Outstanding Institutes to study mathematical science in India.

MATH IN UNIVERSITY 2025 RANKS

What are **Math** Ranks?

We found the best mathematics and statistics departments in Indian colleges & universities.

Math Ranks are prepared at Cheenta Academy, Kolkata. Cheenta is an institute of Olympiad, Research & Leadership programs for outstanding school students.

In this document we have ranked Mathematics and Statistics departments at colleges and universities based on **faculty** strength (qualification, international exposure), **publication** in past one year, frequency of **seminars** - symposiums and **reputation**.
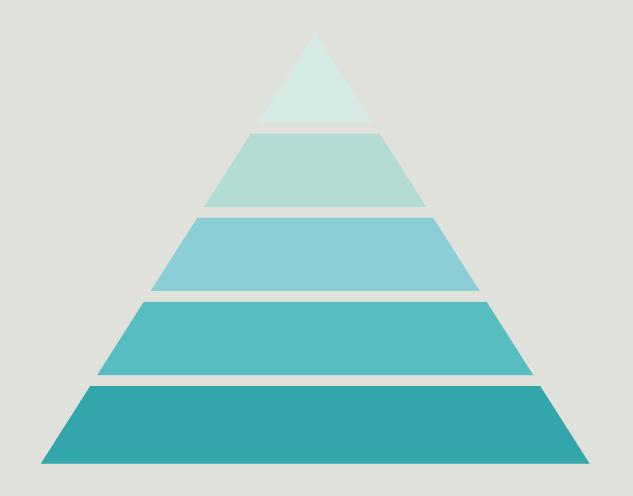
Read with <u>**Caution**</u>

We have compiled research activities, seminars and faculty strength carefully.

However this process is not error-free. We welcome (and infact need) more input from colleges and universities to improve this list.

You may send your suggestions to helpdesk@cheenta.com.

The sole purpose of this document is to assist students in high school to choose colleges and universities at the undergraduate level.

Understand

The top 50 institutions are ranked in 5 Levels based on research intensity and reputation.

However the institutes **inside each level are not "ranked"** per-se. For example Chennai Mathematical Institute and Indian Statistical Institute are both in Level 1. We have avoided ranking one ahead of the other.

Indian Institute of Science

28 Faculty members

98 journal publications in 2024

154 seminars related in mathematical science in 2024

Karnataka

Admission is based on performance in one of the following national examinations: Joint Entrance Examination Main, Joint Entrance Examination Advanced.

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Indian Institute of Technology Kanpur

Level 1 - B

53 Faculty members

205 journal publications in 2024

29 seminars related in mathematical science in 2024

Admission is based on the Joint Entrance Examination (JEE) Advanced rank.

Uttar Pradesh

Special Note:

Level 1 - B

H. S. Sathya Chandra Sagar[1,2], Akash Anand[1], Maia E. Persche[1], Anna M. Pidgeon[1], Benjamin Zuckerberg[3], Çağan H. Şekercioğlu[3] and Zuzana Buřivalová[1,2]

[1]Department of Forest and Wildlife Ecology, University of Wisconsin, Madison WI 53706, USA
[2]Nelson Institute for Environmental Studies, University of Wisconsin, Madison WI 53726, USA
[3]School of Biological Sciences, The University of Utah, Salt Lake UT 84112, USA

HSSCS, 0000-0002-1183-6845; ZB, 0000-0001-5730-7546

Animal communication plays a crucial role in biology, yet the wide variability in vocalizations is not fully understood. Previous studies in birds have been limited in taxonomic and analytical breadth. Here, w analyse an extensive dataset of >140 000 recordings of vocalizations from 8450 bird species, representing nearly every avian order and family under a structural causal model framework, to explore the influence o eco-evolutionary traits on acoustic frequency characteristics. We find tha body mass, beak size, habitat associations and geography influence acousti frequency characteristics, with varying degrees of interaction with song acquisition type. We find no evidence for the influence of vegetation density, sexual dimorphism, range size and competition on our measure of acoustic frequency characteristics. Our results, built on decades o researchers' empirical observations collected across the globe, provide new breadth of evidence about how eco-evolutionary processes shape bird communication.

Example of Research in 2024

Global analysis of acoustic frequency characteristics in birds

Akash Anand et al.

64 seats

BS program in Mathematics & Scientific Computing

Approximately ₹800,000 over four years

This institution admits both male and female students

Indian Statistical Institute

Level 1 - C

28 Faculty members

51 journal publications in 2024

109 seminars related in mathematical science in 2024

ISI Admission Test - Objective Section (MCQs), Descriptive Section. Interview (Shortlisted candidate).

West Bengal

Special Note:

Level 1 - C

On high-dimensional modifications of the nearest neighbor classifier

Annesha Ghosh[1], Deep Ghoshal[2], Bilol Banerjee[1], and Anil K. Ghosh[1]

[1] Theoretical Statistics and Mathematics Unit, Indian Statistical Institute, India
[2] Department of Statistics, University of Illinois at Urbana-Champaign, USA.
E-mail*: anneshaghosh659@gmail.com

October 25, 2024

Abstract

Nearest neighbor classifier is arguably the most simple and popular nonparametric classifier available in the literature. However, due to the concentration of pairwise distances and the violation of the neighborhood structure, this classifier often suffers in high-dimension, low-sample size (HDLSS) situations, especially when the scale difference between the competing classes dominates their location difference. Several attempts have been made in the literature to take care of this problem. In this article, we discuss some of those existing methods and propose some new ones. We carry out some theoretical investigations in this regard and analyze several simulated and benchmark datasets to compare the empirical performances of our proposed methods with some of the existing ones.

Keywords: Dimension reduction; Feature extraction; HDLSS asymptotics; Mixture distributions; Nearest neighbors.

1 Introduction

In supervised classification, we use a training set of labeled observations from different competing classes to form a decision rule for classifying unlabeled test set observations as accurately as possible. Starting from Fisher (1936), Rao (1948) and Fix and Hodges (1951), several parametric as well as nonparametric classifiers have been developed for this purpose (see, e.g., Duda *et al.*, 2007; Hastie *et al.*, 2009). Among them, the nearest neighbor classifier (see, e.g., Cover and Hart, 1967) is perhaps the most popular one. The k-nearest neighbor classifier (k-NN) classifies an observation $\mathbf{x}$ to the class having the maximum number of representatives among the k nearest neighbors of $\mathbf{x}$. This classifier works well if the training sample size is large compared to the dimension of the data. For a suitable choice of k (which increases with the training sample size at an appropriate rate), under some mild regularity conditions, the misclassification rate of the k-NN classifier converges to the Bayes risk (i.e., the misclassification rate of the Bayes classifier) as the training sample size grows to infinity (see, e.g. Devroye *et al.*, 2013; Hall *et al.*, 2008). However, like other nonparametric methods, this classifier also suffers from the curse of dimensionality (see, e.g., Carrerira-Perpinan, 2009), especially when the dimension of the data is much larger than the training sample size. In such high-dimension, low-sample-size (HDLSS) situations, the concentration of pairwise distances (see, e.g., Hall *et al.*, 2005; François *et al.*, 2007), presence of hubs and the violation of the neighborhood structure (see, e.g., Radovanovic *et al.*, 2010; Pal *et al.*, 2016) often have adverse effects on the performance of the nearest neighbor classifier.

To demonstrate this, we consider some simple examples involving two d-dimensional normal distributions. Descriptions of these examples are given below.

Examples 1 - 3: *In these three examples, the first class has a normal distribution with the mean vector $\mathbf{0}_d = (0, 0, \ldots, 0)^\top$ and the dispersion matrix $\mathbf{I}_d$ (the $d \times d$ identity matrix), while the second class has the mean vector $\mu \mathbf{1}_d = \mu(1, 1, \ldots, 1)^\top = (\mu, \mu, \ldots, \mu)^\top$ and the dispersion matrix $\sigma^2 \mathbf{I}_d$. In Example 1, we consider a location problem where we take $\mu = 1$ and $\sigma = 1$. Example 2 deals with a location-scale problem with $\mu = 1$ and $\sigma = 2$. As Example 3, we choose a scale problem, where μ and σ are taken as 0 and 2, respectively.*

In each of these examples, we carry out our experiment for 7 different choices of d ranging between 10 and

The seat limit is approximately 50

B. Math. (Hons.)

The complete expenditure is ₹40,000 approximately

This institution admits both male and female students

Example of Research in 2024

On high-dimensional modifications of the nearest neighbor classifier

Anil K. Ghosh et al.

Special Note:

Level 1 - C

79 seats

B.Stat (Hons)

Course fees are not specified clearly

This institution admits both male and female students

Example of Research in 2024

LASER: A new method for locally adaptive nonparametric regression

Soumendu Sundar Mukherjee et al.

Indian Institute Of Technology Madras

45 Faculty members

140 journal publications in 2024

38 seminars related in mathematical science in 2024

Admission is based on the Joint Entrance Examination (JEE) Main rank.

Tamil Nadu

Indian Institute Of Technology Delhi

43 Faculty members

180 journal publications in 2024

1 seminar related in mathematical science in 2024

Delhi

Admission is based on the Joint Entrance Examination (JEE) Main rank.

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Special Note:

Level 1 - E

FRACTAL DIMENSIONS OF FRACTAL TRANSFORMATIONS AND QUANTIZATION DIMENSIONS FOR BI-LIPSCHITZ MAPPINGS

MANUJ VERMA, AMIT PRIYADARSHI, AND SAURABH VERMA

ABSTRACT. In this paper, we study the fractal dimension of the graph of a fractal transformation and also determine the quantization dimension of a probability measure supported on the graph of the fractal transformation. Moreover, we estimate the quantization dimension of the invariant measures corresponding to a weighted iterated function system consisting of bi-Lipschitz mappings under the strong open set condition.

1. INTRODUCTION

In Fractal Geometry, Iterated Function Systems (IFSs) play an important role. They are commonly used to generate fractals. In fact, most of the fractals are the attractors of some IFS. There are many literature available on the study of IFS, its attractor and fractal dimension of attractor, see, for more details, [7, 1, 10, 13, 17]. In 2009, Barnsley [2] introduced the idea of fractal transformation. Basically, fractal transformation is a map between the attractor of one IFS to the attractor of another IFS. After that, Barnsley et al. [3] discussed many applications of fractal transformation. In 2014, Barnsely and his collaborators [4] determined some conditions under which fractal transformation is measure preserving. In 2016, Bandt et al. [5] proved that under some conditions fractal transformation becomes homeomorphism. In 2018, Vince [18] showed that we can extend fractal transformation from the non-empty attractor to whole space and described that under some conditions fractal transformation is the attractor of some IFS, which is constructed from the given IFSs.

The quantization dimension is one of the most important thing in the quantization theory. In 1963, Zador [19] was the first, who introduced the term quantization dimension and also discussed some properties of this dimension. In 2002, Graf and Luschgy [9] gave a formula of the quantization dimension of the self-similar measures under the open set condition (OSC). After that, Lindsay et al. [11] generalized the result of Graf and Luschgy [8] for the self-conformal measures and described some connection between quantization theory and fractal geometry. The quantization dimension is also related to some other known fractal dimensions like the Hausdorff dimension and the box-counting dimension, see, for more details [8]. In 2010, Roychowdhury [14] obtained the quantization dimension of the Moran measures. After that, Roychowdhury [15] also determined the quantization dimension of a Borel probability measure supported on the attractor of the bi-Lipschitz IFS by taking some conditions on the bi-Lipschitz constant and the IFS satisfying SOSC. In 2021, Roychowdhury and Selmi [16] estimated bounds of the quantization dimension of the invariant measure generated by the hyperbolic recurrent IFS under the strong separation condition. In this paper, we determine bounds of the quantization dimension of the invariant Borel probability measures supported on the attractor of a general class of bi-Lipschitz IFSs under the SOSC. This result also generalizes the result of Graf and Luschgy [8]. We also estimate the quantization dimension for the invariant Borel probability measures supported on the graph of the fractal transformation. Here, we discuss some dimensional results for the graph of the fractal transformation.

The paper is organized as follows. In upcoming Section 2, we discuss some preliminary results and the required definitions for forthcoming section. In Section 3, we give some results on the fractal transformation and the product of two IFSs. Firstly, we determine some results related to

The total number of seats is not clearly specified

Bachelor of Technology (B.Tech.) in Mathematics and Computing Engineering

The course fee is approximately 8,00,000

This institution admits both male and female students

Example of Research in 2024

Fractal dimensions of fractal transformations and quantization dimensions for bi-Lipschitz mappings

Amit Priyadarshi et al.

Indian Institute Of Technology Bombay

Level 1 - F

49 Faculty members

115 journal publications in 2024

6 seminars related in mathematical science in 2024

Admission is based on the Joint Entrance Examination (JEE) Advanced rank.

Maharashtra

Special Note:

Level 1 - F

Low-rank matrices, tournaments, and symmetric designs*

Niranjan Balachandran & Brahadeesh Sankarnarayanan†
Department of Mathematics, Indian Institute of Technology Bombay,
Mumbai 400076, Maharashtra, India.
{niranj,bs}@math.iitb.ac.in

29 April 2024

Abstract

Let $\mathbf{a} = (a_i)_{i \geq 1}$ be a sequence in a field $\mathbb{F}$, and $f : \mathbb{F} \times \mathbb{F} \to \mathbb{F}$ be a function such that $f(a_i, a_i) \neq 0$ for all $i \geq 1$. For any tournament T over $[n]$, consider the $n \times n$ symmetric matrix M_T with zero diagonal whose (i, j)th entry (for $i < j$) is $f(a_i, a_i)$ if $i \to j$ in T, and $f(a_j, a_i)$ if $j \to i$ in T. It is known [3] that if T is a uniformly random tournament over $[n]$, then $\text{rank}(M_T) \geq (\frac{1}{2} - o(1))n$ with high probability when $\text{char}(\mathbb{F}) \neq 2$ and f is a linear function.

In this paper, we investigate the other extremal question: how low can the ranks of such matrices be? We work with sequences $\mathbf{a}$ that take only two distinct values, so the rank of any such $n \times n$ matrix is at least $n/2$. First, we show that the rank of any such matrix depends on whether an associated bipartite graph has certain eigenvalues of high multiplicity. Using this, we show that if f is linear, then there are real matrices $M_T(f, \mathbf{a})$ of rank at most $\frac{n}{2} + O(1)$. For rational matrices, we show that for each $\varepsilon > 0$ we can find a sequence $\mathbf{a}(\varepsilon)$ for which there are matrices $M_T(f, \mathbf{a})$ of rank at most $(\frac{1}{2} + c)n + O(1)$. These matrices are constructed from symmetric designs, and we also use them to produce bisection-closed families of size greater than $\lfloor 3n/2 \rfloor - 2$ for $n \leq 15$, which improves the previously best known bound given in [5].

1 Introduction

Let a and b be two nonzero real numbers, and let T be a tournament over $[n]$. Consider the $n \times n$ symmetric matrix M_T with zero diagonal and $M_T(i, j) = a$ if $i \to j$ in T, and $M_T(i, j) = b$ if $j \to i$ in T, for all $i < j$.

What can be said about the rank of M_T?

1

18 Seats

BS in Mathematics program

The course fee is approximately 8,00,000 INR

This institution admits both male and female students

Example of Research in 2024

Low-rank matrices, tournaments, and symmetric designs

Niranjan Balachandran et al

Indian Institute Of Technology Kharagpur

Level 1 - G

37 Faculty members

147 journal publications in 2024

15 seminars related in mathematical science in 2024

Admission is based on the Joint Entrance Examination (JEE) Main rank.

West Bengal

Special Note:

Level 1 - G

Minsum Problem for Discrete and Weighted Set Flow on Dynamic Path Network*

Bubai Manna[1], Bodhayan Roy[1], and Vorapong Suppakitpaisarn[2]

[1] IIT Kharagpur, Kharagpur, India
[2] The University of Tokyo, Tokyo, Japan

Abstract. In this research, we examine the minsum flow problem in dynamic path networks where flows are represented as discrete and weighted sets. The minsum flow problem has been widely studied for its relevance in finding evacuation routes during emergencies such as earthquakes. However, previous approaches often assume that individuals are separable and identical, which does not adequately account for the fact that some groups of people, such as families, need to move together and that some groups may be more important than others. To address these limitations, we modify the minsum flow problem to support flows represented as discrete and weighted sets. We also propose a 2-approximation pseudo-polynomial time algorithm to solve this modified problem for path networks with uniform capacity.

Keywords: Minsum Bin Packing · Dynamic Flow · Approximation Algorithm.

1 Introduction

Flow problems on dynamic graphs [7] are considered by many researchers (e.g. [13,16]) because of many reasons. One of the reasons is their relevance in finding evacuation routes during emergencies such as earthquakes or fires [12]. In those applications, we aim to move persons in the ways that they arrive at aiding facilities as soon as possible.

A common objective function for those problems is minimax, which aims to minimize the time until all persons arrive at facilities. In this work, however, we consider another common objective function called minsum, which aims to minimize the summation of time that each individual needs for their trips.

Example 1. In Figure 1a, there are 4 people at node 1 and 6 people at node 2. These 10 people need to be transported to the aid facility at node 3. Both edges have capacity constraints: a maximum of 3 people can be moved on the edge between nodes 1 and 2 in one unit of time, and a maximum of 4 people can be

* This research was partly conducted during Bubai Manna's and Bodhayan Roy's visit to The University of Tokyo. The visit was hosted by Prof. Reiji Suda and was supported by the JST Sakura Science Program. Vorapong Suppakitpaisarn was partially supported by KAKENHI Grant 23H04377. The authors would like to thank the reviewers for their comments, which significantly improved this paper.

Example of Research in 2024

Minsum Problem for Discrete and Weighted Set Flow on Dynamic Path Network

Bodhayan Roy et al.

69 Seats
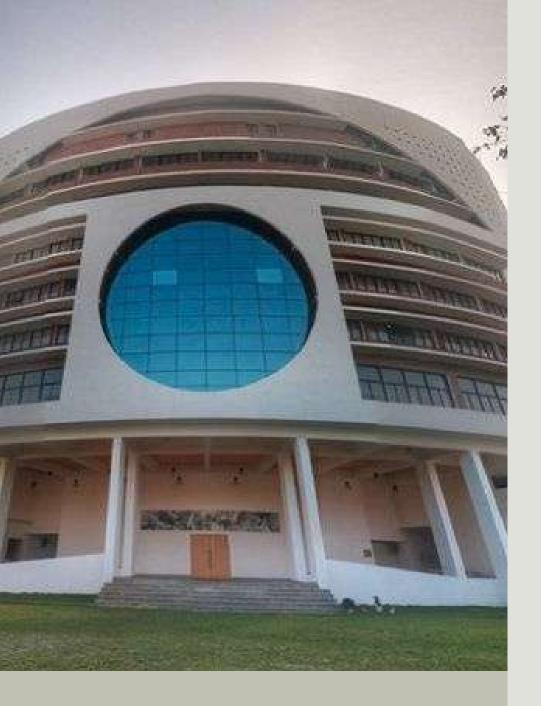
Bachelor of Science (BSc) program in Mathematics and Computing

The course fee is approximately 8,00,000 INR

This institution admits both male and female students

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Chennai Mathematical Institute

Level 1 - H

18 Faculty members

57 journal publications in 2024

66 seminars related in mathematical science in 2024

Tamil Nadu

CMI Entrance Exam, conducted in May. Direct Admission via National Olympiads In Mathematics - Mathematical Olympiad (RMO, INMO)

Untangling Climate's Complexity: Methodological Insights

Alka Yadav[1], Sourish Das[2,*], and Anirban Chakraborti[1,**]

[1]School of Computational and Integrative Sciences, Jawaharlal Nehru University, New Delhi-110067, India
[2]Chennai Mathematical Institute, Chennai-603103, Tamil Nadu, India
*sourish@cmi.ac.in
**anirban@jnu.ac.in

ABSTRACT

In this article, we review the interdisciplinary techniques (borrowed from physics, mathematics, statistics, machine-learning, etc.) and methodological framework that we have used to understand climate systems, which serve as examples of "complex systems". We believe that this would offer valuable insights to comprehend the complexity of climate variability and pave the way for drafting policies for action against climate change, etc. Our basic aim is to analyse time-series data structures across diverse climate parameters, extract Fourier-transformed features to recognize and model the trends/seasonalities in the climate variables using standard methods like detrended residual series analyses, correlation structures among climate parameters, Granger causal models, and other statistical machine-learning techniques. We cite and briefly explain two case studies: (i) the relationship between the Standardised Precipitation Index (SPI) and specific climate variables including Sea Surface Temperature (SST), El Niño Southern Oscillation (ENSO), and Indian Ocean Dipole (IOD), uncovering temporal shifts in correlations between SPI and these variables, and reveal complex patterns that drive drought and wet climate conditions in South-West Australia; (ii) the complex interactions of North Atlantic Oscillation (NAO) index, with SST and sea ice extent (SIE), potentially arising from positive feedback loops.

1 Introduction

"If you think the economy is more important than the environment, try holding your breath while counting your money." – Professor Guy McPherson

The climate system is an excellent example of a "complex system", which is composed of many interconnected and interdependent parts that exhibit "emergent" behaviors and properties not easily predictable from the behavior of individual parts or "sum of its parts"[1-3]. Complex systems are ubiquitous and hence are studied in various domains such as physics, biology, ecology, sociology, economics, environmental science, etc. They exhibit characteristics like: (i) non-linearity: Small changes in one part of the system can lead to significant and often unpredictable effects throughout the system; (ii) emergence: Novel properties or behaviors emerge at higher levels of organization that are not directly attributable to the individual components of the system; (iii) dynamical behavior and adaptation: systems often exhibit dynamic behaviors such as self-organization, chaos, phase transitions, and they have the ability to adapt and evolve in response to changes in their environment or internal dynamics; (iv) feedback loops: Interactions among system components create feedback loops, where the output of a process feeds back into the system, influencing further interactions, and often leading to catastrophic instabilities[4]. Understanding the dynamics of complex systems, therefore, necessitates a multidisciplinary approach

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Special Note:

Level 1 - H

Approximately 30 Seats

BSc (Hons) in Mathematics and Computer Science

The course Rs 1,25,000/- per semester

This institution admits both male and female students

Example of Research in 2024

Untangling Climate's Complexity: Methodological Insights

Sourish Das et al.

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Special Note:

Level 1 - H

FRÖBERG'S THEOREM, VERTEX SPLITTABILITY AND HIGHER INDEPENDENCE COMPLEXES

PRIYAVRAT DESHPANDE, AMIT ROY, ANURAG SINGH, AND ADAM VAN TUYL

ABSTRACT. A celebrated theorem of Fröberg gives a complete combinatorial classification of quadratic square-free monomial ideals with a linear resolution. A generalization of this theorem to higher degree square-free monomial ideals is an active area of research. The existence of a linear resolution of such ideals often depends on the field over which the polynomial ring is defined. Hence, it is too much to expect that in the higher degree case a linear resolution can be identified purely using a combinatorial feature of an associated combinatorial structure. However, some classes of ideals having linear resolutions have been identified using combinatorial structures. In the present paper, we use the notion of r-independence to construct an r-uniform hypergraph from the given graph. We then show that when the underlying graph is co-chordal, the corresponding edge ideal is vertex splittable, a condition stronger than having a linear resolution. We use this result to explicitly compute graded Betti numbers for various graph classes. Finally, we give a different proof for the existence of a linear resolution using the topological notion of r-collapsibility.

1. INTRODUCTION

Let G be a finite simple graph with $V(G) = \{x_1, \ldots, x_n\}$ as its vertex set and $E(G)$ be its edge set. The independence complex of G, denoted by $\mathrm{Ind}(G)$, is the simplicial complex whose simplices are independent subsets of vertices in G. The complex $\mathrm{Ind}(G)$ is an important object in combinatorics which lies at the crossroads of various fields of mathematics and computer science. For example, via *edge ideals*, a concept introduced by Villarreal [17], the independence complex appears in commutative algebra. In particular, let $R = \mathbb{K}[x_1, \ldots, x_n]$ be the polynomial ring in n variables over a field $\mathbb{K}$. Then the edge ideal $I(G)$ of G is the quadratic square-free monomial ideal $\langle x_i x_j \mid \{x_i, x_j\} \in E(G) \rangle$ of R. The ideal $I(G)$ is also the *Stanley-Reisner* ideal of $\mathrm{Ind}(G)$. Determining algebraic and homological properties of the ideal $I(G)$ in terms of the combinatorial properties of $\mathrm{Ind}(G)$ is an active area of research in commutative algebra.

In 2018 Paolini and Salvetti [16] considered a generalisation of the independence complex in the context of braid groups, called the *r-independence complex* $\mathrm{Ind}_r(G)$ of G, for any positive integer r. A subset $A \subseteq V(G)$ is called r-independent if each connected component of the induced subgraph $G[A]$ has at most r vertices. The collection of all r-independent sets forms the simplicial complex $\mathrm{Ind}_r(G)$. Note that $\mathrm{Ind}_1(G)$ is the independence complex of G.

The main focus of Paolini and Salvetti [16] was to understand twisted (co)homology groups of the classical braid groups via relating them to that of r-independence complexes of certain

1

Example of Research in 2024

Fröberg's theorem, vertex splittability and higher Independence complexes

Priyavrat C Deshpande et al.

Approximately 20 Seats

The course Rs 1,25,000/- per semester

BSc (Hons) in Mathematics & Physics

This institution admits both male and female students

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IISER Mohali

Punjab

21 Faculty members

34 journal publications in 2024

59 seminars related in mathematical science in 2024

Admission is primarily through the IISER Aptitude Test (IAT). The IAT assesses proficiency in Physics, Chemistry, Mathematics, and Biology.

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Indian Institute of Science Education and Research Mohali

Special Note:

Level 1 - I

The seat limit is approximately 270

Five Year Integrated BS-MS program

Example of Research in 2024

Automorphic Word Maps and Amit–ashurst Conjecture

Amit Kulshrestha et al.

The complete expenditure is Rs.424,950 approximately

This institution admits both male and female students

Math Ranks are prepared at www.cheenta.com | Olympiad, Research, & Leadership programs for outstanding school students

IISER Thiruvananthapuram

24 Faculty members

44 journal publications in 2024

72 seminars related in mathematical science in 2024

Admission is primarily through the IISER Aptitude Test (IAT). The IAT assesses proficiency in Physics, Chemistry, Mathematics, and Biology.

Kerala

Math Ranks are prepared at www.cheenta.com | Olympiad, Research, & Leadership programs for outstanding school students

Special Note:

Level 1 - J

The paper shown (left):

WELL-POSEDNESS OF THREE-DIMENSIONAL DAMPED CAHN-HILLIARD-NAVIER-STOKES EQUATIONS

MANIKA BAG, SHEETAL DHARMATTI AND MANIL T. MOHAN

ABSTRACT. This paper presents a mathematical analysis of the evolution of a mixture of two incompressible, isothermal fluids flowing through a porous medium in a three-dimensional bounded domain. The model is governed by a coupled system of convective Brinkman-Forchheimer equations and the Cahn-Hilliard equation, considering a regular potential and non-degenerate mobility. We first establish the existence of a Leray-Hopf weak solution for the coupled system when the absorption exponent $r \geq 1$. Additionally, we prove that every weak solution satisfies the energy equality for $r \geq 3$. This further leads to the uniqueness of weak solutions in three-dimensional bounded domains, subject to certain restrictions on the viscosity (ν) and the Forchheimer coefficient (β) in the critical case $r = 3$. Moreover, we provide an alternative simplified proof for the uniqueness of weak solutions for $r \geq 3$ that holds without imposing any restrictions on ν or β. Similar results are also obtained for the case of degenerate mobility and singular potential.

1. Introduction

We study here a diffuse interface model characterized by the local Cahn-Hilliard equation coupled with the convective Brinkman-Frochheimer equations or damped Navier-Stokes equations. To the best of authors' knowledge, this is the first paper considering such a coupling and its mathematical analysis. Our aim is to study the well-posedness of this model in three dimensions (3D) with various possible choices for the potential and mobility.

The diffuse interface theory explains how two fluids which do not squish easily but flow thickly move and how the boundary between them changes. This formulation was first introduced by Hohenberg and Halperin in [25]. The model is based on the equilibrium between mass and momentum, incorporating constitutive laws that align with a variant of the second law of thermodynamics. The model has been utilised in various numerical investigations for specific practical applications, such as droplet formation and collision, moving contact lines, large deformation flows, etc. We refer the readers to [6] and citations contained therein for an overview of these topics. The above formulation is characterised by the Cahn-Hilliard

[1,2]School of Mathematics, Indian Institute of Science Education and Research, Thiruvananthapuram (IISER-TVM), Maruthamala PO, Vithura, Thiruvananthapuram, Kerala, 695 551, INDIA.
e-mail: Manika Bag: manikabag19@iisertvm.ac.in
e-mail: Sheetal Dharmatti: sheetal@iisertvm.ac.in
[3]Department of Mathematics, Indian Institute of Technology Roorkee-IIT Roorkee, Haridwar Highway, Roorkee, Uttarakhand 247667, INDIA.
e-mail: Manil T. Mohan: maniltmohan@ma.iitr.ac.in, maniltmohan@gmail.com.
*Corresponding author.

Keywords: Cahn-Hilliard equation, Brinkman-Frochheimer equations, Leray-Hopf weak solution, energy equality
Mathematics Subject Classification (2020): Primary 35A01, 35A02, 76B03 ; Secondary 35Q35, 76D03 .

Example of Research in 2024

Well-posedness of Three-dimensional Damped Cahn-hilliard-navier-stokes Equations

Dharmatti Sheetal et al.

The seat limit is approximately 180

Integrated and Interdisciplinary Sciences (i2 Mathematical Sciences) program

The complete expenditure is Rs.3,57,000 approximately

This institution admits both male and female students

NISER

Odisha

22 Faculty members

36 journal publications in 2024

3 seminars related in mathematical science in 2024

Admission for the Bachelor Programme are conducted via National Entrance Screening Test (NEST), the pan-India test that NISER and CEBS, Mumbai jointly conduct for intake of students into the flagship Integrated BSc programme of these institutions.

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Special Note:

Level 2 - A

The seat limit is approximately 200

Integrated B.Sc. + M.Sc. program in Mathematics

The complete expenditure is Rs.95,650 approximately

This institution admits both male and female students

Example of Research in 2024

Coexistence of Hilbert Space Effects and Orthogonality

Anil Kumar Karn

COEXISTENCE OF HILBERT SPACE EFFECTS AND ORTHOGONALITY

ANIL KUMAR KARN

ABSTRACT. In this paper, we show that every pair of absolutely compatible Hilbert space effects are coexistent and exhibit a partial orthogonality property. We introduce the notion of partially ortho-coexistence. We generalize absolute compatibility to obtain more examples of partially ortho-coexistent pairs and introduce the notion of generalized compatibility. In the case of M_2, we discuss a geometric behaviour of the generalized compatibility.

1. INTRODUCTION

The study of measurements is one of the main objectives of quantum mechanics. In the classical formulation, an observable is represented by a projection valued measure defined on the Borel sets of $\mathbb{R}$. However, this formulation assumes that measurements are accurate which is far from reality.

To overcome this situation, G. Ludwig proposed an alternative formulation. In his mathematical formulation of quantum mechanics, a quantum event is represented by a self-adjoint operator on a complex Hilbert space whose spectrum lies in $[0, 1]$. Such operators are called *effects* or more specifically, *Hilbert space effects* and the set of all effects is called the *effect algebra*.

Let H be a complex Hilbert space and let $B(H)$ denote the set of all bounded linear operators on H. We write

$$B(H)_{sa} := \{x \in B(H) : x = x^*\}$$

where a^* is the adjoint operator of $a \in B(H)$ and

$$B(H)^+ := \{a \in B(H)_{sa} : \langle a\xi, \xi \rangle \geq 0 \text{ for all } \xi \in H\}.$$

For $x, y \in B(H)_{sa}$, we define $x \leq y$ (or $y \geq x$), if $y - x \in B(H)^+$.

1

Jadavpur University

Level 2 - B

34 Faculty members

192 journal publications in 2024

0 seminar related in mathematical science in 2024

West Bengal

Admission is based strictly on the marks obtained in the 10+2 Board examination. There is no admission test for the B.Sc. Mathematics program.

Special Note:

Level 2 - B

Abstract We have studied the formation of arbitrary amplitude ion-acoustic solitary structures using Sagdeev pseudo-potential approach in an unmagnetized dusty plasma system in the absence of collision whose constituents are combined Kappa-Cairns distributed electrons, negative-charged stationary dust particulates and adiabatic warm ions. This system supports both positive and negative potential conventional solitons along with the coexistence of these two solitons, double layers and supersolitons of negative polarity. Different types of solitary structures along with the impacts of the plasma parameters, viz., Mach number, suprathermal parameter and nonthermal parameter, of this system on the amplitude of these structures have been investigated by plotting the pseudo-potential with respect to the electrostatic potential. The formation of supersoliton after the formation of soliton has been illustrated using the mechanical analogy of phase portraits. The transition of soliton to supersoliton and soliton to double layer has been illustrated.

Keywords Ion-acoustic waves, Dusty plasma, Combined Kappa-Cairns distribution, Solitary waves, Phase portrait

Ion-acoustic solitary structures in electron-ion dusty plasma

Rittika Pain[1] • Sandip Dalui[2] • Sankirtan Sardar[3] • Anup Bandyopadhyay[1]

1 Introduction

The presence of a standard electron-ion plasma with an extra constituent, i.e., charged dust particle (Shukla and Mamun 2015) as the omnipresent constituent of the universe spurs research about dust-plasma interaction. The existence of charged dust particles has been identified by numerous spacecrafts in several well-known space systems such as comets (De Angelis et al. 1988), planetary rings (Goertz 1989; Verheest 1996; Merlino 2006; Lianhunthang 2019), Orion nebula, Eagle nebula, interstellar medium, circumstellar clouds (Verheest 2000; Shukla 2001; Merlino 2006; Shukla and Mamun 2015), Jupiter and Earth's atmosphere (Havnes et al. 1992; Shukla and Mamun 2015).

The appearance of dust particles with electron-ion plasma generates different acoustic wave mode (Shukla and Silin 1992). Numerous laboratory experiments (Barkan et al. 1996; Merlino et al. 1998; Nakamura and Sarma 2001) confirm the impact of dust grains on ion-acoustic waves (IAWs) in dusty plasma. After the confirmation of IAWs in dusty plasma both analytically and experimentally, several authors (De Angelis et al. 1988; Shukla and Rosenberg 1999; Bharuthram and Shukla 1992; Das et al. 2012; Paul et al. 2017; Debnath and Bandyopadhyay 2020) have studied nonlinear structures of IAWs including solitary structures like solitons, supersolitons (SS), and double layers (DLs) in dusty plasma. To characterize the propagation of arbitrary amplitude solitary waves, the Sagdeev pseudo-potential approach (Sagdeev and Leontovich 1966) was employed in the above-mentioned articles. Several researchers (Tolba 2021; El-Taibany et al. 2022; Halder et al. 2023b,a; Choudhury 2023; Naeem et al. 2023; Hussein and Selim 2021) have also explored the propagation characteristics of dust-acoustic and dust ion-acoustic waves in different plasma systems.

Rittika Pain
Sandip Dalui
Sankirtan Sardar
Anup Bandyopadhyay
Correspondence: dalui.sandip77@gmail.com
[1] Department of Mathematics, Jadavpur University, Kolkata - 700032, India.
[2] Division of Mathematics, School of Advanced Sciences, Vellore Institute of Technology, Chennai 600127 India.
[3] Department of Mathematics, Guru Ghasidas Vishwavidyalaya, Bilaspur 495009, India.

The seat limit is approximately 75

Integrated B.Sc. + M.Sc. program in Mathematics

The complete expenditure is ₹7200 approximately

This institution admits both male and female students

Example of Research in 2024

Ion-acoustic solitary structures in electron-ion dusty plasma

Anup Bandyopadhyay et al.

Indian Institute Of Technology Roorkee

Level 2 - C

28 Faculty members

174 journal publications in 2024

0 seminar related in mathematical science in 2024

Admission is based on the Joint Entrance Examination (JEE) Main and Advanced rank.

Uttarakhand

JFM PAPERS

Can isothermal plane Couette flow in fluid overlying porous layer be linearly unstable?

N. Barman[1], A. Aleria[1] and P. Bera[1],†

[1]Department of Mathematics, Indian Institute of Technology Roorkee, Roorkee 247667, India

The present study aims to examine the temporal linear stability analysis of isothermal plane Couette flow over a porous layer using the two-domain approach. The flow in the porous layer is described by the unsteady Darcy–Brinkman equations, whereas it is characterised by the Navier–Stokes equations in the fluid layer. In contrast to the Darcy model, it is observed that the isothermal plane Couette flow becomes unstable for such a superposed system on the inclusion of the Brinkman term. From the stability analysis, the two-dimensional mode is found to be least stable, and two modes of instability, namely porous mode and mixed mode are obtained under the consideration of the Darcy–Brinkman model along with advection term (DBA model). For Darcy number (δ) = 0.01, depending on the value of the stress-jump coefficient, mixed mode controls the instability of the system at small values of depth ratio ($\hat{d}$), and it disappears for relatively high values of $\hat{d}$, where the porous mode dominates. In addition, it has been observed that when $\hat{d} = 0.1$, the critical mode of instability is found to be mixed for $\delta > 0.02$ and porous for $\delta \leq 0.02$. The stress-jump coefficient destabilises the flow in terms of energy production through perturbed stresses at the interface. As observed in the case of isothermal plane Poiseuille flow studied by Chang, Chen & Straughan (J. Fluid Mech., vol. 564, 2006, pp. 287–303), here also depth ratio (Darcy number) stabilises (destabilises) the flow. However, this characteristic does not remain valid when the advection term is eliminated from the considered momentum equation. For a certain range of $\hat{d}(\delta)$, the destabilising (stabilising) characteristic of the respective parameters are encountered when the fluid mode of instability prevails.

Key words: shear-flow instability, porous media, multiphase flow

† Email address for correspondence: pberafma@iitr.ac.in

Aligarh Muslim University

26 Faculty members

143 journal publications in 2024

1 seminar related in mathematical science in 2024

Admission is based on the candidate's performance in the CUET, conducted by the National Testing Agency (NTA).

Uttar Pradesh

THE IMPACT OF SEED SIZE ON INITIAL DROUGHT STRESS RESILIENCE AND YIELD IN WHEAT CULTIVATION

CHATTHA MB, MAQSOOD MZ*, JAVID II, ALI S, ABBAS MA, ANAS M

Department of Agronomy, Faculty of Agricultural Sciences, Quaid e Azam Campus, University of the Punjab, Lahore, Pakistan
*Correspondence Author Email Address: zubairmaqsood034@gmail.com

Abstract Wheat yield is affected severely by drought in this era of changing climate patterns, including high temperatures and altered precipitation patterns. Drought is among the most challenging environmental stressors, limiting wheat cultivars' growth, productivity, and performance. The current study was conducted during the rabi season 2022 at the Research Area, Department of Agronomy, University of the Punjab, Lahore, Pakistan. Therefore, the present study evaluated the potential of diverse seed sizes to advance wheat crop growth, development, and yield when subjected to different drought levels. The study comprised two experiments. The first was a lab experiment that included different drought levels (DL), DL0: 0.0 bar, DL1: -2 bar, DL2: -4 bar, and DL3: -6 bar (drought levels were induced by solutions of PEG-6000 at different concentrations) and three wheat seed size classes, i.e., bold grain (>38 g), medium grain (<33 g), and small grain (<25 g). In the field experiment, drought stress levels were DL0 (regular irrigation), DL1 (first irrigation at 30 days), DL2 (first irrigation at 45 days), and DL3 (first irrigation at 60 days). Seed sizes included W1 (bold >38 g), W2 (medium <33 g), and W3 (small <25 g). Drought severity increased with DL1 to DL3. The outcomes of the field experiment revealed that varying levels of drought stress and seed size classes significantly affected parameters such as emergence time, growth traits, biomass allocation, tiller count, plant height, and grain and biomass outcomes. Bold seeds contributed to higher biomass and grain yield, while severe drought decreased yields. Notably, the Harvest Index was affected, indicating bold seeds allocate more biomass to grains. In conclusion, proper seed size selection, favouring bold seeds, can enhance resilience to drought, benefiting wheat cultivation in water-scarce regions.
[Citation: Chattha, M.B., Maqsood, M.Z., Javid, I.I., Ali, S., Abbas, M.A., Anas, M. (2024). The impact of seed size on initial drought stress resilience and yield in wheat cultivation. Bull. Biol. All. Sci. Res. 9: 79. doi: https://doi.org/10.54112/bbasr.v2024i1.79]
Keywords: Drought stress; Bold seed; Growth; Yield; Wheat

Introduction
Drought is a predominant environmental pressure that affects around 32% of the total area of 165 million hectares under wheat cultivation (Rajaram, 2000). The productivity of global crops faces a substantial threat from drought, which stands as one of the foremost abiotic stresses that severely inhibits growth and affects physiology and economic production (Ali et al., 2022; Kadam et al., 2014). Throughout the crop growth cycle, drought may emerge at any time. Nevertheless, two periods are anticipated: the early period, which may have an impact on seedling emergence, vegetative phase, and germination, and the later terminal drought, which may have an impact on pollination, seed growth, and overall formation (Watts & El Mourid, 1988). Thus, in wheat, the stages of stem elongation to booting are more affected negatively by drought than by flowering or grain-filling. Drought stress in wheat occurs during the early vegetative stages of leaf development, shoot elongation, and tillering, primarily due to reduced carbon dioxide assimilation caused by decreased transpiration, gaseous exchange, stomatal conductance, and restricted plant water supplies (Cossani & Reynolds, 2012).

Plants exhibit various drought tolerance mechanisms significantly in biomass distribution to the various organs (Asch et al., 1999). Semi-dwarf stature, early vigorous growth, tillering capacity, and early maturity serve as responsive strategies for environments characterized by terminal heat and drought stresses (Morgan, 1995; Van Ginkel et al., 1998; Kirkegaard et al., 2001; Bai et al., 2004 and Álvaro et al., 2008). Therefore, high-yielding, large-seeded, short-statured genotypes could offer substantial advantages to farmers in harsh environments like drought-pronounced areas. (Trethowan et al., 2001).

Drought caused a more incredibly significant amount of dry weight in stems rather than roots and leaves for high-yielding wheat genotypes (Veneklas & Peacock, 1994). According to Mason & Spaner (2006) and Andrew et al. (2015), plant height, early growth, and tillering capacity stand out as the most critical genotypic features that provide wheat and other cereals their competitive abilities. Opting for a tall, low-yielding wheat genotype over a semi-dwarf,

1

Example of Research in 2024

The Impact of Seed Size on Initial Drought Stress Resilience and Yield in Wheat Cultivation

Shakir Ali et al.

Aligarh Muslim University

Special Note:

Level 2 - D

The seat limit is approximately 120

B.Sc. (Hons.) in Mathematics

The yearly expenditure is ₹7,600 approximately

This institution admits both male and female students

Math Ranks are prepared at www.cheenta.com | Olympiad, Research, & Leadership programs for outstanding school students

Banaras Hindu University

Level 2 - E

25 Faculty members

132 journal publications in 2024

2 seminars related in mathematical science in 2024

Admission is based on the candidate's performance in the CUET, conducted by the National Testing Agency (NTA).

Uttar Pradesh

Special Note:

Level 2 - E

Example of Research in 2024

Modeling the impacts of chemical substances and time delay to mitigate regional atmospheric pollutants and enhance rainfall

A K Misra et al.

573 Seats (15% of its total seats for foreign nationals, including NRI(s) and PIOs)

B.Sc. (Hons.) in Mathematics

The complete expenditure is ₹17,052 approximately

This institution admits both male and female students

IISER Pune

Level 2 - F

25 Faculty members

66 journal publications in 2024

17 seminars related in mathematical science in 2024

Maharashtra

Admission is primarily through the IISER Aptitude Test (IAT). The IAT assesses proficiency in Physics, Chemistry, Mathematics, and Biology.

Special Note:

Level 2 - F

A MOTIVIC RIEMANN-ROCH THEOREM FOR DELIGNE-MUMFORD STACKS

UTSAV CHOUDHURY, NEERAJ DESHMUKH, AND AMIT HOGADI

ABSTRACT. We develop a motivic cohomology theory, representable in the Voevodsky's triangulated category of motives, for smooth separated Deligne-Mumford stacks and show that the resulting higher Chow groups are canonically isomorphic to the higher K-theory of such stacks. This generalises the Grothendieck-Riemann-Roch theorem to the category of smooth Deligne-Mumford stacks.

The seat limit is approximately 288

BS-MS dual degree program in Mathematical Sciences

The complete expenditure is ₹3,56,500 approximately

This institution admits both male and female students

Example of Research in 2024

A Motivic Riemann-roch Theorem for Deligne-mumford Stacks

Amit Hogadi et al.

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IISER Bhopal

23 Faculty members

48 journal publications in 2024

38 seminars related in mathematical science in 2024

Madhya Pradesh

Admission is primarily through the IISER Aptitude Test (IAT). The IAT assesses proficiency in Physics, Chemistry, Mathematics, and Biology.

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**HECKE EIGENVALUES
AND FOURIER–JACOBI COEFFICIENTS
OF SIEGEL CUSP FORMS OF DEGREE 2**

MURUGESAN MANICKAM, KARAM DEO SHANKHADHAR
AND VASUDEVAN SRIVATSA

The nonvanishing of the first Fourier–Jacobi coefficient of a Siegel eigenform F gives us that the vanishing of its m-th Fourier–Jacobi coefficient $F|\rho_m$ implies the vanishing of its m-th eigenvalue $\lambda_F(m)$. Conversely, we prove that for any odd, squarefree m if $\lambda_F(m)$ is zero then $F|\rho_m$ vanishes. While investigating this converse question and its important consequences, we generalize certain existing results of Kohnen and Skoruppa (1989) for index 1 Jacobi cusp forms to any arbitrary index, which are also of independent interest.

1. Introduction

In [6], Kohnen and Skoruppa introduced a novel Dirichlet series attached to any two Siegel cusp forms of degree 2 involving their Fourier–Jacobi coefficients. More importantly they could connect the Dirichlet series attached to a Siegel eigenform and any Siegel cusp form in the Maass space to the spinor zeta function of the Siegel eigenform. In particular, this connection gives us that the image of the m-th Fourier–Jacobi coefficient under certain adjoint operator is same as the m-th eigenvalue times the first Fourier–Jacobi coefficient of the Siegel eigenform (see (1)). Formally this could be viewed as an analogue of the relation between Fourier coefficients and eigenvalues of the Hecke eigenforms in the degree 1 case. Therefore it is natural to explore the relation between Fourier–Jacobi coefficients and eigenvalues further. In this paper, we take up this problem and investigate it in detail.

To state our results precisely, let us first introduce some notation. Throughout this article, k stands for an even integer and $k \geq 4$. Let $S_k(\Gamma_2)$ be the space of Siegel cusp forms of weight k for the symplectic group $\Gamma_2 := \mathrm{Sp}_4(\mathbb{Z})$. Let $J_{k,m}^{cusp}$ denote the space of Jacobi cusp forms of weight k and index m for the group $SL_2(\mathbb{Z}) \ltimes (\mathbb{Z} \times \mathbb{Z})$. For any $l \geq 1$, let $V_{m,l} : J_{k,m}^{cusp} \to J_{k,ml}^{cusp}$ be the linear operator defined by [3, page 41, (2)]

MSC2020: 11F11, 11F37, 11F46, 11F50.
Keywords: Siegel modular forms, Hecke operators, Hecke eigenvalues, Fourier–Jacobi coefficients, Jacobi forms, modular forms of integral and half-integral weight.

Example of Research in 2024

Hecke Eigenvalues And Fourier–jacobi Coefficients Of Siegel Cusp Forms of Degree 2

Karam Deo Shankhadhar et al.

Special Note:

Indian Institutes of Science Education and Research Bhopal

Level 2 - G

The number of seats is not specified

Integrated B.Sc. + M.Sc. program in Mathematics

The complete expenditure is ₹3.15 lakh approximately

This institution admits both male and female students

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BITS Pilani

21 Faculty members

121 journal publications in 2024

0 seminar related in mathematical science in 2024

BITSAT (BITS Admission Test): Admission is based on the candidate's performance in BITSAT, a computer-based online test conducted by BITS Pilani.

Rajasthan

Special Note:

Level 2 - H

The number of seats is not specified

Bachelor of Engineering in Mathematics and Computing (4 years)

The complete expenditure is ₹20.76 Lakh approximately

This institution admits both male and female students

Example of Research in 2024

A Parameter-uniform Implicit Approach for Two-parameter Singularly Perturbed Parabolic Problems

Devendra Kumar et al.

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A PARAMETER-UNIFORM IMPLICIT APPROACH FOR TWO-PARAMETER SINGULARLY PERTURBED PARABOLIC PROBLEMS

PARVIN KUMARI[1], DEVENDRA KUMAR[2], HIGINIO RAMOS[3,4]

ABSTRACT. A parameter-uniform implicit approach for two-parameter singularly perturbed boundary value problems is constructed. On the solution derivatives, sharp limits are presented. The solution is additionally divided into regular and singular components, limiting the derivatives of these components utilized in the convergence analysis. In the temporal direction, the system of ordinary differential equations produced by the Crank-Nicolson scheme on a uniform mesh is further discretized in the spatial direction by employing a finite difference technique on a selected Shishkin mesh. Through a rigorous analysis, we establish the theoretical results for two cases: Case I. $\varepsilon_1/\varepsilon_2^2 \to 0$ as $\varepsilon_2 \to 0$, and Case II. $\varepsilon_2^2/\varepsilon_1 \to 0$ as $\varepsilon_1 \to 0$, showing that the technique is convergent regardless of the magnitude of the $\varepsilon_1, \varepsilon_2$ parameters. The order of accuracy in Case I and II are shown to be $\mathcal{O}((\Delta t)^2 + N^{-1}(\ln N)^2)$ and $\mathcal{O}((\Delta t)^2 + N^{-2}(\ln N)^2)$, respectively. Two examples are presented to verify the theoretical results.

Keywords. two-parameter problems, Shishkin mesh, singular perturbation, parameter-uniform convergence, error estimates.

AMS subject classifications. 65L10, 65L12, 65L20, 65L70

1. INTRODUCTION

Consider the rectangular domain $\mathfrak{R} = \Omega \times \Lambda$ where $\Omega = (0,1)$, $\Lambda = (0,T]$. The boundary of the domain is $\mathfrak{d} = \mathfrak{d}_l \cup \mathfrak{d}_b \cup \mathfrak{d}_r$, where $\mathfrak{d}_l = \{(0,t) \mid t \in [0,T]\}$, $\mathfrak{d}_b = \{(x,0) \mid x \in [0,1]\}$ and $\mathfrak{d}_r = \{(1,t) \mid t \in [0,T]\}$ are the left, bottom and right boundaries of $\mathfrak{R}$, respectively. The goal of this work is to find accurate approximations to $\psi(x,t) \in C^{4,2}(\mathfrak{R})$, which is the solution of the following two-parameter parabolic singularly perturbed boundary value problem (SPBVP)

$$L\psi(x,t) = -\frac{\partial \psi}{\partial t} + \varepsilon_1 \frac{\partial^2 \psi}{\partial x^2} + \varepsilon_2 a(x,t) \frac{\partial \psi}{\partial x} - b(x,t)\psi(x,t) = f(x,t), \quad (x,t) \in \mathfrak{R}, \quad (1.1a)$$

$$\psi(x,0) = \psi_b(x), \; x \in \bar{\Omega}, \quad (1.1b)$$

$$\psi(0,t) = \psi_l(t), \; t \in \bar{\Lambda}, \quad (1.1c)$$

$$\psi(1,t) = \psi_r(t), \; t \in \bar{\Lambda}. \quad (1.1d)$$

where $0 < \varepsilon_1, \varepsilon_2 \ll 1$ are the perturbation parameters. The following assumptions are made to establish the existence and uniqueness of the solution of problem (1.1):

- All the functions involved in problem (1.1) are considered to be bounded and twice continuously differentiable.
- $a(x,t) \geq a^* > 0$, $b(x,t) \geq b^* > 0$, $(x,t) \in \bar{\mathfrak{R}}$.
- At the domain's corner points, the corresponding compatibility conditions are met.

The two-parameter SPBVPs have applications in electrical networks, control theory, lubrication theory [4,13,14]. To the best of our knowledge, O'Malley was the first to study these issues asymptotically (see [14–19]). When $\varepsilon_2 = 1$, an exponential boundary layer of width $O(\varepsilon_1)$ appears in the vicinity of $\mathfrak{d}_l$, and when $\varepsilon_2 = 0$, parabolic boundary layers of width $O(\sqrt{\varepsilon_1})$ appear as $\varepsilon_1 \to 0$ at the left and right lateral boundaries. Here, we will

[1]Department of Mathematics and Statistics, Manipal University Jaipur- 303007, India
[2]Department of Mathematics, Birla Institute of Technology and Science, Pilani, Rajasthan-333031, India
[3]Scientific Computing Group, Universidad de Salamanca, Plaza de la Merced, 37008 Salamanca, Spain
[4]Escuela Politécnica Superior de Zamora, Campus Viriato, 49029 Zamora, Spain
E-mails: parvinbsdmnl@gmail.com (P. Kumari), dkumar@pilani.bits-pilani.ac.in (D. Kumar), higra@usal.es (H. Ramos)
Manuscript received on December 28, 2023.

1

A. John Presin Kumar[1], M. Rajesh[1(✉)], P. Loganathan[2], M. Dhanashekar[3], S. Ayyanar[4], V. Nadanakumar[5], J. Godwin John[6], P. Sarmaji Kumar[7], and R. Selva Kumar[5]

[1] Department of Mechanical Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, India
Mvrajesh1991@gmail.com
[2] Department of Mechanical Engineering, Karpaga Vinayaga College of Engineering and Technology, Chinna Kolambakkam, Chennai, India
[3] Department of Mechanical Engineering, Bharath Institute of Higher Education and Research, Selaiyur, Chennai, India
[4] Department of Mechanical Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Chennai, India
[5] Department of Automobile Engineering, Hindustan Institute of Technology and Science, Padur, Chennai, India
[6] Department of Mechanical Engineering, Rajalakshmi Institute of Technology, Poonamalle, Chennai, India
[7] Department of Mechanical Engineering, Prathyusha Engineering College, Chennai, India

Abstract. The influence of TiB$_2$ particles on wear characteristics of AA7175 composite was achieved by using powder metallurgy techniques to fabricate the composite material. The distribution of TiB$_2$ particles on AA7175 is analysed using a Scanning Electron Microscope (SEM). An Analysis of Variance (ANOVA) is used to examine the dry sliding wear behaviour of a composite in order to determine an optimal performance parameter. The influence of variables such as the rate at which two surfaces slide against each other, the amount of force applied, the distance across which sliding occurs, and the proportion of reinforcement present. This study is centred around the utilisation of a reduced matrix to determine the optimal parameters for dry sliding wear characteristics. The composite exhibited a favourable sintering reaction, resulting in the attainment of maximal density. The SEM micrographs revealed an effective dispersion of reinforcing particles throughout the composites. The ANOVA analysis provided the optimal parameter settings for the wear process. The increase in load has a substantial impact on the worn surface, as shown by the influence of frictional heat on the intermediate zone and the observation of scale development in the SEM images.

Keywords: Aluminium composite powder metallurgy · Optimization · Worn surface · SEM

Anna University

Special Note:

Level 2 - I

The seat limit is approximately 100.Other state students cannot apply for BSc programs at Anna University

BSc Mathematics program

The complete expenditure is not specified properly

This institution admits both male and female students

Example of Research in 2024

Global analysis of acoustic frequency characteristics in birds
Akash Anand et al.

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IISER Kolkata

18 Faculty members

36 journal publications in 2024

29 seminars related in mathematical science in 2024

West Bengal

Direct Admission is based Candidates JEE Advanced rank within a specified cutoff. Candidates who have passed 10+2 with science subjects but do not have JEE Advanced eligibility can appear for the IISER Aptitude Test

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Example of Research in 2024

Mean Residual Life Ageing Intensity Function

Asok K. Nanda et al.

Indian Institutes of Science Education and Research Kolkata

Special Note:

Level 2 - J

The seat limit is not clearly specified

5 Year BS-MS Dual Degree Programme

The semester based expenditure is ₹44,455 approximately

This institution admits both male and female students

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Hansraj College

21 Faculty members

21 journal publications in 2024

4 seminars related in mathematical science in 2024

Admission is based on the candidate's performance in the CUET exam

Delhi

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Special Note:

Level 3 - A

The seat limit is 101 approximately

BSc (Hons.) in Mathematics

Example of Research in 2024

Conjugacy Classes of Automorphisms of the Unit Ball in a Complex Hilbert Space

Mukund Madhav Mishra et al.

The entire academic expenditure is ₹540 approximately
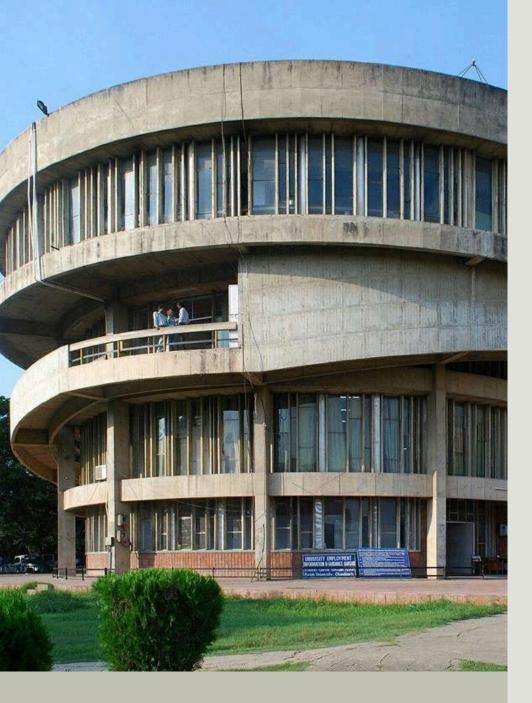
This institution admits both male and female students

Panjab University

21 Faculty members

40 journal publications in 2024

0 seminar related in mathematical science in 2024

Admission is based on the candidate's performance in the iPanjab University Common Entrance Test (Undergraduate) [PU-CET (U.G.)].

Punjab

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Panjab University

Special Note:

Level 3 - B

The seat limit is 35 approximately

B.Sc. (Hons.) in Mathematics program

The entire academic expenditure is ₹40,625 approximately

This institution admits both male and female students

Example of Research in 2024

Corrigendum to "The discriminant of compositum of algebraic number fields"

Mukund Madhav Mishra et al.

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Rational group algebras of generalized strongly monomial groups: primitive idempotents and units

Gurmeet K. Bakshi[a,*], Jyoti Garg[a,†] and Gabriela Olteanu[b]

[a]Department of Mathematics,
Panjab University, Chandigarh 160014, India
and
[b]Department of Statistics-Forecasts-Mathematics,
Babeş-Bolyai University, Str. T. Mihali 58-60, 400591 Cluj-Napoca, Romania
emails: gkbakshi@pu.ac.in, jyotigarg0811@gmail.com, gabriela.olteanu@econ.ubbcluj.ro

Abstract

We present a method to explicitly compute a complete set of orthogonal primitive idempotents in a simple component with Schur index 1 of a rational group algebra $\mathbb{Q}G$ for G a finite generalized strongly monomial group. For the same groups with no exceptional simple components in $\mathbb{Q}G$, we describe a subgroup of finite index in the group of units $\mathcal{U}(\mathbb{Z}G)$ of the integral group ring $\mathbb{Z}G$ that is generated by three nilpotent groups for which we give explicit description of their generators. We exemplify the theoretical constructions with a detailed concrete example to illustrate the theory. We also show that the Frobenius groups of odd order with a cyclic complement is a class of generalized strongly monomial groups where the theory developed in this paper is applicable.

Keywords: Shoda pairs, generalized strong Shoda pairs, primitive idempotents, unit group, Schur index, Frobenius groups.

MSC2000 : 16K20, 16S35, 16U60, 20C05, 17C27.

1 Introduction

The primitive idempotents in semisimple group algebras have been studied in a series of articles (see [VGO11, JOdR12, JOdRVG13, OVG15, OVG16, OVG22]).

1

Kirori Mal College

20 Faculty members

17 journal publications in 2024

1 seminar related in mathematical science in 2024

Admission is based on the candidate's performance in the CUET exam

Delhi

Special Note:

Level 3 - C

The seat limit is 83

B.Sc. (Hons.) in Mathematics

The entire academic expenditure is ₹50,445 approximately

This institution admits both male and female students

Example of Research in 2024

Frames as Operator Orbits for Quaternionic Hilbert spaces

Dr. Shiv Kumar Kaushik et al.

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(Inset journal article excerpt:)

Frames as Operator Orbits for Quaternionic Hilbert spaces

Ruchi Bhardwaj[1], S. K. Sharma[2,*] and S. K. Kaushik[3]

[1] Department of Mathematics, University of Delhi
[2] Department of Mathematics, Kirori Mal College, University of Delhi
[3] Department of Mathematics, Kirori Mal College, University of Delhi

Abstract: In this paper, we study frames which can be expressed as operator orbits $\{\mathcal{T}^n(\phi)\}_{n\in\mathbb{Z}}$ under a single generator ϕ and an operator $\mathcal{T}$ on a right quaternionic Hilbert space $\mathfrak{H}$ and prove a necessary and sufficient condition under which the sequence $\{\mathfrak{h}_n\}_{n\in\mathbb{Z}}$ is expressible as orbit of some operator $\mathcal{T}$. Also, a necessary condition for a frame $\{\mathfrak{h}_n\}_{n\in\mathbb{Z}}$ to have an operator orbit representation $\{\mathfrak{h}_n\}_{n\in\mathbb{Z}} = \{\mathcal{T}^n(\mathfrak{h}_0)\}_{n\in\mathbb{Z}}$ using a bounded operator $\mathcal{T}$ is given. Further, a characterization for the boundedness of the operator $\mathcal{T}$, given that $\{\mathfrak{h}_n\}_{n\in\mathbb{Z}} = \{\mathcal{T}^n(\mathfrak{h}_0)\}_{n\in\mathbb{Z}}$ forms a frame is obtained. Moreover, it is proved that a redundant frame with finite excess can never be expressed as an orbit of a bounded operator whereas for a Riesz sequence an operator orbit representation with a bounded operator is always possible. Furthermore, we discuss the stability of frames that can be expressed as an orbit of some operator and prove that it remains undisturbed under some perturbation conditions. Finally as an application, we approximate frames that cannot be expressed as operator orbit using the sub-orbit representation of hypercyclic operators.

Keywords: Frames; Operator orbit; Quaternions.

2010 Mathematics Subject Classification. 94A20; 42C15.

1 Introduction and Preliminaries

In recent years, many researchers have studied the concept of dynamical sampling with the help of frames. Aldroubi et al. [1,2,3] presented the notion of dynamical sampling that analyses the properties of the sequences expressible as orbit of some operator under single generator. Also, Christensen et al. [5,6] gave some crucial results concerning the boundedness of the operator and stability of operator representation of frames. One of the main concerns of dynamical sampling is to examine the frames expressible as $\{\mathcal{T}^n(\psi)\}_{n\in\mathbb{Z}}$ where $\mathcal{T} : \mathfrak{H} \to \mathfrak{H}$ is a bounded operator and $\psi \in \mathfrak{H}$ is a fixed element. But, this is quite restrictive and not very easy to achieve expression using a bounded operator. Various necessary and sufficient conditions required for these orbit representations have been already studied in Hilbert spaces [8,9]. Along with that, there comes some limitations as well that are also considered and rectified by many researchers in context of dynamical sampling [7]. But, can this very significant topic of dynamical sampling be extended to quaternionic Hilbert spaces? This question motivates us to prove some of the important results of Hilbert spaces concerning orbit representation of frames sequences, for quaternionic Hilbert spaces.

Moreover, the concept of frame sequences and their generalizations have been already introduced to quaternionic Hilbert spaces in [11,13]. The generalization of this concept of frame sequences as operator orbits, to quaternionic Hilbert spaces has become an interesting problem because of its significant applications in dynamical sampling concerning quaternionic Hilbert spaces. In this article, our main concern is to deal with the frame properties of the sequences $\{\mathcal{T}^n(\psi)\}_{n\in\mathbb{Z}}$, which are expressible as an orbit of some operator $\mathcal{T}$ in quaternionic Hilbert spaces. Once we get the desired representation with the help of some operator, the very next crucial part is to check for the conditions under which such an expression is feasible with some bounded operator $\mathcal{T}$. It gives rise to many questions, as if every frame could have this representation? If not, can we approximate these frames with orbit or sub-orbit of any operator?
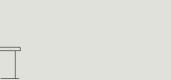
* Corresponding author e-mail: sumitkumarsharma@gmail.com

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On the Design of a Searchable Encryption Protocol for Keyword Search using Proactive Secret Sharing

Praveen K*, Gabriel Anand K S*, Indranil Ghosh Ray†, Avishek Adhikari‡, Sabyasachi Datta§, Arnab Kumar Biswas†

*TIFAC CORE in Cyber Security, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, India
†Queen's University Belfast, UK
‡Department of Mathematics, Presidency University, India
‡Department of Computer Science and Engineering, SRM University, India
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†{I.GhoshRay,a.biswas}@qub.ac.uk,
‡avishek.maths@presiuniv.ac.in,§sabyasachi.d@srmap.edu.in

Abstract—Searchable encryption allows users to perform search operations on encrypted data before decrypting it first. Secret sharing is one of the most important cryptographic primitives used to design an information theoretic scheme. Nowadays cryptosystem designers are providing a facility to adjust the security parameters in real time to circumvent AI-enabled cyber security threats. For long term security of data which is used by various applications, proactive secret sharing allows the shares of the original secret to be dynamically adjusted during a specific interval of time. In proactive secret sharing, the updation of shares at regular intervals of time is done by the servers (participants) and not by the dealer. In this paper, we propose a novel proactive secret sharing scheme where the shares stored at servers are updated using preshared pairwise keys between servers at regular intervals of time. The direct search of words over sentences using the conjunctive search function without the generation of any index is possible using the underlying querying method.

Index Terms—Searchable Encryption, Secret Sharing, Proactive Secret Sharing, Information Theoretic Security, Hardware Secure Module.

I. INTRODUCTION

With the advent of generative AI, one new interdisciplinary area of research that is emerging very fast is AI enabled encryption. With AI enabled encryption, the data owner can readjust the security parameters in the future depending on the risk factors so as to guard AI enabled machine learning attack. Another new areas of study in the cyber security are homomorphic encryption[3] and searchable encryption(SE)[22] as a tool of secure science communication, which allows privacy-preserving search operations on queries directly over encrypted data without having to decrypt it. In the standard searchable encryption, the schemes are always exposed to the risk of *search pattern attack* and *access pattern attack*. In this paper, we study the searchable encryption technique under the provision of readjustment of some security parameters by using proactive secret sharing so as to make the encryption technique secure from AI enabled machine learning attacks, mostly by exploiting search pattern and access pattern.

PCI DSS (Payment Card Industry Data Security Standard) is an information security standard which enforces security for the cardholder data so as to reduce payment card fraud. As per the PCI DSS, the card information (debit and credit) should not be stored in plain text. To comply with PCI DSS, companies use a hashing technique (SHA-256) to store the card information in the database. So during the transaction when the user enters his card details, based on the hash value of the card details the information such as name and address are auto-filled. The hashing technique has its limitations. Firstly it is exposed to the risk of statistical attack. Secondly, with this method any third party having the oracle access of the hash engine can perform a successful search. Thirdly this method is susceptible to replay attack. Adversary can eavesdrop and collect the previous hashes used for search, and can reuse them for future search. Recall that searchable encryption is a technique which allows privacy-preserving search operations or queries over encrypted data which can address most of the above mentioned security issues. In

Example of Research in 2024

On the Design of a Searchable Encryption Protocol for Keyword Search using Proactive Secret Sharing

Avishek Adhikari et al.

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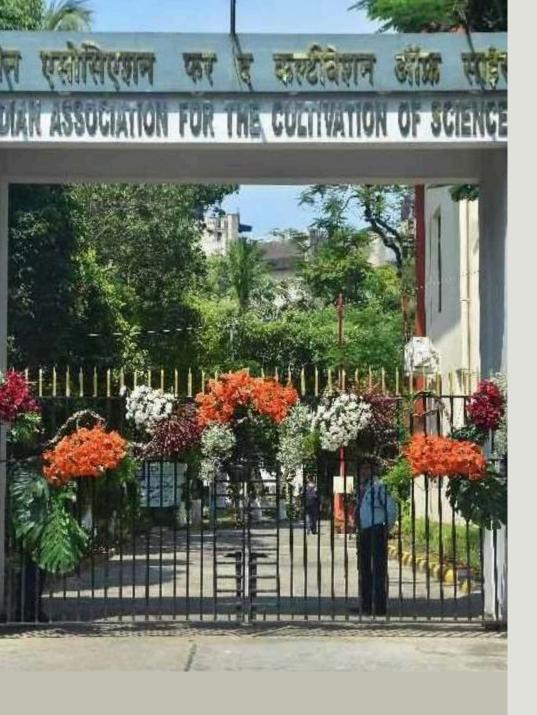
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ARCH-COMP 2024 Category Report: Falsification

Rajarshi Ray et al.

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ARCH-COMP 2024 Category Report: Falsification

Tanmay Khandait[1], Federico Formica[2]; Paolo Arcaini[3], Surdeep Chotaliya[1], Georgios Fainekos[4], Abdelrahman Hekal[5], Atanu Kundu[6], Ethan Lew[7], Michele Loreti[8], Claudio Menghi[9,2], Laura Nenzi[10], Giulia Pedrielli[1], Jarkko Peltomäki[11], Ivan Porres[11], Rajarshi Ray[6], Valentin Soloviev[11], Ennio Visconti[12], Masaki Waga[13], and Zhenya Zhang[14]

[1] Arizona State University (ASU), Tempe, USA {tkhandai,schotali,gpedriel}@asu.edu
[2] McMaster University, Hamilton, Canada {formicaf,menghic}@mcmaster.ca
[3] National Institute of Informatics (NII), Tokyo, Japan arcaini@nii.ac.jp
[4] Toyota Motor North America, Research & Development georgios.fainekos@toyota.com
[5] Newcastle University, Newcastle upon Tyne, UK a.waleed-elsayed-aly-hekal@newcastle.ac.uk
[6] Indian Association for the Cultivation of Science, Kolkata, India {mcsak2346,rajarshi.ray}@iacs.res.in
[7] Galois Inc, Portland, USA elew@galois.com
[8] University of Camerino, Camerino, Italy michele.loreti@unicam.it
[9] University of Bergamo, Bergamo, Italy claudio.menghi@unibg.it
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[13] Kyoto University, Japan mwaga@fos.kuis.kyoto-u.ac.jp
[14] Kyushu University, Japan zhang@ait.kyushu-u.ac.jp

Abstract
This report presents the results from the falsification category of the 2024 competition in the Applied Verification for Continuous and Hybrid Systems (ARCH) workshop. The report summarizes the competition rules and settings, the benchmark models for the tool comparison, and provides background on the participating teams and tools. Finally, it presents and discusses the results of the competition.

Data: https://gitlab.com/goranf/ARCH-COMP, https://dx.doi.org/10.5281/zenodo.8824426

1 Introduction

The Applied Verification for Continuous and Hybrid Systems (ARCH) competition is a yearly competition comparing state-of-the-art tools for testing and verifying hybrid systems. The com-

*The first two authors lead the validation effort for the falsification category. The remaining authors represent all participants who have contributed results and/or text to this report and they are listed alphabetically.

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Abstract In this paper, a new scalarization function is introduced with respect to a partial set order relation established by Karaman et. al. (Positivity 22(3) : 783 − 802, 2018). A few properties of this function are studied. Scalarization results and some characterizations for set of minimal and weak minimal solutions of a set optimization problem (SOP) in terms of the optimal solution set of the scalar optimization problem (P) are obtained using the newly defined scalarization function. Further, two types of well-posedness for (SOP) are introduced. Equivalence between the well-posedness of (SOP) with (P) is established and a few necessary conditions are obtained for the two well-posedness defined above.

Keywords Set optimization · Partial set order relation · Scalarization function · Well-posedness

Mathematics Subject Classification (2010) 49J53 · 49K40 · 90C48

1 Introduction

In the last few decades, set optimization problems have received a great attention due to its wide applications. Many problems in different areas like welfare economics, fuzzy and robust optimization, game theory and many more (see

Sakshi Gupta, Corresponding Author
Department of Mathematics, University of Delhi, Delhi 110007, India.
E-mail: sakshidumaths@gmail.com

Rekha Gupta
Department of Mathematics, Miranda House, University of Delhi, Delhi 110007, India.
E-mail: rekhagupta0283@gmail.com

Manjari Srivastava
Department of Mathematics, Miranda House, University of Delhi, Delhi 110007, India.
E-mail: manjari.srivastava@mirandahouse.ac.in

Example of Research in 2024

On scalarization and well-posedness in set optimization with a partial set order relation

Manjari Srivastava et al.

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Analysis of Stability, Bifurcation, and Chaos in Generalized Mackey-Glass Equations

Sachin Bhalekar et al.

Analysis of Stability, Bifurcation, and Chaos in Generalized Mackey-Glass Equations

Deepa Gupta and Sachin Bhalekar

November 6, 2024

Abstract

Mackey-Glass equation arises in the leukemia model. We generalize this equation to include fractional-order derivatives in two directions. The first generalization contains one whereas the second contains two fractional derivatives.

Such generalizations improve the model because the nonlocal operators viz. fractional derivatives are more suitable for the natural systems. We present the detailed stability and bifurcation analysis of the proposed models. We observe stable orbits, periodic oscillations, and chaos in these models. The parameter space is divided into a variety of regions, viz. stable region (delay independent), unstable region, single stable region, and stability/instability switch. Furthermore, we propose a control method for chaos in these general equations.

1 Introduction

Insertion of the delay improves the dynamics by modeling memory in the natural systems accurately [1, 2, 3, 4]. In the delay differential equations (DDE), the rate of change of the state at the present time depends on the state values in the past. These systems are popular among mathematicians, too, because they are infinite dimensional systems, and their stability analysis is a challenging task [5]. In contrast with their ODE counterparts, the scalar DDEs may exhibit chaotic oscillations [6, 7, 8, 9, 10].

On the other hand, including a nonlocal operator such as fractional order derivative makes the model more realistic [11]. Fractional differential equations are employed to model the phenomena in Physics [12], Visco-elasticity [13, 14], Biology [15, 16], Engineering [17] and Economics [18, 19]. Thus, the equations involving the delay and fractional derivative are crucial [20]. Stability analysis of fractional order delay differential equations is provided in [21, 22, 23, 24, 25, 26].

In their celebrated paper [27], Mackey and Glass proposed a simple scalar nonlinear delay differential equation $\dot{x}(t) = \frac{ax(t-\tau)}{1+x^n(t-\tau)} - \mu x(t)$ modeling physiological system. This equation models the control of hematopoiesis in chronic granulocytic leukemia patients. The equation shows various dynamical behavior, including periodic and chaotic oscillations. Oscillatory solutions of such equations and the global attractivity are presented in [28, 29, 30]. The electronic analog of the Mackey-Glass (MG) system is designed in [31, 32]. Losson et al. [33] discussed the multistability in the MG and some other DDEs.

Motivated by the above discussion, we propose the generalizations to the MG model to include the Caputo fractional derivatives.

The paper is organized as follows: Section 2 present some basic definitions, theorems and the literature survey related to classical Mackey-Glass equation. Section 3 describes the stability, bifurcation, chaos and chaos control in the fractional-order Mackey-Glass equation. Analysis of the generalized Mackey-Glass equation containing two fractional derivatives is given in Section 4. Validation of results are described in Section 5. Section 6 concludes the results given in the paper.

2 Preliminaries

In this section, we provide some basic definitions described in the literature [34, 35, 11, 21, 36, 24].

1

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Tamil Nadu

Annmaria Baby [a], D. Antony Xavier [a], Syed Ajaz K. Kirmani [b], Muhammad Imran [c,*], Muhammad Usman Ghani [d], Manal Elzain Mohamad Abdalla [e]

[a] Department of Mathematics, Loyola College, University of Madras, Chennai, India
[b] Department of Electrical Engineering, College of Engineering, Qassim University, Saudi Arabia
[c] Department of Mathematics and Natural Sciences, Prince Mohammad Bin Fahd University, P.O. Box 1664, Al Khobar 31952, Saudi Arabia
[d] Institute of Mathematics, Khawaja Fareed University of Engineering & Information Technology, Abu Dhabi Road, 64200, Rahim Yar Khan, Pakistan
[e] Department of Mathematics, King Khalid University, Muhayil, Saudi Arabia

ABSTRACT

Carbon nanocone, characterized by planar networks primarily consisting of hexagonal carbon faces and a few pentagons in the core, hold significant promise in various fields such as electronics, medicine, and material research due to their exceptional properties. This study exclusively investigates the topological descriptors of symmetrically configured carbon nanocones, specifically nanocones with two and three pentagonal core respectively. By modeling these structures as chemical graphs and employing molecular descriptors, we aim to provide a quantitative analysis of the structures without laboratory experimentation. The quotient graph approach is employed to determine the distance based descriptors, namely wiener, szeged and Padmakar-Ivan indices for these symmetrically configured carbon nanocones. The analytically closed formulas determined could be useful in quantitative structure-property-activity relationship studies, which helps in predicting the physico-chemical properties of the underlying structures. Thus the findings in this work not only deepen our understanding of symmetric carbon nanocones but also pave the way for significant advancements in nanotechnology and materials science.

ARTICLE INFO

Keywords:
Carbon
Nanocone
Quotient graph approach
Distance based descriptors
Wiener index
Szeged indices
Padmakar-Ivan index

1. Introduction

1.1. Carbon nanocone - an overview

Carbon nanocones, conical-shaped carbon nanostructures, were first observed by Harris et al. [1], but it was not until 1999 that Iijima et al. officially identified them. These nanocones are categorized into single-walled and multi-walled types. The synthesis of multi-walled carbon nanocones was achieved in 1997 via the pyrolysis of heavy oil in a carbon electric arc, while clustered nanocones were produced in 1999 using laser ablation of graphite [3–4]. Carbon nanocones are planar graphs predominantly featuring hexagonal faces with non-hexagonal faces, typically pentagons, located in the core. Variations in the number and arrangement of these non-hexagonal and hexagonal faces define different nanocone types. Notable among the nanocone category is the single k-gonal nanocone. They are characterized by a core cycle C_k, where $k \geq 3$ surrounded by concentric layers of hexagons. Another type feature mul-

tiple pentagons in the core, enclosed by concentric hexagonal layers. Carbon nanocones are developed from graphitic structures, whose classifications are described by Douglas J. Klein in [5]. He has given a complete categorization of global aspects of locally defected graphitic structures, which are the nanocones. In [6] Douglas J. Klein and Alexandru T. Balaban have detailed about the eight classes of different nanocone structures along with its various sub-classes. Eight distinct core types have been documented in [7] with each configuration exhibiting superior porosity, conductivity, chemical stability, and catalytic properties compared to other carbon nanostructures. Consequently, nanocones are considered viable alternatives to carbon nanotubes and graphene, finding applications in biofuel cells, supercapacitors, gas storage devices, biochemical sensing, and electrochemical sensing [8–11].

In our study, we consider carbon nanocone with two and three pentagons in their core along with a symmetric arrangement of the hexagonal faces. These symmetrically configured nanocones are denoted as $CN_s^z(n) : x \in \{2, 3\}$ and $n \geq 1$, where 's' represents their structural sym-

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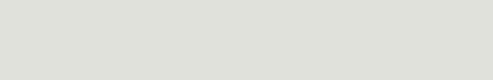
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Molecular descriptors of symmetrically configured carbon nanocones via quotient graph technique

D. Antony Xavier et al.

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Poisson Input and Exponential Service Time Finite Capacity Interdependent Queueing Model with Breakdown and Controllable Arrival Rates

S Nivetha Therasal[1]*, M Thiagarajan[1]

1 PG & Research Department of Mathematics, St. Joseph's College (Autonomous), Affiliated to Bharathidasan University, Tiruchirappalli, 620002, Tamil Nadu, India

Abstract

Objectives: This study aims at (i) introducing the finite capacity of the interdependent queueing model with breakdown and controllable arrival rates, (ii) calculating the average number of clients in the system, and identifying the expected waiting period of the clients in the system, (iii) dealing with the model descriptions, steady-state equations, and characteristics, which are expressed in terms of $P_{(1,1)}(0)$, and (iv) analyzing the probabilities of the queueing system and its characteristics with numerical verification of the obtained results. **Methods:** While providing the input, the arrival rates through faster and slower arrival rates are controlled using the Poisson process. Also, the service provides an exponential distribution. The server provides the service on an FCFS basis. In this article, two types of models are used: $(1, i)$ and $(2, i)$ which are the system's conditions, where i represents the number of units present in the queue in which their probability is $P_{1,i}$ and $P_{2,i}$. All probabilities are distributed based on the speed of advent using this concept. Then, the steady-state probabilities are computed using a recursive approach. **Findings:** This paper discovers the number of clients using the system on average (L_s) and the expected number of clients in the system (W_s) using the probability of the steady-state calculation. Little's formula is used to derive the expected waiting period of the clients in the system. **Novelty:** There are articles connected to the finite capacity of failed service in functioning and malfunctioning, but this takes the initiative to provide a link in connection with the rates of the controllable arrivals and interdependency in the arrival and service processes.

Mathematics Subject allocation: 60K25, 68M20, 90B22.
Keywords: M/M/1/K Queue Model; Finite Capacity; Breakdown; Controllable Arrival rates; FCFS Queue Discipline

St. Joseph's College

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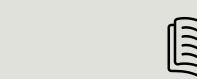
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Poisson Input and Exponential Service Time Finite Capacity Interdependent Queueing Model with Breakdown and Controllable Arrival Rates

M Thiagarajan et al.

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Couette flow of viscoelastic dusty fluid through a porous oscillating plate in a rotating frame along with heat transfer

Gohar Ali[1] | Matin Ahmad[1] | Farhad Ali[1] |
Arshad Khan[2] | Ilyas Khan[3]

[1]Department of Mathematics, City University of Science and Information Technology, Peshawar, Pakistan

[2]Institute of Computer Sciences and Information Technology, The University of Agriculture, Peshawar, Pakistan

[3]Department of Mathematics, College of Science Al-Zulfi, Majmaah University, Al-Majmaah, Saudi Arabia

Correspondence
Gohar Ali, Matin Ahmad, and Farhad Ali, Department of Mathematics, City University of Science and Information Technology, Peshawar 25000, Pakistan.
Email: goharali.cu@gmail.com, matinahmad52@gmail.com and farhadali@cusit.edu.pk

Abstract

Usually, suction/blowing is used to control the channel's fluid flow, which is why this worth-noting effect is considered. The fluid velocity is considered along the x-axis due to the oscillations of the right plate. The thermal effect on the flow due to the heated right plate is also considered. The fluid and dust particles have complex velocities due to the rotation, which are the sum of primary and secondary velocities. To convert the aforementioned physical phenomenon into mathematical form, partial differential equations are used for modeling the subject flow regime. Appropriate nondimensional variables are employed to nondimensionalize the system of governing equations. With the assistance of assumed periodic solutions, the system of partial differential equations is reduced to a system of ordinary differential equations which is then solved by the perturb solution utilizing Poincare–Lighthill perturbation techniques. The engineering interest quantities, the Nusselt number, and skin friction are also determined. The impact of various parameters on skin friction, viscoelastic fluid, and dust particle velocity profiles is also investigated. It is worth mentioning that suction controls the boundary layer to grow unexpectedly, even in the resonance case. The obtained solution is also valid in the case of injection.

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Couette flow of viscoelastic dusty fluid through a porous oscillating plate in a rotating frame along with heat transfer

Arshad Khan et al.

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Rationalized Toeplitz Hankel operators on the space of Torus $L^2(\mathbb{T}^n)$

Ruchika Verma (Batra)*

Ramjas College, University of Delhi, Delhi-110007, India.

ABSTRACT

In this paper we introduce the class of Rationalized Toeplitz Hankel operators on the space $L^2(\mathbb{T}^n)$, $\mathbb{T}$ being the unit circle in complex plane and $L^2(\mathbb{T}^n)$ is the space of Lebesgue square integrable functions on $\mathbb{T}^n$. We also introduce the Rationalized Toeplitz Hankel matrix of level n and give the characterization of Rationalized Toeplitz Hankel Operator.

1 Introduction

Toeplitz operators, Hankel operators, Slant Toeplitz operators have vast literature and have been studied extensively in the last few decades. This class of operators have many applications in wavelet theory and dynamical systems. In 1911, O.Toeplitz introduced the notion of Toeplitz operators and subsequently many researchers have worked on these operators on different spaces. A parallel study of Hankel operators have been a subject of investigation for many scholars. Later in 1995, Slant Toeplitz operators were introduced. The first systematic study of Slant Toeplitz operators was introduced by Ho [8] where he studied many algebraic and spectral properties of these operators. In [3] the authors introduced Slant Hankel operators on the space $L^2(\mathbb{T})$ and also generalize the notion of Slant Toeplitz operators [1]. After that a lot of work has been done on this class of operators and their generalizations on different spaces. Recently many researchers (see [6,7,12]) have studied Slant Hankel Operators and Slant Toeplitz operators on the Lebesgue space of the Torus $\mathbb{T}^n$; so it is still an interesting area for mathematicians.

Motivated by all these, in 2022 [4], the author has introduced the generalization of all such kind of Toeplitz, Hankel, Slant Toeplitz and Slant Hankel operators on $L^2(\mathbb{T})$ as the Rationalized Toeplitz Hankel operators on $L^2(\mathbb{T})$. Many algebraic and spectral properties can be seen in [4,5]. All these extend the scope of study of Rationalized Toeplitz Hankel operators on the Lebesgue space $L^2(\mathbb{T}^n)$ of the Torus $\mathbb{T}^n$. We begin with the following preliminaries.

*Corresponding author, Ruchika Verma (Batra), E-mail address: ruchikaverma@ramjas.du.ac.in

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Example of Research in 2024

\text { Rationalized Toeplitz Hankel operators on the space of Torus } L^2\left(T^n\right)

Ruchika Verma et al.

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Tamil Nadu

Econometric and stochastic analysis of stock price before and during COVID-19 in India

Madhavan Madheswaran[1] · Kasilingam Lingaraja[2] · Pandiaraja Duraisamy[3]

Abstract

Unexpected and sudden spread of the novel Coronavirus disease (COVID-19) has opened up many scopes for researchers in the fields of biotechnology, health care, educational sectors, agriculture, manufacturing, service sectors, marketing, finance, etc. Hence, the researchers are concerned to study, analyze and predict the impact of infection of COVID-19. The COVID-19 pandemic has affected many fields, particularly the stock markets in the financial sector. In this paper, we have proposed an econometric approach and stochastic approach to analyze the stochastic nature of stock price before and during a COVID-19-specific pandemic period. For our study, we considered the BSE SENSEX INDEX closing pricing data from the Bombay Stock Exchange for the period before and during COVID-19. We have applied the statistical tools, namely descriptive statistics for testing the normal distribution of data, unit root test for testing the stationarity, and GARCH and stochastic model for measuring the risk, also investigated drift and volatility (or diffusion) coefficients of the stock price SDE by using R Environment software and formulated the 95% confidence level bound with the help of 500 times simulations. Finally, the results have been obtained from these methods and simulations are discussed.

Keywords COVID-19 · Stock price · GARCH · Stochastic differential equation · Simulation

✉ Pandiaraja Duraisamy
  pandiaraja.d@gmail.com

  Madhavan Madheswaran
  madhu135@gmail.com

  Kasilingam Lingaraja
  klingarajaphd@gmail.com

[1] Department of Mathematics, Thiagarajar College, Madurai Kamaraj University, Madurai, Tamil Nadu 625009, India

[2] Department of Business Administration, Thiagarajar College, Madurai, Tamil Nadu 625009, India

[3] Department of Mathematics, National Centre of Excellence (MHRD), Thiagarajar College,

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Econometric and stochastic analysis of stock price before and during COVID-19 in India

Madhavan Madheswaran et al.

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An orthogonal spline collocation method for singularly perturbed parabolic reaction–diffusion problems with time delay

Jewel Howlader[1] · Pankaj Mishra[2] · Kapil K. Sharma[1]

Abstract
In this article, a numerical technique is developed and analyzed for singularly perturbed delay parabolic reaction–diffusion problems with Dirichlet boundary condition. An orthogonal spline collocation method with C^1-cubic spline basis functions on a Shishkin mesh is used in the spatial direction. In the temporal direction Crank–Nicolson method on an equidistant mesh is used. An extensive analysis has been undertaken to establish the uniform convergence with respect to the perturbation parameter. To support the theoretical findings, numerical experiments have been presented.

Keywords Boundary layer · Singularly perturbed problems · Orthogonal spline collocation methods · Reaction–diffusion problems · Parameter uniform convergence · Time delay

Mathematics Subject Classification 65M70

1 Introduction

We consider a class of singularly perturbed delay parabolic reaction–diffusion problems in one dimension on the unit interval $\Omega = (0, 1)$ of the form

✉ Kapil K. Sharma
kapil.sharma@sau.ac.in

Jewel Howlader
jewelmth34@gmail.com

Pankaj Mishra
pmishra@db.du.ac.in

[1] Department of Mathematics, South Asian University, New Delhi 110068, India

[2] Department of Mathematics, Deshbandhu College, University of Delhi, New Delhi 110019, India

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An orthogonal spline collocation method for singularly perturbed parabolic reaction–diffusion problems with time delay

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Abstract

This paper presents a Stancu-type generalization of Szász operators linked to Hermite polynomials. The convergence properties of these operators are discussed by utilizing Korovkin's theorem. Additionally, the paper explores approximation theorems for these operators using various tools, including Peetre's K-functional, classical and second-order modulus of continuity. The convergence rate for Lipschitz-type functions is estimated as well. Furthermore, the paper investigates the rate of weighted A-statistical convergence and demonstrates a Voronovskaya-type asymptotic result for these operators.

Keywords Hermite polynomials · Convergence rate · Modulus of continuity · Weighted A-statistical convergence · Voronovskaja-type theorem

Mathematics Subject Classification 41A25 · 26A15 · 40A35 · 40A05 · 41A36

✉ Ajay Kumar
akumar1@ma.iitr.ac.in

Akanksha Verma
akankshaverma.maths@dsc.du.ac.in

Laxmi Rathour
laxmirathour817@gmail.com

Lakshmi Narayan Mishra
lakshminarayanmishra04@gmail.com

Vishnu Narayan Mishra
vishnunarayanmishra@gmail.com

[1] Department of Mathematics, B.L.P. Govt. P. G. College MHOW, Indore 453441, Madhya Pradesh, India

[2] Department of Mathematics, Dyal Singh College, University of Delhi, Lodhi Road, Pragati Vihar, New Delhi 110003, India

[3] Ward Number - 16, Bhagatbandh, Anuppur 484 224, Madhya Pradesh, India

[4] Department of Mathematics, School of Advanced Sciences, Vellore Institute of Technology, Vellore 632 014, Tamil Nadu, India

[5] Department of Mathematics, Indira Gandhi National Tribal University, Lalpur, Amarkantak, Anuppur 484 887, Madhya Pradesh, India

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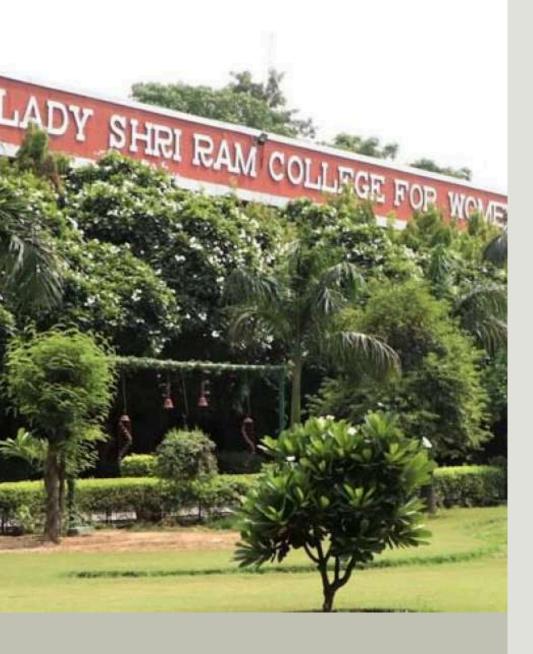
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Group decision making model for selection of performance indicators for sustainable supplier evaluation in agro-food supply chain

Rashi Sharma [a], Devika Kannan [b,c,*], Jyoti Dhingra Darbari [d], P.C. Jha [e]

[a] Lal Bahadur Shastri Institute of Management, Delhi, India
[b] Centre for Sustainable Operations and Resilient Supply Chain (CSORSC), Adelaide Business School (ABS), Institute for Sustainability, Energy and Resources (ISER), University of Adelaide, Adelaide, Australia
[c] School of Business, Woxsen University, Sadasivpet, Telangana, India
[d] Department of Mathematics, Lady Shri Ram College, Delhi University, India
[e] Department of Operational Research, Delhi University, India

ARTICLE INFO

Keywords:
Agro-food supply chain
Supplier and sub-supplier sustainability
Performance indicators
Group analytical hierarchy process

ABSTRACT

Sustainable food production is of vital importance to ensure food security, enhanced stability, environmental protection, and economic development for any developing nation. In an Agro-Food Supply Chain (AFSC), joint efforts of all supply chain actors inclined towards sustainability can contribute significantly towards sustainable production. Suppliers, who are intermediaries between Food Processing Firm (FPF) and sub-suppliers or farmers, must follow the FPF's sustainability practices at their own level, and they must monitor the enactment of these activities at their sub-supplier level. In this regard, the study focuses on developing a group consensus mathematical model to derive a broader set of performance indicators to evaluate a supplier's competency in maintaining, monitoring, and tracing sustainable performance in his sub-supplier network. A two-phased group consensus model is presented; it selects performance indicators using the Delphi method and it utilizes a feedback mechanism rooted in Group Analytical Hierarchy Process. This system is based on an iterative algorithm to generate weights that all decision makers accept. The proposed model is illustrated with an analysis of an Indian flour milling company. Kendall's concordance coefficient is employed to understand the degree of agreement among decision makers before and after the application of the proposed model. Increase in its value post-application validates the efficacy of the model. This approach for performance indicator selection for sustainable supplier evaluation research is unique in the field of AFSC. Results of the study indicate that the top ranking indicator is 'Food Safety' followed by 'Payment to Sub-suppliers'. Key policy implications are drawn from the result findings which can be further integrated to support sustainable growth and development of suppliers and sub-suppliers in any AFSC.

1. Introduction

Over the previous decade, Agro-Food Supply Chain (AFSC) management has become very challenging. Concerns have emerged over sustainability, safety, quality, waste management, and competence of the processes because of growing consumer awareness, government regulations, market competition, and pressure exerted by non-government organizations (Chauhan et al., 2021). In response to these global concerns, a considerable number of Food Processing Firms (FPFs) are now encouraged to adopt social and environmental measures in their supply chain (SC) (Hou et al., 2019). However, to attain overall

sustainability of the AFSC, the FPF requires all its SC members to undertake responsibility to conduct their operations in a sustainable manner (Grabs and Carodenuto, 2021). In an Indian AFSC, management of sustainable practices across all echelons of the SC is still in its nascent stage. Although Indian FPFs are inclined towards enhancing sustainability of their SC, their SC network efficiency largely relies on the performance of the supplier network which is not entirely under their control (Rogers et al., 2019). In a typical Indian AFSC, the main raw material growers are the farmers, and there are many suppliers and sub-suppliers who manage the logistics and transport for the FPF. Generally, the inbound supplier network is widely spread and

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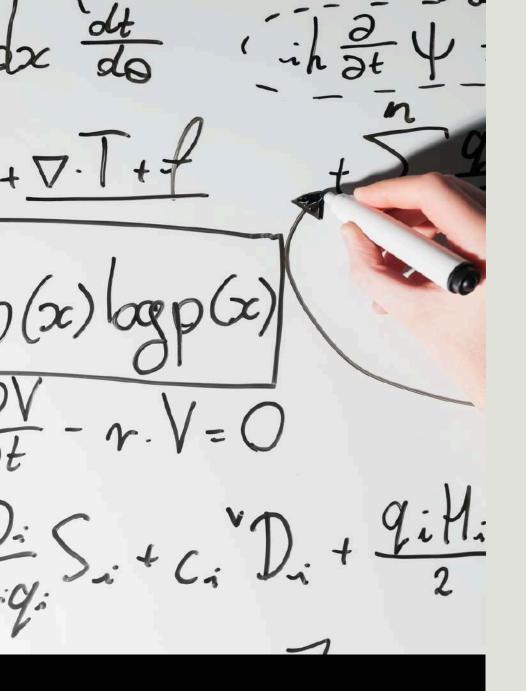# S.R.M. Institute of Science and Technology

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On the learning of high order polynomial reconstructions for essentially non-oscillatory schemes

Vikas Kumar Jayswal and Ritesh Kumar Dubey

Department of Mathematics, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu-603203, Tamil Nadu, India

E-mail: vikasjayswal990@gmail.com and riteshkd@srmist.edu.in

Keywords: ENO and WENO reconstructions, multi-class indicator functions, supervised classification learning problems, multi-layer perceptrons (MLP)

Abstract

Approximation accuracy and convergence behavior are essential required properties for the computed numerical solution of differential equations. These requirements restrict the application of deep learning networks in the domain of scientific computing. Moreover, the recipe to create suitable synthetic data which can be used to train a good model is also not very clear. This study focuses on learning of third order essentially non-oscillatory (ENO) and weighted essentially non-oscillatory (WENO) reconstructions using classification neural networks with small data sets. In particular, this work (i) proposes a novel way to obtain a third order WENO reconstruction which can be posed as classification problem, (ii) gives simple and novel approach to sample data sets which are small but rich enough to inherit the latent feature of inter-spatial regularity information in the constructed data, (iii) it is established that sampling of train data sets impacts quantitatively as well as qualitatively the required accuracy and non-oscillatory properties of resulting ENO3 and WENO3 schemes, (iv) proposes to use a limiter based multi model to retain desired accuracy as well as non-oscillatory properties of the resulting numerical schemes. Computational results are given which established that learned networks perform well and retain the features of the reconstruction methods.

1. Introduction

Solution approximation of partial differential equations has been a primary interest for applied mathematicians and engineers for decades. High order polynomial interpolations and reconstructions like essentially non-oscillatory (ENO) and weighted essentially non-oscillatory (WENO) have been at the center of solution approximations techniques for hyperbolic conservation laws and convectively dominated flow problems [1, 2]. The essentially non oscillatory (ENO) procedure is first introduced in [3] for high order piecewise polynomial reconstruction using cell average of a function and applied for constructing high-order ENO schemes to approximate the solution of hyperbolic conservation laws. The ENO reconstruction of a function can be loosely interpreted as ENO interpolation applied to its primitive function. Later weighted ENO are proposed which give superior accuracy of order $(2k - 1)$ for smooth solution using the same stencil of $(2k - 1)$ grid values used for k order ENO reconstruction [4]. Recently, in [5] a new procedure using polynomial length for the ENO reconstruction is given which has advantage over classical ENO procedure. It is further extended and applied to construct accuracy preserving ENO or WENO schemes for hyperbolic conservation laws.

In recent years, deep learning has become popular in data analysis and increasingly seen as having potential to reformulate numerical methods for partial differential equations. In particular, Artificial neural networks (ANNs) which are computational model with ability to process information, regulate by learning from observational data [6] and have been shown to posses universal approximation properties [7–9] and used to solve different ordinary and partial differential equations. It is important to mention that the field of numerical solution of partial differential demands for approximation accuracy and convergence behavior of computed

Example of Research in 2024

On the learning of high order polynomial reconstructions for essentially non-oscillatory schemes

Ritesh Kumar Dubey et al.

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Graphoidally independent infinite cactus

Deepti Jain et al.

Paper thumbnail content:

Graphoidally independent infinite cactus

Deepti Jain[1,*], and Purnima Gupta[2]

[1] Department of Mathematics, Sri Venkateswara College, University of Delhi, Delhi, India
*djain@svc.ac.in

[2] Adjunct Professor (Prof of Eminence), Department of Mathematics, Ramanujan College, University of Delhi, Delhi, India
purnimachandni1@gmail.com

Abstract: A graphoidal cover of a graph G (not necessarily finite) is a collection ψ of paths (not necessarily finite, not necessarily open) satisfying the following axioms: (GC-1) Every vertex of G is an internal vertex of at most one path in ψ, and (GC-2) every edge of G is in exactly one path in ψ. The pair (G, ψ) is called a graphoidally covered graph and the paths in ψ are called the ψ-edges of G. In a graphoidally covered graph (G, ψ), two distinct vertices u and v are ψ-adjacent if they are the ends of an open ψ-edge. A graphoidally covered graph (G, ψ) in which no two distinct vertices are ψ-adjacent is called ψ-independent and the graphoidal cover ψ is called a totally disconnecting graphoidal cover of G. Further, a graph possessing a totally disconnecting graphoidal cover is called a graphoidally independent graph. The aim of this paper is to establish complete characterization of graphoidally independent infinite cactus.

Keywords: Graphoidal cover of a graph, graphoidally covered graphs, graphoidally independent graphs, cactus

AMS Subject classification: 05C69
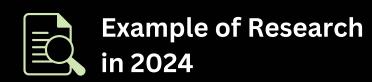
1. Introduction

Throughout this paper, we shall follow the notation and terminology of West [17] for graphs, except that a graph could be infinite in which case the reader is referred to Ore [14].

The concept of graphoidal covers for finite graphs was first introduced by Acharya and Sampathkumar [4] in 1987. There are several variations of the concept of graphoidal

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CONTROLLER'S SECTION

LAKSHMI NILAYAM

Binary soft simply* alpha open sets and continuous function

C. R. Parvathy
PSGR Krishnammal College for Women
Coimbatore-641004
Tamil Nadu
India
parvathycr@psgrkcw.ac.in

A. Sofia*
PSGR Krishnammal College for Women
Coimbatore-641004
Tamil Nadu
India
sofiaarjunan11@gmail.com
19phdms003@psgrkcw.ac.in

Abstract. A topological rough approximation space is defined over two different universes using binary soft relations. A new class of binary soft set and its corresponding soft topology is obtained. Continuity functions for the newly defined set are introduced. The characteristics of continuity functions between two binary soft topological spaces and that between binary soft topological space and topological rough approximation space are examined. The proposed definitions and properties are demonstrated with suitable examples.

Keywords: soft set, binary soft set, binary soft nowhere dense, continuity mappings, approximation space.

MSC 2020: 54A05, 54C05, 03B52, 03E72, 03E75

1. Introduction

Data involving uncertainties are present in various disciplines such as economics, engineering, social science, and medical science. Uncertainty in events complicates decision making in many aspects. To handle problems with uncertainty, the concept of fuzzy sets was first defined by Zadeh [34]. Though fuzzy set theory helped in solving problems with uncertainty, assigning membership values to a large number of data was challenging. To overcome such difficulties, the concepts of rough set and soft set were developed. Pawlak [26] first defined rough sets in 1982. These sets were related to upper and lower approximations and generally are crisp sets. Pawlak's rough sets are based on equivalence relations, but finding an equivalence relation among the elements of a set was difficult. Though different relations were used to define rough set theory, they had compli-

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THE PROCEEDINGS BOOK OF MICOPAM 2024

Modular forms and its application

Utpal Pore [*1] and *S. N. Fathima* [2]

In this article, we give an overview of background relevant to the proof of congruence for 2^t-core [4, Theorem 2.3] by using modular forms.

2020 MSC: 05A17, 11P83

KEYWORDS: Modular Forms, t-core partitions, Partitions, Theta functions, Congruences.

Introduction

Let $\bar{\mathbb{C}}$ denote $\mathbb{C} \cup \{\infty\}$ (i.e., the complex projective line $\mathbb{P}_{\mathbb{C}}^1$, also known as the "Reimann Sphere").

Given an element $g = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \in SL_2(\mathbb{R})$ and a point $z \in \mathbb{C}$, we define

$$gz := \frac{az+b}{cz+d}; \quad g\infty := a/c = \lim_{z \to \infty} gz. \qquad (1)$$

(Thus $g(-d/c) = \infty$, and if $c = 0$, then $g\infty = \infty$). It is easy to check that (1) defines a group action on the set $\bar{\mathbb{C}}$. Clearly $\pm I$ are the only matrices which act trivially on $\bar{\mathbb{C}}$. Thus the quotient group $SL_2(\mathbb{R}/ \pm I$ acts "faithfully" on $\mathbb{C}$.
let $\mathbb{H} = \{z \in \mathbb{C} \mid Im(z) > 0\}$. It is important to note that any $g \in SL_2(\mathbb{R})$ preserves $\mathbb{H}$, i.e., $Im(z) > 0$ implies $Im(gz) > 0$.
The subgroup of $SL_2(\mathbb{R})$ consisting of matrices with integer entries is, defined by $SL_2(\mathbb{Z})$. It is called "full modular group," and is sometimes denoted by Γ.
The group $\bar{\Gamma} = SL_2(\mathbb{Z})/\pm I$ acts faithfully on $\mathbb{H}$. For our purposes the most important congruence subgroups of Γ are:

$$\Gamma(N) := \{\begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma : a \equiv d \equiv 1 \pmod{N} \text{ and } b \equiv c \equiv 0 \pmod{N}\};$$

$$\Gamma_0(N) := \{\begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma : c \equiv 0 \pmod{N}\};$$

$$\Gamma_1(N) := \{\begin{pmatrix} a & b \\ c & d \end{pmatrix} \in \Gamma : a \equiv d \equiv 1 \pmod{N} \text{ and } c \equiv 0 \pmod{N}\}.$$

Whenever a group acts on a set, it divides the set into equivalence classes, where two points are said to be in same equivalence class if there is an element of the group which takes one to the other. In particular, if G is a subgroup of Γ, we say that two points $z_1, z_2 \in \mathbb{H}$ are "G-equivalent" if there exist $g \in G$ such that $z_2 = gz_1$.
Let F be a closed region in $\mathbb{H}$.(Usually, F will also be simply connected.) We say that F is a "fundamental domain" for the subgroup G of Γ if every $z \in \mathbb{H}$ is G-equivalent to a point in F, but no two distinct points z_1, z_2 in the interior of F are

332   Antalya, TÜRKİYE

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CONSTRUCTION OF IRREGULAR COMPLETE INTERPOLATION SETS FOR SHIFT-INVARIANT SPACES

KUMARI PRIYANKA AND A. ANTONY SELVAN†

ABSTRACT. For several shift-invariant spaces, there exists a real number $\alpha \in \mathbb{R}$ such that the set $\alpha + \mathbb{Z}$ is a complete interpolation set. In this paper, we characterize the complete interpolation property of the set $(\alpha + \mathbb{N}_0) \cup (\alpha + a + \mathbb{N}^-)$ for shift-invariant spaces using Toeplitz operators. Using this characterization, we determine all α for which the sample set $\mathbb{N}_0 \cup \alpha + \mathbb{N}^-$ forms a complete interpolation set for transversal-invariant spaces. We introduce a new recurrence relation for exponential splines, examines the zeros of these splines, and explores the zero-free region of the doubly infinite Lerch zeta function. Consequently, we demonstrate that $(\frac{m}{2}) + \mathbb{N}_0 \cup \alpha + (\frac{m}{2}) + \mathbb{N}^-$ is a complete interpolation set for a shift-invariant spline space of order $m \geq 2$ if and only if $|\alpha| < 1/2$.

1. INTRODUCTION

Sampling and interpolation in shift-invariant spaces have been a central topic in mathematical analysis, particularly due to their applications in signal processing, approximation theory, and functional analysis. A classical example of a shift-invariant space is the space of bandlimited signals with bandwidth π. In the literature, an almost characterization of sampling sets and of interpolation sets for a large class of shift-invariant spaces has been given in terms of Beurling densities [6, 16, 18, 22]. The problem of complete interpolation sets is much more subtle. Pavlov [26] characterized complete interpolation sets for the space of bandlimited functions in the context of non-harmonic Fourier series. Recently, the authors in [5] solved the problem of complete interpolating sets for the Gaussian shift-invariant space.

Characterizing complete interpolation sets for the space of multi-bandlimited signals is a challenging problem and constructing such a set is generally quite difficult. This problem is equivalent to finding Riesz bases of exponential systems on a disconnected set Ω. This problem is solved for a finite union of disjoint intervals in [21] and bounded remainder sets in [15]. We refer to [25] for an extensive survey of recent progress on the exponential bases problem.

In many concrete shift-invariant spaces, it has been established that there exists a real number $\alpha \in \mathbb{R}$ such that the set $\alpha + \mathbb{Z}$ forms a complete interpolation set. See [3, 8, 17, 27, 30]. The idea of shifting lattices traces back to Kohlenberg's work [19], where he first considered the conditions under which a union of shifted lattices could

1

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Domination Integrity of Generalized Transformation Graphs

A. Sugirtha[1*] and Y. Therese Sunitha Mary[2]

[1] Research Scholar, PG and Research Department of Mathematics, Reg no 2221128209208,
St. Xavier's College (Autonomous), Tirunelveli, Tamil Nadu, India
[2] Assistant Professor and Head, PG and Research Department of Mathematics,
St. Xavier's College (Autonomous), Tirunelveli, Tamil Nadu, India
Affiliated to, Manonmaniam Sundaranar University, Abishekapatti, Tamil Nadu

*Corresponding author's e-mail: sugirtha1994@gmail.com

ABSTRACT

The vulnerability values help network designers build communication networks that maintain stability even when some of their nodes or communication links are disrupted. The transformation graphs investigated in this research are used as a network system model, demonstrating how to strengthen and stabilise the network. For this reason, more nodes are added to the network. Generalized transformation graphs of graphs are the concept used in the construction of this new network. The domination integrity of graph G is defined by $DI(G) = \min \{|S| + m (G - S)\}$ where S is a dominating set of G and $m (G - S)$ denotes the order of the largest component in G - S. This parameter is a measures of vulnerability of a graph. In this paper, we investigate the domination integrity of generalized transformation graph G^{++} of standard graphs and the domination integrity of cartesian product of generalized transformation graphs G^{+-}. And also determine domination integrity of generalized transformation graphs G^+, G^{-+} and G^{--}.

Keywords: Vulnerability, Integrity, Domination Integrity, Generalized transformation graphs

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Domination Integrity of Generalized Transformation Graphs

Therese Sunitha Mary et al.

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On the total edge irregularity strength of certain classes of cycle related graphs

Saranya A. S.
University College (Affiliated to University of Kerala), India
and
Santhosh Kumar K. R.
University College, India

Abstract

For a graph $G = (V, E)$, an edge irregular total k-labeling is a labeling of the vertices and edges of G with labels from the set $\{1, 2, ..., k\}$ such that any two different edges have distinct weights. The sum of the label of edge uv and the labels of vertices u and v determine the weight of the edge uv. The smallest possible k for which the graph G has an edge irregular total k-labeling is called the total edge irregularity strength of G. We determine the exact value of the total edge irregularity strength for some cycle related graphs.

University College, Thiruvananthapuram

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Santhosh Kumar K R et al.

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Hardy Spaces and Integral Means of Certain Integral Operators on Analytic Functions

JOCELYN JOHNSON [1] and S. SUNIL VARMA [2]

ABSTRACT. In this paper, we determine the Hardy spaces of certain integral operators on normalised analytic functions defined in the open unit disk in the complex plane with the prior knowledge of the Hardy spaces of the functions or their derivatives in the integral.

1. INTRODUCTION

Given an analytic function $f : \Delta \to \mathbb{C}$, where $\Delta = \{z \in \mathbb{C} : |z| < 1\}$ in the complex plane, the integral means of f are defined as

$$M_p(r, f) = \begin{cases} \{\frac{1}{2\pi} \int_0^{2\pi} |f(re^{i\theta})|^p d\theta\}^{1/p}, & \text{if } 0 < p < \infty \\ \max_{0 \le \theta < 2\pi} |f(re^{i\theta})|, & \text{if } p = \infty. \end{cases}$$

For $0 < p \le \infty$, a function $f(z) = \sum_{n=0}^{\infty} a_n z^n$ analytic in Δ is said to belong to the Hardy space H^p if the integral mean $M_p(r, f)$ is bounded as $r \to 1^-$. i.e.,

$$\lim_{r \to 1^-} M_p(r, f) \le K,$$

where K is a constant depending on f. When $p = \infty$, the class H^∞ consists of all bounded analytic functions in Δ. In particular, when $p = 2$, H^2 consists of all functions $f(z) = \sum_{n=0}^{\infty} a_n z^n$ analytic in the open unit disk with $\sum_{n=0}^{\infty} |a_n|^2 < \infty$. If $0 < p < q \le \infty$, then $H^p \supset H^q \supset H^\infty$ [2].

Let $\mathcal{A}$ denote the class of analytic functions f defined on Δ with the normalization [4]

$$f(0) = f'(0) - 1 = 0,$$

having the Taylor's series representation

$$f(z) = z + \sum_{n=2}^{\infty} a_n z^n.$$

Several integral operators on the subclasses of analytic functions on the unit disk were studied in the past [1, 3, 6, 8, 9, 10, 11, 14].

In this article, we construct the integral operators F_i's considering the Hornich operators on functions in Class $\mathcal{A}$, we determine the inclusion theorems involving Hardy spaces of F_i's provided the Hardy space in which the functions f's or its derivatives used in constructing F_i's are known. We also analyse a bound for their integral means by establishing a relation between the integral means of these integral operators and that of the integrands. In addition, we examine the limiting behavior of the Taylor's coefficients of these integral operators.

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Example of Research in 2024

Hardy Spaces and Integral Means of Certain Integral Operators on Analytic Functions

S Sunil Verma et al.

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Bifurcation and Stability of a Discrete-time SIS Epidemic Model with Treatment

Ozlem AK GUMUS[1], George Maria SELVAM[2,*], Janagaraj RAJENDRAN[3]

[1]Department of Mathematics, Faculty of Arts and Sciences, Adiyaman University, 02040, Adiyaman, Türkiye
[2]Department of Mathematics, Sacred Heart College, Tirupattur-635601, Tamil Nadu, India
[3]Department of Mathematics, Faculty of Engineering, Karpagam Academy of Higher Education, Coimbatore-641021, Tamil Nadu, India

Highlights
• The aim of this work focuses on investigating the spread and control of infection in a SIS model.
• Discrete-time version of the system subject to treatment is proposed to examine the spread of infection.
• Bifurcation theory is applied to achieve the flip bifurcation conditions.
• The Neimark Sacker bifurcation diagram is presented depending on the step size.
• Chaos is controlled via a hybrid controlled method.

Abstract

The mathematical dynamics are suitable in examining the effect of infective populations. Conditions involving the spread and control of the disease are calculated by analyzing mathematical models so that it is possible to have information about the behavior of the infection. This article includes the dynamics of a discrete SIS endemic model thru treatment. After determining that the fixed point conditions are fulfilled, the stability analysis is completed for those fixed points. The derived endemic fixed point's stability and bifurcation conditions are examined. Depending on the infection coefficient, the flip bifurcation condition is obtained. At the same time, it is determined in which situation Neimark-sacker bifurcation (NSB) may occur depending on the step size, and bifurcation is controlled. Our theoretical findings are supported by a rich dynamical nature.

1. INTRODUCTION

In order to understand the complicated connections within and between species, numerous models based on discrete or continuous time steps have been developed. There is no overlap between successive generations since populations in ecology evolve at different time steps. Therefore, difference models are useful for studying the behavior of populations. Additionally, it is observed that discretization of continuous population models works better when the population is smaller than continuous ones [1-4]. The behavior of discrete-time models has gained the attention to numerous researchers. These studies include the dynamics of models created with discrete-time equations [5-8] and discrete-time systems [9-20] as well as the dynamics of models created forward Euler's scheme [1, 3, 4, 21, 22] non-standard discretization procedure [2] discretization of fractional order systems [23, 24, 25] and discretization with piecewise constant arguments.

Investigating the dynamics of epidemic disease models is essential, which is one of the population interaction dynamics. Epidemic diseases such as influenza, plague, cholera, typhoid, aids, smallpox, malaria, mers, ebola, measles, tuberculosis, and Covid-19 have been problematic for humanity throughout history, affect infected individuals and infected individuals the whole society in many ways. Vaccination and treatment are among the most effective strategies in combating epidemics. The treatment is particularly significant to decrease the blowout of epidemics until the vaccine is developed [26-30]. In recent times, several researchers have investigated the dynamics of endemic models [31-35].

*Corresponding author, e-mail:agmshc@gmail.com

Example of Research in 2024

Bifurcation and Stability of a Discrete-time SIS Epidemic Model with Treatment

George Maria SELVAM et al.

St.Teresa's College,Ernakulam

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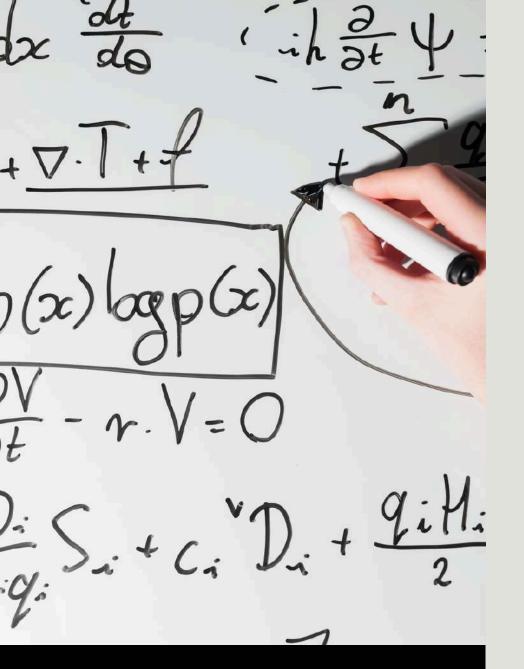
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Fluid Maxwell's equations in the language of geometric algebra

Susan Mathew Panakkal et al.

Fluid Maxwell's equations in the language of geometric algebra

R PARAMESWARAN[1,2]*, SUSAN MATHEW PANAKKAL[3] and M J VEDAN[1]

[1]Department of Computer Applications, Cochin University of Science and Technology, Cochin 680 022, India
[2]Department of Mathematics, School of Physical Sciences, Amrita Vishwa Vidyapeetham, Cochin 680 024, India
[3]Department of Mathematics, St. Teresa's College (Autonomous), Cochin 680 011, India
*Corresponding author. E-mail: ramanparameswaran@gmail.com

Abstract. A comparison of the vorticity field tensor with the electromagnetic tensor is done. An attempt is made to express the vorticity and its dual in the language of geometric algebra using bivectors. In the language of geometric algebra, all four fluid Maxwell's equations are reduced to a single equation in two ways, i.e., using a bivector $\mathbf{F}$ and also its Hodge dual $\mathbf{F}^*$, and these are analogous to the corresponding results in electromagnetism. The complex structure $\mathbf{F} = \mathbf{L} - I\mathbf{W}$ in fluid dynamics is a novel approach in this work. A multivector representation of Maxwell's equations and an expression for the Poynting vector are also obtained.

1. Introduction

1.1 Electromagnetic tensor

An electromagnetic field in space–time is represented by an electromagnetic field tensor or simple electromagnetic tensor. This tensor is also known as the Faraday tensor or Maxwell bivector. Herman Minkowski introduced the concept of field tensors similar to that of the four-dimensional tensors in the field of special relativity. The main advantage of the tensor is that it helps to write very concisely the physical laws and allows the quantisation of the electromagnetic field by the Lagrangian formulation [1,2]. The electromagnetic field $\mathcal{F}$ – a differential two form is expressed as

$$\mathcal{F} = \frac{E_1}{c}dx \wedge dt + \frac{E_2}{c}dy \wedge dt + \frac{E_3}{c}dz \wedge dt$$
$$+ B_1 dy \wedge dz + B_2 dz \wedge dx + B_3 dx \wedge dy. \quad (1)$$

Here $E = (E_1, E_2, E_3)$ is the electric field, $B = (B_1, B_2, B_3)$ represents the magnetic field and c denotes the speed of light [2]. The contravariant matrix form of this 2-form with metric signature $(+, -, -, -)$ can be represented as [3]
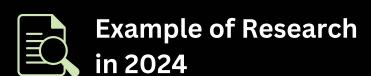
$$\mathcal{F} = \begin{bmatrix} 0 & \frac{-E_1}{c} & \frac{-E_2}{c} & \frac{-E_3}{c} \\ \frac{E_1}{c} & 0 & -B_3 & B_2 \\ \frac{E_2}{c} & B_3 & 0 & -B_1 \\ \frac{E_3}{c} & -B_2 & B_1 & 0 \end{bmatrix}. \quad (2)$$

Corresponding to the above Faraday's tensor, its Hodge dual in the differential 2-form is given by

$$\mathcal{F}^* = B_1 dx \wedge dt + B_2 dy \wedge dt + B_3 dz \wedge dt$$
$$+ \frac{E_1}{c}dy \wedge dz + \frac{E_2}{c}dz \wedge dx + \frac{E_3}{c}dx \wedge dy. \quad (3)$$

which in the matrix notation is given as

$$\mathcal{F}^* = \begin{bmatrix} 0 & -B_1 & -B_2 & -B_3 \\ B_1 & 0 & \frac{-E_3}{c} & \frac{E_2}{c} \\ B_2 & \frac{E_3}{c} & 0 & \frac{E_1}{c} \\ B_3 & \frac{-E_2}{c} & \frac{-E_1}{c} & 0 \end{bmatrix}. \quad (4)$$

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NON-PÓLYA FIELDS WITH LARGE PÓLYA GROUPS ARISING FROM LEHMER QUINTICS

NIMISH KUMAR MAHAPATRA AND PREM PRAKASH PANDEY

ABSTRACT. In this article we construct a new family of quintic non-Pólya fields with large Pólya groups. We study the upper bound of Pólya numbers of such fields and show that the Pólya numbers never exceed five times the size of its Pólya group. Finally we show that such non-Pólya fields are non-monogenic fields of field index one.

1. INTRODUCTION

Let K be an algebraic number field and $\mathcal{O}_K$ be its ring of integers. Let $Int(\mathcal{O}_K) = \{f \in K[X] \mid f(\mathcal{O}_K) \subseteq \mathcal{O}_K\}$ be the ring of integer valued polynomials on $\mathcal{O}_K$. Then the number field K is said to be a Pólya field if the $\mathcal{O}_K$-module $Int(\mathcal{O}_K)$ has a regular basis, that is, a basis (f_n) such that for each $n \in \mathbb{N} \cup \{0\}$, degree$(f_n) = n$ (see [26]). For each $n \in \mathbb{N}$, the leading coefficients of the polynomials in $Int(\mathcal{O}_K)$ of degree n together with zero form a fractional ideal of $\mathcal{O}_K$, denoted by $\mathfrak{J}_n(K)$. The following result establishes a connection between $\mathfrak{J}_n(K)$ and the Pólya-ness of the number field K.

Proposition 1.1. [1] A number field K is a Pólya field if and only if $\mathfrak{J}_n(K)$ is principal for all integer $n \geq 1$.

It follows immediately from Proposition 1.1 that if the class number of K is one then K is a Pólya field. However, the converse is not valid in general. That is, if the class number h_K of K is not one then we can not decide whether K is a Pólya field or not: for instance, every cyclotomic field is a Pólya field (see [26]).

Let $Cl(K)$ denote the ideal class group of K. For each integer $n \geq 1$, let $[\mathfrak{J}_n(K)]$ be the ideal class in $Cl(K)$ corresponding to the fractional ideal $\mathfrak{J}_n(K)$. The Pólya group $Po(K)$ of K is defined to be the subgroup of $Cl(K)$ generated by the elements $[\mathfrak{J}_n(K)]$ in $Cl(K)$. Therefore, K is a Pólya field if and only if $Po(K) = \{1\}$.

It is an interesting problem to look for explicit families of number fields that are Pólya /non-Pólya (for example see [9],[10],[19],[23]). In fact, the classification of

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2020 Mathematics Subject Classification. 11R09; 11R29; 11R34.

Example of Research in 2024

Non-polya Fields With Large P´
Olya Groups Arising´
From Lehmer Quintics

Prem Prakash Pandey et al.

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