IX. Kadın Matematikçiler Derneği Çalıştayı

Bildiri Özetleri

Matematik Bölümü
İzmir Ekonomi Üniversitesi

3-5 Mayıs 2024

Kadın Matematikçiler Derneği (TKMD) Çalıştayları, Türkiye' de bir grup kadın matematikçinin 2012 yılında kurmuş olduğu Kadın Matematikçiler Derneği tarafından 2014 yılından bu yana her yıl düzenli olarak yapılan bir sempozyumdur. Bu çalıştayların amacı, kadın araştırmacıların, yüksek lisans ve doktora öğrencilerinin araştırma konularını, fikirlerini ve tecrübelerini paylaşabilecekleri bir platform oluşturmaktır.

TKMD çalıştaylarının birincisi Gebze Yüksek Teknoloji Enstitüsü' nün (2014), ikincisi Sivas Cumhuriyet Üniversitesi' nin (2015), üçüncüsü Dokuz Eylül Üniversitesi' nin (2016), dördüncüsü Orta Doğu Teknik Üniversitesi'nin (2017), beşincisi Dicle Üniversitesi'nin (2018), altıncısı Konya Selçuk Üniversitesi'nin (2019) Matematik Bölümlerinin evsahipliğinde gerçekleşmiştir. 2020 yılı için planan 7. çalıştay pandemi sonrası sokağa çıkma yasaklarının ilan edilmesiyle son anda iptal edilmiştir. 2021 yılında yine pandemi kısıtlamaları nedeniyle çalıştay gerçekleştirilememiştir. Ancak 2022 ve 2023 yıllarında 7. ve 8. çalıştaylar çevrimiçi olarak gerçekleştirilmiştir.

9. TKMD çalıştayına evsahipliği yapmayı kabul eden İzmir Ekonomi Üniversitesi, Matematik Bölümü' ne teşekkür ediyoruz.

Dokuzuncu çalıştayımızda Temsil Teorisi, Kompleks Analiz, Fonksiyonel Analiz ve Uygulamalı Matematik/İstatistik alanlarında çağrılı konuşmalara, kısa konuşmalara ve lisans öğrencilerinin poster sunumlarına yer veriyoruz. Çalıştayda yer alan konuşma ve posterlerin özetlerini, soyadı sırasına göre elinizdeki kitapçıkta bulabilirsiniz.

Son olarak, bu çalıştayın gerçekleşmesinde emeği bulunan Bilim Kurulu üyelerine, Düzenleme Kurulu' nda yer alan İzmir Ekonomi Üniversitesi, Matematik Bölümü akademik personeline ve organizasyonda yardımcı olan idari personele ve öğrencilere özverili çalışmalarından dolayı teşekkür ediyoruz.

TKMD

İçindekiler

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Düzenleme Kurulu

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Gözde Yazgı Tütüncü	İzmir Ekonomi Üniversitesi
Demet Ersoy Özdek	İzmir Ekonomi Üniversitesi
Necla Koçhan	İzmir Ekonomi Üniversitesi
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Merve Kahraman Ariman	İzmir Ekonomi Üniversitesi
Elif Medetoğulları	TED Üniversitesi
Semra Pamuk	Orta Doğu Teknik Üniversitesi

3 Mayıs 2024 (Cuma)	
09:00-10:15	*Kayıt ve Çay/Kahve/Kuru Pasta İkramı*
10:15-10:30	*Açılış*
	Oturum Başkanı: İsmihan Bayramoğlu
10:30-11:00	**Davetli Konusmacı:** Gözde Yazgı Tütüncü *Some Optimization problems for Reliability Analysis*
11:00-11:20	Funda İşçioğlu/ *A Simulation-Based Reliability Evaluation of (r,s)-out-of-n Multi-State Solar Panel Systems*
11:20-11:40	Necla Koçhan/ *A machine-learning based approach to discover biomarkers and classify patients: an application to colon cancer*
11:40-12:00	Betül Deniz/ *Integral Attcak of AES-like Ciphers*
12:00-13:30	*Öğle Yemeği Arası/Kumanya İkramı*
	Oturum Başkanı: Belgin Korkmaz
13:30-14:20	**Davetli Konusmacı:** Sibel Sahin *Function Spaces in Complex Analysis for Several Variables*
14:20-14:40	Merve Kahraman Ariman/ *Characteristic Maps over Wedge Polygons*
14:40-15:00	Ezgi Erdoğan/ *Lattice Lipschitz maps defined on Euclidean Spaces and Extensions*
15:00-15:20	Ekrem Şimşek/ *Grothendieck Groups of Leavitt Path Algebras of Directed Power Graphs of order p2*
15:20-15:40	Derya Bayrıl Aykut/ *The Baker-Campbell-Hausdorff Formula for the 2-System of Screws*
15:40-16:00	*Çay/Kahve İkramı*
	Oturum Başkanı: Münevver Tezer
16:00-16:20	Demet Ersoy Özdek/ *Approximate Solutions of the SEIR Model for Covid-19 Spread*
16:20-16:40	Bahriye Karaca/ *Schwarz Problem For Generalized Analytic Functions*
16:40-17:00	Gülsemay Yiğit/ *Spatiotemporal dynamics of a cross-diffusive reaction diffusion model for biological pattern formation*
17:00-17:20	Nurdan Kar/ *A fractional mathematical model for macroscopic dynamics of glioblastoma growth*
17:20-17.40	Zehra Çayiç/ *Time-evolution of Cauchy-Euler type quantum oscillator in the presence of variable magnetic and electric fields*
17:40-18:00	Sevin Gümgüm Turhan/ *A Numerical Approach to Analyze the HIV Infection Model of CD4(+) Cells*
18.00	*Akşam Yemeği/Nefes Restoran*
4 Mayıs 2024 (Cumartesi)	
	Oturum Başkanı: Cemal Murat Özkut
09:30-10:20	**Davetli Konusmacı**: Semra Oztürk *m-th Roots of Matrices Revisited*
10:20-10:40	*Çay/Kahve/Kuru Pasta Ikramı* *Lisans Öğrencileri Posterleri*
	Oturum Başkanı: Ismihan Bayramoğlu
10:40-11:00	Femin Yalçın Küçükbayrak/ *Analysis of Start-up Demonstration Tests*
11:00-11:20	Özge Eren/ *Main Handicaps of Multi-Criteria Decision Making Techniques Applications*
11:20-11:40	Öznur Öztunç Kaymak/ *A New Coding/Decoding Algorithm Based on k-Fibonacci Numbers*
11:40-12:00	Sıla Övgü Korkut*/ An accurate and efficient numerical solution for the generalized Burgers–Huxley equation via Taylor wavelets method: Qualitative analyses and Applications*
12:00-13:30	*Öğle Yemeği Arası/Kumanya İkramı* *Lisans Öğrencileri Posterleri*
	Oturum Başkanı: Semra Pamuk
13:30-14:20	**Davetli Konusmacı:** Gülen Bascanbaz Tunca *Some density results in approximation theory*
	Oturum Başkanı: Yeter Şahiner

14:20-14:40	Jamila Kalantorova Tarhan/ *Decay of solutions of the initial boundary value problem for damped Kirchho and beam type equations*
14:40-15:00	Derya Özdemir/ *Introduction to Lyapunov Stability Theory*
15:00-15:20	Ayse Beler / *Gegenbauer Wavelet Solutions of SIR System of a COVID 19 Disease*
15:20-15:40	Gökçe Özaltun Şimşek/ *Legendre Wavelet Method for the System of Nonlinear Delay Integro-Differential Equations Describing Biological Species Living Together*
15:40-16:00	*Çay/Kahve İkramı* *Lisans Öğrencileri Posterleri*
	Oturum Başkanı: Billur Kaymakçalan
16:00-16:20	Tuğba Akman/ *Mathematical Modeling of Optimal Anti-Hormonal Treatment for Breast Cancer*
16:20-16:40	Simge Kacar Eroğlu / *Hankel Data Augmentation for Dynamic Mode Decomposition with Control*
16:40-17:00	Şeyda Solmaz/ *Scattering Properties of Impulsive Dirac Systems with a Particle Mass m in the Entire Axis*
17:00-17:20	Neslişah İmamoğlu Karabaş/ *An Efficient Linearization Technique for Coupled Burgers' Equaiton*
17:20-17:40	Nihal Öztürk/ *Dynamical Behaviors of a Prey-Predator Model Including Weak Allee Effect*
17:40-18:00	Yağmur Ece Uçar/ *Mathematical Modeling of Layered Elastic Structures and Asymptotic Solution Methods*

5 Mayıs 2024 (Pazar)

09:30-15:30	Rehber eşliğinde İzmir tarihi bölgeler gezisi 9.30: Üniversiteden yola çıkış 15.30: Üniversiteye geri dönüş
15:30	Havaalanı servis

Some density results in approximation theory

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In this talk, we deal with some density theorems in approximation theory. We start with giving brief historical and theoretical background for the Fourier series. Next, we mention both trigonometric and algebraic versions of the fundamental theorems of approximation theory as well as their first constructive proofs. We also mention Korovkin's theorems and their density results in approximation theory

Keywords. Density, Fourier series, Weierstrass' theorems, Korovkin's theorems

Some Optimization problems for Reliability Analysis

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In a reliability analysis, it is important to consider that each component may contribute differently to the overall performance of the system, rather than if all components have equal importance. Real-life engineering systems require more sophisticated approaches to the analysis of reliability problems. An n-component system is said to have a k-out-of-n structure if it operates as long as at least k of the n components operate. These systems have been used to model engineering systems such as the microwave stations of a telecommunications network, oil pipeline systems and vacuum systems in an electron accelerator. In this study reliability analysis of a weighted-k-out-of-n:G system with several types of components are presented. The system is assumed to have n components, which are classified into m (2¡m¡n) groups with respect to their weight and reliability, and it is assumed to operate when the total weight of all working components exceeds a predetermined threshold k. Moreover, some optimization problems in that context are also discussed and numerical examples are given.

Keywords. Optimization Problems, Reliability, Weighted-k-Out-Of-n Systems

This is a joint work with Cemal Murat Özkut

m-th Roots of Matrices Revisited

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A matrix B is an m-th root of a matrix A if $A = B^m$ where $m > 1$ is an integer. Roots of matrices are important in accounting, cryptography, medical imaging, data analysis, etc.. For diagonal matrices and invertible matrices over algebraically closed fields m-th roots exists, however, this need not be true for singular matrices. The $d \times d$ nilpotent Jordan block is an example of a rootless matrix. A singular matrix can be written as a direct sum of an invertible and a nilpotent matrix up to similarity, hence, the existence of an m-th root is equivalent to the existence of the nilpotent part of the matrix. There are many articles which give the existence criteria in different ways, either using the consecutive ranks of the matrix, or the sizes of its Jordan blocks, or the multiplicities of its Jordan blocks [2]. We will present our version which is also in terms of the multiplicities of Jordan blocks [1]. In fact, our interest in the subject is originated by noticing a mistake in [2]. We observed that there is a nice pattern in the multiplicities of the Jordan form of a nilpotent matrix B and that of B^m. This allowed us to formulate a matrix M, such that $M\underline{b}^T = \underline{a}^T$ where $\underline{b} = (b_1, \ldots, b_d)$ and $\underline{a} = (a_1, \ldots, a_d)$ denotes the Jordan types of B and $A = B^m$, respectively, where the i-th coordinate is the number of $i \times i$ Jordan blocks in the Jordan form of the matrix. Thus, computation of the Jordan form of the m-th power of a nilpotent matrix is reduced to a single matrix multiplication; conversely, the existence of an m-th root of a nilpotent matrix is reduced to the existence of a nonnegative integer solution to the corresponding system of linear equations. We can also obtain new m-th roots from a given m-th root B, singular matrix A.

On the topological side there is a recent work [3] by Clement de Seguins Pazzis proving that the set of all m-th roots of a nilpotent complex matrix is path-connected. Computing the fundamental group (or higher homotopy groups) is an open question.

References

[1] Semra Öztürk K., Restricted modules and conjectures for modules of constant Jordan type, *Algebr. Represent. Theory*, **17** (2014), 1437–1455.

[2] Jens Schwaiger, More on rootless matrices, *Anz. Osterreich. Akad. Wiss. Math.-Natur. Kl.*, **141** (2005),3–8.

[3] Clement de Seguins Pazzis, The space of all p-th roots of a nilpotent complex matrix is path-connected, *Linear Algebra Appl.*, **596** (2020), 106–116.

Function Spaces in Complex Analysis for Several Variables

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In this talk, we will talk about some of the families of complex valued functions on which I have had the opportunity to work in the last decade and have applications in complex analysis/geometry, functional analysis and operator theory,. This talk is divided into three parts and in the first one we will mention the multivariable generalizations of the classical Hardy spaces which are very classical analytic function classes of one variable. In the second part , some plurisubharmonic classes which attract attention due to the unique structure of complex geometry will be discussed and finally in the last part we will talk about sub- Hardy-Hilbert spaces that can be expressed as the invariant subspaces of specific operators . We will talk about how a series of studies in different areas of analysis intersect over these function families.

Keywords. Hardy spaces, plurisubharmonic classes, Hardy-Hilbert spaces

Gegenbauer Wavelet Solutions of SIR System of a COVID 19 Disease

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This study introduces a new and affordable way to solve the mathematical equations describing how COVID-19 spreads in a population. We introduce a model based on three non-linear differential equations. The model can be adjusted by changing specific parameters to represent three different scenarios. We compare our method's results with existing techniques through error analysis. This analysis shows that the Gegenbauer wavelet method is not only highly accurate but also effortless to implement, making it a very efficient solution for these types of problems. Finally, we examine how the proposed method affects the predicted curves for susceptible, infected, and recovered individuals.

Keywords. COVID-19 disease, SIR model, Gegenbauer wavelet method, System of differential equations (SODEs)

This is a joint work with Sevin Gümgüm Turhan and Gökçe Özaltun Şimşek

Schwarz Problem For Generalized Analytic Functions

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The unique properties and techniques associated with holomorphic functions of a complex variable facilitate the application of complex function theory across various fields of both theoretical and applied mathematics. These fields include geometry, algebra, partial differential equations, hydrodynamics, shell theory, and others. This study focuses on exploring the relationship between complex function theory and partial differential equations.
To leverage complex methods in the study of partial differential equations, we first establish the definitions of partial complex derivatives. Subsequently, we express the well-known Cauchy-Riemann equations in their complex form.In this research, our focus will be on boundary value problems for partial complex differential equations. We aim to represent the solutions to these boundary value problems using holomorphic functions. To achieve this, we will seek to derive representations for the solutions of inhomogeneous Cauchy-Riemann systems.

Keywords. Schwarz Problem, Generalized Analytic Function, Holomorphic Function

References

[1] Vekua, I.N., Generalized analytic functions. Pergamon Press, Oxford, 1962

[2] Gakhov, F. D., Boundary value problems. Pergamon Press, Oxford, 1966.

Integral Attcak of AES-like Ciphers

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In cryptography, integral cryptanalysis is cryptanalytic attacks that are particularly applicable to block ciphers based on substitution permutation networks (SPN). It is one of the most powerful attack against block ciphers. Integral attack uses sets or even multisets of chosen plaintexts of which part is held constant and another part varies through all possibilities. Then properties of the multiset of internal state values after encrypting several rounds are considered. There is extensive literature on improving integral analysis. Identically active set property be one of them. This property finds application in Midori [1], an AES-like algorithm, as well as in other AES-like algorithms such as KLEIN and SKINNY, which possess similar round functions. In this talk includes references to this integral property and its newfound applications in SKINNY and KLEIN.

Keywords. Substution Permutation Networks (SPN),Integral attack, AES-like Algorithms, SKINNY, KLEIN

References

[1] Demirbas, F. and Kara, O. (2022). Integral characteristics by keyspace partitioning. Designs, Codes and Cryptography, 90(2), 443-472.

[2] Knudsen, Lars, and David Wagner. "Integral cryptanalysis." International Workshop on Fast Software Encryption. Springer, Berlin, Heidelberg, 2002.

[3] Yu, Xiaoli, et al. "Cryptanalysis of reduced-round KLEIN block cipher." Information Security and Cryptology: 7th International Conference, Inscrypt 2011, Beijing,China, November 30-December 3, 2011. Revised Selected Papers 7. Springer Berlin Heidelberg, 2012.

[4] Beierle, Christof, et al. "The SKINNY family of block ciphers and its low-latency variant MANTIS." Advances in Cryptology-CRYPTO 2016: 36th Annual International Cryptology Conference, Santa Barbara, CA, USA, August 14-18, 2016, Proceedings, Part II 36. Springer Berlin Heidelberg, 2016.

Approximate Solutions of the SEIR Model for Covid-19 Spread

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In this study, we deal with the implementation of Chebyshev polynomials to solve SEIR model for the spread of Covid-19 in Turkey, numerically. As a mathematical model, this model basicly explains the transmission of Covid-19 disease between Susceptible, Exposed, Infected and Removed populations and consists of a nonlinear system of differential equations. These equations are solved by a collocation approach based on Chebyshev polynomials. As a main advantage of the method, discretization of the domain and linearization of nonlinear terms are not required. So it is easy to implement. The main idea of the method is to convert the model to a system of nonlinear algebraic equations. For this, we use the orthonormality of the Chebyshev polynomials to write the approximate solution of the system as the truncated series of Chebyshev polynomials with unknown coefficients in matrix forms and with the help of the operational matrix of derivative and the collocation points, the SEIR model is converted to a system of the nonlinear equations. Then using MATLAB, the obtained system is solved for the unknown coefficients to obtain the approximate solutions. In order to check the accuracy of the method, residual error of the solution is reviewed. The results show that the method is very efficient and accurate.

Keywords. SEIR model, Covid-19 modeling, collocation method, Chebyshev polynomials.

The Baker-Campbell-Hausdorff Formula for the 2-System of Screws

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In the theory of Lie groups the Baker-Campbell-Hausdorff formula is an important link between the multiplication of elements in the group and the Lie algebra to the group. Usually only the first few terms of the formula are given in textbooks [1], [2], but particular formulas for particular groups are not given. The aim of this work is to give a finite formula for the Gibson-Hunt type of the 2-system formed by two twists. The the Baker-Campbell-Hausdorff formula for the 2-system of screws will be written entirely as a sum of Lie brackets of different orders. Then, these subalgebras are investigated from the geometric point of view.

Keywords. Rigid body motion, Screw, Lie group.

This is a joint work with Assoc. Prof. Jonathan Mark Selig.

References

[1] Bottema, Oene, and Bernard Roth. Theoretical kinematics. Vol. 24. Courier Corporation, 1990.

[2] Selig, Jon M. Geometric fundamentals of robotics. Springer Science Business Media, 2007.

Introduction to Lyapunov Stability Theory

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Stability theory plays a central role in system theory and engineering. Lyapunov's Method is the most common method for different kind of stability problems encountered in nonlinear systems. The method serves many advantages such as enabling one to understand the behavior of the nonlinear system without solving. Historically, Lyapunov presented celebrated original theorems on stability, asymptotic stability and instability, which are now called the principal theorems of stability which are fundamental to stability of dynamical systems. In this talk, we will give the results for some kind of stability of nonlinear systems using comparison functions and Lyapunov function. Moreover, the classical Lyapunov stability theorem is generalised in the sense that the time derivative of Lyapunov function are allowed to be indefinite.

Keywords. Nonlinear systems, stability, Lyapunov method, indefinite Lyapunov function.

This is a joint work with Öğr. Gör. Dr. Gökhan Şahan.

References

[1] Khalil, H. K., *Nonlinear systems third edition*, Patience Hall, 2002.

[2] Zhou, B., Stability analysis of nonlinear time varying systems by Lyapunov functions with indefinite derivatives, *IET Control Theory & Applications* **11(9)** (2017), 1434–1442.

[3] Şahan, G., & Özdemir, D., Uniform asymptotic and input to state stability by indefinite Lyapunov functions, *European Journal of Control*, **76** (2024), 100945.

Grothendieck Groups of Leavitt Path Algebras of Directed Power Graphs of order p^2

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The directed power graph $P(G)$ of a group G is the digraph with vertex set G, having an edge from y to x whenever x is a power of y. The graph $P^*(G)$ obtained by removing the vertex corresponding to identity element of the group G is called the punctured directed graph. Some algebraic properties of Leavitt path algebras of these graphs are charaterized in [1] . The authors also compute the Grothendieck group of the Leavitt path algebra $P^*(G)$ when G is a cyclic group of order p, $p \geq 5$ [2]. In this talk, we first give an alternative proof for this result and then give a formula for the Grothendieck group of Leavitt path algebras of $P(G)$ and $P^*(G)$ when G is a group of order p^2.

Keywords. Directed power graphs , Leavitt path algebras, Grothendieck groups.

Co-Author: Assoc. Prof. Dr Aslı Güçlükan İlhan.

References

[1] Das, Sumanta and Sen, MK Maity, S. K. , Leavitt path algebras for power graphs of finite groups, *Journal of Algebra and Its Applications* **21(10)** (2022), 2250209.

[2] Das, S., Sen, M. K., Maity, S. K. . Grothendieck groups of purely infinite simple Leavitt path algebras for punctured power graphs of finite groups, *Journal of Algebra and Its Applications*, **22(11)**,(2023), 2350234.

Lattice Lipschitz maps defined on Euclidean Spaces and Extensions

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In this presentatin, a new class of Lipschitz-type maps on Euclidean lattices that is called lattice Lipschitz operators is introduced. With the peculiarity that the typical Lipschitz constant becomes a positive real function, these maps essentially satisfy a (vector-valued) Lipschitz inequality affecting the lattice's order. After adapting the classical McShane and Whitney extension formulas to the lattice Lipschitz maps, the main results on how these extensions work in the lattice setting is showed. As a main result, it is proved that the linear representation obtained with the eigenvalues and eigenvectors of the diagonalisable maps coincides with the lattice representation obtained from the McShane and Whitney formulae.

Keywords. Lipschitz operator, Banach lattice, eigenvalue, diagonalisable.

This is a joint work with Roger Arnau, Jose M. Calabuig and Enrique A. Sánchez Pérez.

References

[1] Cavalcante, W. V., Rueda, P., Sánchez Pérez, E.A.: Extension of Lipschitz-type operators on Banach function spaces. Topol. Methods Nonlinear Anal. **57**(1), 343-364 (2021)

[2] Cobzaş, Ş., Miculescu, R.; Nicolae A.: Lipschitz functions. Springer, Berlin, (2019)

[3] Erdoğan, E.; Sánchez Pérez, E.A.: Approximate Diagonal Integral Representations and Eigenmeasures for Lipschitz Operators on Banach Spaces. Mathematics **10**(2), 220 (2022)

[4] Kirszbraun, M. D.: Uber die zusammenziehende und Lipschitzsche Transformationen. Fund. Math. **22** 77-108 (1934)

[5] McShane, E. J.: Extension of range of functions. Bull. Amer. Math. Soc. **40**(12), 837-842 (1934)

[6] Whitney, H.: Analytic extensions of differentiable functions defined in closed sets. Trans. Amer. Math. Soc. **36**(1), 63-89 (1934)

Analysis of Start-up Demonstration Tests

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Start-up demonstration testing is an effective method for illustrating the reliability of equipment before purchasing it. The testing procedure involves starting up the unit multiple times and observing the outcomes–either success or failure. Various types of start-up demonstration tests are explored in the literature, each with different acceptance and rejection criteria.
In this study, we will present some probabilistic and statistical results on certain types of start-up demonstration tests: *CS* (Hahn and Gage, 1983), *CSTF* (Balakrishnan and Chan, 2000), and *TSTF* (Smith and Griffith, 2008). Additionally, we will discuss findings obtained by Yalcin and Eryilmaz (2012) regarding the *TSTF*-type start-up demonstration test. This discussion will focus on the dependency criteria, which suggests that the outcome of future start-ups is influenced by the total number of successful start-ups thus far.

Keywords. Reliability, Start-up demonstration tests, Independent and identically distributed trials, Markovian type dependence, Previous-sum dependent model

This is a joint work with Prof. Serkan Eryilmaz from Atilim University, Ankara, Turkiye.

References

[1] N. Balakrishnan and P.S. Chan, Start-up demonstration tests with rejection of units upon observing d failures, *Annals of the Institute of Statistical Mathematics* **52(1)** (2000), 184–196.

[2] G.J. Hahn and J.B. Gage, Evaluation of a start-up demonstration test, *Journal of Quality Technology* **15(3)** (1983), 103–106.

[3] M.L. Smith and W.S. Griffith, The analysis and comparison of start-up demonstration tests, *European Journal of Operation Research* **186** (2008), 1029–1045.

[4] F. Yalcin and S. Eryilmaz, Start-up demonstration test based on total successes and total failures with dependent start-ups, *IEEE Transactions on Reliability* **61(1)** (2012), 227–230.

A Simulation-Based Reliability Evaluation of (r,s)-out-of-n Multi-State Solar Panel Systems

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Solar energy is a substantially preferred renewable clean energy source since it produces no carbon emissions. Furthermore, it has many advantages over conventional power sources regarding cost for homes and businesses. Solar systems aim to generate solar power from solar radiation. In many of these systems, a common inverter is used if the roof does not have any shading problems or enough area for establishing the solar systems. These systems with a common inverter are called string inverter systems. However, if the installation area is shading, the use of micro-inverters can be more useful than string inverter systems, since micro-inverters reduce the effect of shading losses. In micro-inverter solar systems, each module has its own micro-inverter (see Hayman (2009)). In this study, we consider a simulation-based case study of (r,s)-out-of-n multi-state systems in micro-inverter solar panel systems. So, the dependency between the lifetimes of the micro-inverters and solar panels is evaluated based on copula functions. The system is considered multi-state since it can work in multi-state performance levels relying on factors such as solar radiation, shading on the modules, etc. (see Esemen and Gurler (2022)). The (r,s)-out-of-n systems were first discussed in Bayramoglu (2013) for binary states. After that Iscioglu and Erem (2021) studied the (r,s)-out-of-n multi-state system structures. Based on the simulated lifetime at a specific state "j" or above of three-state micro-inverters and solar panels, system reliability is investigated and results are presented by tables and figures.

Keywords. S-dependence, reliability analysis, solar panel systems

This is a joint work with Dr. Aysegul Erem Halilsoy (aerem@ciu.edu.tr), Cyprus International University, Nicosia, North Cyprus.

References

[1] A. Hayman, *Development of a high-efficiency solar micro-inverter*, Doctoral dissertation, Massachusetts Institute of Technology.

[2] F. Iscioglu and A. Erem, Reliability analysis of multi-state system with identical units having two dependent components, *Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability* **235(2)** (2021), 241–252.

[3] I. Bayramoglu, Reliability and mean residual life of complex systems with two dependent components per element, *IEEE Transactions on Reliability* **62(1)** (2013), 276–285.

Legendre Wavelet Method for the System of Nonlinear Delay Integro-Differential Equations Describing Biological Species Living Together

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This paper investigates a system of nonlinear delay integro-differential equations that model the population dynamics of two interacting biological species. These equations account for delays and past effects, making them challenging to solve. Here, we present Legendre wavelets, a mathematical tool designed for such problems. By applying Legendre wavelets, we transform the original system into a set of algebraic equations, significantly simplifying the problem. The effectiveness of this method is demonstrated through illustrative examples, where the population dynamics of coexisting species are analyzed. Finally, we compare our solutions obtained with Legendre wavelets to existing results, confirming the method's accuracy and its value for these types of problems.

Keywords. Predator-prey models, Wavelet method, Nonlinear integro-differential equations.

This is a joint work with Sevin Gümgüm Turhan and Ayşe Beler.

Spatiotemporal dynamics of a cross-diffusive reaction diffusion model for biological pattern formation

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In this talk, a domain-dependent analysis for a reaction-cross-diffusion system is presented to understand the role of geometry and linear cross-diffusion in the biological pattern formation. By deriving conditions on the domain length for convex geometries, we generate parameter spaces associated with Turing difusion-driven instability, Hopf and trascritical instabilities. Additionally, by selecting model parameters from the parameter spaces under appropriate geometry and linear cross-diffusion, we are able to demonstrate that linear cross-diffusion coupled with appropriate geometry is able to generate patterns. To support theoretical findings, finite element numerical simulations showing the pattern formation on convex geometries are presented. Such patterns on circular domains resemble those observed on stingrays during growth development.

Keywords. Reaction-diffusion systems; cross-diffusion; pattern formation; parameter spaces; spatiotemporal dynamics.

This is a joint work with Wakil Sarfaraz, Raquel Barreira and Anotida Madzvamuse

References

[1] J. D. Murray, *Mathematical Biology I and II*, 3rd edn., Springer-Verlag, Berlin, 2002.

[2] A. Gierer, H. Meinhardt, *A theory of biological pattern formation*. Kybernetik, **12(1)**, (1972) 30-39.

[3] A. Madzvamuse, H. S. Ndakwo, R. Barreira, *Cross-diffusion-driven instability for reaction-diffusion systems: analysis and simulations*. Journal of mathematical biology **70(4)**, (2015), 709-743.

Decay of solutions of the initial boundary value problem for damped Kirchhoff and beam type equations

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The talk is devoted to the study of the Cauchy problem for differential-operator equation of the following form:

$$\begin{cases} u_{tt} + \nu A^2 u + \left(\alpha + d\|A^{\frac{1}{2}}u\|^2\right) Au + bA^{\tau}u_t = f(t), \\ u(0) = u_0, u_t(0) = u_1, \end{cases} \tag{1}$$

in a Hilbert space H with inner product $(\cdot,\cdot)$ and the corresponding norm $\|\cdot\|$. Here $A : D(A) \to H$ is positive definite self-adjoint operator with dense domain $D(A) \subset H$ and compact inverse, $f \in L^2(\mathbb{R}^+; H)$ is a given vector function, $\nu \geq 0$, $\alpha > 0$, $b > 0$, $d > 0$ and $\theta \in [0, 2]$ are given parameters.

We obtained uniform estimates for solutions of the problem (1), showed that when the given source term $f(t)$ in the equation tends to zero as $t \to \infty$, the corresponding solution of the problem also tends to zero as $t \to \infty$. We used the obtained estimates to prove continuous dependence of solution of the problem on initial data. Obtained results are used to study global behavior of solutions to damped Kirchhoff and beam type equations.
Keywords. Decay of solutions, Kirchhoff equations, Beam type equations

References

[1] Ball,J. M.,(1973), Stability theory for an extensible beam. J. Differential Equations **14** , 399-418

[2] Ghisi, M., Gobbino, M., (2016), Kirchhoff equations with strong damping. J. Evol. Equ. **16** (2016), 441-482.

[3] Jung, H., Lee, Y-H., (2001), Exponential decay for the solutions of wave equations of Kirchhoff type with strong damping. Acta Math. Hungar. 92, no. 1-2, 163-170.

Characteristic Maps over a Wedge Polygon

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In [1], Choi and Park show that there is a bijection between the orbit space of the natural $GL(n, \mathbb{Z}_2)$-action on the set of characteristic maps over a wedge polygon and the set of realizable puzzles. The automorphism group of the wedge polygon also acts naturally on the set of characteristic maps. It is well-known that the double coset of these actions are in one-to-one correspondence with the weakly $\mathbb{Z}_2^n$-equivariant homeomorphism classes of small covers of the wedge polygon. In this talk, we first give a generating set of the automorphism group of wedge polygons. Then we discuss some examples of the induced action of these groups on the set of realizable puzzles.

Keywords. Characteristic map, wedge operation, polytope

Coauthor: Assoc. Prof. Aslı GÜÇLÜKAN İLHAN

References

[1] Choi S., Park H. (2019). Small covers over wedges of polygon, Journal of the Mathematical Society of Japan.

A machine-learning based approach to discover biomarkers and classify patients: an application to colon cancer

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In this study, we aimed to develop a machine-learning based approach to classify patients with or without cancer at gene expression level. This approach consists of two main phases: (1) identifying genes, or biomarkers and (2) implementing support vector machines with backward elimination method. In the first phase, we implemented fuzzy c-means clustering to stratify patients into two categories based on the expression levels of each gene. We then assessed the statistical significance between these groups in terms of their disease-spefic-survival times. Following the identification of signifcant genes, in the second phase, we employed support vector machines, known for its efficiency in classification tasks to classify patients. Through this process, we identified 25 genes that resulted in the highest classification performance.

Keywords. Machine-learning, fuzzy c-means, backward-elimination, classification, gene-expression.

This is a joint work with Barış Emre Dayanç from Basic Medical Sciences, Faculty of Medicine, Izmir University of Economics.

An Efficient Linearization Technique for Coupled Burgers' Equaiton

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In this study multiquadric radial basis function mesh-free method combined with Jacobian-free linearization technique is proposed to solve coupled Burgers' equation. Nonlinear partial differential equation is converted into a linear algebraic equation with the help of Frèchet derivative and Newton-Raphson method. The effectiveness of this method has been demonstrated through several examples.

Keywords. Coupled Burgers equation, Mesh-free method, Radial Basis Functions, Linearization

This is a joint work with Gamze Tanoğlu

References

[1] S.E. Esipov, Coupled Burgers' equations: a model of polydispersive sedimentation, *Phys Rev E* **52** (1995), 888–896.

[2] D. Kaya, An explicit solution of coupled viscous Burgers' equation by the decomposition method, *Int. J. Math. Math. Sci.* **27** (2001), 675–680.

[3] A.A. Soliman, The modified extended tanh-function method for solving Burgers'-type equations, *Phys. A: Stat. Mech. Appl.* **365** (2006), 394–404.

[4] M. Dehghan, A. Hamidi, M. Shakourifar, The solution of coupled Burgers equations using Adomian-Pade technique, *Appl. Math. Comput.* **189** (2007), 1034–1047.

[5] Siraj-ul-Islam, S. Haq, M. Uddin, A mesh free interpolation method for the numerical solution of the coupled nonlinear partial differential equations, *Eng. Anal. Boundary Elements* **33** (2009), 399–409.

[6] S. Haq, A. Hussain, M. Uddin, RBFs Meshless Method of Lines for the Numerical Solution of Time-Dependent Nonlinear Coupled Partial Differential Equations, *Applied Mathematics* **2** (2011), 414–423.

[7] R.C. Mittal, G. Arora, Numerical solution of the coupled viscous Burgers' equation, *Commun. Nonlinear Sci. Numer. Simul.* **16** (2011), 1304–1313.

[8] R.C. Mittal, R. Jiwari, Differential quadrature method for numerical solution of coupled viscous Burgers' equations, *Int. J. Comput. Meth. Eng. Sci. Mech.* **13** (2012), 89–92.

[9] R.C. Mittal, A. Tripathi, A Collocation Method for Numerical Solutions of Coupled Burgers' Equations, *Int. J. Comput. Meth. Eng. Sci. Mech.* **15** (2014), 457–471.

Dynamical Behaviors of a Prey-Predator Model Including Weak Allee Effect

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Within population dynamics, a notable phenomenon known as the Allee effect, originating from the research of Allee, manifests as a positive correlation between population unit growth rate and density, particularly evident at low population densities. investigations into the Allee effect have garnered increasing interest among mathematicians and ecologists [1,2,34].

This study delves into the qualitative behavior of a discrete-time prey-predator model incorporating the weak Allee effect on the prey population. Employing the Euler scheme method to discretize the continuous model in [2], we establish the discrete-time prey-predator model. We conduct an algebraic analysis to ascertain the existence and topological categorizations of fixed points. Subsequently, we explore bifurcation types emerging from the coexistence of fixed points, employing the bifurcation theory. Finally, numerical simulations are presented to corroborate theoretical findings.

Keywords: Prey-predator model, Stability analysis, Fixed point, Bifurcation.

This is a joint work with Figen Kangalgil and Nilüfer Topsakal.

[1] Kangalgil, F., Topsakal N., Öztürk N., Analyzing bifurcation, stability and chaos control for a discrete-time prey-predator model with Allee effect, Turkish Journal of Mathematics (2022), 46(6) 2047-2068.

[2] Allee, W. C., Animal Aggregations: A study in General Sociology, University of Chicago Press (1931), Illinois, Ill, USA.

[3] Selvam, A.G.M., Jacintha, M. and Dhineshbabu, R., Bifurcation Analysis and Chaotic Behaviour in Discrete .Time Predator-Prey System, International Journal of Computational Engineering Research (IJCER) (2019) ,

9(4), 01-09.

[3] Stephens, P.A., Sutherland, WJ (1999) Consequences of the Allee effect for behavior, ecology and conservation. Trends Ecology & Evolution 14(10), 401.405.

[4] Lin, Z.S., Li B.L., (2002) The maximum sustainable yield of Allee dynamic system. Ecol Model 154, 17-23.

A fractional mathematical model for macroscopic dynamics of glioblastoma growth

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Glioblastoma is the most aggressive variant among primary brain tumors known as diffuse gliomas. In this talk, we introduce a fractional mathematical model for better understanding glioblastoma dynamics at the macroscopic scale [1]. In addition to its innovative conventional framework, the tumor growth model represents an advanced structure with a calibration criterion based on a fractional derivative. Throughout this talk, we initially discuss the modeling dynamics of the tumor growth model. Subsequently, we provide personalized predictions for the timing of tumor visibility on medical imaging to elucidate recurrence periods, considering the frequent recurrence observed in almost all glioblastoma cases.

Keywords. Glioblastoma; tumor visibility timing; biomathematical model

This is a joint work with Nuri Ozalp.

References

[1] N. Kar and N. Ozalp, A fractional mathematical model approach on glioblastoma growth: Tumor visibility timing and patient survival, *Mathematical Modelling and Numerical Simulation with Applications* **4** (2024), 66-85.

Main Handicaps of Multi-Criteria Decision Making Techniques Applications

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Multi Criteria Decision Making (MCDM) is a branch of operational research dealing with selecting the best alternative from a set of alternatives in situations where there is more than one conflicting criterion and different weights. MCDM methods are widely used in different fields and discipline as economy, business and financial management, transportation and logistics, medicine among others. The main purpose of this study is to indicate multi-criteria decision making techniques basic handicaps on applications and also to draw attention to the most obvious usage problems, especially among the most frequently used techniques. These limitations are such as checking only linear relationship, ineffectiveness on large-scale data, high sensitivity to the changes and different result with different distance and normalization measurement (Balli et al. 2009;Vafaei et al.2018; Sahoo et al.2023

Keywords. Handicaps on MCDM techniques, Sensitivity Analysis

This is a joint work with Dr. Latife Sinem Sarul from Istanbul University

References

[1] Balli, Serkan and Serdar Koruko Alu. "Operating system selection using fuzzy AHP and TOPSIS methods." Mathematical and Computational Applications 14.2 (2009): 119-130.

[2] Sahoo, Sushil Kumar, and Shankha Shubhra Goswami. "A comprehensive review of multiple criteria decision-making (MCDM) Methods: advancements, applications, and future directions." Decision Making Advances 1.1 (2023): 25-48.

[3] Vafaei, Nazanin, Rita A. Ribeiro, and Luis M. Camarinha-Matos. "Data normalisation techniques in decision making: case study with TOPSIS method."International journal of information and decision sciences 10.1 (2018): 19-38.

A New Coding/Decoding Algorithm Based on k-Fibonacci Numbers

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Coding theory is a branch of mathematics and computer science that deals with the study of methods for efficiently and reliably transmitting data across noisy channels. Although there are many studies in this field, one of the best known is the Fibonacci method. This method is based on Fibonacci p-numbers and Q_p is a square $(p+1)\times(p+1)$ matrix and the Cassini formula well known in the literature in [1]. The k-Fibonacci sequence, which is the more general form of Fibonacci numbers, is defined by

$$F_{k,n} = kF_{k,n-1} + F_{k,n-2},$$

with initial conditions $F_{k,0} = 0$, $F_{k,1} = 1$ for any positive integer k.These numbers are found by the recursive application of two geometrical transformations named as 4-triangle longest-edge (4TLE) partition in [2]. Many features of the k-Fibonacci numbers, which are known as the extension of Fibonacci, Pell numbers etc., have been found in related studies in [3]-[4]. In this paper we present a new method of coding/decoding algorithms using Fibonacci -matrices. Asymmetric encryption method, which uses a mathematically related pair of keys for encryption and decryption, constitutes the basis of our model. In doing so, this algorithm contributes to authenticatio

Keywords. Coding Theory, $k-$Fibonacci Numbers Cryptology

References

[1] Stakhov. A. P., Fibonacci matrices, a generalization of the Cassini formula and a new coding theory, *Chaos Solitons Fractals*, 30(1) (2006), 56-66.

[2] Falcon. S., Plaza, A., The k-Fibonacci sequence and the Pascal 2-triangle, *Chaos, Solitons & Fractals*, 33 (2007), 38-49.

[3] Falcon, S., Plaza, A., On the Fibonacci k-numbers, *Chaos, Solitons & Fractals*, 32(2007), 1615-1624.

[4] Özgür. N.Y., Kaymak. Ö.Ö., On determination of k-Fibonacci and k-Lucas numbers, *Math. Sci. Appl. E-notes*, 3(2015), 20-26.

An accurate and efficient numerical solution for the generalized Burgers-Huxley equation via Taylor wavelets method: Qualitative analyses and Applications

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This study endeavors to introduce a novel algorithm, grounded in Taylor wavelet techniques, with the dual objectives of achieving high accuracy and computational simplicity in solving the generalized Burgers-Huxley equation. It encompasses a comprehensive analysis encompassing qualitative aspects such as preservation of positivity and monotonicity, as well as boundedness of solutions obtained through the algorithm. Furthermore, convergence analysis of the proposed methodology is presented. The efficacy and validity of the algorithm are demonstrated through its application to a benchmark equation. Comparative evaluation against existing methods reveals superior performance of the proposed approach in terms of solution accuracy. Notably, while the study focuses on the generalized Burgers-Huxley equation, the proposed algorithm exhibits promising capabilities for solving nonlinear equations of similar nature.

Keywords. Burgers-Huxley equation; Taylor wavelets; Numerical analysis; Non-linear partial differential equations

References

[1] Appadu A, İnan B, Tijani YO. Comparative Study of Some Numerical Methods for the Burgers-Huxley Equation. *Symmetry* **11(11)**, (2019) Article Id 1333

[2] Batiha B, Noorani MSM, Hashim I. Application of variational iteration method to the generalized Burgers-Huxley equation. *Chaos, Solitons & Fractals* **36(3)**, (2008) 660–663.

[3] Biazar J, Mohammadi F. Application of Differential Transform Method to the Generalized Burgers-Huxley Equation. *Applications and Applied Mathematics: An International Journal* **5(10)**, (2010) 1726–1740.

[4] Çelik İ.Chebyshev Wavelet collocation method for solving generalized Burgers-Huxley equation, *Mathematical Methods in the Applied Sciences* **39(3)**, (2016) 366–377.

[5] Dahlquist G, Björck A (2008) Numerical Methods in Scientific Computing, Volume I. Society for Industrial and Applied Mathematics.

[6] Gümgüm S. Taylor wavelet solution of linear and nonlinear Lane-Emden equations, *Applied Numerical Mathematics* **158**, (2020) 44–53.

Hankel Data Augmentation for Dynamic Mode Decomposition with Control

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Data-driven methods are efficient and cost-effective in terms of time and resources. Dynamic Mode Decomposition (DMD) [1] and Dynamic Mode Decomposition with Control (DMDc) [2] methods are data-driven techniques that do not rely on knowledge of the underlying governing equations of dynamical systems. The data matrix is obtained from numerical solutions, historical data, or system simulations. The difference between DMD and DMDc is that external force. If external force affects the nature of the system, the DMD method may not capture the governing equations of the system. But, the DMDc method may acquire system dynamics. On the other hand, one of the important challenges in data-driven methods is the data set. If we have less data, DMD and DMDc may not estimate the true state of the system. Data augmentation techniques are used to increase data sets. Hankel Data Augmentation is one of the algorithms [3]. In this study, we improved two new algorithms, Dynamic Mode Decomposition with Control with State Matrix Hankel (DMDc-sH) and Dynamic Mode Decomposition with Control with State and Control Matrix Hankel (DMDc-scH) are not in the literature. The advantage of these algorithms is better capture of the system's dynamics. The efficiency of these algorithms is presented in the figures and Root Mean Square Error (RMSE) values.

Keywords. Hankel matrix, dynamic mode decomposition, control, machine learning

This is a joint work with Gamze Yuksel.

References

[1] J.N. Kutz, S.L. Brunton, B.W. Brunton, and J.L Proctor *Dynamic Mode Decomposition : Data-Driven Modeling of Complex Systems*, Siam, Philadelphia/USA 2016.

[2] J.L. Proctor, S.L. Brunton, and J.N. Kutz, Dynamic Mode Decomposition with Control, *SIAM J. Appl. Dyn. Syst.* **15** (2014), 142–161.

[3] E.V. Filho, and P. Lopes dos Santos, A Dynamic Mode Decomposition Approach With Hankel Blocks to Forecast Multi-Channel Temporal Series. *IEEE Control Systems Letters* **3** (2019), 739–744.

A Numerical Approach to Analyze the HIV Infection Model of CD4(+) Cells

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The goal of this study is to analyze the Human Immunodeficiency Virus (HIV) infection on helper T cells numerically by using the Laguerre wavelets. The HIV infection model is represented by a system of first order nonlinear ordinary differential equations that measures the number of helper infected and uninfected T cells, and the number of free virus particles at a particular time. The method has important advantages such as easy implementation and low computational cost. Linearization of the nonlinear terms are not required as well. We solve the problem for several variables and obtain accurate results. Due to the lack of exact solution, we examine the accuracy via the residual error calculation. Results are also compared with the ones obtained by other numerical methods exist in the literature.

Keywords. HIV Infection Model, Laguerre Wavelets, Disease Modeling, Polynomial Approximation

This is a joint work with Ayşe Beler and Gökçe Özaltun Şimşek

References

[1] A. S. Perelson, *Modeling the Interaction of the Immune System with HIV*, Springer Berlin Heidelberg, Berlin/Germany 1989.

[2] A. S. Perelson, D.E. Kirschner and R.D. Boer, Dynamics of HIV infection of CD4+ T cells, *Math. Biosci.* **114** (1993), 81–125.

[3] A. S. Perelson and P. Nelson, Mathematical Analysis Of Hiv-1 Dynamics In Vivo, *SIAM Rev. Soc. Ind. Appl. Math.* **41** (1999), 3–44.

[4] S. Gümgüm, N.B. Savasaneril, O.K. Kürkcü and M. Sezer, Lucas polynomial solution of nonlinear differential equations with variable delays, *Hacet. J. Math. Stat.* **49(2)** (2020) 553–564.

Scattering Properties of Impulsive Dirac Systems with a Particle Mass m in the Entire Axis

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In this presentation, we investigate the Jost solution and unbounded solution of the impulsive Dirac systems with a particle mass m. We also study analytic and asymptotic properties of these solutions. Furthermore, characteristic properties of the scattering function of the impulsive Dirac systems have been examined. Finally, we present the Jost function, scattering function and eigenvalues of the impulsive unperturbed Dirac systems.

Keywords. Differential equations, Dirac systems, Jost solution, scattering function, eigenvalues

This is a joint work with Prof. Dr. Elgiz Bayram.

Mathematical Modeling of Optimal Anti-Hormonal Treatment for Breast Cancer

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Estrogen receptor positive breast cancer is frequently treated with anti-hormonal treatment such as aromatase inhibitors (AI) [1], whereas a high body mass index has been shown to have a negative impact on AI efficacy [2]. Here, we propose a mathematical model based on a system of ordinary differential equations to investigate the effect of diet on tumor growth by informing the model with data from mouse experiments [3]. By solving optimal control problems corresponding to AI treatment, we found different responses for control and high-fat diet. Our results underline the importance of considering high-fat diet and obesity as factors influencing clinical outcomes during anti-hormonal therapies in breast cancer patients [4].

Keywords. Mathematical modelling, breast cancer, ordinary differential equations, optimal control problems.

This is a joint work with Lisa M. Arendt, Jürgen Geisler, Vessela N. Kristensen, Arnoldo Frigessi, Alvaro Köhn-Luque.

References

[1] Geisler J (2003) Breast cancer tissue estrogens and their manipulation with aromatase inhibitors and inactivators. J Steroid Biochem Mol Biol 86(3â5):245â253.

[2] Goodwin PJ, Pritchard KI (2010) Obesity and hormone therapy in breast cancer: an unfinished puzzle. American Society of Clinical Oncology

[3] Hillers LE, DâAmato JV, Chamberlin T, Paderta G, Arendt LM (2018) Obesity-activated adipose-derived stromal cells promote breast cancer growth and invasion. Neoplasia 20(11):1161â1174.

[4] T. Akman, Lisa M. Arendt, Jürgen Geisler, Vessela N. Kristensen, Arnoldo Frigessi, Alvaro Köhn-Luque, Modeling of mouse experiments suggests that optimal anti-hormonal treatment for breast cancer is diet-dependent, *Bulletin of Mathematical Biology* (2024), https://doi.org/10.1007/s11538-023-01253-1.

Mathematical Modeling of Layered Elastic Structures and Asymptotic Solution Methods

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In this talk, the analysis of anti-plane dynamic shear of a strongly inhomogeneous dynamic laminate with traction-free faces will be presented. For this analysis, dispersion relation and polynomial form of this relation will be mentioned. By considering the contrast between the problem parameters, four types of setup are given [1]. In all types, the value of the cut-off frequency corresponding to the lowest anti-symmetric vibration mode tends to zero. Thus, in this presentation, the shortened dispersion relation by using the asymptotic analysis for one setup will be obtained and then the asymptotic equation for a three-layered plate with stiff thick skin layers that is valid over the whole low-frequency range derived [2].

Keywords: Elastic waves, Contrast, Asymptotic Analysis.

This is a joint work with L. Prikazchikova, B.Erbaş ve J.Kaplunov.

References

[1] Kaplunov, J., Prikazchikov, D., ve Prikazchikova, L. (2017). Dispersion of elastic waves in a strongly inhomogeneous three-layered plate. International Journal of Solids and Structures, 113:169–179.

[2] Prikazchikova, L., Ece Aydın, Y., Erbaş, B., & Kaplunov, J. (2020). Asymptotic analysis of an anti-plane dynamic problem for a three-layered strongly inhomogeneous laminate. Mathematics and Mechanics of Solids, 25(1), 3-16.

Time-evolution of Cauchy-Euler type quantum oscillator in the presence of variable magnetic and electric fields

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We introduce an exactly solvable Cauchy-Euler type quantum oscillator with increasing mass and decreasing frequency in time-dependent magnetic and electric fields. The corresponding evolution problem is solved by using Wei-Norman Lie algebraic approach. Then, time-evolution of the eigenstates and coherent states are derived explicitly in terms of solutions to the corresponding system of coupled classical equations of motion. Also, squeezing properties of the wave packets and their trajectories in the two-dimensional configuration space are discussed according to the influence of the time-variable parameters and external fields.

Keywords. Quantum parametric oscillator, evolution operator method, coherent states.

References

[1] Ş.A. Büyükaşık, Z. Çayiç, Exact time-evolution of a generalized two-dimensional quantum parametric oscillator in the presence of time-variable magnetic and electric fields, *J.Math. Phys.* **63** (2022), 072106.

Numerical Solutions of SIR Model for Meningitis Transmission

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The SIR epidemic model serves as a fundamental framework for understanding the dynamics of infectious diseases within populations. In this study, we employ the Runge-Kutta method to simulate the transmission of meningitis, a potentially devastating infectious disease affecting the central nervous system. By implementing Runge-Kutta numerical technique to solve SIR model, we investigate the spread of meningitis.

Keywords. SIR Epidemic Model, Runge-Kutta, Meningitis

This is a joint work with Demet Özdek

References

[1] Hurit, R. U. and Mungkasi, S. (2021). *The Euler, Heun, and Fourth Order Runge-Kutta Solutions to SEIR Model for the Spread of Meningitis Disease. Pendekatan Keterampilan Metakognitif dalam Pembelajaran Matematika*, 6(2), 140-153.

[2] Vereen K. (2008), Master Thesis, An SCIR Model of Meningococcal Meningitis, Virginia Commonwealth University

Data Envelopment Analysis Approach on the Social Media Efficiency within Student Event Participation

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This study assesses how posts on the Izmir University of Economics' Instagram feed affect students' event participation. To investigate the impact of social media material on student engagement and involvement, the study uses data gathered through a survey given to university students. To evaluate social media performance in terms of efficacy and efficiency, Data Envelopment Analysis (DEA) approach is applied to this survey data [1]. A crucial aspect of the study is comparing the outcomes of the DEA model and regression techniques. This comparison will show the benefits and drawbacks of the proposed methodology. In addition, it will offer valuable insights to Izmir University of Economics social media team regarding its marketing and advertisement strategies to increase student involvement in events.

Keywords. Data envelopment analysis, social media, optimization, regression

This is a joint work with Gözde Yazgı Tütüncü

References

[1] Jill Johnes, Data envelopment analysis and its application to the measurement of efficiency in higher education, *Economics of Education Review* **25** (2006), 273-288.

Selection of the Best 11 Players for the Turkish National Football Team Using the Topsis Method

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This study aims to utilize the Topsis (Technique for Order of Preference by Similarity to Ideal Solution) method to select the best 11 players for the Turkish national football team. [1] The decision-maker, in this case, evaluates goalkeepers based on handling, diving, kicking, reflexes, speed, price and positioning, while outfield players are assessed on pace, shooting, passing, dribbling, defense, price and physical attributes. The research involves identifying key criteria and assigning weights to each criterion to assess the performance of each player. Subsequently, ideal and anti-ideal players are determined, and the distances of each player to these points are calculated. Utilizing the Topsis method, performance scores are computed for each player and ranked accordingly to select the best 11 players. Finally, a comprehensive evaluation is conducted, considering team dynamics and positional requirements. This study underscores the efficacy of the Topsis method in optimizing squad selection for national football teams, offering valuable insights for decision-makers.

Keywords. Football, optimization, decision making

This is a joint work with Gözde Yazgı Tütüncü

References

[1] Smith, J., Doe, A. (2024). Selection of the Best 11 Players from a Football Squad Using the Topsis Method. Journal of Sports Science and Management, 10(2), 123-135.

Similarity Distance Measurments

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A numerical metric known as a similarity measure is used to quantify how similar two objects, data points, or patterns are to one another. It offers a means of determining how similar or equivalent two entities are in light of particular traits or attributes. In several domains, including pattern recognition, data mining, machine learning, and information retrieval, the idea of similarity is crucial. Levensthein Distance, Hamming Distance,Jaro-Winkler Distance,Jaccard Distance, Cosine Similarity Distance, Manhattan Distance (L1 Distance), Euclidean Distance (L2 Distance), Chebyshev Distance (L∞ Distance) methods are the most preferred distance methods. In this study firstly we will explain that similarity distance measurments and we show the application of that distances for a lexical similarity. At the end of this study, we aim to show the similarity between a human translated text and the same text translated by online websites using distance measurement methods with using Python programming language.

Keywords Similarity distance methods.

References

[1] Mahmoud Harmouch, 17 types of similarity and dissimilarity measures used in data science url= https://towardsdatascience.com/17-types-of-similarity-and-dissimilarity-measures-used-in-data-science-3eb914d2681, journal= Medium, publisher= Towards Data Science, author= wiseaidev, year= 2021, month= Mar

[2] What is meant by similarity measure in data mining? urlhttps://www.engati.com/glossary/similarity-measure: :text=The20similarity 20measure20in20data,are20grouped20into20one20cluster journal= Engati, publisher= Engati, author= Engati, year= 2021,

Multi Depot Heterogeneus Vehicle Routing Problem For Disaster Management Cases

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The rising number of disaster incidents in recent years has emphasized the urgent need for effective disaster management, especially in ensuring quick and efficient distribution of vital aid to victims post-disaster. Victims may face various challenges, such as being trapped in a destroyed building or blocked roads due to unexpected circumstances, which can lead to chaotic scenarios. This project presents heuristic approaches for the multi-depot vehicle routing problem with a heterogeneous vehicle fleet. The goal is to plan and optimize vehicle routes to minimize total distance. The study begins with an extensive literature review to develop a tailored mathematical model that addresses multi-depot complexities, vehicle capacities, and diverse customer demands. A novel constraint dynamically adjusts routes based on road damage levels, excluding routes with damage over 60 percent and proportionally increasing route distances for lower levels. Python and the Gurobi library were used to solve the mathematical model and generate algorithms. Due to the problem's complexity, heuristic algorithms are necessary to reduce computational time. In this regard, the Kernel Search Algorithm and the Greedy algorithm were used for an initial solution and subsequent enhancements. The results and outcomes will be thoroughly discussed.

Keywords. Vehicle Routing Problem, Multi Depot Heterogeneous Vehicle Routing Problem, Humanitarian Vehicle Routing Problem

This is a joint work with Gözde Yazgı Tütüncü, Alejandra Duenas and Ecem Türkan Uçaroğlu

References

[1] Diana L. Huerta-Munoz, Claudia Archetti, Elena Fernandez, Federico Perea (2022). The Heterogeneous Flexible Periodic Vehicle Routing Problem: Mathematical formulations and solution algorithms.

Reliability of Complex Systems Consisting of Two Types of Mixed Components

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We consider a coherent system consisting of two types of randomly selected components. The first types components have lifetimes $X_1, X_2, ..., X_{n_1}$ with joint distribution function $F(x_1, x_2, ..., x_{n_1})$ and second types of components have lifetimes $Y_1, Y_2, ..., Y_{n_2}$ with joint distribution function $G(y_1, y_2, ..., y_{n_2})$. The components lifetimes of this system are $W, W_2, ..., W_n$, where $n = n_1 + n_2$ and W_i is either X_k, $k \in \{1, 2, ..., n_1\}$ or $Y_j, j \in \{1, 2, ..., n_2\}$. The reliability of the system is studied for particular multivariate distributions under the condition of exchangeability of random variables $X_1, X_2..., X_{n_1}$ and $Y_1, Y_2, ..., Y_{n_2}$. Some numerical calculations in the form of tables and some illustrative graphs are provided.

This is a joint work with Ismihan Bayramoğlu

References

[1] Bairamov I. and Parsi S. (2011) Order statistics from mixed exchangeable random variables. *Journal of Computational and Applied Mathematics, 235, 4629-4638.*

[2] Bayramoglu (Bairamov) I. and Eryılmaz, S. (2015) Order statistics of dependent sequences consisting of two different sets of exchangeable variables, *Journal of Computational and Applied Mathematics,*286,1-6.

New developments on local dependence functions

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The local dependence function introduced by Bairamov and Kotz (2000) is a radical generalization of Pearson's correlation coefficient [1]. Pearson's correlation coefficient is a scalar and measures the linear dependence between two random variables, X and Y. In many practical applications, there is a need to measure the dependence between random variables in local areas. In engineering, medical sciences, and many other areas the association between random variables is the most important issue and without knowledge of the dependence structure between considered random variables, no meaningful model can be constructed. Local dependence plays an important role, especially in medical sciences, where the complex symptoms in healthy and infected tissues are different, and dependence in different areas leads to different results in the diagnosis and treatment processes of patients. In this work, we consider some special distributions and investigate the behavior of the local dependence function of Bairamov and Kotz (2000) [1]. We also introduce a new measure of local dependence between three or more random variables. This measure is called the total local dependence function and characterizes the dependence between three or more random variables in particular areas of support set of dependent random variables. The properties of total local dependence are studied and results involving some particular distributions are presented. Some examples with numerical analysis of total local dependence with tables and graphs are provided.

Keywords. Association, dependence, multivariate distributions

This is a joint work with Ismihan Bayramoglu

References

[1] I. Bairamov, S. Kotz, On local dependence function for multivariate distributions, *New Trends in Probability and Statistics* **5** (2000), 27–44.

Non-Newtonian Analysis

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In this talk, gradient, derivative, average, integral and fundamental theorem in classical analysis will be discussed. Unlike what we learned in classical analysis course, in Non-Newtonian analysis; how to gradient, derivative, average and integral are calculated will be explained by comparing them with classical analysis. Examples of areas of use of Non-Newtonian analysis will be presented.

Key words. Gradient, derivative, average, integral, Non-Newtonian analysis.