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2nd International Conference

ON MATHEMATICAL ANALYSIS AND MACHINE LEARNING

(ICMAML2024)

TOPICS

- Mathematical analysis
- Algebra and Applications
- Mathematics for Finance
- Optimization
- Statistics
- Artificial intelligence

28-30 November, 2024

AT THE FACULTY OF SCIENCE AGADIR

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OUR KEYNOTE SPEAKERS

Pr. Abdallah Mkhadri,
University of Cadi Ayyad, Morocco.

Pr. Abdeljalil Nachaoui,
University of Nantes, France.

Pr. Abdelkarim Bourouihia,
Nova Southeastern University, USA

Pr. Belmesnaoui Aqzzouz,
Mohamed V University, Morocco.

Pr. El Haj Laamri,
University of Lorraine, France.

Pr. Emmanuel Lepinette,
Paris Dauphine University, France.

Pr. Mohammed Baraa,
University of Cadi Ayyad, Morocco.

Pr. Nour Eddine Alaa,
University of Cadi Ayyad, Morocco.

Pr. Yasmine LAMARI,
University of Ibn Zohr, Morocco.

OVERVIEW

The aim of this conference is to bring together researchers, academices, and students from both the academic and industrial sectors, all connected by their interest in mathematics and its Applications. On the others hand, it gives the participants an opportunity to establish contacts and exchange new ideas, dicuss challenging issues, foster future collaborations and interact with each other. this also motivates young researchers and graduate students to work in many fertile subjects of mathematices.

TOPICS

- *Mathematical analysis*
- *Optimization*
- *Algebra and Applications*
- *Statistics*
- *Mathematics for Finance*
- *Artificial intelligence*

KEY, DATES AND DEADLINES

- *Abstracts Submission Deadline : 27 octobre 2024*
- *Notification of acceptance : 3 Novembre 2024*
- *Publication of the program : 23 Novembre 2024*

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PLENARY SESSIONS

2nd International Conference
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Séparateur à Vaste Marge pour données en grande dimension

Abdallah Mkhadri

Université Cadi Ayyad, Faculté des Sciences Semlalia, Marrakech

Abstract

Dans cet exposé, je rappelle en première partie la méthode purement d'apprentissage automatique fond´ee sur les classificateurs d'hyperplan séparateur ou encore le Séparateur 'a Vaste Marges (SVM : Support Vector Machines). Ils permettent la généralisation des méthodes statistiques linéaires par la recherche d'une séparation linéaire de deux classes dans un espace étendu de transformation des variables initiales par l'astuce d'un noyau qui évite de définir l'espace de représentation et de la transformation non-linéaire. Leur particularité est qu'ils sont définis via un problème d'optimisation convexe, ce qui est complètement différent des approches traditionnelles. La deuxième partie sera concernée par les méthodes de régularisation de SVM permettant la réduction de la dimension de l'espace des observations par la sélection de variable et l'estimation simultanément des paramètres minimisant le critère de SVM pénalisée par une pénalité de type L_1 non différentiable en zéro. On termine par la présentation de nouveaux critère SVM pénalisés où la fonction marge de SVM est remplacée par une fonction lisse différentiable (ou de classe C^2). Cette modification permet d'accélérer la vitesse de convergence des algorithmes standards fondés sur la descente par coordonnée et des moindres carrés partiels et facilite l'analyse théorique des estimations. Quelques illustrations numériques seront présent.

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Recent developments in meshless methods for inverse problems

Abdeljalil nachaoui

University of Nantes, France

Abstract

This talk provides an introduction to meshless methods for solving boundary value problems (BVPs) with a focus on their application to inverse problems. Meshless methods offer a flexible alternative to traditional grid-based techniques, eliminating the need for mesh generation and providing greater adaptability to complex geometries and irregular domains.

We begin with an overview of the key concepts underlying meshless methods, including radial basis functions (RBFs), Element-Free Galerkin (EFG) and collocation approaches. The talk then covers meshless collocation methods based on polynomial and Haar wavelet expansions. In particular, we will detail an extended collocation approach where the solution is approximated using a two-dimensional basis expansion. Practical numerical examples are provided to illustrate the effectiveness of these methods in recovering missing information in different inverse problems, with discussions on accuracy, stability, and optimization strategies.

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Some Partial Results on the HRT Conjecture

Abdelkrim Bourouihiya

Nova Southeastern University, United States of America

Abstract

Stated more than thirty years ago, the HRT (Heil, Ramanathan, and Topiwala) conjecture, which is still open in its general setting, is about the linear independence of every finite system of time-frequency translates of a nonzero square integrable function. In this talk, we will present several partial results of the conjecture along with some techniques to prove those results.

SIMILARITIES AND DIFFERENCES BETWEEN SPHERICAL SPECTRUM OF QUATERNIONIC RIGHT LINEAR BOUNDED OPERATORS AND SPECTRA OF COMPLEX LINEAR OPERATORS

BARRAA MOHAMED

Abstract. In this talk, we give an overvieuw of the fundamentals of the theory of spherical spectrum of a right linear bounded operator on a right quaternionic Banach space. In particular, we will be interested in what properties of the usual spectrum for complex bounded operators carry over to this spectrum.

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Similarities and differences between spherical spectrum of quaternionic right linear bounded operators and spectra of complex linear operators

BARRAA Mohamed

Cadi Ayyad University, Faculty of Sciences Semlalia, Marrakech

Abstract

In this talk, we give an overvieuw of the fundamentals of the theory of spherical spectrum of a right linear bounded operator on a right quaternionic Banach space. In particular, we will be interested in what prop- erties of the usual spectrum for complex bounded operators carry over to this spectrum.

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Some Results on Portfolio Theory in Infinte Dimensional Vector Lattices

Belmesnaoui Aqzzouz

Mohammed V university, Rabat

Abstract

We consider a security market containing an infinitely countably many securities. We assume that only an arbitrary finite portfolio holdings by the number of investors having identical expectations on the security payoffs.

A portfolio x is a sequence of share holdings $x = (x_1, x_2, \ldots)$, where x, is the number of shares of security 11. In our situation, our economic model i.e. the space of such portfolios is the vector space of all eventually zero real sequences, which is an infinite dimensional Dedekind complete normed vector lattice.

In our talk we look to the existence of an equilibrium portfolio allocations in that market.

To do this, we will use the theory of Aliprantis-Brown on the existence of Walrasian equilibrium in Symmetric

Riesz dual systems. Also, since our commodity space is of infinite dimension, demand functions ans supply functions didnt exist. In this situation, we will use the generalization of the Second Welfare Theorem of Arrow, which gave some relations between Equilibrium portfolio allocations and Pareto Optimal portfolio allocations.

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Conditional operator and random optimization in mathematical finance

Emmanuel LEPINETTE

Paris Dauphine university, France

Abstract

In mathematical finance, two conditional operators play fundamental roles: the conditional expectation for linear models and conditional essential infimum/supremum more recently for non linear models. The later is actually related to the random maximization problem of a random function on a random set. In this talk, we explain why this operators are useful and how we may use them in finance.

Global existence for reaction-diffusion systems with control of total mass : recent results

El-Haj LAAMRI
Université de Lorraine
Institut Elie Cartan de Lorraine, Campus Nancy
El-Haj.Laamri@univ-lorraine.fr

Models issued from ecology, chemical reactions and several other application fields lead to parabolic reaction-diffusion systems with super-linear growth.
Many of these systems naturally satisfy the two following properties:
(P): the positivity of the solutions is preserved as long as they exist ;
(M): the total mass of the components is controlled (or even preserved).

It turns out that the structure (P)+ (M) does not prevent the solution from blowing up in L^∞-norm in finite time. Thus, some growth restrictions and extra structure on the reactive terms are needed for global-in-time existence of classical solutions. This issue has been intensively studied in the semi-linear case with bounded initial data. Despite being standard, the mathematical understanding of these parabolic systems is still very limited.

In this talk, we will present some recent results on systems that verify (P) and (M). These results were recently obtained in collaboration with Maha Daoud and Azeddine Baalal [1] in the case of non-local diffusion, and with Rajae Malek Chérif Ziti in the case of local diffusion[4, 5]. The three aforementioned works extend some results previously published in references [3, 2] and [6].

References

[1] Maha Daoud, El-Haj Laamri and Azeddine Baalal : *A class of fractional parabolic reaction–diffusion systems with control of total mass: theory and numerics.* J. Pseudo-Differ. Oper. Appl. **15**(18) (2024). https://doi.org/10.1007/s11868-023-00576-w

[2] Klemens Fellner, El-Haj Laamri : *Exponential decay towards equilibrium and global classical solutions for nonlinear reaction-diffusion systems*, J. Evol. Equ. **16** (2016), 681–704.

[3] El-Haj Laamri : *Global existence of classical solutions for a class of reaction-diffusion systems*, Acta Appl. Math. **115**(2) (2011), 153–165.

[4] El-Haj Laamri, Rajae Malek, Chérif Ziti : *Global existence for parabolic reaction-diffusion systems with exponential growth: a numerical study.* Submitted.

[5] El-Haj Laamri, Rajae Malek, Chérif Ziti : *On global existence for reaction-diffusion systems modeling reversible chemical reactions.* Submitted.

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Global existence for reaction-diffusion systems with control of total mass : recent results

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Abstract

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Séparateur à Vaste Marge pour données en grande dimension

Abdallah Mkhadri
Département de Mathématiques, FSSM, Marrakech

Dans cet exposé, je rappelle en première partie la méthode purement d'apprentissage automatique fondée sur les classifieurs d'hyperplan séparateur ou encore le Séparateur à Vaste Marges (SVM : Support Vector Machines). Ils permettent la généralisation des méthodes statistiques linéaires par la recherche d'une séparation linéaire de deux classes dans un espace étendu de transformation des variables initiales par l'astuce d'un noyau qui évite de définir l'espace de représentation et de la transformation nonlinéaire. Leur particularité est qu'ils sont définis via un problème d'optimisation convexe, ce qui est complètement différent des approches traditionnelles. La deuxième partie sera concernée par les méthodes de régurisation de SVM permettant la réduction de la dimension de l'espace des observations par la sélection de variable et l'estimation simultanément des paramètres minimisant le critème de SVM pénalisée par une pénalité de type L_1 non différentiable en zéro. On termine par la présentation de nouveaux critère SVM pénalisés où la fonction marge de SVM est remplacée par une fonction lisse différentiable (ou de classe C^2). Cette modification permet d'accélérer la vitesse de convergence des algorithmes standards fondés sur la descente par coordonnée et des moindres carrés partiels et facilite l'analyse théorique des estimations. Quelles illustrations numériques seront présentées pour montrer la performance et l'efficacité de ces nouvelles approches.

Mots-Clefs : SVM, Classement, Sélection de Variables, Régularisation, Polynômes de Bernstein, Borne d'Erreur Non Asymptotic.

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Nonlinear hyperbolic system involving $p(x)$-growth conditions and its application to image decomposition

Noureddine Alaa

University of Cadi Ayyad, Marrakech, Morroco

Abstract

This presentation explores nonlinear hyperbolic-parabolic equations with variable exponents, motivated by their applications in digital image decomposition. We begin by providing a brief overview of the importance of image decomposition and the classical techniques commonly employed in this field. Subsequently, we propose a novel model based on a system of hyperbolic-parabolic partial differential equations governed by the $p(x)$-Laplacian. To support the theoretical foundation of our model, we establish existence and uniqueness results within an appropriate Lebesgue-Sobolev space framework with variable exponents. Additionally, we present a discretization scheme for the proposed model. Numerical experiments and simulations demonstrate the superior performance of our model compared to classical approaches, highlighting its potential efficacy in practical applications

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Bridging Data and Creativity with Generative AI and Machine Learning advances

Yasmine Lamari

University Ibn Zohr, Agadir, Morroco

Abstract

Generative AI and machine learning are transversal fields at the forefront of technological innovation, revolutionizing various industries and domains. Generative AI refers to techniques designed to create new content, such as images, text, and music, that imitate human creativity. Machine learning, on the other hand, aims to let systems learn and improve from data without explicit programming. This planned talk explores the intersection of generative AI and machine learning, highlighting their synergies and applications. While endeavoring to address the question: How can generative AI contribute to machine learning, and vice versa? And that without forgetting to address challenges and ethical considerations inherent in these fields, such as data privacy, bias in generated content, and the societal impact of AI-generated media.

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Pricing of American Options with Jump Diffusion and Non-Standard Volatility

AATIF EL HASSAN [1], EL MOUATASIM ABDELKARIM [2]

[1,2] Laboratory Analyse Mathématique et Calcul Scientifique, University of Ibn Zohr, Agadir, Morocco

Abstract

We propose a generalized Black-Scholes model with jumps for pricing American options, where asset prices follow a stochastic process. This leads to a partial integro-differential equation, formulated as a linear complementarity problem (LCP) due to the early exercise constraint. A finite difference scheme approximates the LCP solution, and we conduct a comparative numerical study using model-specific coefficient values.

Keywords: American options pricing, jump diffusion model, volatility models..

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Upper-semi-Fredholm property of operators and their modulus on Banach lattices

Othman Aboutafail [1], R. Nouira [2], Y. Ezzaki [1]

[1] Engineering Sciences laboratory. Université Ibn tofail, Kenitra, Morrocco
[2] Regional Center for Education and Formation (CRMEF), Kenitra, Morocco

Abstract

In the present manuscript, we present examples of regular upper semi-Fredholm(resp. non upper semi-Fredholm) operators on Banach lattices having non upper semi-Fredholm (resp. upper semi-Fredholm) modulus. We give also an example of a regularupper semi-Fredholm operator on Banach lattices with no modulus.

Keywords: Upper semi-Fredholm operators · Fredholm operators · Banach lattice ·Order bounded operator · Modulus of an operator.

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Analysis of potential pathological behaviors of the B-S operator

MUSTAPHA.ACHEHBOUNE [1], AHMED.SANI [2]

[1] Department of Mathematics Computer Science and Applications, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco

[2]Department of Mathematics Computer Science and Applications, Faculty of Sciences, Ibn Zohr University, Agadir, Morocco

Abstract

The aim of this presentation is to analyze specific properties of the Black-Scholes operator within Banach and Hilbert spaces. This method can be used to investigate and understand the potential pathological behaviors of this operator, which is widely employed in financial contexts for option pricing models.

Keywords: Partial differential equations, Black-Scholes operator, Spectral Analysis, Stability - Perturbations.

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Équations fonctionnelles trigonométrique dans un semi-groupe

Youssef Aserrar [1]

[1] Laboratory Mathematics and Applications, University Ibn Zohr, Agadir, Morocco

Abstract

We plan to present the results of a doctoral thesis prepared in the Mathematics and Applications laboratory at Ibn Zohr University, Faculty of Sciences.
Keywords: Functional equation, Trigonometric equation, Addition and Subtraction law, d'Alembert's equation, Wilson's equation, Kannappan's equation, Van Vleck's equation, Automorphism, Anti-automorphism, Semigroup.

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Low multilinear rank updating for the sylvester tensor equation

Zineb AATRIF [1], Atika ARCHID [1] A. Hafid BENTBIB [2]

[1] Laboratory of engineering sciences, University Ibn Zohr, Agadir, Morocco
[2] Laboratory LAMAI, University Cadi Ayyad, Marrakesh, Morocco

Abstract

In this work, we focus on low multilinear rank updating for the Sylvester tensor equation that can arise from the discretization of high order partial differential equations (PDEs). Sylvester tensor equation plays a very important role in the field of stability and control theory. In order to apply a standard Krylov subspace method and reduce the main problem to a projected Sylvester tensor equation, we will construct a low multilinear rank right hand side, based on the Higher-Order Singular Value Decomposition (HOSVD) of a tensor, which has enabled us to demonstrate that the solution of the Sylvester tensor equation with a right-hand side of low multilinear rank is also of low multilinear rank.

Keywords:Sylvester tensor equation, Low-rank, Low multilinear-rank, HOSVD decomposition

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SOME CHARACTERIZATIONS OF UNBOUNDED DUNFORD-PETTIS OPERATORS

A. El Kaddouri [1], S. Boumnidel [2] O. Aboutafail [1]

[1] Engineering Sciences Laboratory, National School of Applied Sciences (ENSAK) , Ibn Tofail University, Kenitra, Morocco

[2] LDepartment of Mathematics, Faculty Polydisciplinary of Larache, Abdelmalek Essaadi University, Larache , Morocco.

Abstract

We give some characterizations of σ-unbounded Dunford-Pettis operator, (whenever $x_n uaw \longrightarrow 0$ implies that $T(x_n) un \longrightarrow 0$).

In addition, we study some properties of this operator. Furthermore, we study the relationship between this class and other classes of operators, some other interesting results are also obtained..
Keywords: uaw-convergence, un-convergence, uaw-compact operator, unbounded norm compact operator.

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Spectral Analysis of the Bicomplex Magnetic Laplacian and a New Bargmann Transform

Issame Ahizoune [1], Aiad Elgourari [1] Allal Ghanmi [2]

[1] Lab. P.D.E., Algebra and Spectral Geometry
Department of mathematics, Faculty of Sciences, P.O. Box 133. Ibn Tofaïl University in Kenitra; Morocco

[2] Analysis, P.D.E & Spectral Geometry - Lab M.I.A.-S.I., CeReMAR,
Department of Mathematics, P.O. Box 1014, Faculty of Sciences, Mohammed V University in Rabat, Morocco

Abstract

In this talk, we conduct a spectral analysis of the **bicomplex magnetic Laplacian** (bc-magnetic Laplacian), defined as a pair of magnetic Laplacians on two separate complex planes. Within the bicomplex p-Hilbert space, we provide an explicit characterization of its L^2-eigenspaces and address the common eigenfunction problem for the bc-magnetic Laplacian and its †-conjugate. This includes a detailed description of the corresponding eigenspaces and explicit expressions for their reproducing kernels. Additionally, we present an integral representation of Bargmann type for these eigenspaces.

Keywords: Bicomplex, Magnetic Laplacian, Spectral analysis, Bargmann Transform.

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Hyperstability of cubic functional equation in ultrametric spaces

Youssef Aribou
University of Ibn Tofail, Morocco
Muaadh Almahalebi
University of Ibn Tofail, Morocco
and
Samir kabbaj
University of Ibn Tofail, Morocco
Received : December 2016. Accepted : March 2017

Abstract

In this paper, we present the hyperstability results of cubic functional equations in ultrametric Banach spaces.

Keywords : *Stability, hyperstability, ultrametric space, cubic functional equation.*

Mathematics Subject Classification : *Primary 39B82; Secondary 39B52, 47H10.*

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Closed-Form Solution of Linear Differential Equations Using a Generalized Fractional Power Series

*** Youness Assebbane[1], Mohamed Echchehira[1] and Mustapha Atraoui[1]**

(1) Ibn Zohr University, Ait Melloul University Campus, Faculty of Applied Sciences, Department of Mathematics, BP 6146, 86150, Agadir, Morocco.

Abstract

The main objective of this paper is to introduce an algorithm for solving Linear Differential Equations based on a generalized fractional power series. The algorithm relies on expanding the solution of an FDE or an ODE as a generalized power series, shedding light on the choice of the exponent for the monomials. The key contribution is how the exponents for these terms are chosen, which is different from traditional methods.

Keywords: fractional power series; fractional-order differential equations; Riemann-Liouville fractional derivative; Caputo fractional derivative; Mittag-Leffler function.

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On the stochastic maximal L^p-regularity for perturbed evolution equations

Hamza Bounacer [1], Said Hadd [2]

[1] LAMA, IBN ZOHR University, Faculty of Sciences, Agadir, Morocco
[2] LAMA, IBN ZOHR University, Faculty of Sciences, Agadir, Morocco

Abstract

The concept of stochastic maximal L^p-regularity is a technique utilized to solve non-linear, quasi-linear, as well as non-autonomous linear stochastic evolution equations, driven by a cylindrical brownian motion, in Banach spaces. In [4, 5] sufficient conditions for stochastic maximal L^p-regularity were derived, and various applications to stochastic partial differential equations are worked out. The stochastic maximal L^p-regularity has undergone further development in the work of [1, 3]. The authors have demonstrated that various characteristics of deterministic maximal L^p-regularity can also be applied to the stochastic version. Additionally, a significant contribution is made in Section 6 of [1], where the authors prove the invariance of stochastic maximal L^p-regularity under a specific category of unbounded linear perturbations. In this talk, we aim to provide further insights into the stability of stochastic maximal L^p-regularity when subjected to perturbation. Specifically, Miyadera-Voigt perturbations. These results generalize those obtained in the deterministic case, see e.g. [2] and complement the ones presented in [1].
Keywords: Stochastic equations, maximal regularity, perturbation, admissible observation operators.

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Another Cosine-Sine functional equation on semigroups.

Keltouma Belfakih[1] and Elhoucien Elqorachi [2]

[1] Multidisciplinary Faculty, Ibn Zohr University, Taroudant, Morocco
[2] Ibn Zohr University, Faculty of sciences, Department of mathematics, Agadir,

Abstract

Let S be a semigroup. In this paper we find the solutions $f, g, h : S \longrightarrow \mathbb{C}$ of the Cosine-Sine other functional equation $f(xy) = f(x)f(y) + g(x)g(y) + h(x)h(y),\ x, y \in S$, in terms of multiplicative functions on S, solutions of the special Sine addition law: $\phi(xy) = \phi(x)\chi(y) + \chi(x)\phi(y),\ x, y \in S$ and solutions of the particular Cosine-Sine functional equation: $\psi(xy) = \psi(x)\chi(y) + \chi(x)\psi(y) + \phi(x)\phi(y),\ x, y \in S$, in which χ: $S \longrightarrow \mathbb{C}$ is a multiplicative function. As an application we give the solutions (f, g, h) of the functional equation $f(xy) = g(x)h(y) + h(x)g(y) + f(x)f(y), \quad x, y \in S$.

Keywords: Semigroup, Levi-Civita functional equation, Sine-Cosine addition law.

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Convergence Analysis and Acceleration of the JN Relaxed Algorithm for Convection-Diffusion Cauchy Problems

Khalifa Boumzough[1], Adnane Azzouzi[2] Abdeljalil Nachaoui [3]

[1] LABSI, Faculty of Sciences Agadir, Ibn Zohr University, Agadir, Morocco
[2] LAMA, Faculty of sciences, Dhar El Mahraz Sidi Mohammed Ben Abdellah University, Fez, Morocco
[3] Laboratoire de Mathématiques Jean Leray, Nantes Université, Nantes, France

Abstract

We introduce the JN relaxed algorithm to solve the Cauchy problem for convection-diffusion equations in a bounded domain. The algorithm iteratively updates mixed boundary conditions using a relaxation parameter to improve convergence. We establish theoretical convergence criteria and show that optimal parameter choices accelerate the algorithm compared to standard methods like the KMF algorithm. This approach offers a robust solution for applications in fluid dynamics and heat transfer.

Keywords: Inverse Cauchy Problem, convection-diffusion equation, JN relaxed algorithm, convergence analysis, KMF algorithm, iterative methods.

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Parabolic reaction-diffusion systems governed by different fractional Laplacians with mass control : Theory and simulations

Maha DAOUD [1], El Haj LAAMRI [2] Azeddine BAALAL [3]

[1] POEMS, ENSTA Paris, Institut Polytechnique de Paris, Palaiseau, France
[2] Institut Elie Cartan de Lorraine, Université de Lorraine, Campus Nancy, France
[3] LMFA, Université Hassan II de Casablanca, Casablanca, Maroc

Abstract

In this talk based on [1, 2], we present some new results about global-in-time existence of strong solutions to a class of fractional parabolic reaction–diffusion systems posed in a bounded domain of $\mathbb{R}^N$. The nonlinear reactive terms are assumed to satisfy natural structure conditions which provide nonnegativity of the solutions and uniform control of the total mass. The diffusion operators are of type $u_i \mapsto d_i(-\Delta)^{s_i}u_i$ where $0 < s_i < 1$. For more details about this kind of operators, we refer the interested reader to [3] and references therein. Global existence of strong solutions is proved under the assumption that the reactive terms are at most of polynomial growth. Our results extend previous results obtained in [4, 5] where the diffusion operators are of type $u_i \mapsto -d_i\Delta u_i$.

Also, we present some numerical simulations in order to examine the global existence of solutions to systems with exponentially growing right-hand sides, which remains so far an open theoretical question even in the case where the diffusion is driven by the classical Laplacian.
Keywords: Reaction–diffusion system, Fractional diffusion, Strong solution, Global existence, Numerical simulation.

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A new variant of Wilson's

Hajira Dimou [1], Elhoucien Elqorachi [2] Abdellatif Chahbi [1,2]

[1] Laboratory LMA, Ibn Zohr, Agadir, Morocco
[2] Laboratory LMA, Ibn Zohr, Agadir, Morocco

Abstract

We find on a monoid M the complex-valued solutions $f, g : M \to \mathbb{C}$ such that f is central and g is continuous of the functional equation

$$f(x\sigma(y)) + f(\tau(y)x) = 2f(x)g(y), \quad x, y \in M,$$

where $\sigma : M \to M$ is an involutive automorphism and $\tau : M \to M$ is an involutive anti-automorphism.
The solutions are described in terms of multiplicative functions, additive functions and characters of 2-dimensional representations of M.
Keywords: Monoid, Functional Equation, d'Alembert's Equation, Involutif Automorphism.

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Elliptic equations with nonstandard growth involving measures

Eddaoudi Hicham
Ibn Tofail University

Abstract

In this paper, we study the relationship between Riesz measure μ and $G(\cdot)$-superharmonic functions u, which satisfies:

$$-\operatorname{div} \mathcal{A}(x, Du) = \mu,$$

in the distribution sense such that $\mathcal{A}(x, \xi) \cdot \xi \approx G(x, |\xi|)$ and $G(\cdot)$ is Φ-function..

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Stability results for a type of functional equations

Iz-iddine EL-Fassi

Faculty of Science and Techniques, S. M. Ben Abdellah University, Fez, Morocco,
izidd-math@hotmail.fr; iziddine.elfassi@usmba.ac.ma

Abstract

It is well-known that the concept of stability for a functional equation arises when we replace functional equation by an inequality which acts as a perturbation of the equation. In this work, we describe the general solution of a class of functional equations, and in the next part we prove the approximate solution of such functional equation under some weak natural assumptions. We conclude this work with a few significant applications.
Keywords: Functional equations; Approximation, Topological vector space, Stability.

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Preprocessing via fitting copula

Oussama Elamrani [1], Loubna Karbil[2], Ahmed Sani[3]

[1,3] Laboratory LAMA, Ibnou Zohr University, Faculty of Science, Agadir, Morocco
[2] Laboratory LIIMA, ENISIASD Taroudant, Ibnou Zohr University, Morocco

Abstract

Data are so important to construct new knowledge. This fact obviously falls within the domain of data mining. For an instructive and rapid deal with different concepts of this vast field of research, we refer to [3] and for challenges that on challenges that face researchers, mainly on problems of higher dimensions, the survey [2] is recommendable since it stars with basics of the art to the recent developments in Machine and deep learning. Among many papers concerned with pre-processing techniques, we refer to classical ones.
We will roughly explain the interest of pre-processing which means at this stage the pre-treatment of raw data. Our main tool will be the copulas as detailed in [1] and improvements given recently Sani, Karbil, Elamrani and Elmaazouz in [5], [6], [7] and [8].
Keywords: Copulas, Generative learning, Fitting models.

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Stability analysis of an SEIS epidemic model with saturated incidence rates

Soufiane Elkhaiar [1],

[1] Laboratory of innovations in mathematics and intelligent systems, Faculty of Applied Sciences, Ait Melloul, Ibn Zohr University, Agadir, Morocco

Abstract

In this work, we study the nonlinear dynamics of an SEIS epidemic model that includes a saturated incidence rates. Under some hypotheses, it is shown that the global dynamics is determined by the basic reproduction number R_0. If $R_0 < 1$, the disease-free equilibrium is both locally and globally stable and the disease dies out. If R_0 is greater than unity, sufficient conditions for the global stability of the endemic equilibrium are obtained by the geometric approach. Finally, some numerical simulations are performed to verify the theoretical analysis.

Keywords: SEIS epidemic model; saturated incidence rates; global asymptotic stability; geometric approach.

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Dynkin games in defaultable settings: Valuation problem via a doubly reflected BSDEs approach

Badr ELMANSOURI [1], Mohamed EL OTMANI [1]

[1] Laboratory LAMA, Faculty of Sciences Agadir, Ibn Zohr University, Agadir, Morocco

Abstract

Default risk is one of the most extensively studied aspects of credit risk, attracting significant attention in the last decades. This presentation addresses the valuation problem for Dynkin games with a fixed expiry time in a defaultable environment, specifically focusing on American game options. The information flow $\mathbb{G} := (\mathcal{G}_t)_{t\geq 0}$ is driven by a standard Brownian motion W in the filtration $\mathbb{F} := (\mathcal{F}_t)_{t\geq 0} = (\sigma\{W_s : s \in [0,t]\})_{t\geq 0}$, along with a random time $\tau : \Omega \to (0, +\infty)$, known as the *default time*, which is not a stopping time with respect to $\mathbb{F}$. Our approach uses the theory of Doubly Reflected Backward Stochastic Differential Equations (DRBSDEs) with two distinct right-continuous with left-limits (RCLL) barriers.

The stability of the class of semi-martingales under filtration shrinking or enlargement has been a key topic of research in recent decades. It is well-established that any $\mathbb{G}$-semi-martingale, if $\mathbb{F}$-adapted, is also an $\mathbb{F}$-semi-martingale, as per Stricker's theorem (filtration shrinking). However, when dealing with an enlarged filtration, the situation becomes more complex, and the semi-martingale property does not always persist. Consequently, the Brownian motion W may no longer be a Brownian motion in the $\mathbb{G}$ filtration. In this context, the $\mathcal{H}$-hypothesis (also known as the immersion property in credit risk modeling) states that any $\mathbb{F}$-local martingale is also a $\mathbb{G}$-local martingale. However, this assumption is often considered too restrictive.

Our methodology involves two approaches:

1. In the first approach, we assume the immersion property holds and solve the pricing problem of an American game option in a financial market with default using DRBSDEs with a stochastic Lipschitz coefficient.
2. In the second approach, we relax the $\mathcal{H}$-hypothesis for the stopped process W^τ, applying a change of probability measure under which W^τ becomes a Brownian motion in the enlarged filtration $\mathbb{G}$. This new framework allows us to tackle a broader class of Dynkin games using DRBSDEs with stochastic Lipschitz coefficients.

In both cases, the cost function or the game's upper and lower values are expressed in terms of a non-linear expectation derived from a classical BSDE with a stochastic Lipschitz driver and a default jump.

Keywords: Doubly reflected BSDEs, RCLL barriers, Stochastic Lipschitz coefficients, Progressive enlargement of filtration, Game options, Default time, Non-linear expectations.

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Application of intuitionistic fuzzy laplace adomian decomposition method for solving intuitionistic fuzzy differential equations

R. ETTOUSSI [1], S. MELLIANI [1] and L. S. CHADLI [1]

[1] Laboratory of Applied Mathematics and Scientific Computing, Sultan Moulay Slimane University, Beni Mellal, Morocco.

Abstract

In this work, we explain the methodology of intuitionistic fuzzy Laplace adomian decomposition method for solving intuitionistic fuzzy differential equations. Finally, we present an example to illustrate this work.

Keywords: Intuitionistic fuzzy solution, Intuitionistic fuzzy number, intuitionistic fuzzy Laplace adomian decomposition.

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On Numerical Solution of Conformable Fractional Differential Equations Using a New Predictive-Corrective Approach

Mohamed Echchehira [1], Mustapha Atraoui [1] & Mohamed Bouaouid [2]

[1] Laboratory for Innovation in Mathematics and Intelligent Systems, University of Ibn Zohr, Agadir, Morocco.

[2] Laboratory of Applied Mathematics and Scientific Computing, University of Sultan Moulay Slimane, Beni Mellal, Morocco.

Abstract

This paper presents a novel predictor-corrector algorithm tailored for solving conformable fractional differential equations (CFDEs). The algorithm leverages the unique properties of conformable derivatives, which generalize the classical notion of differentiation to non-integer orders while preserving the essential features of differential calculus. The predictor step employs an initial approximation based on the conformable Euler method, providing a preliminary solution estimate. Subsequently, the corrector step refines this estimate through iterative application of a conformable fractional trapezoidal rule, enhancing accuracy and stability. The convergence and error analysis demonstrate the algorithm's robustness and efficiency in handling a wide range of CFDEs. Comparative numerical experiments highlight the superior performance of the proposed method against traditional integer-order differential equation solvers and other fractional techniques. This advancement opens new avenues for accurately modeling and solving problems in diverse fields such as physics, engineering, and finance, where fractional dynamics play a crucial role.

Keywords: Conformable Fractional Differential Equations; Predictor-Corrector Algorithm; Numerical Methods; Conformable Derivatives; Fractional Calculus.

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Heat Kernel for heat equation with inverse square potential and dynamic boundary conditions

Hind El Baggari

Faculty of Science Samlalia, LMDP,Marrakech. Email adress : hindbaggari@gmail.com

Boulite Said

ENSA,Marrakech. Email adress : s.boulite@uca.ma

Lahcen Maniar

Faculty of Science Samlalia, LMDP,Marrakech. Email adress :maniar@uca.ma

Abdelaziz Rhandi

Dipartimento di Matematica
Universita degli Studi di Salerno;
Via Giovanni Paolo II, 132, Fisciano (Sa), 84084, Italy. Email adress : arhandi@unisa.it

September 23, 2024

Let $T > 0$ be a fixed final time and let $\Omega \subset \mathbb{R}^n$ $(n \geq 3)$ be a bounded domain such that $0 \in \Omega$ with smooth boundary $\Gamma = \partial\Omega$ of class C^2. We denote by $\Omega_T = (0,T) \times \Omega$ and $\Gamma_T = (0,T) \times \Gamma$. Let $0 \leq \mu < \mu^*(n) := \frac{(n-2)^2}{4}$. We consider the following heat equation with a singular potential subject to dynamic boundary conditions we establish the parabolic Harnack inequality for a coupled system of partial differential equations featuring a singular heat equation with dynamic boundary conditions. The system under consideration is given by:

$$\begin{cases} \partial_t y - \Delta y - \dfrac{\mu}{|x|^2} y = f_1, & \text{in } \Omega_T, \\ \partial_t y_\Gamma - \Delta_\Gamma y_\Gamma + \partial_\nu y = f_2, & \text{on } \Gamma_T, \\ y_\Gamma(t,x) = y_{|\Gamma}(t,x), & \text{on } \Gamma_T, \\ (y, y_\Gamma)|_{t=0} = (y_0, y_{0,\Gamma}), & \text{in } \Omega \times \Gamma. \end{cases} \tag{1}$$

The problem involves the heat equation with an inverse square potential $\frac{\mu}{|x|^2}$ in the domain Ω and a boundary equation that couples the solution y with its boundary component y_Γ. We derive heat kernel

estimates for this system by carefully addressing the singular nature of the potential and the dynamic coupling at the boundary. Utilizing the Hardy inequality and techniques from weighted Sobolev spaces, we prove the parabolic Harnack inequality, which provides valuable insights into the regularity and long-term behavior of the solution. These results enhance the understanding of Harnack-type estimates in the presence of singularities and dynamic boundary conditions.

keywords: Singular heat equation, dynamic boundary conditions, heat kernel estimates, Hardy inequality, parabolic Harnack inequality.

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Spectral flow and $\mathbb{Z}/k\mathbb{Z}$-manifolds

Adnane EL MRABTY
Ibn Zohr University :
Superior School of Technology
Guelmim, Morocco

25 octobre 2024

Abstract : Let (X, Y, α) be an odd-dimensional Riemannian Spin $\mathbb{Z}/k\mathbb{Z}$-manifold. The data (X, Y, α) gives rise to a Dirac-type operator $\mathcal{D}_{X,k}$ on X. Let $u : (X, Y, \alpha) \to \mathcal{U}(n)$ be a continuous map (here $\mathcal{U}(n)$ is the unitary group of degree n).

There is an analytically-defined spectral flow $\mathrm{SF}_k(\mathcal{D}_{X,k}, u^*\mathcal{D}_{X,k}) \in \mathbb{Z}/k\mathbb{Z}$, which is an invariant assignment over solutions of partial differential equations, and a topological index $\mathrm{Ind}\big((X, Y, \alpha); u\big) \in \mathbb{Z}/k\mathbb{Z}$.

In this presentation, we conceptually establish the index formula

$$\mathrm{SF}_k(\mathcal{D}_{X,k}, u^*\mathcal{D}_{X,k}) = \mathrm{Ind}\big((X, Y, \alpha); u\big)$$

showing that $\mathrm{SF}_k(\mathcal{D}_{X,k}, u^*\mathcal{D}_{X,k})$ is a local invariant.

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Comparative Study of Enhanced Numerical Methods for Solving Integral and Differential Equations

E. Aourir [1], N. Izem [1]

[1] Laboratory of Mathematical Engineering and Computer Science, Faculty of Science, Ibn Zohr University, Morocco

Abstract

In this work, we present a comparative analysis of different numerical methods for solving integral and differential equations. This analysis could be useful to determine which numerical method would be more convenient to solve these equations. These equations were evaluated by applying the highly efficient methods available. Several examples illustrating the performance of the proposed methods are presented below. From this analysis, we conclude that the Bernstein method exhibits the best accuracy and computation time.

Keywords: Numerical methods, Integral equations, Differential equations.

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Stability of an extension of the Levi-Cevita equation on semigroup

Karim Farhat, Omar Ajebbar, Idriss Ellahiani, Belaid Bouikhalene

Laboratory of Innovation, Applied Mathematics and Information Technologies, Department of Mathematics and Informatics, Polydisciplinary Faculty, Sultan Moulay Slimane university, Beni Mellal, Morocco

Abstract

In this work, we treate the stability properties of the functional equation $f(xy) = f(x)f(y) + g(x)g(y) + \alpha f(x)g(y)$, on semigroup by using tow-side invariant properties of a linear space $\mathcal{F}$. Where $\alpha \in \mathbb{R}$, and f, g are complex valued functions.
Keywords: Stability, Levi-Cevita equation, Conine functional equation, semigroup, multiplicative function, bounded function.

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Multiple-term improvements of Jensen's inequality for (p,h)-convex and (p,h)-log convex functions

A. Gourty [1], M. Boumazgour [1] M.A. Ighachane [2] D. Q. Huy [3]

[1] Mathematics and Applications Laboratory Faculty of Sciences of Agadir, Morocco.
[2] Higher School of Education and Training, Chouaib Doukkali University, El Jadida, Morocco.
[3] Department of Mathematics,Tay Nguyen University, Vietnam.

Abstract

In this paper, we present several new multiple-term improvements of Jensen's inequality for (p,h)-convex and (p,h)-log convex functions. As applications of our results, we present new bounds by employing means and Hölder type inequalities for the symmetric norms for τ-measurable operators. We make links between our findings and a number of well-known discoveries in the literature.
Keywords: (p,h)-convex function; (p,h)-log-convex functions, Weak sub-majorization, Jensen's inequality, Scalar means.

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Domination problem of positive operators between Banach lattices

Jawad H'michane * [1]

[1] Ibn Tofail University, Kenitra. – Morocco

In this talke, we address the domination problem for positive operators acting between Banach lattices. Specifically, we seek to determine under what conditions a positive operator T:E→F inherits the same property from its dominating operator S:E→F, meaning T(x)≤S(x) for all elements x in the Banach lattice E. We present a comprehensive analysis of domination in various settings, identifying key properties and frameworks that facilitate such dominance relationships. By leveraging techniques from the theory of Banach lattices, we establish both necessary and sufficient conditions for operator domination. Additionally, we explore the implications of these results in the context of lattice homomorphisms and functional analysis. Our findings extend existing theoretical frameworks and provide new tools for understanding the interplay between positive operators and the lattice structure of Banach spaces.

*Speaker

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FINITE ELEMENT DISCRETIZATION OF THE TWO-FLUID NONSTATIONARY INCOMPRESSIBLE MAGNETOHYDRODYNAMICS EQUATIONS WITH FREE SURFACE

K. Elhadi [1], K. Benmoussa [1] D. Yakoubi [2]

[1] Labsi, Faculty of Sciences, Université Ibn Zohr. Agadir
[2] Léonard de Vinci Pôle Universitaire, Research Center, 92 916 Paris La Défense, France.

Abstract

We propose an implicit finite element discretization of the nonstationary incompressible magnetohydrodynamics equations with variable density, viscosity, and electric conductivity. The discretization satisfies a discrete energy law, and a discrete maximum principle for the positive density, and iterates converge to weak solutions of the problem. Furthermore, we rigorously establish the error estimates for the velocity and magnetic induction unconditionally in the sense that the time step is independent of the spacial mesh size. A simple fixed point scheme, together with an appropriate stopping criterion is proposed, which decouples the computation of density, velocity, and magnetic field.

Keywords: Coupled incompressible magnetohydrodynamic equations, Pressure boundary conditions, Free surface, Divergence-free approximations,Finite element discretization.

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Wolff potential estimates for supersolutions of equations with generalized Orlicz growth

Khlifi Ismail
Faculté des Sciences et Techniques de Settat

Abstract

We establish pointwise estimates for super-solutions of quasilinear elliptic equations with Musielak-Orlicz growth in terms of a Wolff type potential. As a consequence, under the extra assumption, we obtain that the super-solutions satisfy a Harnack inequality and local Hölder continuity.

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A Numerical Scheme of a Fractional Coupled System of Volterra Integro -Differential Equations with the Caputo Fabrizio Fractional Derivative

TADOUMMANT LAHOUCINE [1]

[1] Laboratory LAGA, University ibn tofial, KENITRA, morocco

Abstract

in this presentation we have developed a new computational scheme for solving coupled systems of fractional order Volterra-type integro-differential equation (FVIDE). We construct new operational matrices, which serve as building blocks for converting the FVIDE into a Sylvester-type algebraic structure that is more easily solvable. This computational scheme is based on Legendre polynomials,and we have used Matlab for simulating the proposed scheme.
Keywords: orthogonal polynomials, fractional calculus, numerical analysis, approximation

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EXISTENCE OF SOLUTIONS FOR A SINGULAR DOUBLE PHASE KIRCHHOFF TYPE PROBLEMS INVOLVING THE FRACTIONAL $q(x,.)$-LAPLACIAN OPERATOR

RYM CHAMMEM, ABDELJABBAR GHANMI, AND MAHFOUDH MECHERGUI

Abstract. In this paper, we consider a class of fractional Laplacian problems involving fractional $q_i(x,.)$-Laplacian operators $(i = 1 : 2)$, and a singular nonlinearity. By using variational methods and monotonicity arguments combined with the theory of the generalized Lebesgue Sobolev spaces, we prove the existence of solutions for such problems. An illustrative example is presented to validate the main results of this paper.

1. introduction

This paper is motivated by recent advances in the problems involving the nonlocal fractional $q(x)$-Laplacian operator $(-\Delta)^s_{q(x)}$, which is defined by the Riesz potential as

$$(-\Delta)^s_{q(x,.)}u(x) = p.v. \int_\Omega \frac{|u(x)-u(y)|^{q(x,y)-2}(u(x)-u(y))}{|x-y|^{N+sq(x,y)}}dy, x \in \Omega,$$

where $0 < s < 1$, Ω is a bounded domain in $\mathbf{R}^N$ $(N \geq 2)$, and $p.v.$ is a commonly used abbreviation in the principal value sense, $q \in C(\overline{\Omega} \times \overline{\Omega}, (1, +\infty))$. This differential operator is a generalization of both the fractional q-Laplacian operator $(-\Delta)^s_q$ (which corresponds to $q(x,y) = q =$ constant) and to the $q(x)$-Laplacian operator

$$\Delta_{q(x)}u(x) = div\left(|\nabla|^{q(x)-2}u(x)\right),$$

which corresponds to the local case.
The study of this type of operator has attracted the interest of many authors in different fields such as electrorheological fluids (see [30]), elastic mechanics (see [33]), stationary thermo-rheological viscous flows of non-Newtonian fluids, image processing (See [15]) and several other varieties of physical phenomena.

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Key words and phrases. Fractional $q(x)$-laplacian, Kirchhoff problems, singular equations, variational methods, generalized Sobolev space.

Corresponding author .

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Department of Mathematics, Faculty of Sciences, Tunis El Manar University, 2092 Tunis, Tunisia.
Email address: rym.chemmam@fst.utm.tn

Department of Mathematics, Faculty of Sciences, Tunis El Manar University, 2092 Tunis, Tunisia.
Email address: abdeljabbar.ghanmi@lamsin.rnu.tn

Department of Mathematics, Faculty of Sciences, Tunis El Manar University, 2092 Tunis, Tunisia.
Email address: mecherguimahfoud78@gmail.com

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Non-autonomous Cauchy problem with instantaneous average.

Mohamed Boukdir

[1] Laboratory AMCS, Ibn Zohr University, Ouarzazate, Morocco

Abstract

We are concerned with the non-autonomous evolutionary problem

$$(P)\begin{cases} \dot{u}(t) + A(t)u(t) = f(t), & t \in [0, \eta] \\ u(0) = u_0. \end{cases}$$

Each operator $A(t)$ is associated with a sesquilinear form $\mathfrak{a}(t;.,.)$ on a Hilbert separable space $(H, \|\cdot\|)$. Under the known assumptions on $t \mapsto A(t)$, we prove the L_p-maximal regularity of (P), $p > 1$, using the instantaneous mean function: $t \mapsto \frac{1}{\delta}\int_t^{t+\delta} A(s)ds$. Moreover, for $A(t) \in (V_\gamma, V'_\beta)$ and $u(0) \in V_{\beta'}$ we establish a relationship between β, γ, p and β'.

Keywords: sesquilinear form, generator, semigroup, Non-autonomous problems, L^p-maximal regularity.

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Some new results on the class of b-weakly compact operators and applications.

Youssef Nafnaf [1], Hassan Khabaoui [2], Kamal El Fahri [1]

[1] Faculty of Sciences, Ibnou Zohr University, Agadir, Morocco.
[2] Faculty of sciences, Moulay Ismail University, Meknes, Morocco.

Abstract

We establish some new characterizations of b-weakly compact operators from a Banach lattice into a Banach space. Consequently, we derive some interesting results about the KB-spaces.
Keywords: b-weakly compact operator, o-weakly compact operator, b-semicompact operator, KB-space

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BSDEs with central value reflection

Kaoutar Nasroallah[1], Youssef Ouknine [1 2] [3]

Abstract

In the present paper, we study the well-posedness of a BSDE with jumps and central value reflection. This reflection constraint is applied to the real-valued function obtained from solving the equation $\mathbb{E}(\arctan(Y_t - x)) = 0$ at each time $t \in [0, T]$. The driver of this problem depends on the distribution of the solution term Y and has the general quadratic-exponential structure. The terminal value is considered to be bounded. Through the use of a fixed point argument and BMO martingale theory, we examine the existence and uniqueness of a local solutions to this problem, that will be stitched together to form a global solution defined on the entire time interval $[0, T]$.

Keyword: Central value reflection, BMO martingales, Jumps.

[1]Mathematics Department, Faculty of Sciences Semalalia, Cadi Ayyad University, Morocco. E-mail: kaoutar.nasroallah@ced.uca.ma, ouknine@uca.ac.ma

[2]Africa Business School, Mohammed VI Polytechnic University, Morocco E-mail: youssef.ouknine@um6p.ma,

[3]Hassan II Academy of Sciences and Technologies, Rabat, Morocco.

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On the class of b almost order (L) sets in Banach lattices

Fatima Zah Oughajji
Ibn Tofail University, kenitra, Morocco, fatimazahraoughajji@gmail.com

Abstract: The paper is devoted to such sets of E' on which every b order bounded disjoint sequence $(x_n) \subset E$ converges uniformly to zero. We characterize this class of sets (b almost order (L) sets), consequently, we obtain some new characterizations of b weakly compact operators and KB spaces. Moreover, we present a dual version of Dunford Pettis theorem concerning relatively weakly compact subsets of a KB space, and show that in a Banach lattice whose dual has order continuous norm, every b almost order (L) set is relatively weakly compact. Furthermore, we prove that we can replace disjoint sequences appearing in the definition of b almost order (L) sets with positive weakly null ones, and we claim that a subset $A \subset E'$ is b almost order (L) set if, and only if, every b order bounded positive weakly null sequence converges uniformly to zero on the subset A.

Keywords: b almost order (L) set, b weakly compact operator, KB space.

Impulse controllability for degenerate parabolic equation in non divergence form with drift

Brahim Allal

Departement of mathematics, Faculty of applied Sciences, University Ibn Zohr, Aït-Melloul, Morocco. Email adress : b.allal@uhp.ac.ma

Lahcen Maniar

Department of Mathematics, Faculty of Sciences Semlalia, Laboratory of Mathematics and Populations Dynamics, Cadi Ayyad University, Bd Prince Moulay Abdellah, Marrakesh, Morocco. Email adress : lahcenmaniar@gmail.com

Ilham Ouelddris

Department of Mathematics, Faculty of Sciences Semlalia, Laboratory of Mathematics and Populations Dynamics, Cadi Ayyad University, Bd Prince Moulay Abdellah, Marrakesh, Morocco. Email adress : ouelddris.ilham@gmail.com

Jawad Salhi

Department of Mathematics, FST Errachidia, Moulay Ismail University of Meknes, MAIS Lab., MAMCS Group, Errachidia, Morocco. Email adress : sj.salhi@gmail.com

September 30, 2024

The main goal is to investigate the null approximate impulse controllability for a one-dimensional degenerate heat equation in non divergence form with a drift term.

Let ω be a nonempty open subset of $(0,1)$ and $T>0$ the length of the time-horizon. We consider the following impulsive degenerate system

$$\begin{cases} \partial_t y - x^\alpha y_{xx} - x^\gamma y_x = 0, & \text{in } (0,1)\times(0,T)\backslash\{\tau\}, \\ y(\cdot,\tau) = y\left(\cdot,\tau^-\right) + \mathbb{1}_\omega h(\cdot,\tau), & \text{in } (0,1), \\ y(1,t) = y(0,t) = 0, & \text{on } (0,T), \\ y(x,0) = y_0(x), & \text{on } (0,1), \end{cases} \tag{1}$$

where $\tau \in (0,T)$ is an impulse time, y_0 is the initial data, $y(.,\tau^-)$ represents the left limit of the function y at time τ, $\mathbb{1}_\omega$ is the characteristic function of ω and $h(\cdot,\tau) \in L^2(\omega)$ is the impulse control.

To achieve this result, we derive a logarithmic convexity estimate for the solution of the corresponding homogeneous system. This estimate is obtained using the Carleman commutator technique with a tailored weight function. Specifically, there exists a positive constant $\mathcal{C}$ and $\rho \in (0,1)$ such that the following observation estimate is satisfied

$$\| u(\cdot,T) \|_{\frac{1}{\sigma}} \leq \left(e^{\mathcal{C}\left(1+\frac{1}{T}\right)} \| u(.,T) \|_{L^2_{\frac{1}{\sigma}}(\omega)} \right)^{\rho} \| u(\cdot,0) \|^{1-\rho}_{\frac{1}{\sigma}}, \tag{2}$$

where u is the solution of the following non-impulsive system

$$\begin{cases} \partial_t u - x^\alpha u_{xx} - x^\gamma u_x = 0, & \text{in } Q := (0,1)\times(0,T), \\ u(1,t) = u(0,t) = 0, & \text{on } (0,T), \\ u(x,0) = u_0(x), & \text{on } (0,1). \end{cases} \tag{3}$$

Here, we adopt the following assumptions

1. The control is supported in the right neighborhood of $x = 0$, i.e.,

$$\omega := (0,\kappa), \tag{4}$$

for some constant $\kappa \in (0,1)$.

2. The parameters α and γ are such that :

$$\alpha \in (0,2) \qquad \text{and } \ \gamma > \alpha - 1. \tag{5}$$

keywords: Impulsive approximate controllability, impulse control problems, Carleman commutator, logarithmic convexity, degenerate equation, non divergence form.

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On the subordination principle for completely positive kernels

Rachid GUIRHIR [1], Ahmed FADILI [2]

[1] Laboratory LIMATI, Sultan Moulay Slimane University, Beni Mellal, Morocco
[2] Laboratory LIMATI, Sultan Moulay Slimane University, Beni Mellal, Morocco

Abstract

In this work we study the scalar Volterra integral equation of convolution type using the subordination principle. This allows us to construct a new resolvent from an existing one. We, First, introduce some property of several classes of kernels, then we give a representation of the new resolvent in terms of the existing one.
Keywords: Volterra equations, resolvent families, subordinated resolvent, .

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Daugavet equation for basic elementary opeartors

Sougrati Abdelghani[1], Boumazgour Mohamed[2] and Taki Zakaria [3]

[1] Laboratory of mathematics and applications, Ibn Zohr University, Faculty of sciences, Agadir, Morocco.
[2] Laboratory of mathematics and applications, Ibn Zohr University, Faculty of Economical Sciences, Agadir, Morocco.
[3] Laboratory of mathematics and applications, University Cadi Ayyad, Faculty of sciences-Semlalia Marrakesh, Morocco.

Abstract

Let $\mathcal{B}(\mathcal{H})$ be the algebra of all bounded linear operators on a Hilbert space H. For $A, B \in \mathcal{B}(\mathcal{H})$, define the basic elementary operator $M_{A,B}$ by

$$M_{A,B}(X) = AXB, \ (X \in \mathcal{B}(\mathcal{H})).$$

If J is a symmetric norm ideal of $\mathcal{B}(\mathcal{H})$, we denote $M_{J,A,B}$ the restriction of $M_{A,B}$ to J. In this paper, the generalized Daugavet equation

$$\|I + M_{J,A,B} + M_{J,C,D}\| = 1 + \|A\|\|B\| + \|C\|\|D\|$$

is studied. In particular, we give necessary and sufficient conditions on positive operators A and B to hold this equality in the special case when J is the Hilbert-Schmidt ideal of operators in $\mathcal{B}(\mathcal{H})$.

Keywords: Norm;elementary operator:norm ideals; Daugavet equation; Numerical range.

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About the numerical range of the basic elementary operator in semi-Hilbertian spaces

ZAKARIA TAKI[1]

[1] ERAMA, Cadi Ayyad University, Marrakesh, Morocco

Abstract

Let A be a positive bounded operator acting on a complex Hilbert space $\mathcal{H}$. For two bounded operators B and C on $\mathcal{H}$, we denote by $M_{2,B,C}$ the basic elementary operator on the class of Hilbert-Schmidt operators $\mathcal{C}_2(\mathcal{H})$, i.e., $M_{2,B,C}(X) = BXC$ for all $X \in \mathcal{C}_2(\mathcal{H})$. In this talk, we investigate the $\mathbb{A}$-numerical range $W_{\mathbb{A}}\left(M_{2,B,(C^{\sharp_A})^*}\right)$, where $\mathbb{A} = M_{2,A,A}$, $C^{\sharp_A}$ is the reduced solution of the equation $AX = C^*A$ and C^* is the adjoint of C. Within this framework, we show, under some A-hyponormality conditions, the following two equality: $\overline{W_{\mathbb{A}}\left(M_{2,B,(C^{\sharp_A})^*}\right)} = \mathrm{co}\left(\overline{W_A(B)} \cdot \overline{W_A(C)}\right)$, where $W^A(\cdot)$ and $\mathrm{co}(\cdot)$ denote respectively the A-numerical range and the convex hull. Here, the bar stands for the closure. As a result of this equality, we establish that

$$\left\|M_{2,B,(C^{\sharp_A})^*}\right\|_{\mathbb{A}} = \|B\|_A\|C\|_A,$$

where $\|\cdot\|_{\mathbb{A}}$ and $\|\cdot\|_A$ designate the $\mathbb{A}$-operator seminorm and the A-operator seminorm, respectively.
Keywords: Semi-inner product; positive operator; hyponormal operator; numerical range; maximal numerical range; elementary operators.

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Robust methods for improving the approximate solution of a discontinuous elliptic problem

Hatim TAYEQ[1], Anouar EL HARRAK [1] and Amal BERGAM[1]

[1] Laboratory Simulation et Modélisation Mathématique, Analyse des données, Chimie des substances naturelles , Polydisciplinary Faculty of Larache, Abdelmalek Essaadi University, Larache, Morocco

Abstract

When dealing with concrete problems, the studied phenomena are often discontinuous, and afterwards their study must satisfy this condition which is difficult to treat, that is why our approach by a posteriori analysis of the error will give a powerful tool for the study of discontinuous problems, and especially to make good use of available computer resources.

In this work, we develop a family of indicators based on a posteriori error analysis for the Poisson equation using a finite volume method derived of discontinuous approximation. The discretization is tacked in a nonconforming piecewise linear spaces. The calculated indicators are formed by the residual of strong equation, the jumps of both the discrete solution and its normal derivative across the edges since we work with discontinuous functions.

Our techniques are validated by numerical simulations to show the effectiveness of the developed indicators by comparing the CPU time and nodes number before and after the use of our mesh self-adaptive algorithm.

Keywords: Finite volume method, A posteriori error estimation, Self adaptive mesh refinement, Discontinuous problems, Upper bound of the error, Lower bound of the error.

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Insert here the title of the abstract

Abderrahim Bahssini [1], Nouh Izem [1] Mohammed Seaid [2], M Shadi Mohamed [3]

[1] Laboratory of Mathematical Engineering and computing, Faculty of Science, Ibn Zohr University Agadir, Morocco.
[2] School of Engineering and Computing Sciences, University of Durham, UK.
[3] School of Energy, Geoscience, Infrastructure and Society, Heriot-Watt University, Edinburgh EH14 4AS, UK.

Abstract

In this work, nonlinear heterogeneous anisotropic transient heat diffusion problems is studied. This problem can be simplified as where the diffusivity changes with the direction inside the medium and depends on the temperature. The numerical modeling and problem-solving are the main topics of this essay. It can be difficult to handle this problem using the conventional finite element method. To deal with this challenge, we propose an enriched finite element formulation where the basis functions are augmented with a summation of exponential functions inspired from the fundamental solution. First, the initial-value problem is integrated in time using a semi-implicit scheme and the semi-discrete problem is then integrated in space using the enriched finite elements. We demonstrate through several numerical examples that the proposed approach can solve accurately nonlinear anisotropic transient diffusion problems on coarse meshes and with much fewer degrees of freedom compared to the standard finite element method. Thus, a significant reduction in the computational requirements is achieved without compromising on the solution accuracy..
Keywords:Heterogeneous media. Anisotropic diffusion. Partition of unity method, Finite element method, Nonlinear problem.

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Artificial Viscosity Stabilization of Meshless Methods for One-Dimensional Shallow Water in Channels

Mariam Ijerch [1], Mohamed Sadik [1] Abdelaziz Beljadid [2]

[1] Engineering of Sciences Laboratory, Ibn Zohr University, Morocco
[2] Department of Civil Engineering, University of Ottawa, Canada

Abstract

The purpose of this work is to present an efficient localized meshless methods based on radial basis functions to accurately analyze the one-dimensional shallow water equations (SWEs) in open channels. It is a hyperbolic system of first-order nonlinear partial differential equations, commonly utilized to model various phenomena in hydraulic and ocean engineering. Due to their classification as advection equations, they allow for discontinuous solutions, often characterized by shock behavior in simulations. Therefore, the development of an efficient and accurate numerical model for analyzing the SWEs holds critical importance in scientific research. In order to remove the non-physical oscillations near discontinuities, a technique involving artificial viscosity (hyperviscosity) is integrated with the local meshless methods for spatial discretization of the SWEs, while temporal discretization is achieved using the fourth-order Runge-Kutta method. A series of experiments has been conducted to evaluate the effectiveness and accuracy of the suggested methods. These experiments included examining flow at a steady state with and without friction, as well as studying the dam-break scenario on a wet bed. The results compared with analytical solutions, demonstrate that the artificial viscosity technique combined with the proposed methods proficiently capture shocks and effectively manage discontinuous flow by introducing an appropriate viscosity coefficient to the equations. Overall, the results are satisfactory and show good agreement.
Keywords: Shallow water equations, Open channel, Radial basis function partition of unity method (RBF-PUM), Radial basis function finite difference (RBF-FD) method, QR factorization.

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SIRWLS: A New Approach for Dimension Reduction and Variable Selection in High-Dimensional Data

Nadia ASRIR [1], Abdellah Mkhadri [1]

[1] Laboratory Ibn Al Banna of applied mathematics , FSSM , Cadi Ayyad University

Abstract

In high-dimensional data analysis, the limitations of traditional multiple linear regression (MLR) become apparent, especially when exploring complex, nonlinear structures. Sliced Inverse Regression (SIR), introduced in 1991, has emerged as a robust alternative for both dimension reduction and variable selection, offering significant advantages in capturing nonlinear relationships. Over the years, enhancements to the original SIR methodology have expanded its applicability and effectiveness, particularly in addressing high-dimensional regression challenges. This presentation reviews the evolution of SIR, from its foundational principles to recent advances, such as regularized and weighted variants, which improve prediction accuracy and computational efficiency. We highlight how SIR methodologies maintain key features of interpretability and model robustness, positioning them as compelling alternatives for nonlinear modeling and variable selection in complex data settings.

Keywords: Regression analysis, reduction dimension , variable selection, sliced inverse regression.

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Comparison of parameter estimation using the Extended Kalman Filter and Ensemble Kalman Filter for a stochastic SIR model of the Covid-19 epidemic

Youssef Belgraoui [1], Aziza Belmaati[1], Mustapha Kabil [1]

[1] LMCSA Laboratory, Faculty of Sciences and Technology, Hassan II University, Mohammedia, Morocco

Abstract

The current global health crisis, caused by the novel coronavirus Covid-19, represents the most significant challenge of the 21st century. Since its emergence in Wuhan in December 2019, it has had a daily impact on the country's healthcare systems. In Morocco, the first case of local transmission was identified on 3rd March 2020 [8]. However, the majority of mathematical approaches used to describe the evolution of this epidemic are based on deterministic models that fail to capture the real complexity of its spread. Stochastic models are considered one of the effective models for understanding the spread of infectious diseases and predicting them. The stochastic SIR epidemic model, which is based on the concepts of susceptible, infected and recovered individuals, was employed to model the Covid-19 epidemic. This model, as presented in the article by Semlali et al [4], is following:

$$\begin{cases} dS_t = [A + b - \mu S_t - \frac{\beta S_t I_t}{1+\alpha_1 S_t+\alpha_2 I_t} - \nu S_t]dt + \sigma_1 S_t dB_{1,t}, \\ dI_t = [c + \frac{\beta S_t I_t}{1+\alpha_1 S_t+\alpha_2 I_t} - (\mu + \gamma + r)I_t]dt + \sigma_2 I_t dB_{2,t}, \\ dR_t = [rI_t + \nu S_t - \mu R_t]dt + \sigma_3 R_t dB_{3,t}. \end{cases} \tag{1}$$

where S_t, I_t and R_t are the numbers of susceptible, infected, and recovered individuals at time t, respectively. The terms $B_{i,t}$ for $i = 1, 2, 3$ are standard independent Brownian motions, and the parameters σ_i denote the intensities of the perturbations for $i = 1, 2, 3$. In model (1), all the parameters are assumed to be positive, except for c, which may be negative. A detailed description of these parameters can be found in Table 1.

Since the first two equations of the system (1) are independent of R_t, the model (1) can be rewritten following:

$$\begin{cases} dS_t = [A + b - \mu S_t - \frac{\beta S_t I_t}{1+\alpha_1 S_t+\alpha_2 I_t} - \nu S_t]dt + \sigma_1 S_t dB_{1,t}, \\ dI_t = [c + \frac{\beta S_t I_t}{1+\alpha_1 S_t+\alpha_2 I_t} - (\mu + \gamma + r)I_t]dt + \sigma_2 I_t dB_{2,t}. \end{cases} \tag{2}$$

This model consists of nonlinear stochastic differential equations. The numerical simulation of these equations is carried out using the Euler-Maruyama scheme. In this study, we estimated two parameters, β and γ, along with the transmission states of COVID-19 spread by developing an Extended Kalman Filter (EKF) and an Ensemble Kalman Filter (EnKF) based on the stochastic SIR epidemic

Parameters	Biological explanations
A	The recruitment rate of susceptible individuals
b	The rate of immigration to susceptible individuals
c	The rate of immigration of infected individuals
β	The rate of infection
γ	The death rate due to Covid-19
μ	The natural death rate
ν	The rate of vaccination
r	The recovery rate for infected individuals
α_1 and α_2	Assess the effects of saturation on susceptible and infected individuals

Table 1: Explanation of stochastic SIR model parameters.

model [1, 2, 3, 5, 6, 7]. Table 2 presents the estimation results for the two parameters, β and γ, along with the transmission states at time t_n for different values of α_1 and α_2. These estimates were obtained using two methods: the EKF and the EnKF.

α_1	α_2	Method	β	γ	S_n	I_n
0.0009	0.09	Simulation	0.2	0.1	64.1532	1159.9216
		EKF	0.3203	0.1002	41.2595	1159.9222
		EnKF	0.2125	0.1125	61.1603	1159.9224
0.09	0.09	Simulation	0.2	0.1	67.7066	1156.7812
		EKF	0.2173	0.0984	63.0525	1156.7818
		EnKF	0.2023	0.1090	67.5947	1156.7820
0.1	0.1	Simulation	0.2	0.1	75.2580	1150.1352
		EKF	0.2160	0.0985	70.4997	1150.1359
		EnKF	0.2008	0.1092	75.6234	1150.1361
0.2	0.2	Simulation	0.2	0.1	153.8234	1080.3615
		EKF	0.2070	0.0995	148.0678	1080.3622
		EnKF	0.1994	0.1108	152.0844	1080.3624
0.5	0.5	Simulation	0.2	0.1	405.0203	854.9236
		EKF	0.1938	0.0981	406.3612	854.9244
		EnKF	0.1987	0.1119	385.7146	854.9246
1	1	Simulation	0.2	0.1	835.0895	467.8729
		EKF	0.2129	0.1083	797.2817	467.8743
		EnKF	0.1677	0.0823	849.8017	467.8745

Table 2: Parameter estimates and states using EKF and EnKF for different values of α_1 and α_2

A comparative analysis of the performance showed that the EnKF provides accurate estimates when the parameters α_1 and α_2 approach 0, whereas the EKF performs less effectively. Conversely, when α_1 and α_2 approach 1, the EKF outperforms the EnKF in terms of accuracy. These results highlight the efficiency of the EKF for weakly nonlinear systems, while the EnKF is better suited for large-scale and strongly nonlinear systems. This analysis enhances our understanding of the impact of variations in the coefficients α_1 and α_2 on the performance of the filters.

Keywords: Stochastic SIR epidemic model, Extended Kalman Filter, Ensemble Kalman Filter, Estimation parameters.

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Optimal rank-based procedures for testing non linear regression model

Dounia BOURZIK [1], Aziz LMAKRI[2], Amal MELLOUK[3] and Abdelhadi AKHARIF [1]

[1] LMA, FSTT, Abdelmalek Essaadi University, Tetouan, Morocco
[2] AICSE laboratory, ENSAM, Hassan II University, Casablanca, Morocco
[3] Regional Center for Education and Training Trades, Tangier, Morocco

Abstract

This paper aims to detect a non-linear regression model by proposing parametric and nonparametric tests that are locally and asymptotically optimal. These tests are specifically designed to determine if the null hypothesis of a traditional linear regression model can be rejected in favor of a non-linear regression model, using the Local Asymptotic Normality (LAN) property. The effectiveness of the proposed tests is confirmed through numerical simulations, which demonstrate that the van der Waerden version of rank-based tests consistently performs better than other methods.
Keywords: Local asymptotic normality, Gaussian tests, Rank tests.

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Parameter estimate of stochastical SIR model using EM algorithm

Aziza Belmaati[1], Youssef Belgraoui [1]

[1] LMCSA Laboratory, Faculty of Sciences and Technology, Hassan II University, Mohammedia, Morocco

Abstract

Mathematical models that describe the dynamic behavior of infectious diseases are widely recognized as essential tools for understanding both the diseases themselves and their transmission mechanisms. Herein, parameter estimation is crucial in the recognition of epidemic models as it enables accurate identification and characterization of key factors driving the spread of infectious diseases. By estimating parameters such as transmission rates, recovery rates, and incubation periods, these models can more effectively predict disease dynamics, inform public health interventions, and guide decision-making in controlling outbreaks.

The Expectation-Maximization (EM) algorithm is a powerful iterative method for parameter estimation, especially when dealing with incomplete or hidden data, which makes it particularly useful in stochastic epidemic models where we may not have full information on all transmission events. Our target is to apply the EM algorithm to estimate the parameters of an SIR model described in [1] that having a normal stationary distribution. Noting by β the average incidence rate without taking the infected individuals into consideration, $a > 0$ the saturationconstant, and $\beta_c > 0$ the average reduced contact rate due to the presence of the infected individuals. Also, Λ denotes the intrinsic recruitment rate, μ and α are the natural death rate and additional disease-induced rate, respectively. γ is the recovered rate of infected individuals.

In the expectation step (E-step) of EM algorithm, we compute the expected value of the complete-data log-likelihood, given the observed data, the current parameter estimates and the stationary distribution wich is normaly distributed as proved in [1]. Next, in the maximisation step (M-step), we maximize the expected log-likelihood obtained from the E-step with respect to the parameters and then, Repeat the E-step and M-step iteratively until the estimates of model parameters converge, i.e., the changes between successive iterations are below a pre-defined threshold.

Keywords: Stochastic SIR epidemic model, EM algorithm, Stationary distribution, Estimation parameters.

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Credit Risk Analysis: A Machine Learning Approach for Moroccan Companies

Aicha Echtouki [1], Hicham El Bouanani [1]

[1] Laboratory of Applied Modeling in Economics and Management, University HASSAN II, Casablanca, Morocco

Abstract

Credit risk assessment is a critical challenge in modern financial transactions, as the ability to accurately identify high-risk borrowers is essential for a bank's profitability and stability. Traditionally, assessing credit risk involved significant manual effort, which was both time-consuming and labor-intensive. While machine learning models have improved the accuracy and reliability of credit risk prediction, the pursuit of more powerful and efficient AI models remains ongoing in the financial industry.

This study focuses on identifying the factors influencing banks' credit rejection decisions, aiming to enhance the understanding of credit approval mechanisms. Credit refusal serves as a risk mitigation strategy adopted by banks to avoid lending to clients with a high likelihood of default. With significant regulatory changes expected to impact company-bank relationships, enhancing the predictive accuracy of credit risk models is crucial.

We leveraged a dataset of 4009 Moroccan companies, encompassing both healthy businesses and those in financial distress, to explore and compare the effectiveness of eight machine learning models: Logistic Regression (LR), Linear Discriminant Analysis (LDA), K-Nearest Neighbors (KNN), Decision Trees (DT), Random Forest (RF), XGBoost, Support Vector Machines (SVM), and Neural Networks (NN). To address class imbalance, we utilized the SMOTE (Synthetic Minority Over-sampling Technique) method to improve model performance.

By applying these models alongside feature selection techniques, we identified key factors influencing credit rejection decisions and enhanced the prediction of credit default risk. Our findings demonstrate that models such as XGBoost, when integrated with SMOTE, offer robust tools for banks to accurately assess the creditworthiness of companies, particularly SMEs, in the Moroccan context.

Keywords: Credit Risk Assessment, Machine Learning, Financial Transactions, Credit Rejection, SMOTE, XGBoost.

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Volatility estimation of Gaussian mean-reverting Ornstein-Uhlenbeck process of the second kind

Fatima-Ezzahra Farah [1], Rachid Belfadli[2] Khalifa Es-Sebaiy[1,2]

[1] Faculty of sciences, Ibn Zohr University, Agadir, Morocco
[2] Faculty of Sciences and Techniques-Marrakesh, Cadi Ayyad University, Marrakesh, Morocco.
[1,2] Faculty of Science, Kuwait University, Kuwait.

Abstract

We study the asymptotic behavior of the realised power variation of the stochastic integral $Z_t = \int_0^t u_s dY^{(1)}_{s,G}$, where u is a process with finite q-variation, $q < 1/(1-\alpha)$ and $= \int_0^t e^{-s} dG_{a(s)}$ with $a(t) = \alpha e^{\frac{t}{\alpha}}$, and $\{G_t,\, t \geq 0\}$ is a Gaussian process. In order to establish results on convergence in probability and in law stably for the realised power variation of Z, we impose some technical conditions on the process G, which are satisfied, for instance, if G is a fractional Brownian motion with Hurst parameter $\alpha \in (0,1)$, G is a subfractional Brownian motion with Hurst parameter $\alpha \in (0, 1/2)$ or G is a bifractional Brownian motion with Hurst parameters $(\alpha, K) \in (0, 1/2) \times (0, 1]$. We use these results to construct an estimator for the integrated volatility parameter of Ornstein-Uhlenbeck processes driven by $Y^{(1)}_G$.

Keywords: Gaussian process, Power variation, Stable convergence, Volatility.

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Agent-Based Approaches in Tourism Studies Insights, Applications, and Future Directions

Smahane JEBRAOUI [1], Bezza HAFIDI [1]

[1] IMI Laboratory, Ibnou Zohr University, Agadir, Morocco

Abstract

Agent-Based Modeling is a versatile and powerful tool with a wide range of applications across diverse domains. ABMs are particularly valuable for simulating complex systems characterized by interactions between autonomous agents. ABM allows us to model a wide spectrum of systems, from those in the distant past to those that have yet to emerge in the future. It is widely applied in fields such as social sciences, economics, supply chains, ecology, agriculture, Crime, epidemiology, tourism, urban, and more. Its flexibility and adaptability make it a powerful method for better understanding complex and dynamic systems and addressing real-world challenges [1].

Agent-Based Modeling (ABM) has emerged as a powerful tool for understanding the complex dynamics of tourism systems. By simulating the behavior of individual agents and their interactions within a given environment, ABM offers researchers and practitioners a unique perspective on how tourism destinations evolve, how tourists make decisions, and how various factors influence the sustainability and resilience of tourism systems [2]. To explore the intersection of agent-based modeling (ABM) and tourism, we conduct a bibliometric analysis to map the landscape of ABM research in tourism.

This analysis aims to identify key trends, themes, and patterns in the literature, offering insights into the evolution and current state of ABM in tourism research. The bibliometric analysis method is used to understand the research landscape and identify future directions. This method employs co-occurrence and co-citation analysis to highlight key authors, journals, institutions, and countries within the field. VOSviewer software [3] is used for its benefits in providing clear and user-friendly network visualizations.

The Web of Science database is chosen for this bibliometric analysis because of its comprehensive coverage of scholarly literature across diverse disciplines, including tourism research.

The search strategy was developed based on relevant keywords and search terms related to agent-based modeling and tourism. Keywords such as "agent-based modeling," "ABM," "tourism," "travel behavior," and "destination choice" were used to identify relevant literature. The search strategy was designed to capture a broad range of publications related to ABM in tourism, while also minimizing the risk of missing relevant studies.

To restrict and make the search relevant, we proceeded by searching for terms only in the titles of the articles, the Abstracts as well as in the keywords. This initial search was broad and intended to

capture all papers on tourism and ABM. Publications were included if they met the following criteria: (1) published between 2004 and 2023, (2) written in English, (3) peer-reviewed research articles or conference papers, and (4) focused on the application of agent-based modeling in the context of tourism. Studies that did not meet these criteria were excluded from the analysis.
The analysis revealed several important findings:

- **Geographic Concentration**: China, the USA, and Canada emerged as the leading countries in the field of "Tourism and ABM," exhibiting well-established collaborative networks. In contrast, the Moroccan context remains largely undeveloped and unexplored in this area, indicating potential opportunities for future research and collaboration.

- **Author Collaboration Clusters**: The analysis identified five distinct clusters representing groups of authors based on their collaborative relationships. Notably, the largest cluster consists of eight authors, indicating a closely interconnected group that collaborates frequently, representing a significant research community within the field. This highlights the role of these authors as key contributors and influencers in ABM tourism research.

- **Emerging Research Themes**: Recent studies increasingly focus on critical topics such as climate change, sustainable tourism, tourist flows, social networks, and the impact of social media. These themes reflect current research priorities and underscore their significance in exploring trends within the tourism sector. Researchers are actively investigating the effects of climate change on tourism practices, the promotion of sustainable tourism initiatives, the dynamics of tourist flows and their implications for destination management, and the role of social networks and social media in shaping tourist behaviors.

Agent-Based Modeling stands out as a powerful and flexible tool for understanding complex systems, particularly within the realm of tourism research. By simulating interactions among agents, ABM provides valuable insights into the dynamics of tourism destinations and the behavior of tourists, while also addressing pressing challenges related to sustainability and resilience. The bibliometric analysis conducted offers a comprehensive overview of the current state of ABM research in tourism, identifying key trends, influential authors, and emerging themes.

Keywords: agent-based modeling, tourism, bibliometric analysis.

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Deep Learning-based Approach for Resource's Management in Cloud Environments using Multi-Objective Optimization

Raja AIT EL MOUDEN & Ahmed ASIMI
Departments of Mathematics and computer sciences, Ibnou Zohr University
Laboratory of Computing Systems & Vision (LabSiV)
Team of Security, Cryptology, Access Control and Modeling (SCCAM)
B. P. 8106, City Dakhla, Agadir, Morocco
e-mail :*raja.aitelmouden@edu.uiz.ac.ma/asimiahmed@uiz.ac.ma*

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Abstract

Resource's effective management within Cloud environments is a mandatory in order to ensure data availability in Cloud, as cloud industry is getting bigger exponentially, it is crucial as it necessitates a real-time management based on user's needs that vary from a single user to another, which makes virtual machines allocation more dynamic and complicated.

In this paper we aim to solve resource's management issue, as one of the big challenges in cloud environments, by proposing a deep learning-based approach for managing resources within the cloud environments. We use a specific scheduling policy to deal with this issue, namely, load balancing, as it plays a significant role to perform task management in the cloud. For this purpose, we propose a multi-objective optimization-based approach for rebalance the resource's loads over the cloud environment, namely, cloud data center. After modeling the cloud data center with a matrix as initialization phase. The pre-treatment phase is dedicated for balancing the load of virtual machines between host machines by using a new emigration trick proposed by two algorithms for segmenting the cloud system matrix, and balancing it according to an arithmetic constraint, respectively. The treatment phase is the final phase, it is dedicated for proposing a new multi-objective model to that seeks to rebalance the output matrix of the previous phase, in order to obtain the rebalanced matrix that models the cloud environment in its final state after the rebalancing process.

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Anomaly Detection in IoT Using Hybrid Deep Learning Models

Arjdal Rguibi [1,2], Asimi Younes[1,3] Asimi Ahmed [1,2] Oumous Lahcen[1,2]

[1] LABSIV LABORATORY, SCCAM TEAM, IBN ZOHR UNIVERSITY, AGADIR, MOROCCO.
[2] FACULTY OF SCIENCES, IBN ZOHR UNIVERSITY, AGADIR,MOROCCO.
[3] TECHNOLOGY HIGH SCHOOL GUELMIM, IBN ZOHR UNIVERSITY, AGADIR,MOROCCO.

Abstract

As the Internet of Things (IoT) continues to expand, it's generating vast amounts of data from interconnected devices. This rapid growth has also exposed these systems to new vulnerabilities, making security a top concern. With increasingly sophisticated attacks, ensuring the integrity of IoT networks demands smarter solutions for detecting irregularities in real-time. In response, we propose a hybrid deep learning approach that blends Convolutional Neural Networks (CNNs) with Long Short-Term Memory (LSTM) networks. This combination is designed to pick up on both spatial and temporal patterns within the data, allowing for more precise anomaly detection. By carefully refining how features are processed and optimizing the model's structure, our method strikes a balance between accuracy and efficiency. This framework provides a scalable way to safeguard IoT systems, keeping them resilient against evolving threats.

Keywords: Internet of Things (IoT), Anomaly detection, Deep learning, IoT Security.

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A Novel Framework for VIX Option Pricing: Overcoming Data Limitations with Deep Learning

Karim BOUNJA[1], Abdeljalil SAKAT [1]

[1] LAMSAD, ENSA Berrechid, Université Hassan 1er, Settat, Morocco

In the financial market, VIX options are a key tool for hedging against volatility and downturns, with a daily trading notional value exceeding 100 billion dollars. The VIX index, often referred to as the "fear gauge," measures market expectations of near-term volatility based on options prices of the SP 500, reflecting investor sentiment and uncertainty. Known for its inherent volatility, the VIX can experience rapid fluctuations, particularly during periods of economic instability or market stress, making it a crucial indicator for risk management strategies.
Accurate pricing of these options is vital, yet it remains difficult due to the scarcity and noise of market data, particularly during extreme events [1][2][3]. Conventional pricing models, such as the Black-Scholes model, often fail under these conditions, resulting in less reliable predictions [4][5].
This study aims to improve VIX option pricing by developing a hybrid deep learning approach that can handle both rare and noisy data. By generating synthetic data and applying noise reduction techniques, the model seeks to enhance pricing accuracy and robustness under volatile market conditions.
We employed Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) to simulate additional data that reflect a range of market scenarios, particularly rare, high-volatility events. Additionally, denoising filters were applied during data preprocessing to refine the inputs and reduce model overfitting on noisy data.
We anticipate that the hybrid model will significantly improve pricing accuracy and generalization in comparison to traditional methods. We expect that the integration of synthetic data will enable the model to perform better under extreme market conditions, and that the application of denoising techniques will enhance the model's reliability in predicting option prices.
By addressing data scarcity and noise, this research contributes a robust approach to VIX option pricing, offering potential benefits for risk management and financial stability. These findings suggest that machine learning techniques like GANs and VAEs are promising for enhancing the accuracy and resilience of financial models in challenging market conditions.

Keywords: Option pricing, Machine learning, Times series, Volatility Forecasting, Risk Management

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Trigger-Service: A Novel E-Health Blockchain Architecture Integrating Supervised Learning Techniques

Soumia Benkou [1], Ahmed asimi [2]

[1] Laboratory LabSiv, Ibn Zouhr University, Agadir, Morocco
[2] Laboratory LabSiv, Ibn Zouhr University, Agadir, Morocco

Abstract

Electronic Health (E-Health) systems have revolutionized the way healthcare is delivered by adopting digital technologies to improve patient care, optimize operations, preserve the integrity of patient data, and ultimately improve health outcomes. Adopting Blockchain technology in healthcare introduces improved traceability, privacy, and decentralized management of medical data. Also, improving treatment and decisions designed by IA under the control of professionals ensures a healthy life for the patient. Ensuring data privacy and integrity of encrypted data via FHE, optimizes patient care and outcomes. As a combination of blockchain, supervised classification methods, and fully homomorphic encryption, trigger-based intelligent healthcare architecture is adapted to diagnose, treat, track patient status, and provide feedback on their recovery through elegant personalized services for each patient. Trigger architecture addresses various obstacles in healthcare management by providing greater responsiveness, automation of procedures and enhanced security. It addresses the concern of the slowness of conventional mechanisms that struggle to respond promptly to changes in patient health. Adapting this architecture in our contribution has the ability to automatically trigger measures such as sending alerts to healthcare professionals or rejecting diagnoses through real-time observation and data analysis. This ensures faster and more efficient intervention. Furthermore, by incorporating technologies such as Blockchain and Fully Homomorphic Encryption (FHE), it ensures traceability and protection of information, while allowing private processing of sensitive data. This protocol improves healthcare management, improves the quality of medical decisions and reduces the risk of errors, thus contributing to better patient care. Our contribution consists of two phases: the pre-processing phase and the treatment and follow-up phase, which implement supervised classification methods via triggers. In the pre-processing phase, the patient registers and the Blockchain is initialized. During the treatment and follow-up phase, the symptoms validated by the patients are verified, acting as triggers for the system to determine the appropriate service for their condition. Then, physicians monitor the patient's condition, updating the information as if they were updating the block. Token rewards for physicians strengthen the incentive to provide quality care. This innovative approach combines the security and immutability of the blockchain, triggers, and token rewards, providing a robust solution for efficient and decentralized healthcare management in a intelligent framework as Web 5.0.

keywords: Blockchain, Trigger, E-health, Supervised, Classification.

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Use of advanced transformer neural networks for honey quality control via thermal image analysis

Boulbarj Ilias [1], Douzi Samira [2] Douzi Hassan [1]

[1] IRF-SIC Laboratory, Ibn Zohr University's -Agadir, Morocco
[2] Faculty of Medicine and Pharmacy, Mohammed V University in Rabat, Morocco

Abstract

This paper presents an innovative methodology to identify cases of honey adulteration, using the Vision Transformer (ViT)[1] model and thermal imaging techniques to assess and classify honey samples. The central problem of this research is that honey adulteration, a popular natural food product, poses significant health and economic risks. Conventional methods for detecting honey adulteration often suffer from long turnaround times and limited sensitivity.

To overcome these limitations, this study focuses on thermal imaging, which has the unique advantage of identifying temperature variations within honey samples. These thermal fluctuations can indicate differences in sugar composition, moisture levels, and the presence of adulterants. A comprehensive database was constructed, comprising thermal images of 9 unadulterated honey samples and 45 samples adulterated at various levels, ranging from 1% to 30%. These data were used to train and refine the proposed model.

The originality of this contribution lies in the application of thermal image analysis via Transformers[2], demonstrating its effectiveness in rapidly and accurately detecting cases of honey adulteration. The results of this study provide strong evidence for the ability of this method to improve food safety and protect consumers from fraudulent practices.

Keywords: Honey adulteration, Transformers, attention mechanism, Thermal imaging, Quality control, human health.

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Arbres de décision et forêts aléatoires : Une étude comparative

EL AOUNG Ahmed [1], HACHIMI Mohamed [1], AZHARI Mourad [2]

[1] Laboratoire des Siences de l'Ingénieur, Université Ibn Zohr, Agadir, Maroc
[2] Laboratoire d'Analyse Mathématique et Applications, Université Mohamed V, Rabat, Maroc

Résumé

L'objectif de cette étude est de montrer la différence entre les arbres de décision et les forêts aléatoires en tant que des algorithmes de machine learning supervisé.
L'arbre de décision est une méthode utilisée pour la régression ou pour la classification, cette méthode est non-paramétrique, non linéaire, acyclique et connexe, ce qui permet de visualiser graphiquement des solutions possibles.
La forêt aléatoire est une méthode ensembliste qui se base sur une stratégie aléatoire, elle est souvent utilisée dans le cas d'un nombre de variables explicatives important. Cet algorithme est rapide à entraîner, puisqu'il est parallélisable, robuste et implémentable dans la plupart des langages et logiciels statistiques.
Dans la partie pratique, on a entraîné ces deux algorithmes sur des données réelles téléchargées via Kaggle pour confirmer les résultats théoriques.

Keywords : machine learning, méthode ensembliste, arbre de décision, forêt aléatoire.

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Enhancing Document Management with Deep Embeddings: A Machine Learning Approach

EL BAZZI Mohamed Salim[1], TAHA Anass[2], AIT IDDER Abdelouahed[2]

[1] Image and Pattern Recognition - Intelligent and Communicating Systems Laboratory, Ibn Zohr University, Faculty of Sciences, Agadir, Morocco.

[2] System Computer Engineering, Mathematics and Applications Laboratory, Ibn Zohr university, Polydisciplinary Faculty, Taroudant, Morocco.

Abstract

Natural language processing (NLP) benefits today from many advances in machine learning, in particular thanks to dimensionality reduction and vectorization models. In this study, we propose a combined approach using mathematical dimensionality reduction methods and vector representation techniques to solve document classification and clustering problems. By exploiting methods such as principal component analysis (PCA) (Jolliffe and Cadima, 2016), which offer a solid mathematical basis to reduce data complexity while preserving essential information, our approach focuses on performance and accuracy in text classification. To capture high-quality textual representations, we use classical vectorization techniques such as TF-IDF and the bag-of-words method (Manning and al., 2008), which transform textual documents into vectors, facilitating the application of clustering methods. In order to integrate a deep semantic dimension, we also use embeddings such as Word2Vec (Mikolov and al., 2013) and GloVe (Pennington et al., 2014), which allow to model the semantics of words in dense vector spaces and thus capture conceptual similarities between documents (Devlin and al., 2019). Our approach relies on clustering algorithms that benefit from dimensionality reduction techniques to reduce the computational cost while maintaining rich semantic relationships between documents. This hybrid model of vectorization and dimensionality reduction has practical applications in document classification, and our results demonstrate that this method outperforms traditional approaches in high-dimensional contexts, particularly in big data environments (Aggarwal and Zhai, 2012). The system has been tested and evaluated with accuracy and performance metrics optimized for machine answering tasks. This system uses advanced NLP architectures such as BERT, ALBERT and RoBERTa, fine-tuned on a corpus of 26,000 IT incident tickets to enable information extraction and classification. The scores obtained, with an Exact Match rate of 83.7%, a BLEU score of 0.837 and an F1-Score of 0.7129, show a high capacity of the model to handle complex classification and information extraction tasks in realistic conditions. These results attest to the effectiveness of BERT optimization for automatic response systems and the efficient use of Word2Vec for vectorization and contextual search. This project presents an innovative solution for document management, combining sophisticated NLP models and robust mathematical algorithms.

These results highlight the effectiveness of machine learning techniques and the relevance of vector models in the field of document management. This research opens perspectives for advanced applications in various organizational contexts and lays solid foundations for future research in the optimization of intelligent systems dedicated to textual data.

Keywords: Text Classification, Clustering Algorithms, Principal Component Analysis (PCA), Word Embeddings, Information Extraction.

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Detecting weak and strong depression on social media

A. El Ghandour [1], I. Akharraz [1]

[1] Mathematical and Informatics Engineering Laboratory, Ibnou Zohr University, Agadir, Morocco

Abstract

Depression is a prevalent mental health condition affecting over 970 million people worldwide, and significantly impacts individuals' lives. Early detection and intervention are crucial for improving outcomes. With the profound expansion of social media and internet users, innovative approaches to mental health care have become increasingly necessary to detect and classify depression content at scale. Previous research has largely approached the detection of depression on social media as a binary task. However, the varied nature of depression means that this is often inappropriate for effectively monitoring social media. Drawing on in-depth conceptual work, we build a multi-class classifier that distinguishes between non-depression, weak depression, and strong depression content. A dataset of tweets was collected using the Twitter API and annotated by experts. Data augmentation techniques were used to address the challenge of limited data, then Machine learning models were trained on the pre-processed data. The empirical results demonstrated that data augmentation significantly improved model performance. This research highlights the potential of machine learning for early detection and intervention in mental health, offering a valuable tool for supporting individuals struggling with depression.

Keywords: Depression Detection, NLP, Data Augmentation, Machine Learning.

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A Novel Approach Based on Autoencoders with Opposite User Inference to Solve Data Sparsity and Gray Sheep Issues in Collaborative Filtering

Lamyae El Youbi El Idrissi[1*], Aziza El Ouaazizi[1,3], Ismail Akharraz[3] & Abdelaziz Ahaitouf[1]

[1]Engineering Sciences Laboratory, Polydisciplinary Faculty of Taza, Sidi Mohamed Ben Abdellah University, Taza 35000, Morocco
[2]Mathematical and Informatics Engineering Laboratory, Faculty of Science Agadir, Ibnou Zohr University, Agadir 80000, Morocco
[3]Artificial Intelligence, Data Sciences and Emerging Systems Laboratory, National School of Applied Sciences, Sidi Mohamed Ben Abdellah University, Fez 30050, Morocco
* Correspondence: lamyae.elyoubielidrissi@usmba.ac.ma

Abstract:

The rapid daily increase in data volume has led to the Big Data paradigm, as the vast amount of information available on the Internet makes it increasingly challenging for users to find relevant information quickly and effectively. Recommendation systems have emerged as a solution to address this challenge. Collaborative filtering is widely adopted in these systems to offer personalized suggestions based on users' past behavior and preferences [1] [2]. Nevertheless, despite its widespread adoption, collaborative filtering presents certain limitations. Notably, challenges such as data sparsity and the gray sheep problem can significantly impact prediction accuracy.

Since the concept of deep learning has gained popularity, various studies have been conducted to improve this form of filtering. In this work, we propose a novel approach called Enriched_AE, that combines an autoencoder, a powerful unsupervised deep learning technique recognized for its strengths in data dimensionality reduction, feature extraction, and data reconstruction with an augmented rating matrix. This matrix not only includes real user data but also integrates virtual users based on opposing ratings provided by actual users. This innovative method aims to enhance prediction accuracy, ultimately delivering recommendations more aligned with user interests.

Our method's performance was evaluated on the MovieLens 100K dataset, where it demonstrated significant reductions in RMSE (Root Mean Squared Error) and MAE (Mean Absolute Error), underscoring its effectiveness compared to traditional collaborative filtering models.

Keywords: collaborative filtering; deep learning; autoencoder; recommender system; sparsity; gray sheep.

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Adaptive Steganographic Model Using Patch-Based Embedding for Large Images

Mohamed Htiti [1], Ismail Akharraz[2], Abdelaziz Ahaitouf [1]

[1]Laboratory of Engineering Sciences (LSI), Polydisciplinary Faculty of Taza, Sidi Mohamed Ben Abdellah University, Fez, Morocco

[2] 2Laboratory of Mathematical and Informatics Engineering, Ibnou Zohr University, Agadir, Morocco

Abstract

With the rapid advancements in computers and the internet, digital media has emerged as a preferred medium for concealing information. This work explores the field of steganography, focusing specifically on image steganography due to the widespread availability and abundance of data within images. The process of image steganography involves two key components: hiding a secret message within a cover image and extracting it from the stego image. Steganographic models are typically limited to images with the same dimensions as those used for training, restricting their application to images of different sizes. In this work, we propose a steganographic model trained on small images to enable efficient secret embedding and retrieval, due to limited computational resources and memory constraints. Our model can embed a small secret image within a similarly small cover image. To scale the model for larger images, we split both the secret and cover images into patches that match the trained image size, enabling the model to hide and retrieve secrets from larger images by processing them in segments. Results show that our model achieves high fidelity in both embedding and retrieval, preserving the quality of the cover image while maintaining accurate recovery of the secret image. This approach ensures both resource efficiency and flexibility for handling varying image sizes.

Keywords: Steganography, Secret image retrieval, Image segmentation, Image hiding, Large image processing

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Comparative Analysis for Variants of Vehicle Routing Problems

N.JAAIFI [1], M.FIKRI [1]

nezha.jaaifi@gmail.com , majdafikri@yahoo.fr

[1]Ingénierie des Systèmes Informatiques, Mathématiques et Applications,FP Taroudant, Ibn Zohr University, Agadir, Morocco

Abstract

The vehicle routing problem (VRP) is a class of operations research problem that has a wide range of applications in the transportation and logistics domain, providing solutions to operational challenges. Over the years, several variants have emerged to address the constraints encountered in dynamic and uncertain environments, making it possible to model operational needs in the real world.

In this work, on the one hand we present a comparative analysis of the different and new variants of the VRP with their mathematical models. On the other hand, and as these problems are classified NP-hard, we will also focus on their resolution methods including exact methods, heuristic and methaheuristic methods as well as hybrid approaches combining these methods and artificial intelligence.

Keywords: VRP, logistic, mathematical model, methaheuristic, Enhanced large neighborhood search, machine learnig, clustering.

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Detecting Depression on Arabic Social Media Using Deep Learning.

Y.Labrik ,I.Akharraz [1]

[1] Laboratory Mathematics and Informatics Engineering, University Ibn Zohr, Agadir, Morocco

Abstract

Depression is a type of emotion that makes people feel bad about themselves. Recently, the number of people suffering from it has been increasing, especially in Arab countries. With the spread of the use of social media, many of new research try to analyze the sentiment of its users their psychological state, feelings and emotions. Our work aims to develop a framework to detect and classify posts and tweets containing depression. We collected a novel Arabic Depression Tweet Dataset, examined several machine learning models trained on word frequency and embedding features, and investigated the performance of pre-trained deep learning models in identifying depression sentiment.

Keywords: NLP, Depression Detection, Arabic Social Media, Deep Learning.

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DTW and K-means Based Algorithm for Selecting the Best Time Series Prediction Model: A Case Study

Mohamed Oubraime [1], Rida El Abassi [2] Abderrahim Sabour [3]

[1,2,3] IMI Laboratory, Ibn Zohr University, Agadir, Morocco.

Abstract

The appropriate selection of time series prediction algorithms is a critical factor in ensuring forecast accuracy, particularly in sectors like water management. Accurate forecasts contribute to the sustainable use of resources, cost reduction, and better anticipation of hydrological events, especially in the current context of climate change and increasing pressures on water systems. In this study, we propose an intelligent algorithm designed to identify the most suitable prediction algorithm for specific types of time series. This algorithm first evaluates the similarity between time series using Dynamic Time Warping (DTW) and then clusters them using the unsupervised K-means classification algorithm. The hypothesis is that these clusters represent groups of time series for which a given prediction algorithm is the most appropriate. We tested this algorithm on time series data describing the daily water volumes of 11 Moroccan dams between 2015 and 2023. The results identified two distinct clusters. Using mean absolute error (MAE) and root mean square error (RMSE) metrics, the first cluster corresponds to time series for which autoregressive integrated moving average (ARIMA) models are the most suitable for prediction, in comparison to machine learning models such as support vector regression (SVR) and long short-term memory (LSTM) networks. Conversely, the second cluster corresponds to time series for which the SVR model is the most appropriate for prediction in this context. The clustering accuracy exceeded 90 percent, as measured by the accuracy metric. While these findings are limited by the scope of the study and the dataset used, they pave the way for further experimentation and the broader application of this approach. This could have a significant impact on water management, enabling more informed and effective decision-making in response to the growing challenges related to water resources.

Keywords: Dynamic Time Warping (DTW), K-means Clustering, Machine Learning Models, Water Management.

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Brain Tumor Segmentation based on RESUNET Architecture

Samir Soukaina and Ismail Akharraz

Mathematical and Informatics Engineering Laboratory,Faculty of Science Agadir,Ibnou Zohr University

Abstract : Brain tumor is recognised as one of the leading causes of death globally.The prognosis of this tumor depends on the early detection. MRI is a vital imaging technique in radiologie for diagnosing illness and precise assessment of tissue structures. In order to predict and segment the tumor,many approaches have been proposed.In this work, we present an approach based on ResUnet architecture for detecting and localising brain tumor using MRI scans.This method was trained on MRI-Brain-Tumor-Segmentation dataset provided with 3929 brain MRI scans.The achieved results show the performance of proposed approach in terms of accuracy, precision, recalland and Dice similarity coefficient. Our classifier model showed an accuracy of 98% in tumor classification.

Keywords : magnetic resonance imaging ;brain tumor ;segmentation ;deep learning ;convolution neural networks

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A Comparative Study of Stock Market Forecasting: Assessing Conventional Time Series Methods Versus Deep Learning Techniques

Ali ZAAOUAT [1], Rachid BOURDAY [1], Issam ATTOUCHI [1], Mounir AIT KERROUM [1]

[1] Computer science research Laboratory, Ibn Tofail University, Kénitra, Morocco

Abstract

The contemporary financial landscape is characterized by dynamic market behavior, making accurate predictions of stock price movements both crucial and challenging for financial decision-makers. This research delves into stock market prediction by employing a comprehensive approach that combines time series analysis with advanced machine learning techniques. The primary goal is to assess the effectiveness of different models in predicting price trends, potentially reshaping stock market forecasts and emphasizing the need for tailored predictive approaches for individual stocks. Focusing on ATTIJARIWAFA BANK (ATW) stock data, we evaluate models including Autoregressive Integrated Moving Average (ARIMA), ARIMA with Rolling Forecast, Long Short-Term Memory (LSTM) neural networks, Support Vector Regression (SVR), Extreme Gradient Boosting (XGBoost), and Convolutional Neural Networks (CNN).

The results demonstrate that the XGBoost model outperforms all other models, achieving the lowest Mean Absolute Error (MAE) of 7.7697, Root Mean Squared Error (RMSE) of 9.9549, and Mean Absolute Percentage Error (MAPE) of 7.9518%. The LSTM and CNN models also exhibit strong predictive capabilities, while the SVR model shows the highest error rates. These findings highlight the superiority of ensemble learning methods in capturing complex patterns in stock price data and underscore the importance of selecting appropriate models for accurate stock price prediction in dynamic financial markets.

Future work will explore the integration of sentiment analysis to further enhance prediction accuracy by incorporating market sentiment from news articles, social media, and financial reports. By combining quantitative data with qualitative sentiment indicators, the predictive models could offer a more holistic view of the factors influencing stock price movements, thereby improving forecasting performance and providing deeper insights into market dynamics.

Keywords: Stock price prediction, machine learning, deep learning, time series analysis.

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Predictive Maintenance in Industrial Systems: A Machine Learning Approach for Failure Prediction

ZAROUAL Soumaya [1], ENNAWAOUI Chouaib [1]

[1] Laboratory of Engineering Sciences for Energy, National School of Applied Sciences, University of Chouaib Doukkali, El Jadida - Morocco

Abstract

The industrial sector faces growing challenges with unplanned equipment failures, leading to significant financial and operational losses. Traditional preventive maintenance methods—such as scheduled inspections and part replacements—do not always accurately reflect the real-time health status of equipment and are often either too conservative or insufficient to avert critical breakdowns. This study aims to develop a machine learning-based predictive maintenance approach, focusing on accurately forecasting potential equipment failures and enabling timely interventions, thus optimizing uptime and minimizing unnecessary maintenance costs.

Our approach leverages a combination of historical and real-time sensor data collected from industrial machinery, focusing on parameters such as temperature, vibration, pressure, and usage cycles. By using a diverse dataset covering a range of operational conditions, we trained and validated several machine learning models, including Random Forest (RF), Support Vector Machines (SVM), and Neural Networks (NN), each evaluated for accuracy, interpretability, and speed of deployment. The Synthetic Minority Over-Sampling Technique (SMOTE) was applied to address the class imbalance often observed in predictive maintenance datasets, where failure events are relatively rare compared to normal operation.

Our analysis identified that models such as Random Forest and Neural Networks, when combined with real-time monitoring and advanced feature engineering techniques, provided high predictive accuracy for imminent equipment failures. By prioritizing features indicative of wear and tear, such as vibration frequency and usage duration, these models can flag early warning signs of potential failure, allowing for preventive actions well before a critical failure occurs. This predictive framework serves as a strategic tool for industries seeking to transition from reactive to proactive maintenance practices, significantly reducing unscheduled downtime and optimizing resource allocation.

The implications of this study are profound for industries seeking to embrace Industry 4.0 principles by integrating artificial intelligence and machine learning into their operational strategies. Implementing such predictive maintenance models offers substantial improvements in operational efficiency, cost effectiveness, and equipment longevity. Furthermore, this research contributes to the development of scalable, automated maintenance systems capable of adapting to various industrial contexts, from manufacturing to energy production.

Keywords: Predictive Maintenance, Machine Learning, Industrial Systems, Downtime Reduction, Predictive Analytics.

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A Game Theory Framework for Blind Image Deconvolution

AsmaaAbassi[1], Noureddine Moussaid [2] Fatima-Ezzahrae salah [3]

[1] Laboratory of Mathematics, Computer science and Applications - FSTM. University Hassan II, Casablanca, Morocco

[2] Laboratory of Mathematics, Computer science and Applications - FSTM. University Hassan II, Casablanca, Morocco

[3] Laboratory of Mathematics, Computer science and Applications - FSTM. University Hassan II, Casablanca, Morocco

Abstract

This study presents an innovative Nash game-based method for blind image deconvolution, focusing on the recovery of linearly degraded images without prior knowledge of the original image or the blur kernel (PSF). The suggested approach models blind deconvolution as a two-player static game, where one player handles image deblurring and the other estimates the PSF. The optimal solution is derived as a Nash equilibrium, leading to effective image restoration. Additionally, we introduce an enhanced game model that integrates fractional-order derivatives, showing potential in improving both the precision and robustness of image restoration, thus contributing to advancements in blind image deconvolution techniques and their practical applications.

Keywords: Image Blind Deconvolution, Multi-criteria Optimization, GL Fractional-order Derivatives, Game Theory, Nash Equilibrium.

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Minimization by Blocks

ENNOURI Chimaa[1], ROUBI Ahmed [1], BOUFI Karima [1]

[1] Laboratory MISI, University Hassan I, Settat, Morocco

Abstract

We are interested in minimizing a convex function $f : X \longrightarrow \mathbb{R}$, over a set $X = X_1 \times X_2 \times \cdots \times X_n$, where X_i are convex subsets of $\mathbb{R}^{n_i}$, $n_i \geq 1$ and $f(x) = f(x_1, x_2, \cdots, x_n)$.This function can be minimized by finding the coordinatewise minimizers using a so-called coordinate descent method. This is an iterative optimization method that, at each iteration, optimizes only over a single chosen variable while keeping the other variables fixed. Generally, its procedure is as follows: For an integer $k \geq 0$ and a point $x^{(k)}$ in X, we select $x_1^{(k+1)}$ as a point that minimizes $f(x_1, x_2^{(k)}, \cdots, x_n^{(k)})$ over X_1, next, we select $x_2^{(k+1)}$ as a point that minimizes $f(x_1^{(k+1)}, x_2, x_3^{(k)}, \cdots, x_n^{(k)})$ over X_2, proceeding in this way for each block.

Keywords: coordinate descent, convex function.

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Optimizing a Difference of Quasiconvex Functions

Khadija Hamdaoui

Laboratory IMI, Ibn Zohr University, Agadir, Morocco

Abstract

Generalized convexity is a hugely important notion in optimization, as said R. Tyrrell Rockafellar: "...in fact, the great watershed in optimization isn't between linearity and nonlinearity, but convexity and nonconvexity". That made us interested in quasiconvexity which was introduced in the first half of the last century as a valuable extension of convexity and we are also intrigued by D.C. programming where the presence of convexity makes Convex analysis useful in nonconvex situations. We thought about combining these two concepts in this contribution in order to enlarge some results established by Hiriart-Urruty [2] for minimizing a difference of two convex functions to recover the class of D.Q.C. functions which is larger than both classes: D.C. functions and quasiconvex ones. To accomplish our aim, we study optimality conditions for local minimizers of the following unconstrained programming problem:

$$(P) \qquad \begin{cases} \inf f(x) - g(x) \\ s.t.\ x \in X, \end{cases} \tag{1}$$

where the objective function is a difference of two quasiconvex functions

$$f,\ g : X \to \overline{\mathbb{R}} = [-\infty,\ +\infty]$$

and X is a Banach space.

The obtained results are given in terms of the Q-subdifferential introduced by Suzuki and Kuroiwa [1] which is suited for quasiconvex functions because it generalizes the subdifferential for convex functions and the derivative for Gâteaux differentiable functions. Moreover, it has some chain rules such as the Q-subdifferential of the composite and the Q-subdifferential of the supremum of quasiconvex functions which is interesting in studying this type of problem. The Q-subdifferential of a quasiconvex function is determined by its generator. Based on this, we introduced a notion of regularity for quasiconvex functions. In addition to certain continuity and Dini differentiability assumptions for the elements of the generators of f and g, this regularity helped us obtain our results.

Keywords: Quasiconvex function, difference of two convex functions, Q-subdifferential, optimality conditions.

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Cauchy problem in anisotropic thermal conduction: stabilization and resolution

H.HAMDI [1], M.ZIOUANE, [2] A.NACHAOUI, [3] M.NACHAOUI[4]

EMI, Université Sultan Moulay Slimane, Béni-Mellal, Morocco
[3] Laboratoire de Mathématiques Jean Leray, Université de Nantes, Nantes, France

Abstract

Solving the Cauchy problem in the context of anisotropic thermal conduction is a challenging ill-posed problem that results in unstable and destabilizing solutions that are too sensitive to data perturbations. This study considers the issue of stability and solving this inverse problem by associating it with a control problem and using some sophisticated algorithms. We introduce a Dirichlet boundary control on the inaccessible part of the boundary in order to decompose the Cauchy problem into two well-posed sub-problems. These are then approximated using FEM and solved using a regularized version of the minimization strategy within an iteration process.

The Limited Memory BFGS (L-BFGS) optimization algorithm is chosen because it works well for large-dimensional problems and guarantees that the computed solutions will converge to the right solution. This combined method not only enhances the accuracy of the solution but also demonstrates resistance to noise and lack of complete information. The approach that has been designed is quite general and can be approached to such similar inverse problems in applied sciences, where the stabilization and solution of ill-posed problems are of great importance.

Keywords: Inverse problem, control problem, finite element, L-BFGS .

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A Comparative Evaluation of Operators in Large Neighbourhood Search metaheuristic

Yassine OULAANZI, Rachida ABOUNACER

Laboratory of Mathematical Engineering and Computer Science (LMECS),

Faculty of Sciences (FS), Ibn Zohr University (UIZ), Agadir – Morocco

Abstract

The Large Neighbourhood Search is a metaheuristic that operates over a larger neighbourhood compared to conventional local search methods. Within LNS, operators can act as primitives to explore the space of solutions. However, users often find it challenging to select the most effective operators due to their varying level of success. Naturally, initial experiments are required to gain preliminary insights on each operator ─ not to exclude poor ones, as they may prove useful under specific conditions during the search. In this study, we review several operators used within the LNS framework to solve vehicle routing problems. We also examine the impact of neighbourhood size on the quality of solutions. Consequently, a high-level rule is essential to guide the selection of operators most likely to improve solution quality under changing conditions.

Keywords:

Large neighborhood search, vehicle routing problem, metaheuristic, operators

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A Discrete Mountain Gazelle Optimizer (DMGO) for Efficiently Solving Capacitated Vehicle Routing Problem

TAHA Anass[1], ELATAR Said[2], EL BAZZI Mohamed Salim[3], AIT IDER Abdelouahed[1]

[1] System Computer Engineering, Mathematics and Applications Laboratory, Ibn Zohr university, Polydisciplinary Faculty, Taroudant, Morocco.

[2] Research in Optimization, Emerging Systems, Networks, and Imaging Laboratory, Chouaib Doukkali University, Faculty of Science, El Jadida, Morocco.

[3] Image and Pattern Recognition - Intelligent and Communicating Systems Laboratory, Ibn Zohr University, Agadir, Morocco.

Abstract

Metaheuristic algorithms, including Genetic Algorithms (GA) [1], Particle Swarm Optimization (PSO) [2], Ant Colony Optimization (ACO) [3], Bat Algorithm [4], are widely employed to solve complex optimization problems, offering efficient and near-optimal solutions within reasonable time constraints. In this paper, we propose the Discrete Mountain Gazelle Optimization Algorithm (DMGO) [5], a novel bio-inspired metaheuristic based on the territorial, migratory, and social behaviors of mountain gazelles in nature. While preserving the overall architecture of the original Mountain Gazelle Optimizer, which was designed for continuous problems, we adapted it to tackle the Capacitated Vehicle Routing Problem (CVRP) [6], a challenging NP-hard combinatorial optimization problem. The DMGO is specifically tailored for CVRP and achieves a well-balanced exploration and intensification of the search process through the use of destroy and repair heuristics. Experimental results on several CVRP benchmark instances demonstrate that DMGO delivers highly competitive results comparing to other algorithms in both solution quality and computational efficiency. These findings suggest that DMGO offers a robust and effective approach for solving CVRP.

Keywords: Discrete Mountain Gazelle Optimizer, Capacitated Vehicle Routing Problem, Search exploration and exploitation, Combinatorial optimization, Nature-Inspired Metaheuristic.

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A variant of the Kannappan-sine addition law on semigroups

Jafar Ahmed [1], Ajebbar Omar [2] Elqorachi Elhoucien [3]

[1],[2],[3] Laboratory LMA, Ibn Zohr University, Agadir, Morocco

Abstract

Given a semigroup S equipped with an involutive automorphic $\sigma : S \to S$, we determine the complex-valued solutions of the following variant of the Kannappan-sine addition law

$$f(x\sigma(y)z_0) = f(x)g(y) + f(y)g(x),\ x, y \in S.$$

As an application we obtain the solutions of the following functional equation

$$f(x\sigma(y)z_0) = f(x)f(z_1y) + f(z_1x)f(y),\ x, y \in S,$$

where z_0, z_1 are two fixed elements in S such that $z_0 \neq z_1$. The continuous solutions on topological semigroups are given.

We illustrate the main result by two examples.

Keywords: Kannappan, sine addition law, semigroups, exponential.

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The Kronecker function ring of semistar

Eddamane Elhousseine

Laboratory Mathématiques Pures, University Molay Ismail, Meknès, Morocco

Abstract

Let R be a Marot ring with Property A. We establish some results on Kronecker function rings with respect to semistar. These constructions parallel the constructions for integral domains as given in [[1], Section 32].
Keywords: Kronecker function ring, Property A, Marot ring.

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The DMP inverse of square matrix

M.El Bilali [1], M. Mouçouf [1]

[1] Laboratory Fundamental Mathematics and their Applications, Chouaib Doukkali University, 24000 El Jadida, Morocco.

Abstract

In this note we introduce a new characterizations and several new properties of DMP inverse and dual DMP inverse of a square matrix. Also, we consider some characterizations of the nonsingularity of relating matrices. In addition, applications of the DMP inverse and dual DMP inverse in solving matrix equations are studied.

Keywords: DMP inverse, dual DMP inverse.

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S-packing colorings of distance graphs D(1,t)

EL kouabli Youssef[a,*], Faouzi Latifa[a,b]

[a] *Département de Mathématiques et informatique, Faculté des Sciences Aïn Chock, Hassan II University of Casablanca, Maroc.*
[b] *Centre Régional des Métiers de l'Education et de la Formation de la région Casablanca-Settat, Maroc.*

Abstract

An S-packing k-coloring of a graph G (with $S = (s_1, s_2, ...)$ is a non-decreasing sequence of positive integers) is a mapping from $V(G)$ to $\{1, ..., k\}$ (the set of colors) such that for every two distincts vertices x and y in $V(G)$ with $f(x) = f(y) = i$ the distance between x and y in G is bigger than s_i. The S-packing chromatic number $\chi_S(G)$ of G is the smallest integer k such that G has an S-packing k-coloring. Given a set $D \subset \mathbb{N}^*$, a distance graph $G(\mathbb{Z}, D)$ with distance set D is a graph with vertex set $\mathbb{Z}$ and two distincts vertices u and v are adjacents if $|u - v| \in D$. In this paper, for $S = (s, s + 1, s + 1, ...)$ with $s \geq \lceil \frac{t}{2} \rceil$ we give a lower bound of $\chi_S(G(\mathbb{Z}, \{1, t\}))$, and a lower bound of $\chi_d(G(\mathbb{Z}, \{1, t\}))$ with $d \geq \lceil \frac{t}{2} \rceil$, for $S = (s_1, s_2, ..., s_i, a, a, ...)$ with $a \geq max(1, t - 2)$ we give an upper bound of $\chi_S(G(\mathbb{Z}, \{1, t\}))$, and we determine the exact values of $\chi_S(G(\mathbb{Z}, \{1, t\}))$ and also of $\chi_d(G(\mathbb{Z}, \{1, t\}))$ for $s \geq max(\lceil \frac{t}{2} \rceil, t - 3)$ and $d \geq max(\lceil \frac{t}{2} \rceil, t - 2)$. And we give a lower and an upper bound of $\chi_S(G(\mathbb{Z}, \{1, t\}))$ for $S = (1, s, s, ...)$ with conditions on s and t, which in the cases $s \geq max(t - 2, \lceil \frac{t}{2} \rceil)$ we determine the exact values of $\chi_S(G(\mathbb{Z}, \{1, t\}))$.

Keywords: S-packing coloring, Distance coloring, Distance graphs, d-distance chromatic number, S-packing chromatic number.

*Laboratoire Mathématiques Fondamentales et Appliquées (LMFA), Faculté des Sciences Aïn Chock, Hassan II University of Casablanca, Maroc.

Email address: youssef.elkouabli-etu@etu.univh2c.ma (EL kouabli Youssef)

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Generalization of Kraft's Theorem

El Hassane Fliouet 1 [1]

[1] Crmef sm Agadir, Morroco

Abstract

Let K be a finitely generated extension of a field k of characteristic $p \neq 0$. In 1947 Dieudonné initiated the study of maximal separable intermediate fields. He gave in particular the form of an important subclass of maximal separable intermediate fields D characterized by the property $K \subseteq k(D^{p^{-\infty}})$, and which are called the distinguished subfields of K/k. In 1970 Kraft showed that the distinguished maximal separable subfields are precisely those over which K is of minimal degree. In the same vein, this communication grew out of an attempt to find a new characterization of distinguished subfields of K/k by means of new inseparability invariants, which generalizes that of Kraft. We also characterize the structure of intermediate fields of K/k preserving a suitably chosen part of exponents of K/k.

Keywords: Distinguished subfield, Degree of inseparability, Kraft's Theorem.

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Abstract. In this paper, we present a new method for studying the Euclidean operator radius of adjointable operators on Hilbert C^*-modules. Our method enables us to obtain some new results and generalize some known theorems for bounded operators on Hilbert spaces to bounded adjointable operators on Hilbert C^*-module spaces.

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A Kannappan-cosine functional equation on semigroups

Jafar Ahmed[1], Ajebbar Omar[2] and Elqorachi Elhoucien[1]

[1] Laboratory of mathematics and applications, Ibn Zohr University, Faculty of sciences, Agadir, Morocco.
[2]Laboratory of mathematics and applications, Sultan Moulay Slimane University, Multidisciplinary Faculty, Beni Mellal, Morocco.

Abstract

Let S be a semigroup and z_0 a fixed element in S. We determine the complex-valued solutions of the following Kannappan-cosine functional equation

$$g(xyz_0) = g(x)g(y) - f(x)f(y)), \quad x, y \in S.$$

Keywords: Semigroup, Kannappan functional equation, cosine addition law.

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On some polynomial overrings of integral domains

M.M. Chems-Eddin[1], O. Ouzzaouit[2], A. Tamoussit[3]

[1] Department of Mathematics, Faculty of Sciences Dhar El Mahraz, University Sidi Mohamed Ben Abdallah, Fez, Morocco

[2] Laboratory of Research of Sciences and Technique (LRST), The Higher School of Education and Training, Ibn Zohr Univeristy, Agadir, Morocco

[3] Department of Mathematics, The Regional Center for Education and Training Professions Souss Massa, Inezgane, Morocco

Abstract

Let D be an integral domain with quotient field K and X an indeterminate over K. A *polynomial overring of* D is defined as a subring of $K[X]$ that contains $D[X]$. In this talk, we investigate distinguished properties of polynomial overrings, including (faithful) flatness, local freeness, and Krull dimension. We further present examples that illustrate some of the established results.
Keywords: Integer-valued polynomials, (faithfully) flat module, essential domain, Krull dimension.

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Irrationality Criteria for Certain Infinite Series

Fedoua Sghiouer [1], Ali Kacha[2]

[1] Laboratory Partial Differential Equations, Algebra, and Spectral Geometry, Ibn Tofail University, Faculty of Sciences, Kenitra, Morocco

[2] Laboratory Partial Differential Equations, Algebra, and Spectral Geometry, Ibn Tofail University, Faculty of Sciences, Kenitra, Morocco

Abstract

This paper examines new irrationality criteria for specific infinite series by applying Diophantine approximation methods and irrationality theorems to analyze the nature of certain types of series. By introducing conditions that determine when a given series converges to an irrational number, this work deepens the understanding of the connections between series structure and irrationality properties. At the end of this paper, several illustrative examples are provided.
Keywords: Irrationality, transcendence, Liouville number, infinite series, convergent.

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2nd International Conference
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On D-algebras between $D[X]$ and $\mathrm{Int}(D)$

J.-L. Chabert [1], A. Tamoussit [2,3]

[1]LAMFA CNRS-UMR 7352, Université de Picardie, 80039 Amiens, France
[2] Department of Mathematics, The Regional Center for Education and Training Professions Souss Massa, Inezgane, Morocco
[3] Laboratory of Mathematics and Applications (LMA), Faculty of Sciences, Ibn Zohr University, Agadir, Morocco

Abstract

In this talk, we investigate conditions on an integral domain D such that any D-algebra between the polynomial ring $D[X]$ and the ring of integer-valued polynomials $\mathrm{Int}(D)$ is (locally) free.
Keywords: Integer-valued polynomials, regular basis, locally free modules, locally essential domains.

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Derivations mapping into the Jacobson radical of a Banach algebra

MOUMEN Mohamed [1], TAOUFIQ Lahcen [2]

[1] ESTIDMA(ENSA), Ibn Zohr University, Agadir, Morocco
[2] ESTIDMA(ENSA), Ibn Zohr University, Agadir, Morocco

Abstract

Let $\mathcal{A}$ be a Banach algebra with Jacobson radical $Rad_{\mathcal{A}}$ and d a continuous derivation of $\mathcal{A}$. The purpose of this article is to investigate some sufficient conditions under which $d(\mathcal{A}) \subseteq Rad_{\mathcal{A}}$ from a topological point of view. Interesting results are established with some applications.
Keywords: Derivation, Radical Banach algebras, quasinilpotent element.

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On Self-Dual Constacyclic Codes of Length p^s over $F_{p^m} + uF_{p^m} + u^2F_{p^m}$

Youssef Ahendouz

Mathematical and Informatics Engineering Laboratory, Agadir , Morocco

Abstract

Let $\mathbb{F}_{2^m}$ be a finite field with cardinality 2^m, and let $R_3 = \frac{\mathbb{F}_{p^m}[u]}{\langle u^3 \rangle}$, where m is a positive integer and $u^3 = 0$. This study classifies self-dual constacyclic codes of length p^s over the ring R_3.

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Derivations acting on symmetric elements with central values

H. FIHI [1], A. MAMOUNI [2], K. Ouarghi[3].

[1] Department of Mathematics, Faculty of Sciences, University of Moulay Ismaïl, Meknes, Morocco.
[2] Department of Mathematics, Faculty of Sciences, University of Moulay Ismaïl, Meknes, Morocco.
[3] Department of Mathematics, Ecole Normale Supérieure, University of Moulay Ismaïl, Meknes, Morocco.

Abstract

Our purpose in this paper is to prove that the set of hermitian elements, defined by commutativity conditions involving derivations over prime rings with involution $*$, are either central elements or their square are central elements. Furthermore, we can find the same results for the set of skew-hermitian elements.

Keywords: Derivation, involution, prime ring, hermitian element.

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Understanding Social Simulation: Purpose, Types, and Impact

Saida Hachimi El Idrissi [1]

[1] Laboratory IMI, Ibn Zohr University, Agadir, Morocco

Abstract

Social simulation is a method used to study and model social phenomena using computational and mathematical techniques. The purpose of the social simulation is to better understand the dynamics of social systems and make predictions about how these systems may behave in the future. By creating virtual representations of real-world social systems, researchers can manipulate variables and test hypotheses in a controlled environment, which is difficult or impossible to do in real-world settings. This allows for a deeper understanding of the factors that influence the behavior of social systems and the potential outcomes of different policies or interventions [1] [2].
Social simulation is commonly used in sociology, anthropology, economics, political science, and psychology to study various topics, such as social networks, economic systems, political systems, and social movements [2].
Some examples of the use of social simulation include:
• Study of social networks: Researchers can use social simulation to model the formation and evolution of social networks and study how information spreads through these networks.
• Study of economic systems: where it can be used to model economic systems and study the effects of different economic policies on the system.
• Study of social movements: Researchers use it to model the emergence and spread of social movements and study how different factors, such as social media or economic conditions, influence the success or failure of these movements.
There are two commonly used approaches for social simulation: Top-Down and Bottom-Up methodologies. The Top-Down models, also known as social simulations based on equations [3] [4], start with a broad understanding of the system's overall structure and dynamics. They then break it down into smaller parts governed by predefined rules and connections. This macro-to-micro approach is good at capturing macro-trends and emergent behavior, and it prioritizes system-level insights. These types of social simulations are among the earliest developed and are fundamentally based on the principles of differential equations used in modeling social dynamics [5]. Examples of this perspective include System Dynamics models and Queueing models.
Conversely, Bottom-Up models adopt the micro-to-macro perspective, which is based on the understanding that macro-level global dynamics are a direct outcome of interactions at the micro-level between individual behaviors [3] [6]
Bottom-up modeling is an approach that focuses on the interactions between individual agents, allowing system-level patterns to emerge spontaneously. It starts with modeling individual agents'

behavior and interactions, then builds up to the macro level. The methods developed through this approach are generally classified under the broader umbrella of object-oriented social simulation models [3]. The famous models of this perspective include Cellular Automaton models and Agent-Based models [2].

Keywords: social simulation, agent-based modeling, system dynamics.

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List of participants

- Aatif El Hassan
- Aatrif Zineb
- Abdelmonaim Elkaddouri
- Abderrahim Bahssini
- Abderrahim Sabour
- Abounacer Rachida
- Aboutafail Othman
- Achehboune Mustapha
- Aghriche Ahmed
- Ahendouz Youssef
- Ahizoune Issame
- Ahmadini Abdullah
- Ait Bakrim Aicha
- Ait Ichou Mohamed
- Ajebbar Omar
- Allal Brahim
- Amzil Abdellah
- Aribou Youssef
- Aserrar Youssef
- Asrir Nadia
- Assebbane Youness
- Belfakih Keltouma
- Bergam Amal
- Boudrai Sofia
- Boulayat Brahim

- Boulbarj Ilias
- Boumasmoud Soufiane
- Boumzough Khalifa
- Bounacer Hamza
- Bounja Karim
- Bourzik Dounia
- Bouydou Rachid
- Chafai Imzegouan
- Chahbi Abdellatif
- Chakiri Mohamed
- Chaouch Hicham
- Dades Abdelaali
- Daoud Maha
- Derham Abdelkarim
- Dimou Hajira
- Echtouki Aicha
- Eddamane Elhousseine
- Eddaoudi Hicham
- El Alaoui Mohammed
- El Baggari Hind
- El Ghandour Abdessamade
- El Guermai Ghita
- El Harrak Anouar
- El Hilali Fatima Zahrae
- El Kouabli Youssef
- El Krouk Tahar
- El Mourchid Samir
- El-Fassi Iz-Iddine
- Elamrani Oussama
- Elansari Taoufyq
- Elbarbouchi Ahmed
- Elfahri Kamal

- Elhachemy Mohammed
- Elhafiane Zakaria
- Elkaf Mariem
- Elkhaiar Soufiane
- Elmansouri Badr
- Ennouri Chimaa
- Es- Saiydy Mohssine
- Essaid Aourir
- Ettoussi Razika
- Fadil Abdessamad
- Farhat Karim
- Fihi Hiba
- Fliouet El Hassane
- Ghafrani Fatima
- Gueli Yahya
- H'michane Jawad
- Hafidi Bezza
- Hamad Sidi Lafdal
- Hamdaoui Khadija
- Hamdi Hafida
- Hannabou Mohamed
- Hassaouy Mohammed
- Ijerch Mariam
- Ismague Fatima
- Izem Nouh
- Izid Malika
- Jafar Ahmed
- Jakani Manal
- Karbil Loubna
- Khabaoui Hassan
- Khadija Elhadi
- Khalouqi Dounia

- Kharfati Khaoula
- Khlifi Ismail
- Labrik Yacine
- Maadan Hicham
- Makran Noreddine
- Maragh Fouad
- Maslouhi Mostafa
- Mechergui Mahfoudh
- Mejmaa Bilal
- Menchih Manal
- Mezzat Chaimae
- Mohamed Boukdir
- Mohsine Hakima
- Mouatassim Khadija
- Moulaharabbi Somayya
- Moumen Mohamed
- Mounir Ayoub
- Moussaddar Asmaa
- Nafnaf Youssef
- Nasroallah Kaoutar
- Ngom Khabane
- Ngom Khabane
- Nokrane Ahmed
- Ouchicha Chaimae
- Ouelddris Ilham
- Oughajji Fatima Zahra
- Ouhabi Ayoub
- Oulaanzi Yassine
- Ouzzaouit Omar
- Rachid Guirhir
- Rafik Mohamed
- Riffi Abdelkbir

- Rikouane Ahmed
- Sadik Fatima-Ezzahra
- Samir Soukaina
- Sani Ahmed
- Sbai Amine
- Sghiouer Fedoua
- Slimane Regui
- Tadoummant Lahoucine
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- Tajani Chakir
- Taki Zakaria
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- Tayeq Hatim
- Tifroute Mohamed
- Tyr Othman
- Zouhair Walid