression with polynomial complexity in relation to the graph's order.

[2]Department of Mathematics, Ariel University, Ariel, Israel, levitv@ariel.ac.il

An expression of a *series-parallel graph* (which is defined recursively and obtained by parallel or series composition of other series-parallel graphs) has a representation in which each label appears only once. This representation is an optimal representation of the series–parallel graph expression. Generating the optimum factored form for expressions of non-series-parallel graphs is NP-complete in the general case.

In our works, we considered various non-series-parallel st-dags. Specifically, we presented algorithms that generate expressions of $O\left(n^2\right)$ complexity for n-vertex *Fibonacci graphs* and of $O\left(n^{\log_2 6}\right)$ complexity for more complicated n-vertex *rhomboidal* graphs. In other works, we have studied *directed grid graphs* having $m \times n$ vertices. For constant m, our proposed decomposition method provides expressions of quasi-linear complexity with respect to n. For a *square grid graph* ($m = n$), this method generates an expression of quasi-polynomial complexity in relation to n.

One of our papers is devoted to a more general problem. We have generated expressions of *complete st-dags* and estimated their complexities. Using these findings, we have shown that the expression of each n-vertex *simple* (without multiple edges) st-dag has a representation with complexity bounded by $2^{O\left(\log^2 n\right)}$. That is, an upper bound of the optimal representation's complexity of the expression for every n-vertex simple st-dag can be estimated in a quasi-polynomial manner.

Finding optimal representations (and computing their complexities) of st-dag expressions remains an open problem.

The k-multiset Antidimension of Graphs with Applications into Privacy in Networks

Dorota Kuziak

University of Cádiz,
Cádiz, Spain
dorota.kuziak@uca.es

Abstract

Let G be a connected graph. Let $S = \{v_1, \ldots, v_r\} \subset V(G)$ and let $x \in V(G) \setminus S$. The *metric representation* of x with respect to S is the vector $r(x|S) = (d_G(x, v_1), \ldots, d_G(x, v_r)$, where $d_G(a, b)$ is the distance between a, b. The set $S \subset V(G)$ is a *k-antiresolving set* for G, if k is the largest integer such that for all $u \notin S$ there exists a set $S_u \subseteq V(G) \setminus (S \cup \{u\})$ with $|S_u| \geq k - 1$ such that $r(u|S) = r(v|S)$ for every $v \in S_u$. The *k-metric antidimension* of G is the cardinality of a smallest k-antiresolving set for G.

This concept was introduced in [1], and was used to generate a privacy measure of social networks called (k, ℓ)-anonymity. A graph G meets (k, ℓ)-*anonymity* with respect to active attacks to its privacy, if k is the smallest positive integer such that the k-metric antidimension of G is not larger than ℓ.

This work considers a variation of this concept, where the notion of vector is changed to that of multiset, while defining the metric representation of a vertex with respect to a set. That is, the *multiset representation* of a vertex

x with respect to a set S is the multiset $m(x|S) = \{\{d_G(x, v_1), \ldots, d_G(x, v_r)\}\}$. The set $S \subset V(G)$ is a *k-multiset antiresolving set* for G, if k is the largest integer such that for all $u \notin S$ there exists a set $S_u \subseteq V(G) \setminus (S \cup \{u\})$ with $|S_u| \geq k - 1$ such that $m(u|S) = m(v|S)$ for every $v \in S_u$. The *k-multiset antidimension* of G is the cardinality of a smallest k-multiset antiresolving set for G.

Acknowledgement: The speaker is supported by the Spanish Ministry of Science and Innovation, ref. PID2019-105824GB-I00.

References

[1] R. Trujillo-Rasúa, I. G. Yero, k-metric antidimension: A privacy measure for social graphs, Information Sciences 328 (2016) 403–417.

Combining Proper and Square Colorings

Borut Lužar

Faculty of Information Sciences in Novo mesto,
Novo mesto, Slovenia
borut.luzar@gmail.com

Abstract

Proper colorings of graphs with additional distance constraints are an attractive topic in both settings: the vertex and the edge coloring. In particular, when we require that two vertices are colored differently if they are at distance at most 2, we are essentially coloring the square of a graph. Similarly, in a proper coloring of edges where two edges are colored differently as soon as they are adjacent or two of their endvertices are at distance 1, we are coloring the square of the line graph of a graph. We usually refer to the former as the square coloring and to the latter as the strong edge coloring.

Motivated by the notion of S-packing coloring, we will consider colorings with two types of colors: proper colors, which will be allowed to appear on two non-adjacent objects (regarding the setting - vertex or edge coloring), and strong colors, with which we will be able to color objects at distance at least 3 (in the edge coloring setting, the distance between two edges is taken as the distance between the corresponding vertices in the line graph). This combination of color types positions us in between the proper and the square colorings, which in most of the cases makes determination of the corresponding chromatic indices harder, but it also reveals several nice properties.

Reich-type Contractive Mapping into a Complete Metric Space and Continuous, Injective and Subsequentially Convergent Mapping

Samoil Malcheski

International Slavic University,
Sveti Nikole, Macedonia
samoil.malcheski@msu.edu.mk

Abstract

In this talk, a generalization of the fixed point theorem of the Reich-type mapping on a complete metric space (X, d) is given. Continuous, injective and sub-sequentially convergent mapping T was used, as well as it is taken that function f is from the class Θ continuous monotonically nondecreasing functions $f : [0, +\infty) \to [0, +\infty)$ such that$f^{-1}(0) = \{0\}$, where it is additionally assumed that it is subadditive, i.e. $f(x + y) \leq f(x) + f(y)$, for each $x, y \in [0, +\infty)$.

Objective Determinantion of the Type of Trend Function in Economic Processes

Risto Malcheski

risto.malceski@gmail.com

Abstract

This talk discusses a method for determining the type of trend function in economic processes, which does not use a priori assumptions. Namely, the type of trend function is not given a priori, but is determined based on the information contained in the time series data. The considered method is based on elementary statements from linear algebra, differential and difference equations.

Generalisations of Connectedness and Separatedness by Using the Notion of Chain

Zoran Misajleski

Faculty of Civil Engineering,
Ss. Cyril and Methodius Univeristy in Skopje
Skopje, Macedonia
zokimisajleski@gmail.com

Abstract

In this talk we will define a generalisations of the notions connectedness and separatedness by using the notion of chain and will state several properties.

Hermite Expansions for Spaces of Functions with Nearly Optimal Time-frequency Decay

Lenny Neyt

University of Trier,
Ghent, Belgium
Lenny.Neyt@UGent.be

Joint work with Joachim Toft and Jasson Vindas.

Abstract

For a non-trivial function $f \in L^2(\mathbb{R})$ and its Fourier transform $\widehat{f}(\xi) = (2\pi)^{-1/2} \int_{-\infty}^{\infty} f(t)e^{-it\xi}dt$, the classical Hardy uncertainty principle states that if

$$|f(t)| \lesssim e^{-\eta x^2} \quad \text{and} \quad |\widehat{f}(\xi)| \lesssim e^{-\eta \xi^2}, \tag{1}$$

then necessarily $0 \leq \eta \leq 1/2$. Moreover, in the extreme case that $\eta = 1/2$, the function f must be a constant multiple of the Gaussian $e^{-\frac{1}{2}x^2}$. In this talk, we will be interested in those functions f for which (1) holds for any $\eta < 1/2$. In particular, we will show that such time-frequency decay for f holds if and only if

$$|H(f,n)| \lesssim e^{-rn}, \qquad \forall r > 0, \tag{2}$$

where $H(f,n)$ denotes the nth Hermite coefficient of f. Moreover, we will see that more refined bounds than those in (2) correspond to a sharper time-frequency decay of f, and vice-versa. Our main tools are the Bargmann

transform and some optimal weighted forms of the Phragmén-Lindelöf principle on sectors.

Topological Data Analysis and Decision Trees for Breast Cancer Detection using Thermal Images

Sijche Pechkova

Faculty of Technology and Metallurgy, Ss Cyril and Methodius Univ.
Skopje, North Macedonia
sijche@gmail.com

Joint work with Lydmila Wenger[3]

Abstract

In our research, we propose an innovative method for analyzing thermal images for breast cancer detection using machine learning. By implementing features extracted from Topological Data Analysis (TDA), we aim to boost the diagnostic precision and consistency of thermal imaging. Our dataset consists of thermal images from breast cancer patients, from which we isolate essential topological characteristics that encapsulate the inherent geometric and structural details. Subsequently, these TDA features are incorporated into our decision tree model to attain a classification precision of 92the potential of merging TDA with machine learning algorithms in medical image analysis. Our results indicate that the addition of topological features can significantly enhance the capabilities of conventional imaging methods, establishing a robust foundation for early and precise detection of breast cancer.

[3]IPectus - https://millawenger.wixsite.com/ipectus Berlin

A Comprehensive Study on Air Pollution Prediction in North Macedonia: Insights from LASSO Modeling

Aleksandar Pechkov

apechkov@gmail.com

Joint work with Mare Srbinovska, Sijche Pechkova, Maja Celeska Krstevska, Aleksandra Krkoleva Mateska, Vesna Andova and Pavel Dimovski.

Abstract

The study delves into the realm of air quality forecasting, employing the LASSO (Least Absolute Shrinkage and Selection Operator) modeling technique for enhanced predictive accuracy. Utilizing a diverse dataset encompassing meteorological parameters, pollutant concentrations, and other relevant factors, the research explores the robustness of LASSO regression in predicting air pollution dynamics. The analysis establishes correlations and identifies key predictors, shedding light on the intricate relationships within the data. The paper contributes valuable insights to the field of air quality prediction, showcasing the efficacy of LASSO modeling in providing accurate and reliable forecasts, thus facilitating proactive measures for pollution mitigation and environmental management. Additionally, the aim of the paper is to investigate whether the COVID-19 pandemic exerted any discernible impact on pollution levels.

The Odd Coloring and its Variations

Mirko Petruševski

Faculty of Mechanical Engineering,
Ss. Cyril and Methodius Univ., Macedonia
mirko.petrushevski@gmail.com

Join work with Riste Škrekovski and Yair Caro

Abstract

A proper vertex coloring φ of graph G is said to be odd if for each non-isolated vertex $x \in V(G)$ there exists a color c such that $\varphi^{-1}(c) \cap N(x)$ is odd-sized. The minimum number of colors in any odd coloring of G, denoted $\chi_o(G)$, is the odd chromatic number. Odd colorings were recently introduced in [M. Petruševski, R. Škrekovski: *Colorings with neighborhood parity condition*]. In the talk we discuss various basic properties of this new graph parameter, establish several upper bounds, several charatcterizatons, and pose some questions and problems. We will also consider another new and related coloring, so called the proper conflict-free coloring. At the end will be considered strong odd colorings.

Core Potentials: a Hypercube Perspective

Guillaume Scholz

Leipzig University
Leipzig, Germany
gllm.scholz@gmail.com

Joint work with Anahy Santiago Arguello and Peter Stadler.

Abstract

Segmentations are partitions of an ordered set into non-overlapping intervals. The Consensus Segmentation problem is a special case of the median problems with applications in time series analysis and computational biology. A wide range of dissimilarity measures for segmentations can be expressed in terms of potentials, a special type of set-functions.

In this talk, I will present some properties of potentials, and how such properties can be used to get insights into the solutions of the Consensus Segmentation problem. In particular, I will discuss the parallel between the Consensus Segmentation problem, and the problem of finding the median of a given set of vertices in the edge-weighted hypercube. As we shall see, this parallel can be used to investigate some open questions related to the Consensus Segmentation problem.

Graph B

Riste Škrekovski

Faculty of Information Studies, Novo mesto
& Faculty of Mathematics and Physics, University of Ljubljana, Slovenia.
skrekovski@gmail.com

Join work with Jelena Sedlar (+ Borut Lužar)

Abstract

In this talk, the focus will be on graph B, which is named after Borut.

On Normal and List Normal Edge-coloring of Cubic Graphs

Diana Švecová

PF UPJŠ – Pavol Jozef Šafárik University in Košice,
Faculty of Science,
Košice, Slovakia
diana.svecova@student.upjs.sk

Abstract

A normal edge-coloring of a cubic graph is a proper edge-coloring, in which every edge is adjacent to edges colored with four distinct colors or to edges colored with two distinct colors. It is conjectured that 5 colors suffices for a normal edge-coloring of any bridgeless cubic graph and this statement is equivalent to the Petersen Coloring Conjecture. Up till now, we only know that any cubic graph admits a normal edge-coloring with at most 7 colors.

We present new results regarding the normal coloring of special graph classes. In the second part, we introduce the study of the list version of the normal edge-coloring. It turns out to be more restrictive and consequently more colors are needed. In particular, we show that there are cubic graphs which need at least 9 colors for a list normal edge-coloring and there are bridgeless cubic graphs which need at least 8 colors.

Geometric description and structure of the photon and electron

Kostadin Trenchevski

Faculty of Civil Engineering Skopje,
Ss. Cyril and Methodius Univeristy in Skopje
velinov.daniel@gmail.com

Abstract

Almost Periodic Functions in the Framework of Measure Theory

Daniel Velinov

Faculty of Civil Engineering Skopje,
Ss. Cyril and Methodius Univeristy in Skopje
velinov.daniel@gmail.com

Abstract

In this talk, various classes of multi-dimensional almost periodic type functions and their generalizations within the framework of general measure are going to be introduced. We introduce new classes of multi-dimensional (ρ, m')-almost periodic type functions, emphasizing their structural properties and practical applications in abstract Volterra integro-differential inclusions in Banach spaces. Furthermore, we discuss their applications in semilinear Volterra integro-differential inclusions, offering a comprehensive overview of their significance in mathematical analysis and related fields.

Derivatives of Multivariate Real Functions Without Limits and Differential Forms on Tangentially Locally Linearly Independent Sets

Aneta Velkoska

University for Information Science and Technology "St. Paul the Apostle"
Ohrid, Macedonia aneta.velkoska@uist.edu.mk

Abstract

The differentiable mappings are usually defined on open sets. On an arbitrary set, a function is differentiable, if a bigger open set exists and it contains the set, and the function is differentiable on it. However, this is only an agreement. In this paper, instead of using the usual definition of derivatives as limits for the differential forms, we use an algebraic approach to the derivative mentioned in [1] to define inner differentiability on a wider family of subsets of Euclidean space called tangentially locally linearly independent - TLLI sets.

References

[1] H. Grauert, I. Lieb, W. Fischer, Diferential-und integralrechnung, Springer Berlin Heidelberg, Berlin, 1989.

On the Iterates of the Laguerre Operator

Đorđe Vučković

Technical Faculty "Mihajlo Pupin"
Zrenjanin, Serbia
djordjeplusja@gmail.com

Joint work with Stevan Pilipović, Nenad Teofanov and Smiljana Jakšić.

Abstract

We introduce spaces of test functions on positive orthants, $\mathbf{G}^{\alpha}_{\alpha}(\mathbb{R}^d_+)$ and $\mathbf{g}^{\alpha}_{\alpha}(\mathbb{R}^d_+)$, $\alpha > 0$, by using the iterates of the Laguerre operator, and show that these spaces represent a natural counterpart of global Pilipović spaces on $\mathbb{R}^d$. Moreover, we show that $\mathbf{G}^{\alpha}_{\alpha}(\mathbb{R}^d_+)$ and $\mathbf{g}^{\alpha}_{\alpha}(\mathbb{R}^d_+)$ coincide with nontrivial $G-$type spaces. We also consider the associated spaces of ultradistributions.

Participants

1. Andonovik Beti
   Faculty of Technology and Metallurgy,
   Ss Cyril and Methodius Univ.,
   Ruger Boskovik 16, 1000 Skopje, Macedonia
   beti@tm.ukim.edu.mk

2. Andova Vesna
   Faculty of Electrical Engineering and Information Technologies,
   Ss Cyril and Methodius Univ.,
   Ruger Boskovik 18, 1000 Skopje, Macedonia
   vesna.andova@gmail.com, vesnaa@feit.ukim.edu.mk

3. Antunovic Suzana
   Faculty of Science,
   University of Split, Croatia
   suzana.antunovic264@gmail.com

4. Atanasova Sanja
   Faculty of Electrical Engineering and Information Technologies,
   Ss Cyril and Methodius Univ.,
   Ruger Boskovik 18, 1000 Skopje, Macedonia
   ksanja@feit.ukim.edu.mk

5. Bašić Nino
   University of Primorska,
   University of Ljubljana
   Koper, Slovenia
   nino.basic@famnit.upr.si

6. Cioslowski Jerzy
   Institute of Physics,
   University of Szczecin
   Szczecin, Poland
   jerzy.cioslowski@usz.edu.pl

7. Dimitrov Aleksandar T.
   Faculty of Technology and Metallurgy,
   Ss Cyril and Methodius Univ.,
   Ruger Boskovik 16, 1000 Skopje, Macedonia
   aco@tm.ukim.edu.mk

8. Dimovski Pavel
   Faculty of Technology and Metallurgy,
   Ss Cyril and Methodius Univ.,
   Ruger Boskovik 16, 1000 Skopje, Macedonia
   dimovski.pavel@gmail.com

9. Jovanović Irena
   School of Computing,
   Union University,
   Belgrade, Serbia
   irenaire@gmail.com

10. Knor Martin
    Slovak University of Technology in Bratislava
    Bratislava, Slovakia
    knor@math.sk

11. Korenblit Mark
    Holon Institute of Technology,
    Holon, Israel
    korenblit@hit.ac.il

12. Kuziak Dorota
    University of Cádiz,
    Cádiz, Spain
    dorota.kuziak@uca.es

13. Lužar Borut
    Faculty of Information Sciences in Novo mesto,
    Novo mesto, Slovenia
    borut.luzar@gmail.com

14. Malcheski Samoil
    International Slavic University,
    Sveti Nikole, Macedonia
    samoil.malcheski@msu.edu.mk

15. Malcheski Risto
    risto.malcheski@gmail.com

16. Misajleski Zoran
    Faculty of Civil Engineering,
    Ss. Cyril and Methodius Univeristy in Skopje
    Skopje, Macedonia
    zokimisajleski@gmail.com

17. Neyt Lenny
    University of Trier,
    Genth, Belgium
    zlenny.neyt@ugent.be

18. Pechkova Sijche
Faculty of Technology and Metallurgy,
Ss Cyril and Methodius Univ.,
Ruger Boskovik 16, 1000 Skopje, Macedonia
sijche@gmail.com

19. Pechkov Aleksandar
apechkov@gmail.com

20. Petruševski Mirko
Faculty of Mechanical Engeineering,
Ss Cyril and Methodius Univ.,
Ruger Boskovik 18, 1000 Skopje, Macedonia
mirko.petrushevski@gmail.com

21. Scholz Guillaume
Leipzig University
Leipzig, Germany
gllm.scholz@gmail.com

22. Sotak Roman
PF UPJŠ – Pavol Jozef Šafárik University in Košice,
Faculty of Science,
Košice, Slovakia
roman.sotak@upjs.sk

23. Srbinovska Mare
    Faculty of Electrical Engineering and Information Technologies,
    Ss Cyril and Methodius Univ.,
    Ruger Boskovik 18, 1000 Skopje, Macedonia
    mares@feit.ukim.edu.mk

24. Škrekovski Riste
    Faculty of Information Studies, Novo mesto &
    Faculty of Mathematics and Physics,
    University of Ljubljana, Slovenia
    skrekovski@gmail.com

25. Švecová Diana
    PF UPJŠ – Pavol Jozef Šafárik University in Košice,
    Faculty of Science,
    Košice, Slovakia
    diana.svecova@student.upjs.sk

26. Trenchevski Kostadin
    Faculty of Natural Sciences and Mathematics,
    Ss. Cyril and Methodius Univeristy in Skopje
    kostadin.trenchevskil@gmail.com

27. Velinov Daniel
    Faculty of Civil Engineering Skopje,
    Ss. Cyril and Methodius Univeristy in Skopje
    velinov.daniel@gmail.com

28. Velkoska Aneta
    University for Information Science and Technology "St. Paul the Apostle"
    Ohrid, Macedonia aneta.velkoska@uist.edu.mk

29. Vindas Jasson
Department of Mathematics: Analysis, Logic and
Discrete Mathematics
Ghent University
Krijgslaan 281
B 9000 Ghent
Belgium
jasson.vindas@ugent.be

30. Vučković Đorđe
Technical Faculty "Mihajlo Pupin"
Zrenjanin, Serbia
djordjeplusja@gmail.com

31. Yero Ismael Gonzalez
University of Cádiz,
Cádiz, Spain
ismael.gonzalez@uca.es

Notes