VIT CHENNAI

VIT CHENNAI

SOUVENIR

2nd International Conference on Emerging Frontiers in Nonlinear Complex Systems, Computational Intelligence and their Applications

08-10 October 2025

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Organized by

Department of Mathematics
School of Advanced Sciences
Vellore Institute of Technology, Chennai, INDIA

VIT - A Place to Learn; A Chance to Grow

Message from Chancellor

I am delighted to welcome you to the **2nd International Conference on Emerging Frontiers in Nonlinear Complex Systems, Computational Intelligence, and their Applications**. It is, indeed, a great privilege for us to host this distinguished gathering of leading mathematicians from across the globe.

More than an event, this conference is undeniably a vibrant forum for sharing innovations, methods, and discoveries. It reflects our full-fledged dedication to advancing mathematical research and building a worldwide community of scholars committed to exploring new horizons of knowledge.

My sincere thanks go to the organizing committee, sponsors, and everyone whose hard work has made this conference possible. Your efforts have been instrumental in uniting such remarkable talents under one roof.

With best wishes,
Dr. G. Viswanathan
Founder & Chancellor
Vellore Institute of Technology

Message from Vice President

A hearty welcome to all participants of the second "**International Conference on Emerging Frontiers in Nonlinear Complex Systems, Computational Intelligence and their Applications**."

This conference serves as a vibrant meeting ground for scholars, researchers, and professionals who share a common passion for advancing the frontiers of mathematical knowledge. Mathematics, as a language of universal significance, has the power to transcend borders and unite us in our pursuit of understanding the intricacies of the world around us.

VIT Chennai is honored to be the host of this prestigious event, and I believe that the next few days will be marked by stimulating discussions, insightful presentations, and the forging of meaningful connections. The diversity of perspectives and experiences represented here reflects our commitment to fostering a global community that thrives on collaboration and the exchange of ideas.

I extend my heartfelt appreciation to the organizing committee for their meticulous planning and dedication in bringing together this exceptional event. To our esteemed speakers and presenters, your expertise and insights are the driving force behind the success of this conference.

Let us make the most of this time together, leveraging the diversity of thought and experience present in this room. May the bonds formed and the knowledge shared during this conference lay the foundation for future advancements in the field of mathematics.

With warm regards,

Dr. G. V. Selvam

Vice President

Vellore Institute of Technology

Message from Pro-Vice Chancellor

It is my unique privilege to welcome the conglomeration of brilliant minds that transcends borders and unites us in the pursuit of mathematical excellence. This conference stands as a testament to our collective commitment to advancing the frontiers of knowledge, fostering international collaboration, and celebrating the richness of mathematics. We are honored to host such a distinguished audience representing diverse cultures, perspectives, and mathematical traditions.

As we embark on this intellectual journey over the coming days, I encourage you to immerse yourselves fully in the spirit of collaboration and exploration. Also, engage in discussions that challenge assumptions, seek connections that transcend disciplines, and forge relationships that extend beyond the confines of this conference room.

To our distinguished speakers and presenters, your presence enriches our academic landscape, and your contributions are the catalysts for the intellectual fire among our scholars and research. The Department of Mathematics, School of Advanced Sciences is not just a venue for this conference; it is a crucible for the synthesis of diverse perspectives, a place where mathematical ideas converge, collide, and give birth to new paradigms.

I congratulate the organizers and wish the conference all success

With warm regards,
Dr. Thyagarajan T
Pro-Vice Chancellor
VIT Chennai

Message from Dean

With a profound sense of enthusiasm and scholarly anticipation, I extend a warm welcome to each of you at the 2nd International Conference on Emerging Frontiers in Nonlinear Complex Systems, Computational Intelligence and their Applications (ICNCS 2025). As the Dean of the School of Advanced Sciences, it is both an honor and a privilege to welcome the architects of tomorrow's scientific and mathematical landscapes to this hub of intellectual dynamism.

Our School is not merely a venue for this conference; it is a sanctuary where the pursuit of knowledge is celebrated as an art form, and where the spirit of inquiry meets the canvas of boundless possibilities. Each one of you represents a vital brushstroke, contributing to the masterpiece that is the collective intelligence of this diverse and esteemed assembly.

The theme of this conference, like a profound mathematical equation awaiting its solution, beckons us to unravel hidden patterns, explore uncharted frontiers, and discover the elegance within complexity. This is not merely a meeting of minds—it is a symphony of intellects converging to shape the future of nonlinear systems, computational intelligence, and their transformative applications.

To our distinguished speakers, your expertise is the beacon guiding us through uncharted waters of discovery. To our participants, you are the collaborators, co-creators of knowledge, and custodians of a shared scientific destiny. In the days ahead, let this conference be a crucible where ideas are forged, assumptions are challenged, and collaborations are sparked. I extend my heartfelt gratitude to the organizing committee, reviewers, and contributors whose tireless efforts have made this gathering possible. May the connections you forge here transcend geographical boundaries and inspire enduring partnerships that redefine the landscape of scientific inquiry.

Wishing you all a stimulating, productive, and memorable conference.

With anticipation and warm regards,

Dr. G. Vinitha

Dean, SAS

VIT Chennai

Contents

Preface

On behalf of the Department of Mathematics, School of Advanced Sciences, we are pleased to welcome all distinguished speakers and participants to ICNCS-2025. This conference provides a scholarly forum for researchers, academicians and professionals to exchange knowledge and engage in discussions on recent advances in nonlinear complex systems and computational intelligence. ICNCS-2025 offers an invaluable opportunity to present innovative mathematical methodologies, disseminate significant research findings, and explore a wide range of applications. With keynote addresses by eminent experts and interactive sessions, the conference aims to foster academic collaboration, intellectual growth, and future-oriented research. This conference focuses on:

- Nonlinear systems and their complex nature
- Chaos and synchronization
- Numerical analysis and the development of algorithms for simulation
- Scientific computing and their applications
- Machine and deep learning
- Data driven model
- Fluid dynamics
- Fuzzy inference system
- Mathematical biological model

For ICNCS-2025, we gratefully acknowledge the financial support received from the Anusandhan National Research Foundation (ANRF) under the Assistance to Professional Bodies and Seminar/Symposia scheme, amounting to ₹2,50,000, as well as from the Council of Scientific and Industrial Research (CSIR) through the Symposia Conference Grant of ₹50,000. The call for abstracts attracted an enthusiastic response from both national and international researchers, with over 200 submissions received. After a rigorous review process, more than 150 abstracts have been accepted for presentation, reflecting the high quality and diversity of research contributions to be featured at the conference. Additionally, we are honoured to have renowned international speakers joining us from esteemed institutions such as Humboldt University (Germany), Thammasat University Rangsit Center (Thailand), University of Colombo (Sri Lanka), and the UAE University (United Arab Emirates). Moreover, we have extended invitations to esteemed Indian senior and young professors from institutions such as IITs, IIST Thiruvananthapuram, Bharathidasan University, Bharathiar University, The Gandhigram Rural Institute (Deemed to be University), Madurai Kamaraj Univerisity and Gauhati University.

The conference is expected to foster new research directions by bridging nonlinear systems and computational intelligence methodologies. In addition to the diverse research presentations and discussions, participants will benefit from the valuable insights shared by distinguished keynote speakers. Renowned in their respective domains, these experts offer perspectives that can inspire innovative approaches and significantly shape future research endeavors. The exchange of knowledge facilitated through these keynote addresses and scholarly interactions enriches the intellectual scope of the conference, providing participants with both depth and breadth of understanding. We sincerely extend our gratitude to the Dean of the School of Advanced Sciences and all faculty members for their continued guidance and support in making this conference a success.

We also extend our sincere appreciation to the organizing team and research scholars for their dedicated efforts in ensuring the successful conduct of this conference. Finally, we express our heartfelt gratitude to all participants and convey our best wishes for their continued success and future endeavors.

Dr. A. Manivannan
Convener, ICNCS 2025
Associate Professor & Head
Department of Mathematics
School of Advanced Sciences
Vellore Institute of Technology, Chennai- 600 127
Tamil Nadu, India

Our Speakers

Keynote Speaker

Dr. Kurunathan Ratnavelu
Professor
Institute of Computer Science and
Digital Innovation
UCSI University, Kuala Lumpur, Malaysia.

Keynote Speaker

Dr. Satyajit Roy
Professor
Indian Institute of Technology Madras
Tamil Nadu, India

Invited Speaker

Prof. Dr. Dr. h.c. mult. Jürgen Kurths
Professor & Senior Scientist
Potsdam Institute for Climate Impact Research,
Potsdam, Germany
Institute of Physics, Humboldt University of Berlin,
Berlin, Germany

Invited Speaker

Dr. Fathalla Ali Rihan
Professor
Department of Mathematical Sciences
College of Science
United Arab Emirates University, Al-Ain
United Arab Emirates

Invited Speaker

Dr. M. Lakshmanan
Professor of Eminence
Centre for Nonlinear Dynamics
Bharathidasan University, Tiruchirappalli
Tamil Nadu, India

Invited Speaker

Dr. K. Balachandran
Mentor Professor
Department of Mathematics
Bharathiar University, Coimbatore,
Tamil Nadu, India

Invited Speaker

Dr. K. Wutiphol Sintunavarat
Associate Professor
Department of Mathematics and Statistics
Thammasat University, Rangsit Center
Pathum Thani, Thailand

Invited Speaker

Dr. Raju K. George
Professor
Department of Mathematics
Indian Institute of Space Science and Technology,
Thiruvananthapuram, Kerala, India

Invited Speaker

Dr. P. Balasubramaniam
Senior Professor
Department of Mathematics
Director International Programme
The Gandhigram Rural Institute - Deemed
University, Dindigul, Tamil Nadu, India

Invited Speaker

Dr. S. Chakraverty
Professor
Department of Mathematics
National Institute of Technology, Rourkela
Odisha, India

Invited Speaker

Dr. S. Muralisankar
Professor
Department of Mathematics
Madurai Kamaraj University, Madurai
Tamil Nadu, India

Invited Speaker

Dr. Praveen Agarwal
Professor and Vice Principal
Anand International College of Engineering
Rajastan, India

International Professor
International Telematic University Uninettuno, Italy

Invited Speaker

Dr. Sanjeewa Perera
Professor of Mathematics (Chair)
Director, Centre for Mathematical Modeling
Department of Mathematics
University of Colombo
Sri Lanka

Invited Speaker

Dr. Hemen Dutta
Associate Professor
Department of Mathematics, Gauhati University,
Assam, India

Program Schedules

Inaugural Function (08 October 2025)

Time		Program
09:30	:	**Invocation - Tamil Thai Vazhthu**
09:35	:	**Lighting the Kuthu Vilakku**
09:40	:	**Welcome Address** Dr. A. Manivannan, Associate Professor & Head, Department of Mathematics, SAS Convener, ICNCS 2025
09:45	:	**About the School** Dr. G. Vinitha, Professor & Dean SAS, VIT Chennai
09:50	:	**Dynamics of the Conference** Dr. Kalyani Desikan, Professor, VIT Chennai
10:00	:	**Felicitation Address** Dr. K. Sathiyanarayanan, Director, VIT Chennai
10:10	:	**Release of Souvenir**
10:20	:	**Inaugural Address** Dr. Kurunathan Ratnavelu, Professor, Institute of Computer Science and Digital Innovation, UCSI University, Kuala Lumpur, Malaysia.
10:40	:	**Vote of Thanks** Dr. V. Parthiban, Co-Convener, ICNCS 2025

Valedictory Function (10 October 2025)

Time		Program
14:50	:	**Welcome Address** Dr. David Raj Micheal Assistant Professor, Co-Convener, VIT Chennai
14:53	:	**Key Outcomes of the Conference** Dr. G. Vinitha, Professor & Dean, SAS, VIT Chennai
15:00	:	**Valedictory Address by Chief Guest** Dr. Sanjeewa Perera, Professor University of Colombo, Sri Lanka
15:05	:	**Address by Guest of Honour** Dr. Uditha Prabhath Liyanage, Senior Lecturer, University of Colombo, Sri Lanka
15:10	:	**Special Address** Dr. Kalyani Desikan, Professor, VIT Chennai
15:15	:	**Feedback from Participants**
15:20	:	**Distribution of Certificates**
15:25	:	**Vote of Thanks** Dr. A. Felix, Associate Professor & Co-Convener, VIT Chennai
15:30	:	**National Anthem**
15:35	:	**High Tea**

DAY 01 (08 OCTOBER 2025)

08:30–09:30 **Registration**

09:30–11:10 **Inauguration & Keynote Addresses**

11:10–11:15 **Group Photo Session**

11:15–11:30 **Tea Break**

Invited Talks

Chair Person: Dhanasekar S, Vellore Institute of Technology Chennai, India

11:30–12:20 Kurunathan Ratnavelu, Institute of Computer Science and Digital Innovation, UCSI University, Kuala Lumpur, Malaysia.
New Results in Knowledge Graphs & Temporal Knowledge Graphs

12:20–14:00 **Lunch Break**

Invited Talks

Chair Person: Prakash M, Vellore Institute of Technology, Vellore, India

14:00–14:40 Jürgen Kurths, Humboldt University, Berlin, Germany
Climate Meets Complex Systems Science: Exploring Extreme Climate Events via a Complex Network Approach

14:50–15:30 Wutiphol Sintunavarat, Thammasat University Rangsit Center, Pathum, Thailand
Bridging Fixed Point Theory and Neural Networks for Advancing Computational Intelligence in Nonlinear Complex Systems with Ecological and Behavioral Applications

15:30–15:45 **Tea Break**

15:45–18:00 **Contributory Talks**

DAY 02 (09 OCTOBER 2025)

Invited Talks

Chair Person: Mini Ghosh, Vellore Institute of Technology, Chennai, India

09:30–10:20 Raju. K. George, IIST, Thiruvananthapuram, India
Controllability of Nonlinear Networked Systems

10:30–11:20 Praveen Agarwal, Anand International College of Engineering, Rajasthan, India
Study of the Mathematical Analysis of Infectious Diseases by Fractional Calculus

11:20–11:30 **Tea Break**

Invited Talk

Chair Person: Vembarasan V, Shiv Nadar University Chennai, India

11:30–12:20 S. Chakraverty, National Institute of Technology, Rourkela, India
Analysing Multidimensional Poverty Through the Lens of Artificial Intelligence

12:20–14:00 **Lunch Break**

Invited Talks

Chair Person: Raju. K. George, IIST, Thiruvananthapuram, India

14:00–14:40 K. Balachandran, Bharathiar University, Coimbatore
On the Solutions of Fractional Differential Equations

14:50–15:30 Fathalla Ali Rihan, UAE University, UAE
Delay Differential Equations in Immunology and Infectious Diseases

15:30–15:45 **Tea Break**

15:45–17:45 **Contributory Talks**

18:00–19:30 **Cultural Programme**

19:30–20:30 **Conference Special Dinner**

DAY 03 (10 OCTOBER 2025)

Invited Talks

Chair Person: Sanjeewa Perera, University of Colombo, Sri Lanka

09:30–10:20 P. Balasubramaniam, Gandhigram Rural Institute (Deemed to be University), Dindigul, India
Solving PDE-Constrained Optimal Control Problems using Artificial Neural Networks

10:30–11:20 S. Muralisankar, Madurai Kamaraj University, Madurai, India
Fixed Point Theorems and its Applications

11:20–11:30 **Tea Break**

Invited Talk

Chair Person: P. Balasubramaniam, Gandhigram Rural Institute (Deemed to be University), Dindigul, India

11:30–12:20 M. Lakshmanan, Bharathidasan University, Tiruchirappalli, India
Complex Structures in Soliton Systems: Coupled Nonlinear Schrödinger Equations

12:20–14:00 **Lunch Break**

Invited Talk

Chair Person: S. Muralisankar, Madurai Kamaraj University, Madurai, India

14:00–14:40 Sanjeewa Perera, University of Colombo, Sri Lanka
Topological Data Analytics for Industrial Applications

14:50–15:30 **Valedictory**

15:30–16:00 **High Tea**

Program Committee

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Dr. Rajivganthi C, Department of Mathematics, SAS, VIT Chennai, India

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Call for Papers

The authors are requested to submit their original research works through online submission in one of the SCI journals (will be finalized soon) by registering themselves after the notification. Please note that the submitted papers will be accepted only after thorough scrutiny and three peer reviews.

Topics chosen could be related to the following topics of interest but not limited to:

- Classical and fractional differential equations
- Machine learning in nonlinear dynamics
- Artificial intelligence (AI) in mathematical perspective
- Quantum computing in dynamical systems
- Soft computing & fuzzy theory
- Algebraic methods and graph theory in network dynamics
- Classical and fractional order models for computer vision
- Control theory and its applications
- Multi-agent systems with game theory
- Computational models for biological systems
- Stability and bifurcation analysis of dynamical systems
- Fractal theory and its applications
- Synchronization and state estimations
- Numerical analysis and development of algorithms
- Chaos in fluid dynamics
- Computational fluid dynamics
- Stochastic modeling of complex systems
- Time-delays/uncertainties phenomena

The submitted research papers will undergo rigorous peer review, and those selected will have the privilege of being published in the following journals:

1. **Bangmod International Journal of Mathematical and Computational Science (JMCS)**

Index in	:	SCOPUS
Publisher	:	Center of Excellence in Theoretical and Computational Science¡
Electronic ISSN	:	3057-0557
Print ISSN	:	2408 – 154X

Abstracts

ICNCS2025_1888

EEG-Based Imagined Speech Classification Using Privacy-Preserving Distributed Learning Approaches

Vaishnavi. K[1], G. Sudha Sadasivam[2], **Moumitha. K**[3], Sruthi. S[4], Durga. G[5] and Darshana. S. M[6]

PSG College of Technology. [1]kvs.cse@psgtech.ac.in; [2]hod.cse@psgtech.ac.in; [3]22z241@psgtech.ac.in; [4]22z264@psgtech.ac.in; [5]22z321@psgtech.ac.in; [6]22z315@psgtech.ac.in

Abstract

The classification of imagined speech using electroencephalography (EEG), has significant applications in Brain-Computer Interfaces (BCIs), especially for people with motor disabilities, enabling communication through imagined speech. However, centralized training methods for these types of data raise serious concerns about data privacy and scalability. This paper presents two separate privacy-preserving solutions to address this problem: Federated Learning and Split Learning. Both approaches employ the Extra Trees Classifier, a robust ensemble model suitable for high-dimensional EEG data. In the federated learning setup, local clients train individually on their private data and only share important features with a central server, which aggregates to update the global model. In split learning, various clients compute partial feature sets and transmit only transformed embeddings to the server, which performs final classification. The EEG dataset used consists of EEG signals of imagined speech of 8 words from 11 participants recorded using eight electrodes. Results show that both methods yield competitive accuracy while preserving privacy—reaching up to 71% in federated learning and 72% with subject-specific split learning. These approaches facilitate learning in edge devices and also preserve data privacy. This study compares and documents the effectiveness of both methods in imagined speech classification and discusses their trade-offs in terms of accuracy, privacy, and computational load.

Keywords: EEG; Imagined Speech; Extra Trees Classifier; Federated Learning; Split Learning; Brain-Computer Interface

ICNCS2025_1925

Advancing Autonomous AI Agents for Scalable and Secure Enterprise Infrastructure

Dinesh G[1] and Ashish Koirala[2]

Kristu Jayanti (Deemed to be University). [1]23csmb11@kristujayanti.com;
[2]23csmb05@kristujayanti.com

Abstract

The rise of autonomous Artificial Intelligence (AI) agents is transforming the management and operation of enterprise AI infrastructures by enabling systems that can independently perceive, reason, and act across distributed environments with minimal human oversight. This research integrates recent advances in modular agent frameworks, multi-agent coordination, and agentic business automation to propose a unified, scalable, and resilient approach to enterprise AI. Key capabilities such as dynamic resource allocation, real-time fault recovery, adaptive decision-making, and enhanced cybersecurity position autonomous agents as foundational components of next-generation systems. Multi-agent architectures, through task partitioning and collaboration, enhance performance and reliability in complex workflows, effectively addressing diverse enterprise demands. To ensure trust, privacy, and regulatory compliance, this work explores security frameworks tailored for distributed agent ecosystems. Lifelong learning and decentralized coordination promote adaptability and robustness, while dynamic role discovery supports flexible task management in evolving operational contexts. Additionally, foundational protocols for agent infrastructure enable coherent context sharing and governance, ensuring transparency and accountability. This comprehensive framework offers actionable strategies for leveraging autonomous agents to drive operational efficiency, innovation, and sustainability. It bridges theoretical developments with practical applications and presents a forward-looking roadmap for enterprises pursuing AI-driven transformation.

Keywords: Artificial Intelligence; Multi-agent Systems; Decision-making; Reinforcement Learning

ICNCS2025_1954

Fuzzy-N Soft Topology (F, N)

A Mohammed Hakil[1] and K. Mahaboob Hassain Sherieff[2]

C. Abdul Hakeem College, affiliated to Thiruvalluvar University, Serkkadu, Tamil Nadu, India. [1]mohammed.hakil@yahoo.com; [2]rosesherieff@yahoo.com

Abstract

In this article, we initiate the concept of fuzzy – N – soft topology (F, N) and few attributes such as fuzzy-N soft basis, fuzzy-N soft neigborhood, fuzzy-N soft interior and fuzzy-N soft subspace topology are analysed.

Keywords: N-soft topology; fuzzy-N soft topology; (F, N) soft basis; (F, N) soft neighborhood; (F, N) soft interior

ICNCS2025_1955

Secure Authentication Protocol for IoT enabled WSNs Based on NTRU

Arman Ahmad[1], Jagatheswari Srirangan[2] and Sriram[3]

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Abstract

IoT-enabled Wireless Sensor Networks (WSNs) consist of distributed sensor nodes that collect and transmit data over public channels. This data is sensitive and contains confidential information. Authentication and key agreement protocol is a promising solution, which first mutually authenticate the communication entities, and then establishes a session key between them to protect transmitted data. Various authentication and key agreement schemes have been proposed to secure the transmitted data. But most of them are based on traditional methods, such as ECC, which are not secure in quantum environment because of Shor's algorithm. Those which are quantum safe are not lightweight enough as these sensors are resource constrained. To overcome these limitations, we propose an NTRU based authentication protocol combining with Fuzzy Extractor technique. The proposed protocol security is formally analysed via ProVerif simulation tool, and informally analysed against various known attacks. Compared with prevailing protocols, the proposed protocol demonstrates better performance in terms of security features, communication and computational overhead.

Keywords: Authentication and Key Agreement; WSNs; NTRU; Fuzzy Extractor; Post-Quantum Cryptography

ICNCS2025_1956

Variational approach to MHD flow towards a stretching sheet with suction/injection, viscous dissipation and heat flux

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Abstract

The physical problem of steady, laminar, two dimensional MHD flow over a stretching sheet with suction/injection, viscous dissipation and heat flux is mathematically modelled as a simultaneous system of non-linear partial differential equations. To achieve the solution for the consider problem numerically, the Gyarmati's variational principle on the basis of non-equilibrium thermodynamics processes in the theory of continua is adopted. To estimate the transportation fluid fields inside the boundary layer, the appropriate trial polynomial functions have been employed and functionals for the integral variational principle are determined. The Euler-Lagrange equations of the functional are obtained as a system of polynomials involving boundary layer thicknesses of momentum and temperature. The expressions of shear stress, Nusselt number have been derived and the effects of various physical factors involved in the problem are explored. The obtained results are compared with previously published results in the literature, to confirm the validity of the solution procedure. The results depict the significant properties of suction/injection, viscous dissipation and heat flux. This classical variational principle permits hydrodynamic engineers and scientists to discuss the laminar MHD fluid flow and heat transfer problems efficiently and effectively. This variational principle presents a significant advantage over the conventional numerical methods which typically require more extensive calculations.

Keywords: MHD fluid flow; Variational principle; Stretching sheet; Heat transfer; Viscous dissipation; Suction and Injection

ICNCS2025_1959

Multiple scale homotopy perturbation method for non-conservative duffing oscillators

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Abstract

The Homotopy Perturbation Method (HPM) is one of the most efficient perturbation methods for solving strongly nonlinear systems as it does not require the presence of small parameter. However, when damping is considered in the case of the non-conservative duffing oscillators, the traditional HPM has a shortcoming since the secular terms cannot be nullified. To overcome this issue, modified methodology is proposed where multiple time scales can be combined with the HPM to solve the governing nonlinear equation of motion for non-conservative duffing oscillators. As a case study, a physical system of composite sandwich plate whose transverse displacement can be modelled by damped duffing equation is considered. The geometric nonlinearity is included in terms of von Karman strain-displacement relations and the third-order shear deformation theory (TSDT) is used to model the deformations. The nonlinear frequency response for free and forced vibrations is analysed using the proposed method.

Keywords: Multiple scale homotopy perturbation method; geometric nonlinearity; damping; duffing oscillator; non-conservative; nonlinear frequency response

ICNCS2025_1961

Soliton dynamics of coupled Schrodinger equation with third-order dispersion and nonlinearity

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Abstract

The coupled nonlinear Schrodinger equation, which is used to describe the pulse propagation in high birefringence fiber and illustrates the complex envelope amplitudes of two modulated weakly resonant waves in two polarizations, has various applications in optical fibers. In this work, we study the dynamics of two-soliton collisions in a two-component coupled nonlinear Schrodinger equation, including third-order dispersion and nonlinearity. Using the Hirota bilinear technique and power series expansion, the coupled equations are converted into ordinary differential equations, and then the one- and two-soliton solutions and their interaction properties are derived.The higher-order dispersion modifies the propagation and interaction of solitons, leading to amplitude reshaping, phase shifts, and energy redistribution during collisions. The numerical simulations explore the graphical representations of soliton solutions and phase shift. The findings provide insights into soliton-based energy transfer, thus extending the understanding of nonlinear wave dynamics in advanced photonic systems.

Keywords: Dispersion; Hirota bilinear method; Schrodinger equation; Soliton

ICNCS2025_1962

Design of discrete-time event-triggered Takagi-Sugeno fuzzy observers for Takagi-Sugeno fuzzy time-delay models and their application to nonlinear dynamics time-delay systems

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Abstract

This paper considers the design of the discrete-time event-triggered Takagi-Sugeno (T-S) fuzzy observers for T-S fuzzy time-delay models subject to disturbances in the state and output vectors. For the first time, a new discrete-time event-triggered mechanism is proposed, which is used in the framework of designing new T-S fuzzy observers. Existence conditions for the proposed discrete-time event-triggered T-S fuzzy observer are established and form in terms of a convex optimization problem. The optimization problem provides observer matrices and minimizes the error in estimating. Finally, an effective algorithm to design the discrete-time event-triggered T-S fuzzy observer is introduced and applied to estimate the state vectors of the continuous-time truck-trailer time-delay model and the stirred tank reactor nonlinear time-delay system.

Keywords: T-S fuzzy time-delay model; event-triggered mechanism (ETM); event-triggered T-S fuzzy observers

ICNCS2025_1963

Symmetry analysis of time fractional $(3+1)-D$ Navier-Stokes equation

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Abstract

We consider the time-fractional $(3+1)-D$ system of Navier-Stokes equations governed by incompressible fluid. First, we derive the infinitesimal transformation under which the given equation remains invariant. Next, we classify them and obtained one-dimensional and three-dimensional optimal system. Consequently, we study the effect of fractional order (β) derivative on the behaviour of solutions graphically.

Keywords: lie symmetry; $(3+1)-D$ Navier-Stokes; fractional calculus

ICNCS2025_1964

Discrete-time event-triggered state estimation for nonlinear fractional-order systems with time delays

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Abstract

In this paper, we address the problem of designing discrete-time event-triggered fractional-order state observers to estimate the state vector of nonlinear one-sided Lipschitz fractional-order systems subject to unknown time delays in the state and input vectors. First, the original system is transformed to a new one where the time delays in the input vectors are eliminated, and a new disturbance appears in the state and output vectors. Then, a new state variable consists of the state variable of the original system, and the created disturbance is introduced to transform the obtained fractional-order system (after the first step) to a new fractional-order descriptor system without disturbance in the output vector. Next, a new observer is designed, and a convex optimization problem is established to provide unknown observer matrices. Finally, a numerical example with simulation results is presented to illustrate the effectiveness of the proposed discrete-time event-triggered fractional-order state observer.

Keywords: Fractional-order time-delay systems; discrete-time event-triggered mechanisms; event-triggered fractional-order state observers; linear matrix inequality

ICNCS2025_1966

Event-Triggered Finite Time Space Guarantee Cost Control for Uncertain Time-Delay Fractional-Order Systems

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Abstract

The finite-time guaranteed cost control (FTGCC) is a method to design controllers such that the obtained closed-loop systems are finite-time stable with an adequate cost level of performance. This method is often used to deal with dynamical systems where system matrices are uncertain and the systems are affected by unknown time delays and external disturbances. Some interesting results on the FTGCC have been reported in the literature. Nevertheless, the existing methods for this problem have not been extended to design event-triggered controllers such that uncertain fractional-order systems subject to time delays and external disturbances are finite-time stable with an adequate cost level of performance. In this paper, we solve the problem of designing an event-triggered finite-time guaranteed cost controller for uncertain polytopic fractional-order systems subject to unknown time-varying delays and external disturbances. Simulation results are provided to demonstrate the effectiveness of the proposed method.

Keywords: Event-triggered mechanisms; Polytopic fractional-order systems; Finite-time stability; Guaranteed cost control; Unknown time-varying delays; Linear matrix inequalities.

ICNCS2025_1967

Reduced-order event-triggered state observers for a full-car active suspension system with delayed input and external disturbances

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Abstract

In this paper, we propose a novel method based on an event-triggered mechanism and a reduced-order second-order observer to estimate state vectors of a full-car active suspension system with delayed input and external disturbances. Mathematical equations of a full-car active suspension system with delayed input and external disturbances are first formulated by applying the D'Alembert's principle. Then, an event-triggered mechanism and a reduced-order second-order observer are designed to estimate unmeasured states of the full-car active suspension system. Finally, the existence conditions of the event-triggered reduced-order second-order observer and a design algorithm are derived. Different from the existing like-Luenberger reduced-order observers in the literature, which are suitable for first-order systems, the one in this paper can be used to estimate unmeasured states of dynamical systems described by second-order systems. Moreover, the proposed method in this paper offers advantages in saving communication resources and cost.

Keywords: Event-triggered reduced-order observers; full-car model of the vehicle suspensions; convex optimization problem; Linear matrix inequalities (LMIs)

ICNCS2025_1970

Design and Analysis of a Meta-Heuristic Approach for Project Schedule Optimization Integrating Genetic Algorithm with CPMPERT for Enhanced Scheduling System

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Abstract

Project scheduling is a critical component of effective project management, directly influencing the timely and cost-effective completion of complex endeavours. Traditional deterministic techniques like the Critical Path Method (CPM) and the Probabilistic Evaluation and Review Technique (PERT) are widely used to identify the longest path of tasks and estimate project duration. However, these methods often operate under simplifying assumptions, such as unlimited resources and fixed task durations, which can limit their realism and optimization capabilities in dynamic environments. This study investigates the application of a metaheuristic Evolutionary Algorithm (EA), specifically a Genetic Algorithm (GA), to solve the project scheduling problem for the development of a ”PC Cart” system. The project network, comprising 13 interrelated activities, was first analysed using CPM to establish a baseline duration of 21 weeks and identify a critical path. The GA was then employed to evolve a population of candidate schedules, optimizing for the minimization of total project duration. The algorithm’s performance was evaluated based on its convergence speed and solution quality. Results demonstrate that the GA not only consistently converges to the known CPM optimum but also provides a robust framework capable of incorporating additional real-world constraints—such as resource allocation, multi-skilled crews, and time-cost trade-offs—that are beyond the scope of classical CPM/PERT. This research concludes that evolutionary algorithms offer a superior, flexible, and powerful alternative for modern project scheduling, enabling managers to discover more efficient and resilient project plans.

Keywords: Project Scheduling; Critical Path Method (CPM); PERT; Genetic Algorithm; Evolutionary Algorithms; Optimization; Metaheuristic; Project Management

ICNCS2025_1973

An Algorithm Based on Pseudospectral Method in Time and Space Direction for Hyperbolic Conservation Law

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Abstract

In this article, a numerical method is introduced to solve the time-space Pseudospectral quadrature simulation technique for a linear hyperbolic conservation law. This technique is based on a Chebyshev–Gauss–Lobatto (CGL) collocation method for discretizing spatial domains, which facilitates the time integration of the resulting algebraic equation system. This system is then solved using the Gauss elimination method. Numerical results confirm the proposed technique's spectral convergence in space and time. Finally, some numerical results show that the proposed technique is effective in our computational approach.

Keywords: Root Mean Square(RMS) error; Mean Absolute(MA) error; Chebyshev-Gauss-Lobbato(CGL) points; Pseudospectral method; Hyperbolic Conservation Law.

ICNCS2025_1975

Freshness-Driven Sustainable Pharmaceutical Inventory Optimization using DRL and Meta-Heuristics under Random Lead Time and Emission-Aware Preservation

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Abstract

The sustainable management of perishable pharmaceuticals presents a critical challenge for pharmacy retailers, who must simultaneously address the distinct characteristics of prescription (Rx) and over-the-counter (OTC) drugs, both of which exhibit freshness-dependent demand, albeit with differing sensitivity levels influenced by regulatory mandates and consumer health preferences. This study proposes a hybrid decision-support framework that integrates analytical modeling, meta-heuristic optimization, and deep reinforcement learning (DRL) to jointly optimize inventory efficiency and sustainability under uncertainty. The inventory system is modeled with freshness-sensitive demand, stochastic lead time determined by fill rate service levels, and deterioration governed by a three-parameter Weibull distribution. Preservation investment is incorporated to decelerate temperature-induced degradation, while its environmental impact, quantified via carbon emissions and associated tax costs, is explicitly captured. The resulting nonlinear model, formulated through governing differential equations, exhibits pseudo-convexity with respect to key decision variables, namely order lot-size, lead time, preservation investment, and service investment. To address analytical intractability, advanced meta-heuristic algorithms are employed to approximate near-optimal solutions and benchmark them against conventional methods. In parallel, a DRL-based policy learning framework is developed to facilitate adaptive, data-driven decision making under real-time operational variability. Extensive numerical experiments using primary data validate the effectiveness of both approaches. Furthermore, a comprehensive sensitivity analysis is conducted on key exogenous parameters, including deterioration characteristics and carbon taxation rates, to assess their impact on the optimal values of preservation investment, lead time, service investment, ordering quantity, and the total inventory cost. The results demonstrate that the integrated framework not only reduces total inventory cost but also enhances sustainability by balancing service

quality, environmental impact, and economic efficiency. This dual-methodology provides a rigorous, scalable, and adaptive paradigm for managing perishable pharmaceutical inventories under complex, uncertain environments.

Keywords: Carbon emission; Deep reinforcement learning; Freshness-sensitive demand; Metaheuristics; Preservation investment; Random lead time; Weibull distribution

ICNCS2025_1977

Darcy–Forchheimer Casson hybrid nanofluid flow in a stenotic artery with the effects of thermophoresis and Brownian motion

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Abstract

Research into the flow of blood through a narrowed artery is crucial in the field of fluid dynamics due to its tremendous importance in biomedical science. By considering these aspects, the current study aims to investigate the theoretical analysis of the behaviour of Casson hybrid nanofluid flow (Au/Al_2O_3) in a stenotic artery, examining the repercussions of Darcy–Forchheimer, thermophoresis, and Brownian motion. Variable viscosity and thermal conductivity have also been used to analyse the influence of flow, heat, and mass transfer. The similarity transformation method leads to ODEs from the governing coupled non-linear set of PDEs. The collocation method is used to build a mathematical model and solve it numerically using a MATLAB solver. Furthermore, the results for velocity and temperature of the nanofluid and hybrid nanofluid cases are presented graphically. The attained results are corroborated by their consistency with previously published findings. It's pertinent to note that the temperature profile rises with growing Brownian motion and thermophoresis parameter values. In contrast, the concentration profile declines as values of the thermophoresis parameter improve.

Keywords: Casson hybrid nanofluid; Stenotic artery; Brownian motion; thermophoresis; variable viscosity

ICNCS2025_1978

Numerical Study and Sensitivity Analysis of Casson Hybrid Nanofluid Flow in a Rotating Channel with Riga Plates

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Abstract

The current study examines the mathematical analysis of Casson hybrid nanofluid flow, utilizing water as the base fluid, and investigates the effects of nanoparticles on two parallel Riga plates, which promote effective flow control and enhanced heat transfer efficiency in solar collector applications. The lower plate is postulated to be stretched and have transient fluid flow attributes. The surface of the moving upper Riga plate is subject to induced squeezing characteristics. The set of governing PDEs, concurrently with the boundary conditions, is restructured into ODEs employing similarity transformations. The transformed equations are evaluated numerically for axial $f'(\eta)$ and transverse $g(\eta)$ velocities and temperature $\theta(\eta)$ via the shooting method. Graphs illustrate and scrutinize the significant results of distinguished parameters on fluid dispersions. The obtained results demonstrate that by enhancing the value of rotation, squeezing, and modified Hartmann number parameters, the velocity profile exhibits dual behavior. Moreover, escalating the value of the radiation parameter elevates the temperature profile. Additionally, sensitivity analysis is employed to identify the effects of the skin friction rate on the parameters: rotation, magnetic, and squeezing. The skin friction rate is observed to have the greatest impact on the squeezing parameter. This study also verified existing findings and demonstrated a satisfactory level of consistency.

Keywords: Riga plates; Casson fluid; Modified Hartmann number; Rotating channel; Hybrid nanofluid

ICNCS2025_1979

Quantum Neural Network-Driven Optimal Control of the Nonlinear Time–Fractional Schrödinger Equation

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Abstract

The optimal control of quantum systems with fractional dynamics has emerged as a powerful approach to capture memory effects, anomalous transport, and non-Markovian behavior. In this work, we develop a hybrid computational framework for the nonlinear time–fractional Schrödinger equation that unifies fractional calculus, advanced numerical solvers, and quantum machine learning. Specifically, the method employs Caputo fractional derivatives via the L1 scheme to incorporate nonlocal temporal effects, an enhanced split-step Fourier method for stable and efficient wave function propagation, and quantum neural networks implemented on variational quantum circuits to generate adaptive control fields. The optimization is guided by a fidelity-based objective functional with regularization to suppress unphysical controls, while gradients of the variational parameters are estimated through finite differences to refine the control landscape. The proposed results demonstrate that combining fractional quantum dynamics with quantum neural networks enables scalable and robust control strategies in non-Markovian and strongly correlated regimes. This framework provides a flexible foundation for extending fractional quantum control theory to applications in quantum technologies, condensed matter systems, and anomalous transport phenomena.

Keywords: Fractional calculus; Schrödinger equations; optimal control; quantum neural networks; split-step methods; quantum machine learning

ICNCS2025_1980

Equidistribution Grid Method for Singularly Perturbed Parabolic Turning Point Problems with Robin Boundary Conditions

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Abstract

In this paper, we investigate a singularly perturbed parabolic convection diffusion problem that possesses a turning point subject to Robin type boundary conditions. To resolve the strong gradients that arise near the boundary layers, we design an equidistribution mesh strategy based on an appropriate monitor function that adapts the spatial grid efficiently to the underlying solution structure. The temporal discretization is carried out on a uniform grid, while the spatial discretization employs a finite difference method constructed on the non-uniform meshes. In the temporal direction, the discretization is performed with the backward Euler approach, while in the spatial direction, the upwind method is employed. A comprehensive theoretical analysis is presented to demonstrate the stability of the method, the precise control of truncation errors, and the convergence that is uniform with respect to the perturbation parameter. The numerical scheme is proven to be first-order accurate in the discrete maximum norm. Rigorous proofs are included for all theorems and lemmas, thereby providing a complete mathematical justification of the proposed methodology. Numerical experiments are carried out to illustrate the theoretical findings and confirm the reliability of the approach.

Keywords: singular perturbations; parabolic partial differential equations; turning point; Robin boundary conditions; boundary layers; equidistribution meshes

ICNCS2025_1981

Impact of Thermal Radiation on Rotational MHD Bioconvection of an Al_2O_3-Water Nanofluid with Chemotaxis and Parabolic Acceleration

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Abstract

This study investigates the coupled effects of thermal radiation and bioconvection in an unsteady, rotational magnetohydrodynamic (MHD) flow of an aluminium oxide-water ($Al_2O_3 - H_2O$) nanofluid. The fluid, containing chemotactic microorganisms, moves past an accelerated vertical plate under a time-dependent ramped heating. A key novelty is the inclusion of linearised thermal radiation, modelled using the Rosseland approximation. The comprehensive physical model also incorporates the effects of Brownian motion, thermophoresis, Joule heating, and viscous dissipation to accurately capture the transport phenomena. The governing partial differential equations are non-dimensionalised and solved using a perturbation technique combined with the Laplace transform method. The central aim is to elucidate how the thermal radiation parameter impacts the interdependent velocity, temperature, nanoparticle concentration, and microorganism density profiles. Enhanced thermal radiation is expected to significantly improve heat transfer, creating a thicker thermal boundary layer. This, in turn, amplifies thermal buoyancy forces, accelerating the primary flow and directly influencing the chemotactic response and spatial distribution of the microorganisms. The findings are vital for optimising technologies like microbial fuel cells, geothermal energy systems, and microfluidic biosensors, where precise control over coupled transport phenomena is critical.

Keywords: MHD; Bioconvection; Nanofluid; Thermal Radiation; Chemotaxis; Parabolic; Ramped Heating.

ICNCS2025_1983

Exponential Stability of impulse fractional order systems with Markovian Jump Parameters

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Abstract

The exponential stability problem for impulsive fractional-order systems with Markovian jump parameters is studied in this work. By combining the fractional-order calculus theory with stochastic analysis, sufficient conditions ensuring exponential stability in the mean square sense are derived. The proposed framework employs a Lyapunov-based approach together with generalized gronwall-type inequalities to handle the combined effects of impulses, system jumps and fractional dynamics. The effect of the fundamental Markov process's impulse instants on the stability region is discussed in detail. Furthermore, the obtained conditions are formulated in terms of Linear Matrix Inequalities (LMI's), which can be efficiently verified using numerical stimulations. Finally, illustrative example is provided to demonstrate the effectiveness and applicability of the theoretical results.

Keywords: Fractional-Order; Exponential Stability; Markovian Jump Parameters

ICNCS2025_1984

One-Dimensional Fractional Volterra Integro-Differential Equation solving Pseudospectral Method

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Abstract

In this paper, Time Space Chebyshev Pseudospectral method is proposed to solve One-Dimensional Fractional Volterra Integro-Differential Equation. These Equations combine a fractional derivative with respect to time, expressed in the Caputo sense, together with an integral term involving a memory kernel, which makes them suitable for modelling hereditary and memory-dependent processes. The fractional order differential matrix establish using Caputo-Fractional derivative matrix at the CGL points. Further using the proposed method. The given problem is reduced to system of algebraic equation and these algebraic equation can be solved Newton's Raphson Method. The proposed results confirm the spectral convergence and comparability better. Numerical experiment illustrate the effectiveness of the approach, showing that the proposed scheme outperforms existing methods in terms of precision and computational efficiency.

Keywords: Integro-Differential Equation; Fractional Volterra Integro-differential Equation; pseudospectral Method

ICNCS2025_1986

Optimizing Air Traffic Forecasting with GRU and Machine Learning Techniques

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Abstract

Air traffic control is increasingly dependent on data-driven systems to maximize airport use and passenger movement through improved forecasting. In this paper, we introduce a new hybrid model consisting of Ridge regression and Gated Recurrent Unit (GRU) neural networks to capture stability as well as temporal dynamics in air traffic forecasting. The GRU learns long-term temporal trends from 15 years (2010–2024) of historical data that include flights, weather, and seasonality, whereas Ridge regression introduces robustness, stability, and interpretability. For more effective decision support, dashboards and scenario-based analyses are combined, and stakeholders can assess alternative operational plans. This mixed-methodology addresses crucial gaps in current forecasting systems, including overdependence on one model, uninterpretability, and inadequate management of India-specific perturbations such as monsoons and festivals. The model facilitates real-time extension for forecasting and focuses on interpretability via Ridge feature attribution and GRU sequence analysis. Evaluation will comprise RMSE, MAE,R^2,and MAPE, in addition to per-scenario performance, showcasing the efficacy of this Ridge+GRU approach towards adaptive and interpretable air traffic decision-making.

Keywords: Air Traffic Forecasting; Time-Series Prediction; Weather and Seasonal Disruption; Modeling Decision Support Systems; Scenario-Based Forecasting; Hybrid GRU–Ridge Model; Machine Learning in Aviation; Flight Landing Counts Forecasting.

ICNCS2025_1987

QSPR modeling with topological indices of some antibiotic and related drugs

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Abstract

The integration of chemical graph theory with antibiotic drug analysis enhances our understanding of structure–activity relationships and supports the development of predictive models in cheminformatics. In this research we have obtained the distance based topological indices such as Padmakar-Ivan index, Szeged index and Mostar index of the molecular graph of some antibiotic and related drugs. Linear, quadratic and cubic regression models is performed finally to validate the correlation between these indices and physicochemical properties to these drugs.

Keywords: Padmakar-Ivan; Szeged and Mostar indices; antibiotic and related drugs; QSPR analysis

ICNCS2025_1988

Analysis of Malaria Transmission Dynamics and Cost-Effective Strategies in India and Nigeria (2018-2024)

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Abstract

Malaria continues to be one of the deadliest vector-borne diseases, especially in sub-Saharan Africa and South Asia, where Plasmodium falciparum is the most prevalent and deadly parasite species. Despite decades of control efforts, malaria transmission continues to pose severe health and socio-economic challenges in highly endemic regions such as India and Nigeria. In this study, we formulate and examine a compartmental malaria transmission model characterized by SEIR dynamics for the human population and SI dynamics for the mosquito vector. The model's well-posedness is established by proving positivity, boundedness, existence and uniqueness of solutions. Equilibrium points are computed, and their stability is examined with respect to the basic reproduction number, $\mathscr{R}_0$. Using epidemiological datasets from India and Nigeria, the model is parameterized and fitted to capture country-specific malaria dynamics. Global sensitivity analysis is then performed to identify the most influential parameters accelerating or reducing disease spread. To design effective interventions, four optimal control strategies are investigated, combining measures such as mosquito repellent nets, diagnostic methods (microscopy and rapid testing), antimalarial treatment and insecticide spraying. Cost-effective analysis reveals that Strategy I (mosquito repellent nets) is optimal for India, while Strategy IV (insecticide spraying) is most effective for Nigeria. These results provide critical insights into region-specific strategies that can aid policymakers in reducing and eventually eliminating malaria.

Keywords: Cost-Effectiveness; Global Sensitivity Analysis; Optimal Control; Plasmodium falciparum; Stability

ICNCS2025_1989

Stochastic Modeling of Measles Dynamics with Nonlinear Perturbations and Discrete Markov Switching in India (2014–2024)

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Abstract

Measles is one of the most contagious viral infections and continues to persist worldwide, challenging public health systems in spite of extensive vaccination efforts. In this work, we develop a stochastic SV_1V_2EIH model to describe the transmission dynamics of measles. It incorporates both nonlinear white noise and colored noise driven by an irreducible continuous-time Markov chain with discrete state variables representing media awareness and environmental perturbations. The model is calibrated using measles case data from India spanning the years 2014 to 2024, allowing for the estimation of key epidemiological parameters. The proposed stochastic model is proven to admit a unique global positive solution for all time. Sufficient criteria involving R_0^s establish the existence and uniqueness of an ergodic stationary distribution, reflecting long-term disease persistence. These results are derived using θ-stochastic Lyapunov functions constructed through a generalized θ-stochastic criterion method, which offers conditions for system stability. In contrast, conditions for disease extinction are obtained under the threshold R_0^e. Finally, numerical simulations illustrate and validate the theoretical findings, confirming the model's effectiveness in capturing the complex interplay among media influence, vaccination strategies, and random perturbations in measles transmission.

Keywords: Extinction; Markov switching; Media coverage; Measles; Nonlinear perturbation; Stationary distribution

ICNCS2025_1992

Performance Modelling of a Single-Server Queue under Multiple Working Vacations and Partial Failures

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Abstract

This article examines a single-server queueing system with two key operational features viz., multiple working vacations and partial breakdowns. Customer arrivals follow a Poisson process, while service times are exponentially distributed. During normal busy periods, the server operates at a full-service rate. However, during working vacations and periods of partial breakdown, the server continues to serve customers but at a reduced rate. The duration of each vacation is exponentially distributed. The system is analyzed using the matrix-geometric method, which enables the derivation of the steady-state probability distribution. Based on this analysis, key performance measures are computed and discussed.

Keywords: Markovian Queue; Single server; Arrival rate; Service Rate; Working vacation; Breakdown; Matrix geometric method

ICNCS2025_1994

Gestation Delay in Predator Dynamics: A Prey–Predator Disease Model with Fear and Prey Refuge Effects

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Abstract

This work analyzes an eco-epidemiological prey-predator model in which the prey population is divided into susceptible and infected classes, while the predator feeds on both types of prey. The model incorporates two biologically relevant mechanisms: a fear effect in the susceptible prey and a refuge mechanism for the infected prey. To account for realistic predator growth, a gestation delay is introduced in the recruitment term. We establish the positivity and boundedness of solutions, derive the basic reproduction number R_0, and examine the stability of the equilibrium points for both delayed and non-delayed systems. Using the gestation delay as a bifurcation parameter, we demonstrate the occurrence of Hopf bifurcations, leading to oscillatory dynamics. Numerical experiments conducted with MATLAB and MatCont include PRCC sensitivity analysis, contour plots, bifurcation diagrams, phase portraits, and time series simulations, all of which validate the theoretical findings. The results highlight that the combined effects of fear, prey refuge, and gestation delay crucially determine system stability and can generate complex dynamic behavior in prey-predator interactions.

Keywords: Fear effect; Prey refuge; Prey predator; Gestation delay; Disease model

ICNCS2025_1995

Linear Stability Analysis of Light-Induced Bioconvection in a Stress-Free Fluid Layer

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Abstract

Phototactic bioconvection arises when light-sensitive microorganisms respond collectively to directed illumination, giving rise to fluid instabilities and convective motion. The present study focuses on the linear stability of such a system when the top surface of the horizontal fluid layer is exposed to a collimated light beam incident from the light source. Both boundaries of the layer are assumed to be stress-free. The governing equations are linearized about the quiescent state, and the resulting eigenvalue problem is solved using a normal-mode formulation coupled with the MATLAB routine bvp4c. The analysis demonstrates that boundary conditions exert a marked influence on stability behavior. In particular, the case with stress-free boundaries at both surfaces exhibits the lowest critical threshold, indicating that the suspension destabilizes earlier than in configurations with one or two rigid boundaries. This enhanced tendency toward instability is linked to the absence of viscous damping at the bounding surfaces, which allows perturbations to amplify more readily. The microorganism concentration fields provide further physical insight. With increasing critical total intensity, the position of the peak concentration gradually shifts toward the upper surface. This migration strengthens density gradients near the top layer and consequently accelerates the onset of convection.

Keywords: Phototactic; bioconvection; algae cells; microorganisms; linear stability analysis; stress-free surface; Navier-Stokes equations.

ICNCS2025_1999

Numerical solution of Gardner's equation using Spatial-Temporal Pseudospectral Method

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Abstract

In this research article, we present a pseudospectral method to approximate the solution of Gardner's equation,which is a prototype of nonlinear dispersive equations. The proposed method is based on Chebyshev-Gauss-Lobatto(CGL) points and employs spectral collocation in both spatial and temporal directions. Further applying the pseudospectral method in spatial and temporal directions to convert Gardner's equations is reduced to a system of nonlinear algebraic equations, which can be efficiently solved using Newton-Raphson Method. Furthermore some numerical experiment results shows that the proposed method is effective and more accurate as compared to other numerical techniques.

Keywords: Gardner's Equation; KdV; Modified KdV; Chebyshev-Gauss-Lobatto point; Pseudospectral method

ICNCS2025_2000

Optimal Charger Deployment for Q-Coverage using Nature-Inspired Algorithms in Wireless Sensor Networks

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Abstract

Wireless Sensor Networks (WSNs) play a crucial role in monitoring and communication applications; however, their performance heavily depends on efficient energy replenishment strategies. This paper addresses the optimal deployment of mobile chargers to maximize sensor coverage under homogeneous conditions using three nature-inspired metaheuristic algorithms: the African Vultures Optimization Algorithm (AVOA), the Chimp Optimization Algorithm (QOA), and the Cuckoo Search Algorithm (CSA). A common Q-coverage fitness function is employed to evaluate the quality of charger placement across multiple simulation runs. Comparative analysis reveals that AVOA achieves superior performance with an average coverage of 95.9%, significantly outperforming QOA (90.1%) and CSA (88.7%). Convergence and fitness distribution plots further confirm the robustness and stability of AVOA in reaching near-optimal solutions. The findings demonstrate the effectiveness of AVOA for charger placement problems in WSNs and highlight its potential for real-world energy management applications.

Keywords: Wireless Sensor Networks; African Vultures Optimization Algorithm; Q-Coverage; Charger optimal placement

ICNCS2025_2001

Metaheuristic-Based Optimal Charger Placement for Q-Coverage in Wireless Sensor Networks Using a Hybrid Kookaburra-Osprey Strategy

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Abstract

Wireless Sensor Networks (WSNs) installed in hostile or hard-to-reach areas usually experience severe challenges with network longevity and sensing reliability because of meager energy supplies. Wireless chargers have been identified as a potential solution for refilling sensor energy without human assistance, but optimal charger placement is a very intricate problem, particularly if sensors need to be covered by multiple chargers to meet high Q-coverage requirements. This paper proposes a Hybrid Kookaburra–Osprey Optimization Algorithm (HKOOA) to optimally place wireless chargers to cover as many Q-covered sensors as possible in an arbitrarily deployed WSNs. The hybrid algorithm combines the exploratory nature of kookaburras and the exploitative diving strategy of ospreys, achieving an optimal balance between global search and local intensification. Large-scale WSNs in adversarial environments with different charger capacities, sensor deployments, and Q-coverage requirements are simulated extensively. Experiments show that the proposed HKOOA – 94.4% outperforms other state-of-the-art metaheuristic algorithms such as Artificial Bee Colony – 87.2% (ABC), Quokka Optimization Algorithm – 81.9%(QOA), Whale Optimization Algorithm – 86.8% (WOA), and Dwarf Mongoose Optimization Algorithm – 83.3% (DMOA) in convergence rate and ratio of Q-covered sensors. The results identify the capability of HKOOA as an effective and dependable method for energy sustainability and robust WSNs operation in extreme conditions.

Keywords: Wireless Sensor Networks; Q- Coverage; Hybrid Kookaburra–Osprey Optimization Algorithm; Optimal Charger Placement

ICNCS2025_2002

Graceful Coloring of Triangular Snake Graphs

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Abstract

A graceful k-coloring of a graph G is a proper vertex coloring using colors from the set $\{1, 2, \ldots, k\}$, where $k \geq 2$, which induces a proper edge coloring such that the color of any edge $e = uv$ is the absolute difference between the colors of vertices u and v. The minimum value of k used in a graceful k-coloring of a graph G is called the graceful chromatic number of G. A Triangular snake graph T_n is obtained from a path $\{u_1, u_2, ..., u_n\}$ by joining u_k and u_{k+1} to a new vertex v_k for $k \in \{1, 2, 3, ..., n\}$. That is, every edge of a path is replaced by a triangle. The double triangular snake graph DT_n consists of two triangular snakes that have a common path. In this paper, we compute the graceful chromatic number of Triangular Snake Graphs and Double Triangular Snake Graphs.

Keywords: Graceful coloring; Graceful chromatic number; Triangular Snake Graphs

ICNCS2025_2005

A Computational Study on Casson Hybrid Nanoliquid flow over a Rough Surfaced Spinning Sphere with Irregular Boundaries under the Influence of Variable Viscosity and Thermal Conductivity

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Abstract

Hybrid nanofluids (HNFs), which are advanced thermal fluids created by suspending two or more distinct types of nanoparticles in a base fluid to greatly improve heat transfer performance, are widely used in high-efficiency cooling systems for engineering and biomedical applications. Applications for flow over rotating spheres include cooling spherical electronic components, biomedical devices including targeted drug delivery systems, and aircraft thermal shielding. Therefore, the present study investigates the non-Newtonian Casson hybrid nanofluid flow across a rotating sphere with a rough surface and uneven boundaries. Water is regarded as the base fluid in this analysis, and the hybrid nanofluid is created by using Copper (Cu) and Titanium dioxide (TiO_2) as suspended nanoparticles. The Modified Buongiorno Model (MBM) framework is used to conduct the inquiry. Based on the prevailing model, the flow's mathematical representation involves defining nonlinear governing equations. After undergoing nonsimilar transformations, a quasilinearization technique and an implicit finite difference scheme are applied to these boundary layer governing equations. The resulting block tridiagonal system of equations is subjected to Varga's algorithm. The outcomes are fairly comparable to those formerly published. The visual findings revealed that the swirl velocity S falls more gradually as the rotation parameter increases, suggesting a deeper rotational impact inside the fluid, whereas the tangential velocity F increases due to increased surface-driven flow. Greater rotational momentum transfer from the spinning sphere to the surrounding fluid is promoted by an increase in swirl velocity S within the boundary layer, which is caused by an increase in β_2 , which represents surface roughness or defects. Furthermore, the fluid temperature inside the flow region increases in tandem with the intensity of thermal radiation. Furthermore, because of enhanced diffusion, a larger Brownian motion parameter (Nb) causes a decrease in nanoparticle concentration close to the wall, intensifying the concentration differential across the boundary layer.

Keywords: Casson Hybrid Nanofluid; Spinning sphere; Irregular boundaries; Implicit Finite Difference Scheme; Thermal radiation

ICNCS2025_2006

Fractal Perturbations in Radial Basis Functions for Improved Interpolation and Prediction with LSTM

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Abstract

This paper proposes a radial basis fractal interpolation function (RBFIF) technique to construct interpolants with controllable smoothness and fractal characteristics. In contrast to standard radial basis function (RBF), which relies on a single shape parameter to determine the shape of the RBF, the proposed method employs an additional set of parameters, vertical scaling factors to regulate smoothness. This dual parameter formulation enables independent control over curve smoothness and shape. To validate the method's capability in capturing intricate data structures, numerical experiments are performed. Furthermore, the interpolated datasets are employed within a long short-term memory (LSTM) for predictive modeling. The findings indicate that the combination of RBFIF and LSTM achieves greater prediction accuracy than interpolation methods, highlighting its practical applicability.

Keywords: Fractal interpolation function (FIF); Radial basis function (RBF); Prediction with LSTM

ICNCS2025_2008

Enhancing Digital Image Security with an Arccos Derived Chaotic Map

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Abstract

This paper introduces a one-dimensional chaotic map based on the inverse trigonometric arccos function for secure image encryption. Analytical evaluations, including bifurcation analysis, positive Lyapunov exponents, and maximized Shannon entropy, confirm that the proposed map demonstrates strong nonlinear properties and maintains stable chaotic behavior across a wide parameter range. Building on these characteristics, we design an encryption scheme that integrates HKDF-derived key scheduling, chaotic keystream generation, FisherYates pixel permutation, and ARX-based diffusion. The scheme ensures both confusion and diffusion, with a decryption process that is the exact inverse of encryption, guaranteeing accuracy. Extensive experiments on benchmark images validate the robustness of the method. Results show high NPCR and UACI values, uniform histograms, entropy values close to the ideal 8, and near-zero pixel correlation, all of which confirm strong resistance against statistical and differential attacks. In addition, elevated PSNR values demonstrate reliable decryption quality. Comparative analysis with existing chaotic encryption approaches highlights that the proposed method not only achieves near-optimal cryptographic performance but also offers competitive efficiency. Overall, these findings establish the arccos-based chaotic map as a secure and effective tool for digital image encryption.

Keywords: Image encryption; arccos chaotic map; HKDF key scheduling; Security analysis

ICNCS2025_2009

An Optimal EOQ Approach for Trapezoidal Demand , Weibull Distribution for Non -Instantaneous Deterioration with Shortages, Preservation and Credit Policy

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Abstract

Inventory maintenance plays a vital and crucial role in supply chain management for the success of any business organisation. In practice, retailers adopt preservation technologies when dealing with non-instantaneous deteriorating products , such as seasonal fruits, flowers and vegetables. Unlike the assumption of constant demand, the demand for such products usually varies depending on location, seasonality and consumer behaviour. In this study, demand is modelled as trapezoidal, which is divided into three distinct phases : initially, demand rises from zero to a peak level, it then remains steady for a certain period and finally , it slowly decreases to zero towards the end of the season. The deterioration rate of items is assumed to follow a two-parameter Weibull distribution, which is widely used due to its flexibility in capturing time-dependent decay and failure patterns. To reflect realistic financial practices, a credit period is incorporated, allowing retailers to generate revenue before payment is due. If payment is made within the credit period, retailers can avoid additional costs, otherwise interest charges apply. Furthermore, shortages are permitted in the system and are assumed to be partially backlogged, reflecting customer willingness to wait for the product during stockout situations. Theoretical results are established through theorems and the proposed model is supported by numerical examples and sensitivity analysis. An optimal economic order quantity(EOQ) is derived for the considered scenario, leading to the determination of the minimum total cost for the retailer.

Keywords: Trapezoidal demand; preservation; deterioration; shortages backlogged; credit policy; economic order quantity

ICNCS2025_2011

Sampling and Reconstruction Over Subspaces of Multiply Generated Spline Spaces of Polynomial Growth

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Abstract

We consider the multiply generated spline interpolation problem namely, given a sequence of samples $\{y_n\}_{n\in\mathbb{Z}}$, find a multiply generated spline f such that $f(n) = y_n$. This extends the well known interpolation problem of Schoenberg. It is shown that for every sequence $\{y_n\}_{n\in\mathbb{Z}}$ of samples of polynomial growth, there exists a unique function f of polynomial growth in certain suitable subspaces of the multiply generated spline space such that $f(n) = y_n$, $n \in \mathbb{Z}$.

Keywords: Cardinal spline interpolation; Multiply generated spline; Multiply generated spline interpolation

ICNCS2025_2013

Odd-Sum Coloring of Ladder Graphs

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Abstract

An odd-sum coloring of a graph G is a proper vertex coloring such that for every $v \in V(G)$, the sum of the assigned colors in the closed neighborhood of v is odd. The odd-sum chromatic number of a graph G, denoted by $\chi_{os}(G)$, refers to the minimum number of colors necessary for an odd-sum coloring. The odd-sum chromatic number for several variants of ladder graphs is investigated in this paper.

Keywords: Odd-sum coloring; Ladder graphs.

ICNCS2025_2015

Stochastic Modeling of EEG Microstate in Autism Spectrum Disorder Assessment

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Abstract

Autism Spectrum Disorder (ASD) remains diagnostically challenging due to the absence of reliable neurophysiological biomarkers. EEG microstates, which represent transient and quasi-stable patterns of large scale brain activity, provide a promising avenue for characterizing altered neural dynamicsin ASD. This study introduces a computational framework that integrates PCA based microstate segmentation with stochastic temporal modeling via sticky Hidden Markov Models (HMM) and unsupervised learning for pattern discovery. EEG recordings from ASD and neurotypical (NT) cohorts were decomposed into principal microstate classes using PCA, followed by HMM-based estimationof temporal metrics including mean lifetime, fractional occupancy, self transition probabilities, and transition entropy. Dimensionality reduction using UMAP and clustering with K-Means revealed three distinct microstate profiles: Balanced Dynamics, Dysregulated High Entropy State, and Mildly Enhanced Stability. Non-parametric group comparison using the Kruskal Wallis test identified eightmicrostate derived features with statistically significant ASD–NT differences ($p < 0.05$). Furthermore, a Random Forest classifier achieved 98.76% accuracy in predicting cluster assignments, underscoring the discriminative power of the proposed features. These findings demonstrate that combining microstate-informed temporal dynamics with stochastic modeling and machine learning offers a robust approach for uncovering clinically relevant neural signatures in ASD.

Keywords: Autism Spectrum Disorder (ASD); Hidden Markov Models (HMM); Microstate analysis; EEG

ICNCS2025_2016

Unsteady MHD Free Convection of Two-Immiscible Casson Fluids in a Porous Channel: Effects of Concentration, Radiation, and Entropy Generation

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Abstract

This study numerically investigates the unsteady, two-region immiscible magneto hydrodynamic (MHD) free convective flow of a Casson fluid through a vertical channel filled with a porous medium, now extended to incorporate a concentration profile. The governing nonlinear equations, accounting for velocity and thermal slip conditions, are solved using a perturbation technique. The model includes the effects of porous medium permeability, Joule heating, viscous dissipation, and thermal radiation. To further enhance the physical relevance, mass transfer is introduced via a species concentration field, enabling the study of solutal buoyancy forces alongside thermal effects. The analysis considers several key dimensionless parameters, such as the Hartmann numbers for both fluid regions, Darcy number, permeability ratio, thermal and solutal Grashof numbers, radiation parameter, Prandtl number, Schmidt number, heat source, and, where applicable, the chemical reaction rate. The influence of these parameters on velocity, temperature, and concentration distributions is thoroughly examined. In addition, the study evaluates entropy generation and Bejan number to understand the thermodynamic behavior of the system. Graphical representations are provided to illustrate how these parameters affect the flow dynamics and transport characteristics. The rates of heat and mass transfer are quantified through Nusselt and Sherwood numbers, respectively, while skin friction and flow rate values are presented in tabular format. All results are analyzed and visualized using MATLAB software to ensure clarity and precision in interpreting the physical behavior of the flow system.

Keywords: MHD; Hartmann number; Casson fluid; Darcy number; Bejan number

ICNCS2025_2017

Edge-Preserving Image Enhancement Using Fractional-Order Derivative Filters

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Abstract

In this paper, a study presented on fractional derivatives filters on the enhancement and edges on images. The fractional derivatives extend normal derivatives to non-integer orders, and they also have non-local and memory properties and which can remove noise and still keep the important details. Here, different derivative filters with fraction order are explored for the denoising of images; further, explore with the edge analysis in term of segmentation and fidelity parameters like PSNR, MSE, SSIM, EBIQA, and ESSIM. In this work, a top down landscape images dataset used for the study, different derivative filters are applied on image and enhanced the visual quality and edge features that will helps in different applications such as land mapping, region segmentation, change detection etc. The results show that a fractional filter preserves and enhance the edges and details as compare to other filters.

Keywords: Derivative filters; fractional order; image enhancement; edge detection

ICNCS2025_2018

Local Antimagic Chromatic Number of Subclasses of Chain Bipartite Graphs

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Abstract

Let $G = (V, E)$ be a simple connected graph with $|V| = p$ and $|E| = q$. A bijection $f : E \rightarrow \{1, 2, 3, \ldots, q\}$ is a local antimagic labeling if for any two adjacent vertices u and v, $w(u) \neq w(v)$, where $w(u) = \sum_{v \in N(u)} f(uv)$. Hence, any local antimagic labeling induces a proper vertex coloring of G where the vertex u is assigned the color $w(u)$. The local antimagic chromatic number $\chi_{la}(G)$ is the minimum number of colors taken over all colorings induced by local antimagic labelings of G. A bipartite graph $G = (X, Y, E)$ is called a chain graph if the neighborhoods of the vertices in X form a chain, i.e., if there is an ordering of the vertices of X, say $[x_1, x_2, ..., x_p]$, such that $N(x_1) \supseteq N(x_2) \supseteq ... \supseteq N(x_p)$. Equivalently, the neighborhoods of vertices in Y also form a chain. In this paper, we determine the local antimagic chromatic number of some subclasses of Chain Bipartite Graphs.

Keywords: Antimagic Labeling; Local Antimagic Labeling; Local Antimagic Chromatic Number; Bipartite Graphs; Chain Graphs

ICNCS2025_2020

Combined Effects of Heat Source and Chemical Reaction on MHD Casson Fluid Flow through a Vertical Channel

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Abstract

The unstable flow of Casson fluid that passes through a vertical channel was examined and evaluated here. The main objective of this work is to give precise final solutions for unstable free convection flows in vertical channels of Casson fluid while accounting for the influence of magnetohydrodynamics (MHD). The findings of the equations governing them were obtained using a technique known as the Laplace transform. Heat source and chemical reaction have been added to the current study. The effects of several dimensionless terms have been computed and assessed, including the following: thermal source, chemical reaction, Casson parameter γ, magnetic field, Prandtl number, Grashof number Gr, Modified Grashof number Gm, skin friction, Sherwood number and Nusselt number. It has been addressed how the above stated parameters affect the profiles of temperature, concentration, and velocity. The behaviour of various profiles over different dimensionless parameters was demonstrated graphically in order to explain and understand deeply. All the graphical results were obtained using MATLAB software which were used to analyse the mathematical solutions of governing equation profiles.

Keywords: Heat and mass transfer; MHD; heat source; thermal radiation and Laplace technique

ICNCS2025_2021

Semi-Markov T-S Fuzzy time-varying Delay Systems under Uncertainties and Disturbances: Robust H_∞ Integral Fuzzy Sliding Mode Control Approach

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Abstract

This paper investigates the problem of robust control for semi-Markov T–S fuzzy time varying delay systems subject to parameter uncertainties and exogenous disturbances. By constructing an appropriate Lyapunov–Krasovskii functional and employing Jensen's inequality, stochastic stability and the prescribed H_∞ performance level are ensured. Based on these conditions, a fuzzy integral sliding mode control (FSMC) scheme is developed without requiring the conventional assumption that the input matrices are plant-rule independent with full column rank. A new sliding mode control law is then proposed to achieve finite-time convergence of the T–S fuzzy system under external disturbances. The derived stability criteria are formulated in terms of linear matrix inequalities (LMIs), and their feasibility is verified through MATLAB results. Compared with existing methods, the proposed approach reduces conservativeness and enhances disturbance attenuation capability. Finally, two numerical examples are provided to illustrate the effectiveness and feasibility of the developed strategy

Keywords: Integral Fuzzy sliding surface; Finite-time stabilization; Lyapunov functional; Robust control; T-S fuzzy systems

ICNCS2025_2024

Best proximity point using proximal generalized k-Kannan mapping, and it's application in boundary value problem

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Abstract

In this paper, we introduced G-k-Kannan mapping and proximal G-k-Kannan mapping, which helps find fixed points and the best proximity points also to validate we gave some examples. G-k-Kannan mapping is used to generalize some results and also we provide an application for the Existence of a solution in the Boundary value problem using Green's function.
Keywords: Generalized Kannan mapping; Best proximity point; Green's function

ICNCS2025_2025

Heat transfer analysis of MHD hybrid nanofluid in a porous trapezoidal cavity with heated fin

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Abstract

This study investigates natural convection flow and heat transfer characteristics of magnetohydrodynamics (MHD) tetra-hybrid nanofluid in a porous finned trapezoidal cavity with the inclusion of thermal radiation and constant magnetic field (B_0). The cavity, which is partially heated from its bottom wall and cooled from its slanted left and right walls, contains a heated fin at the center. The tetra-hybrid nanofluid was made up of copper (Cu), silver (Ag), alumina (Al_2O_3), and magnetite (Fe_3O_4) nanoparticles suspended in water. The governing partial differential equations are numerically solved using the Galerkin finite element method. The computational technique is validated through systematic comparisons with established results. The outcomes indicate that the fluid circulation contours, temperature profile, and local entropy generation are notably affected by the input parameters such as the Rayleigh number, Hartmann number, Darcy number, radiation parameter, and fin length for a nanoparticle volume fraction of

5%. The results reveal that increasing the Darcy number enhances the local Nusselt number, temperature distribution, and flow intensity. A higher heat generation/absorption coefficient and radiation parameter further improve the isotherm patterns and local heat transfer. In addition, variations in fin length and thickness are found to strongly influence fluid circulation and thermal distribution within the cavity. These findings highlight the potential of tetra-hybrid nanofluids with magnetic and radiation effects in porous finned trapezoidal cavities for advanced thermal management applications in the energy, electronics, and process industries.
Keywords: Natural convection; MHD; Thermal Radiation; Porous medium; Tetra-hybrid nanofluid; Trapezoidal cavity; Heated fin

ICNCS2025_2026

Enhanced forecasting of ocean wave parameters via wavelet integrated ML models

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Abstract

This study presents an advanced forecasting approach for ocean wave parameters such as significant wave height (SWH) and average wave period (APD) using hybrid wavelet-based machine learning (WLML) models. Measured buoy data from four NOAA-NDBC stations (Buoy IDs: 46221, 46222, 46225, 46229) recorded in 2023 were analysed. Traditional LSTM and random forest (RF) models were enhanced through discrete wavelet decomposition, enabling multiscale feature extraction and effective noise reduction. The proposed WL-LSTM and WL-RF frameworks demonstrated substantial improvements in prediction accuracy. Comparative analysis using error metrics and visual validation through time series graphs and scatter plots shows that the WLML models achieved up to 75% error reduction across standard evaluation metrics compared to their baseline counterparts. The proposed approach is used to forecast extreme wave events in each location (highest 5% values of each dataset) and confirms the superiority over the corresponding baseline models. The results confirm the efficacy of wavelet integration in improving the reliability of wave forecasting systems, especially in dynamic sea-state conditions.
Keywords: LSTM; Random Forest; Machine learning; Deep learning; Wavelet

ICNCS2025_2027

Investigation on Unsteady Dissipative MHD Oscillatory Casson Fluid Flow: Impact of Irreversibility and Entropy Generation.

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Abstract

Examining the entropy generation in Casson fluid flows is essential for improving thermal performance in biomedical and industrial systems. The Casson Fluid model is describing the behaviour of non-Newtonian fluid and entropy generation analysis is a method used in thermodynamics and heat transfer to quantify the amount of irreversibility occurring within a system. These analyses provide a framework on cooling channels, next generation biomedical devices and energy efficient Heat exchangers where entropy minimization is crucial. The aim of the present study is to inspect the innovation in the analysis of entropy Generation of Casson fluid in oscillatory flow through an asymmetrical wavy channel, considering the effects of Viscous and Ohmic Dissipation. The governing non-dimensional governing equation with the appropriate boundary conditions are solved using homotopy perturbation method. The Perturbation results are compared with the Numerical results using python. The graphical representations of velocity, temperature and volumetric Entropy Generation are presented. Furthermore, the analysis shows that an increase in the Casson parameter enhances the velocity profile and the absence of magnetic field leads to an increase in the fluid velocity.

Keywords: Casson fluid model; MHD; porous channel; oscillatory flow; Entropy Generation

ICNCS2025_2029

On the Application of Haar Wavelet Method for Second-Order initial value Problems in Ordinary Differential Equations: A Comparison with Falkner-Type Method

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Abstract

This paper presents the application of the Haar wavelet method for solving second-order initial value problems in ordinary differential equations. The proposed approach provides a simple yet accurate framework, reducing the computational complexity typically associated with traditional methods. To validate the effectiveness of the technique, results obtained using the Haar wavelet method are compared with the Falkner-type method (FTM). The numerical findings demonstrate that the Haar wavelet solutions are in close agreement with FTM results, while requiring significantly lower computational effort. Furthermore, an error analysis confirms the reliability and efficiency of the proposed method, highlighting its potential as a practical alternative for addressing both linear and nonlinear problems.

Keywords: Haar Wavelet Method (HWM); Falkner-Type Method(FTM); Second -order differential equations

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Mixed Convective MHD Oscillatory Jeffrey Fluid Flow through Asymmetric Porous Channel: Influence of Hall Current and Lorentz force.

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Abstract

The Jeffrey fluid model provides an accurate representation of non-Newtonian viscoelastic behaviour, incorporating relaxation and retardation phenomena, hence rendering it applicable in various engineering contexts. This work investigates the Hall current effects in mixed convective MHD oscillatory flow of a Jeffrey fluid within an asymmetric porous channel. The governing nonlinear partial differential equations, which include the Hall current force, porosity, thermal radiation, and mixed convection effects, are established under the Boussinesq approximation and appropriate oscillatory boundary conditions. An approximate analytical solution is derived for the velocity and temperature profiles. The findings indicate that the Hall current substantially modifies the primary and secondary flow fields, diminishes magnetic damping, and amplifies cross-flow motion within the channel. The combined forced and free convection enhances the velocity of the fluid in the direction of buoyancy force. The research offers novel insights into transport mechanisms in non-Newtonian magnetohydrodynamic flows within porous media, pertinent to applications including petroleum reservoirs, magnetohydrodynamic power production, and plasma dynamics.

Keywords: Mixed convection; MHD; Oscillatory flow; Hall current; Jeffrey fluid; Asymmetric channel

ICNCS2025_2033

Geodesic Dominated Coloring in Certain Graphs

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Abstract

A geodesic dominated coloring of a graph G is a proper coloring in which each color class is dominated by at least one geodesic. The minimum number of colors required for such a coloring is called the geodesic dominated chromatic number, denoted by $\chi^g_{\text{dom}}(G)$. This concept builds upon the classical dominated coloring framework, offering fresh perspectives on vertex domination and graph coloring. By incorporating geodesics into domination, geodesic dominated coloring extends traditional domination by requiring color classes to be dominated through shortest-path structures, rather than adjacency alone. This reinterpretation reflects how the geodesic dominated coloring problem extends the classical domination framework into a new dimension. This shift highlights the evolution from a vertex-centric domination approach to a class-centric one influenced by geodesic structures. In this paper, we determine geodesic dominated chromatic number for several fundamental graph classes, including circulant networks, generalized k-ary trees, line graphs, and ladder-based topologies. For each class, we establish exact values or sharp bounds of geodesic dominated chromatic number and provide algorithmic constructions to realize optimal colorings. We further analyze line graphs, which extend the theory to edge interactions, and cycle of ladder and extended cycle of ladder graphs, deriving closed form expressions for their geodesic dominated chromatic numbers and demonstrating how structural extensions impact domination requirements. The results are not limited to theoretical bounds; constructive algorithms are presented to demonstrate realizable optimal solutions. This dual emphasis strengthens the connection between theory and practice, as algorithmic strategies can be directly applied to network designs requiring minimal redundancy and robust coverage. From a technical perspective, this study highlights the role of structural graph properties in determining coloring behavior. These contributions provide closed-form results and algorithmic strategies that enrich the broader study of distance-based domination. The proposed algorithms not only formalize constructive proofs of these bounds but also highlight applications in communication networks, hierarchical decision systems, and resilient routing structures where shortest-path based coverage is essential.

Keywords: proper coloring; geodesic dominated coloring; line graph; circulant networks; generalized k-ary trees; cycle of ladder; extended cycle of ladder

ICNCS2025_2034

On the Locating-Domination and Locating-Total Domination Numbers of Middle Graphs of Certain Classes of Graphs

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Abstract

Domination in graphs has been a fundamental area of research in graph theory due to its strong theoretical foundations and widely applicable in facility location, and fault-diagnosis in interconnection networks. A dominating set of a graph $G = (V, E)$ is a subset $S \subseteq V(G)$ such that every vertex in $V(G) \setminus S$ is adjacent to at least one vertex of S. The domination number $\gamma(G)$ is the minimum cardinality among all the dominating sets. Over the years, several refined versions of domination have been introduced. Among them, the locating-dominating set (LDS) and the locating-total dominating set (LTDS) have gained special attention. A locating-dominating set of G is a dominating set $S \subseteq V(G)$ such that $N(u) \cap S \neq N(v) \cap S$ for all $u, v \in V(G) \setminus S$. The locating-domination number $\gamma^L(G)$ is the minimum cardinality among all the locating-dominating sets. A locating-total dominating set of G is a total dominating set $S \subseteq V(G)$ such that $N(u) \cap S \neq N(v) \cap S$ for all $u, v \in V(G) \setminus S$. The locating-total domination number $\gamma_t^L(G)$ is the minimum cardinality among all the locating-total dominating sets. These problems are computationally hard in general graphs, yet they capture essential aspects of network monitoring and fault-tolerant systems. Locating-dominating sets (Locating-total dominating sets) can be used to determine the exact location of an object in a graph if devices can detect only objects in its neighbourhood and the object cannot occupy the same vertex as detection devices.

In this paper, we investigate two domination variants under a structural transformation of graphs known as the middle graph, denoted by $M(G)$. For a given graph $G = (V, E)$, the middle graph $M(G)$ is defined as the graph whose vertex set consists of both $V(G) \cup E(G)$. Two vertices in $M(G)$ are adjacent if and only if their corresponding elements in G are either incident (vertex–edge) or adjacent (edge–edge). This construction enriches the original structure and often alters domination-related parameters in non-trivial ways, thereby motivating a systematic study of locating-domination and locating-total domination in middle graphs. We examine four well-studied graph families, namely the path graph (P_n), star graph ($K_{1,n}$), wheel graph (W_n) and friendship graph (F_n). For each case, we derive exact results for the minimum cardinalities of the locating-domination set (LDS) and the locating-total domination set (LTDS) in their corresponding middle graphs.

Keywords: location-dominating set; locating-total dominating set; middle graph; star graph; wheel graph; friendship graph

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Odd-Sum Coloring for Snake Graphs

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Abstract

For a graph G, a function $f : V(G) \to N$ is an odd-sum coloring if any two adjacency vertices receive distinct colors and for every vertex v in G, the sum of the colors assigned to the closed neighborhood of v is odd. The minimum number of colors required for an odd-sum coloring is referred to as odd-sum chromatic number of G, denoted as $\chi_{os}(G)$. In this article, we establish the odd-sum chromatic number for various types of triangular snake graphs and quadrilateral snake graphs.

Keywords: Odd-sum coloring; Odd-sum chromatic number; Types of snake graphs

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Enhanced Analysis of Skin friction and Heat transfer on MHD Burgers fluid under Fuzzified Nonlinear Radiation Effects through α-cut approach

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Abstract

This study investigates the two-dimensional magnetohydrodynamic (MHD) flow of Burgers' fluid over a stretching surface in the presence of fuzzified nonlinear thermal radiation. The novelty of the present work lies in considering the nonlinear radiation parameter as a triangular fuzzy number (TFN) and analyzing its impact on flow characteristics using the α-cut approach. The governing nonlinear partial differential equations (PDEs) defining momentum and energy flow are transformed into ordinary differential equations (ODEs) via similarity transformations. The ODEs are converted into FDEs using the α-cut approach and numerically solved in MATLAB. This work provides deeper insights into the fluctuations in skin friction coefficient and heat transfer rate under uncertain thermal conditions by fuzzifying the radiation parameter across its appropriate range. The findings show that fuzzy modeling not only effectively

captures parametric uncertainty, but also reveals significant changes in the thermal boundary layer and radiative heat transfer. The proposed approach develops a robust framework for dealing with nonlinear and unpredictable radiative effects in complicated non-Newtonian fluid flows, with practical applications in industrial thermal processes and energy systems.

Keywords: Magentohydrodynamics; Burgers Fluid; Heat transfer; Skin friction; Fuzzification; Triangular fuzzy numbers; α-cut approach

ICNCS2025_2039

Numerical investigation of heat transfer inside a closed enclosure with radiation effect: A comparative study

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Abstract

Heat transfer enhancement plays a crucial role in various engineering and science applications, such as resonators, cooling systems, electronic equipment, and the MROI array telescope, all of which have been studied in recent years. One of the most effective ways to cool the system is through natural convection. For the current study, we considered a water-filled dome-shaped enclosure to examine the behaviour of natural convection with thermal radiation effect and appropriate boundary conditions. The physical model is solved using the Galerkin finite element method for the parameters - Rayleigh number (Ra = 103 to 106), Prandtl number (Pr = 5.828), and radiation parameter ($Rd = 0, 2, 6, 10$). The results obtained using the Mathematica software are validated by comparing with the results from the COMSOL Multiphysics software. The findings are presented in terms of streamlines, isotherms, mean Nusselt number, and the mean temperature profile. Furthermore, a comparison study is made with the rectangular-shaped enclosure. The obtained results indicate that the mean Nusselt number increases with an increase in both the Rayleigh number and the radiation parameter. On the other hand, the mean temperature falls with an increase in the radiation parameter and rises with an increase in the Rayleigh number. The mean Nusselt number reaches its maximum at Rayleigh number 10^6 and radiation parameter Rd = 10 compared to the rectangular enclosure. Finally, the dome-shaped enclosure shows an enhanced heat transfer compared to a rectangular enclosure; thus, the fluid moves smoothly inside the enclosure.

Keywords: Natural convection; Heat transfer; FEM; Enclosure

ICNCS2025_2040

Slow Fast Dynamics in Formic Acid Based Electro Oxidation Reaction

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Abstract

Formic acid electro-oxidation reaction (FAEOR) refers to the process in which formic acid (HCOOH) is oxidized electrochemically electrode surface, typically a platinum catalyst, to produce carbon dioxide (CO_2), protons (H^+), and electrons (e^-) three possible pathways: (i) formate, (ii) indirect, and (iii) direct pathway. This reaction is of great interest in the field of fuel cells, especially Direct Formic Acid Fuel Cells (DFAFCs), because of its high energy efficiency, low operating temperature, and low environmental impact. During the electro-oxidation reaction, formic acid is oxidized to CO_2 through the adsorption and oxidation of carbon monoxide and the adsorption of H_2O on the catalyst surface. Although the potential difference of each reaction step provides qualitative and quantitative changes in the FAEOR dynamics, in this work, we have only considered the potential difference due to carbon monoxide oxidation and water adsorption on the electrode surface. Hence, these two potential differences are used as bifurcation parameters. The eigenvalue analysis with the change of the bifurcation parameter reveals that the system has multiple timescales due to the broad difference in magnitude of the real parts. Fast Fourier Transform (FFT) also guarantees the presence of multiple well-separated peaks, characterizing the slow-fast behavior in the phase space.

Keywords: Bifurcation Analysis; Electrochemical Reaction; Multiple time scales; Nonlinear Dynamics

ICNCS2025_2043

QSPR Analysis using Degree-Based Edge Entropy Indices for Angiotensin II Receptor Blockers (ARBs) Drugs

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Abstract

Angiotensin II Receptor Blockers (ARBs) constitute a group of antihypertensive agents that specifically inhibit the interaction of angiotensin II with the angiotensin type 1 (AT_1) receptor, a central component of the renin–angiotensin–aldosterone system (RAAS). By antagonizing this receptor, ARBs prevent vasoconstriction, decrease aldosterone release, and enhance sodium and water excretion, thereby effectively lowering blood pressure. These drugs are extensively employed in the treatment of hypertension, heart failure, chronic kidney disease, and in patients following myocardial infarction, providing significant cardiovascular protection. Since their introduction in the 1990s, ARBs have become a cornerstone in global cardiovascular therapy, offering a safe and effective alternative for millions of patients worldwide, especially those who are intolerant to ACE inhibitors. A topological index is a molecular descriptor that quantitatively encodes the structural features of a molecule and has been extensively employed in modeling diverse physicochemical properties within quantitative structure–property relationship (QSPR) studies. These investigations play a vital role in the early phases of drug development by supporting the identification and optimization of potential candidates and providing economical alternatives to traditional experimental methods. This study focuses on an extensive set of Angiotensin II Receptor Blockers (ARBs), including Losartan, Valsartan, Irbesartan, Candesartan, Olmesartan, Telmisartan, Eprosartan, Azilsartan, Fimasartan, and Olmesartan Medoxomil. In this study, QSPR models will be developed using degree and entropy topological indices, and regression analysis is employed to reveal the most significant correlations with the physicochemical properties of ARB drugs. This integrative approach characterizes the molecular features of ARB drugs, providing a robust framework for understanding their pharmacological activity and therapeutic potential.

Keywords: Degree edge partition; Entropy based topological indices; Angiotensin II Receptor Blockers; Quantitative structure property relationship

ICNCS2025_2044

A Surrogate-Assisted NSGA-II Approach for Optimal Control of Biostatisticians Professional Competency

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Abstract

Biostatistics plays an important role in designing, analyzing, and interpreting data in the life sciences. Biostatisticians are crucial in clinical trials, systematic reviews and meta-analysis, observational and complex interventional studies, and statistical genetics. However, due to differences in education, institutional context, and workforce training opportunities, the professional competency of biostatisticians is not homogeneous. To address this, we demonstrate a novel optimal control framework incorporating synthetic data generation, multi-objective optimization, and surrogate-assisted evolutionary algorithms to analyze and improve the biostatistical competency. In the absence of empirical data, we generated a synthetic dataset that demonstrates professional competencies using a Conditional Tabular Generative Adversarial Network (CTGAN). Although real-world workforce development issues are complex, nonlinear, and include competing objectives, we utilized a Non-dominated Sorting Genetic Algorithm II (NSGA-II) to solve for a bi-objective optimization of maximizing professional competency and minimizing intervention costs. Using the Pareto optimal front, we can provide a visual context to examine the trade-off of the effect of improving competency against available resources. To further improve efficiency and reduce computational expense, we incorporated a Random Forest surrogate model into the NSGA-II to approximate the objective functions and improve the explored solutions in the solution space. The comparison indicates that the surrogate-assisted method found near-optimal solutions, with reduced evaluation cost and improved convergence over regular NSGA-II. These results demonstrate how training, resource allocation, and competency development pathways for biostatisticians can be informed by AI-driven optimal control approaches. Apart from methodological contributions, this framework provides a basis for future empirical validation and evidence-based workforce planning in health sciences.

Keywords: Biostatisticians; Competency; Optimal control; NSGA-II; Pareto optimal front; Random Forest surrogate model

ICNCS2025_2046

Mittag-Leffler Stabilization of Fractional-Order Singular Time-Delay Systems using Hybrid Controller

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Abstract

Sufficient conditions for a fractional-order singular time-delay system to be stabilized in the Mittag-Leffler sense is established in this article. The stability is attained with the help of a hybrid controller; the combination of a simple feedback controller and an event-triggered impulsive controller. By carefully designing the event-triggering conditions, we successfully avoid Zeno behavior. The results are established with the help of Lyapunov theory and Linear Matrix Inequalities. Finally, a few examples are given to validate the proposed theory.

Keywords: Singular systems; time delay; hybrid controller; fractional ordered system; Mittag-Leffler stability

ICNCS2025_2050

A Comparative Study on Soft Computing Approaches In V2G And G2V-Based EV Charging Systems

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Abstract

This paper presents a novel intelligent-control strategy for optimizing single-phase AC/DC and DC/DC bidirectional converters operating in vehicle-to-grid (V2G) and grid-to-vehicle (G2V) systems. V2G enables sustainable and smarter energy grids. With efficiency being paramount in applications of electric vehicle charging, this study focuses on incorporating evolutionary algorithms (EAs) to tune PI controller values. The proposed controller in our paper is a PSO (Particle Swarm Optimization), tuned-PI controller. Particle swarm optimization is chosen because of its ease in programming and fast convergence. The proposed strategy for increasing converter efficiency by using an intelligent control technique with the PSO algorithm is used to improve the performance of the bidirectional converters by minimizing the overshoot, undershoot, settling time and rise time of the output voltage. A comparative study is conducted between the conventional tuning methods like PI, PID, GA (genetic algorithm), tuned-PI and the proposed PSO tuned-PI controller. The performance of each controller is analyzed through MATLAB/Simulink software. Further, various error parameters such as ISE, IAE, ITAE, as well as the overall settling time for each controller, are observed. It was concluded that PSO tuned-PI displayed the best results with a settling time of 4.415 as compared to GA-tuned-PI, PID and PI, which displayed a settling time of 4.471, 4.478, 4.591, respectively. PSO tuned-PI also obtained the best efficiency at 85.5% along with its ISE, ITAE and IAE values as 102.3, 5.336 and 9.376 respectively.

Keywords: Vehicle-to-Grid (V2G); Grid-to-Vehicle (G2V); Bidirectional Converter; Particle Swarm Optimization (PSO); Electric Vehicle Charging; MATLAB/Simulink Simulation

ICNCS2025_2053

A mathematical model of chikungunya transmission with media awareness and the application of optimal control theory

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Abstract

A compartmental mathematical model was developed to examine the transmission dynamics of chikungunya, integrating media awareness and optimal control strategies. Both asymptomatic and symptomatic infectious categories, along with a media-induced awareness component, were incorporated to more precisely represent epidemiological dynamics. The model's positivity, boundedness, and stability characteristics were confirmed, and the basic reproduction number

was calculated using the next-generation matrix method. Model calibration was conducted utilizing cumulative case data from India and high-burden states (Gujarat, Karnataka, and Maharashtra) through maximum likelihood estimation. Sensitivity analysis identified transmission-related parameters, specifically the mosquito biting rate and infection probabilities, as the most significant determinants of epidemic persistence. The system's threshold behavior was further demonstrated through contour plots of R_0 with respect to different pairs of parameters and variations of parameters. A comprehensive control framework incorporating two time-dependent variables—minimization of human–mosquito interaction and augmentation of treatment—was formulated and examined utilizing Pontryagin's Maximum Principle. The optimal control result indicates that the simultaneous application of both controls resulted in the most significant decrease in symptomatic infections, while individual interventions also produced quantifiable advantages. The results emphasize the necessity of incorporating preventive measures, awareness enhancement, and improved treatment into region-specific chikungunya management strategies.

Keywords: Chikungunya disease; nonlinear incidence rate; basic reproduction number; Lyapunov function; stability analysis; Optimal control

ICNCS2025_2058

Oscillation results for Second Order nonlinear Advanced Differential Equations

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Abstract

In this paper, we presents new sufficient conditions for the oscillation of all solutions of the second order nonlinear differential equation with advanced arguments of the form

$$x''(t) - \sum_{i=1}^{n} p_i(t) g_i(x(\varphi_i(t))) = 0, \quad t \geq t_0 \tag{E}$$

where the functions $p_i(t)$, $\varphi_i(t) \in C([t_0, \infty), \mathbb{R}^+)$ and $\varphi_i(t)$ are not necessarily monotone for $1 \leq i \leq n$. Examples are given to demonstrate the importance of the main results.

Keywords: Nonlinear Advanced equation; non-monotone arguments; non-oscillatory solution; oscillatory solution.

ICNCS2025_2061

Characterization of Temporal Behavior in Finite 2D Cellular Automata (Square, Triangular and Hexagonal lattices)

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Abstract

2D cellular automata (CA) offer a powerful framework for modelling complex dynamical systems, but their immense rule space and sensitivity to initial conditions make comprehensive classification intractable. Unlike the well-established Wolfram classification for one-dimensional CA, 2D CA lack a unified taxonomy due to increased neighborhood complexity and visualization challenges. In this study, we leverage a central feature, the ability to represent CA configurations as matrices, to systematically analyze rule behavior on finite lattices. By focusing on rule and initial configuration pairs, we introduce a novel framework based on entropy time-series analysis and state change ratio time series analysis to characterize the evolution of 2D CA. This matrix-based representation enables algorithmic detection of homogeneous and periodic patterns on triangular, square, and hexagonal lattices. Our methodology provides a scalable, geometry-independent approach that avoids exhaustive rule enumeration while revealing critical insights into the spatio-temporal dynamics of 2D CA. We present a flattened visualization of 2D CA evolution, enabling a unified temporal representation across generations. This allows both the overall Shannon entropy and compression ratio to be computed, analogous to methods used in elementary cellular automata.

Keywords: Cellular Automata; Entropy; State-change ratio; Temporal evolution

ICNCS2025_2062

Well-posedness and uniqueness of solutions for abstract neutral integro-differential equations with state-dependent delay and deviated argument

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Abstract

This study investigates the well-posedness of a class of neutral integrodifferential equations with deviated argument. By applying semigroup theory and the Banach fixed-point theorem, the existence and uniqueness of both mild and strict solutions are established. The results establish the existence of a unique strict solution within the defined space while preserving both Hölder and Lipschitz continuity. The imposed conditions, along with Fréchet differentiability, guarantee the boundedness and regularity of the corresponding operators. Further, we established that the proposed system is well-posed, while also demonstrating the practical relevance of the theoretical results.

Keywords: Existence and Uniqueness; Fixed point theorem; Mild solution; Neutral; State delay

ICNCS2025_2063

Oscillation results for second order non-linear differential equations with non-monotone delays

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Abstract

In this paper, we investigate a class of second order nonlinear delay differential equations with several deviating arguments. We present some sufficient conditions for the oscillatory solutions of the equation. Differing from other studies in the literature, delay terms are not necessarily monotone. Finally, we give examples to demonstrate the main results. We consider the second order nonlinear delay differential equation $[r(t)y'(t)]' + q(t)\psi y(\tau_1(t))y(\tau_2(t)), \dots, y(\tau_n(t)) = 0$ Where the functions $q, \tau_i \in C(t_0, \infty, R^+)$ and $\tau_i(t)$ are not necessarily monotone for $1 \leq i \leq n$

Keywords: Delay equations; nonlinear; non monotone arguments; non-oscillatory solution; oscillatory solution

ICNCS2025_2065

Mathematical Modelling and Bifurcation Analysis of Nonlinear Dynamics in Heterogeneous Catalysis

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Abstract

Mathematical modelling is an indispensable tool for elucidating the intricate dynamics governing chemical reaction systems. Given the inherent nonlinearity of most chemical processes, analytical solutions to the governing differential equations remain elusive. Consequently, computational and numerical approaches serve as cornerstones in understanding and predicting reaction behavior. Heterogeneous catalytic reactions exhibit an astonishingly rich array of dynamical behaviors, including multistability, oscillatory regimes, and chaos, necessitating an in-depth comprehension of the underlying physical and chemical interactions. To rigorously investigate these complex dynamics, a reduced-order mathematical model is formulated, comprising a system of nonlinear ordinary differential equations. We conduct a comprehensive investigation of various bifurcation phenomena by employing phase plane analysis and nullcline plotting in codimension-one framework using MATLAB. Additionally, we rigorously establish the existence and stability of equilibrium points, providing deeper insights into the system's dynamical behavior. Numerical simulations are used to demonstrate different types of oscillations and chaos in the kinetic model of heterogeneous catalytic reactions.

Keywords: Heterogeneous Catalysis; Bifurcations; Kinetic Model; Chaos; Limit Cycle

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Wave Scattering by Bottom-mounted Asymmetric Inverse T - shaped Breakwater

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Abstract

Protecting nearshore areas with artificial breakwaters or other defence measures is a primary concern in the field of coastal engineering. Finding the ideal shape to regulate wave diffraction is one of the most crucial objectives in the subject of breakwaters. A range of floating or fixed surface breakwaters with different designs has been created to improve wave attenuation and save building costs. In this sense, breakwaters with a T-shaped or inverse T-shaped shape can fulfill this need. Research on asymmetric inverse T-shaped breakwaters has been lacking; however, there are plenty of articles available on inverse symmetric T-shaped breakwaters. Here, we have taken into consideration the inverse asymmetric T-shaped breakwater, whose two side blocks differ in height or width. The eigen function expansion method is used to solve the problem, and the results are verified by the existing literature. Additionally, for the accuracy of our method, the energy balance relation is used to validate the reflection and transmission coefficients. The impact of various structural and physical factors on the transmission and reflection coefficients is examined in order to evaluate the performance of an asymmetric inverse T-shaped breakwater. Additionally, the wave forces acting on the breakwater are calculated and examined for various structural and physical parameters. By comparing it with the symmetric T-shaped breakwater, the effectiveness of the asymmetric inverse T-shaped breakwater is determined.

Keywords: Inverse T-shaped breakwater; Eigenfunction expansion method; Reflection and transmission coefficient; Wave forces

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Gradient-Based Minimization of Fuzzy Nonlinear Function Using Fletcher-Reeves Algorithm

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Abstract

This study presents a comparative investigation of two gradient-based optimization techniques for minimizing a fuzzy nonlinear function. The function's coefficients are expressed as trapezoidal fuzzy numbers and subsequently transformed into an interval–parametric form using the α cut approach. By systematically varying the fuzzy parameters within this interval representation, we analyse the convergence characteristics of the objective function. The Fletcher–Reeves conjugate gradient method is employed as the primary optimization strategy, and its performance is evaluated against the classical steepest gradient descent method reported in the literature. Sensitivity analysis is conducted to examine the influence of parameter variations on convergence behavior. The results demonstrate that the proposed approach achieves faster convergence than the steepest descent method, requiring fewer iterations to reach optimality.

Keywords: Optimal solution; Gradient descent; Quadratic function; Trapezoidal fuzzy number (TrFN); Parametric form

ICNCS2025_2070

Optimizing Inventory Management Under Partial Swarn Algorithm Using Heptagonal Fuzzy Number

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Abstract

In this paper we are focusing on the inventory management on a uncertain demands which is challenging in supply chain research, particularly today's changeover of people on Health and wellness awareness in society has led to significant changes in consumer behaviour, strongly influencing product demand. Items such as probiotics, multivitamins, protein supplements, and herbal products are witnessing higher-than-usual demand. This creates complex challenges for suppliers and retailers, as demand patterns are uncertain and difficult to predict. To address this, the present study develops an optimization framework that combines fuzzy modelling with a partial swarm optimization algorithm. Fuzzy to handle uncertainty and PSO is used as an optimization tool to find the total cost. The proposed approach captures demand uncertainty using heptagonal fuzzy numbers and minimizes total inventory cost through efficient order quantity decisions. The model provides a systematic method to manage multi-item wellness products under uncertainty, offering practical insights for health-conscious markets.

Keywords: Heptagonal Fuzzy Numbers (HFN); Partial Swarm Optimization (PSO); Multi-Item Inventory Model; Uncertain Demand; Supply Chain Optimization

ICNCS2025_2071

Dynamic Small-World Graphs for Quantum-Resistant Stream Cipher Encryption

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Abstract

Graph-based cryptography has emerged as a viable paradigm for constructing secure, lightweight, and quantum-resistant encryption algorithms. This paper presents an encryption technique for stream cipher encryption that creates pseudorandom keystreams by taking advantage of Dynamic Small-World (Watts–Strogatz) Graphs. High entropy in the generated keystreams is guaranteed by the graph's inherent strong mixing properties, but temporal unpredictability is introduced by the graph's constant rewiring. We describe the suggested encryption and decryption techniques in detail and use the encrypted word GRAPH as a toy example to demonstrate how they work. The results demonstrate how dynamic graph structures can be used to create robust and effective cryptographic systems.

Keywords: Graph-based Cryptography; Dynamic Small-World Graphs; Stream Cipher; Pseudorandom Keystream; Quantum-Resistant Encryption

ICNCS2025_2074

Design of Artificial Intelligent Based Air Quality Monitoring, Prediction and Control Using IoT

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Abstract

Air pollution poses a significant threat to public health and well-being, necessitating innovative solutions to mitigate its adverse effects. The proposed Intelligent Air Quality control system integrates the Internet of Things (IoT) for real-time data collection, artificial intelligence (AI) for predictive analysis, and automated responses. Unlike traditional alerts, this approach proactively monitors, analyses, and responds dynamically to pollution levels in real-time urban environments and densely polluted locations. The proposed system uses AI algorithms to analyse IoT-based sensor data, predict pollution levels, and activate purification components, such as water sprays and air filters, efficiently and also provide autonomous decision-making and adaptive responses to changing environmental situations. The prototype, outfitted with AI-enhanced sensors, persistently tracks real-time air quality parameters, including $PM_{2.5}$, PM_{10}, CO_2, and VOC concentrations. The AI algorithm analyses this data, identifying specific pollutants and determining optimal purification settings. It can predict pollution peaks and automatically increase purification intensity when necessary. Based on the AI's recommendations, the system adjusts the fan speed, filtration stages, and power to achieve effective purification with low energy consumption. The modular design supports flexible deployment across multiple locations, making it ideal for outdoor and indoor public spaces like metro stations, malls, public squares, and sports venues. Additional modules can be attached or removed as needed, adapting the prototype's purification capacity to various scales. The system contributes towards public awareness of air quality by providing real-time data accessible through mobile apps or public displays. This engagement not only educates but also encourages healthier behaviours, such as avoiding high-pollution zones during peak times. This information may help

promote pollution-mitigating habits, such as limiting outside activities during periods of low air quality. AI-enabled may interface with other smart city sensors and systems, augmenting the city's capacity to monitor and regulate air quality holistically. This integrated method results in synchronized air quality control across diverse metropolitan areas.

Keywords: Internet of Things (IoT); Artificial Intelligence (AI); Air Quality measuring; Sensors; smart city

ICNCS2025_2082

Unsteady Response of Blood Flow Under Body Acceleration with Different Combinations of Arterial Stenoses

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Abstract

Atherosclerosis is a progressive disease in which plaque buildup narrows arteries, alters blood flow, and increases the risk of serious cardiovascular complications. To examine these effects, a two-dimensional mathematical model is formulated to investigate the unsteady response of pulsatile blood flow through irregular arterial stenoses subjected to periodic body acceleration. The governing time-dependent nonlinear Navier–Stokes equations in cylindrical coordinates are solved numerically using a finite difference method. The present study aims to investigate the influence of different combinations of stenosis severity under periodic body acceleration on velocity distribution, flow rate, and wall shear stress in irregularly stenosed arteries, to provide insights into pathological flow conditions and contribute to the understanding of cardiovascular complications associated with arterial stenoses.

Keywords: Irregular stenoses; Finite difference scheme; Navier–Stokes equations; body acceleration

ICNCS2025_2083

Robust Picture Fuzzy Regression Function Approach for Stock Market Forecasting: A Systematic Estimator Comparison

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Abstract

A Picture Fuzzy Regression Function (PFRF) framework is an extension of Fuzzy Regression Function (FRF) approach using picture fuzzy sets to enhances the representational capacity by jointly modeling four membership degrees—positive, negative, neutral, and refusal—thus capturing ambiguity and hesitation more accurately than standard fuzzy formulations. Prior FRF studies typically estimated linear specifications via least-squares estimation (LSE) and employed support vector regression (SVR) for more complex structures. Focusing here on linear regression for forecasting stock-market closing prices from lagged predictors, adopting a robust estimation is much more appropriate to deal with outlier. This study aims to conduct a systematic comparison of M-, S-, and MM-estimators, analyzing their predictive efficiency for small, moderate and extreme level outlier contamination to the Stock Market data.

Keywords: Fuzzy Regression Function approach; Picture Fuzzy sets; Robust Regression; Outlier; Forecasting

ICNCS2025_2086

Optimal Control and Cost Effectiveness Analysis for a Fractional Smoking Model Using Spectral Collocation Method

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Abstract

Smoking is a harmful habit that increases the risk of cardiovascular diseases, cancer, asthma, strokes and imposes economic burdens on society. To investigate smoking-related issues among adolescents, a nonlinear fractional-order mathematical model is developed. The model incorporates five compartments: susceptible males, susceptible females, social smokers, chronic smokers, and quitters, to study the transmission dynamics of smoking. Addiction-free and addiction-present equilibrium states are identified, and the basic reproduction number (R_0) is derived to assess the spread of smoking behavior. Local and global stability analyses are performed analytically and numerically. Sensitivity analysis, including normalized forward indices and Partial Rank Correlation Coefficients (PRCC), determines the most influential parameters. Computational solutions are obtained using the spectral collocation method with Chebyshev polynomials, and the method's accuracy is validated via residual error analysis and comparison with standard techniques. The impact of key parameters, such as transmission, recovery, and quit on each compartment is explored through graphical analysis. An optimal control framework with two interventions is proposed to reduce smoking prevalence, accompanied by a cost-effectiveness analysis to evaluate economic feasibility. The results highlight the need for effective, cost-efficient public health strategies to mitigate tobacco use.

Keywords: Fractional smoking model; Stability analysis; Sensitivity analysis; Optimal control; Cost-effectiveness; Chebyshev polynomial; PRCC; Spectral method

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Decode the Attention mechanism of Modern Large Language Models: A study

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Abstract

In today's AI-dominated world, chatbots are used by every company to automate procedures and respond to consumer quiries. With the help of extensive vocabularies and a broad range of themes, these chatbots are able to have engaging conversations. Various methods are employed to ensure that the responses are pertinent and significant in addition to enhancing the chatbot's effectiveness. The model uses vectorizations and an attention mechanism to decide which preceding words, phrases, or sentences are most pertinent to the user's present inquiry. The model may dynamically retrieve information from any segment of the discussion to provide quick response. This study identifies the goal of lightweight attention models for chatbots and compares the attention mechanisms of current chatbots.

Keywords: Chatbots; Attention mechanism; Responses; Lightweight attention models; vectorization

ICNCS2025_2088

Optimal feedback control for stochastic switched non-autonomous differential inclusion with deviated argument

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Abstract

This article is concerned with studying the optimal feedback control for stochastic switched non-autonomous differential inclusion with deviated argument and fractional Brownian motion in Hilbert spaces. Initially, we establish the existence of a mild solution by employing fractional calculus, stochastic analysis theory, resolvent operator and fixed-point techniques in the absence of Lipschitz conditions. This approach is based on the Bohnenblust-Karlin fixed point theorem, which provides a more general and robust framework for handling multi-valued operators in the presence of stochastic effects. Then, we calculate the existence of a feasible pair by leveraging the Filippov theorem and the Cesari property. Additionally, an existence result for optimal pairs of the Lagrange problem is established. Furthermore, an example is given to support the theoretical results.

Keywords: Fractional Brownian motion; stochastic non-autonomous inclusion; optimal feedback control; feasible pairs

ICNCS2025_2091

A revisit notion of circulant fuzzy matrices

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Abstract

A Circulant matrix is a square matrix whose rows are obtained by cyclically rotating by its first row. In this paper, we define the circulant permutation matrix, some properties of circulant fuzzy matrix, idempotent circulant fuzzy matrix, r-idempotent circulant fuzzy matrix, and symmetric circulant fuzzy Matrix.

Keywords: Circulant fuzzy matrix(CFM); Idempotent fuzzy matrix; Permutation fuzzy matrix; r-Idempotent circulant fuzzy matrix; Symmetric circulant fuzzy matrix

ICNCS2025_2092

Coverage-Aware Scheduling in Directional Sensor Networks Through Harris Hawks Optimization

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Abstract

Enhancing target coverage while extending the network lifetime of Directional Sensor Networks (DSNs) is a crucial challenge, as randomly deployed sensors with limited sensing angles often create redundant coverage and deplete energy usage. Thus, efficient sensor scheduling acts as a promising solution to overcome these limitations by organizing sensors into disjoint cover sets. Hence, this paper proposes a scheduling framework for DSN by employing the Harris Hawks Optimization (HHO) algorithm to generate disjoint directional cover sets. HHO imitates the hunting behavior of hawks by using exploration to identify different combinations of cover sets, and exploitation to optimize the best cover sets for maximizing coverage. Through balanced utilization of deployed sensors, the proposed algorithm derives optimized non-overlapping covers which ensure complete target coverage. Simulation results confirm that the HHO-based scheduling approach generates more cover sets compared to the existing algorithms, thereby prolonging the network lifetime.

Keywords: Directional Sensor Networks; Sensor Scheduling; Harris Hawks Optimization; Disjoint Cover Sets; Network Lifetime

ICNCS2025_2093

Fixed-time Synchronization of Hidden Markov Jump Inertial Reaction-Diffusion Neural Networks with Time Delay using Detector Based Boundary Control

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Abstract

This paper addresses the fixed-time synchronization problem for continuous-time hidden Markov jump inertial reaction-diffusion neural networks with time delay using a detector-based boundary control approach. The abrupt changes in network parameters and structure are represented through a hidden Markov jump model that incorporates both hidden and observed states. A key feature of this model is its ability to handle varying levels of detection information, such as complete information, no information, and others, allowing for a general observation framework. Based on the states estimated by the detector, we design a mode-dependent boundary synchronization controller under Neumann boundary conditions. Unlike traditional full domain controller designs, the proposed approach reduces the number of controllers required, thereby lowering implementation costs. In addition, a security control law is developed to ensure fixed-time synchronization of the considered inertial reaction-diffusion neural networks within a fixed settling time. The demonstrated settling time of the designated inertial reaction-diffusion neural networks is provided. Moreover, a novel Lyapunov function is constructed to capture system state information and address challenges arising from reaction-diffusion terms, with synchronization conditions established through inequality techniques. Finally, comparative examples are presented to validate both the correctness and the superiority of the proposed method.

Keywords: Inertial reaction-diffusion neural networks; Hidden Markov jump; Fixed-time synchronization; Detector based boundary control; Settling time

ICNCS2025_2094

Synchronization of Complex Networks Under Deception Attacks Using Aperiodically Intermittent Event triggered Control and Average Delayed Impulsive Gains

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Abstract

This work investigates the synchronization of complex dynamical networks subject to deception attacks and communication constraints. A novel control strategy is developed by integrating aperiodically intermittent event-triggered control (APIETC) with a forced impulsive time sequence, thereby reducing control cost while avoiding Zeno behavior. To capture the cumulative effects of time-varying impulsive delays and impulsive strengths, the concept of Average Delayed Impulsive Gains (ADIG) is introduced. Within this hybrid framework, Lyapunov-based analysis is employed to derive sufficient conditions ensuring global exponential synchronization of the network. The proposed approach demonstrates resilience against adversarial interference and communication disruptions, offering a systematic method to balance control efficiency and network robustness. Finally, an example is simulated to examine the applicability of the theoretical results.

Keywords: Event-triggering mechanism; Aperiodically intermittent; Delayed impulsive control; Average delayed impulsive gains; Deception attacks; Forced impulsive sequence

ICNCS2025_2095

A Novel Risk-Aware Supplier Selection Strategy for Hospital Procurement using CRITIC, PIV, and MAUT

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Abstract

Hospital supplier selection is a critical decision-making process, as the availability of essential medical supplies directly influences patient care, treatment outcomes, and the resilience of healthcare systems. Infirmaries must manage suppliers under stringent conditions of time sensitivity, quality assurance, and risk mitigation. To capture these dimensions, criteria such as sustainability, quality, risk management, and operational performance are incorporated, reflecting the multifaceted requirements of hospital procurement. This research employs the CRITIC method to assess the relative importance of criteria, applies the PIV method to rank supplier performance, and utilizes MAUT to transform scores into utility values for optimized allocation of procurement orders among suppliers. The integrated framework is novel in its ability to capture interdependencies, provide rankings, and support effective procurement decisions. The proposed methodology enhances procurement efficiency, reduces operational risks, and safeguards continuity of critical healthcare services, offering decision-makers a robust tool to strengthen hospital procurement and improve patient care.

Keywords: CRITIC; Healthcare Procurement criteria; Hospital Supplier Selection; Multi-attribute utility theory; Proximity index value

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Fractal-Fractional Partial Differential Models for Plasma Cell Cancer Progression

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Abstract

Plasma cell cancer, is a complex hematologic malignancy characterized by abnormal proliferation of plasma cells in the bone marrow. Traditional mathematical and biological models often fall short in capturing the irregular, scale-invariant behavior of tumor growth and invasion observed in such cancers. This paper explores the application of fractal geometry and fractal-fractional derivatives to model and analyze the progression of plasma cell cancer. By leveraging the inherent self-similar and non-local properties of fractals, combined with the memory-dependent dynamics of fractional calculus, we develop a novel mathematical framework that more accurately represents the spatial and temporal heterogeneity of cancerous tissue. The proposed model utilizes fractal-fractional partial differential equations to simulate tumour growth, nutrient diffusion, and treatment response. Numerical simulations demonstrate that the model captures essential features of plasma cell cancer progression, including irregular boundary development and anomalous diffusion. This approach not only enhances our understanding of the underlying biological mechanisms but also offers a promising direction for predictive modelling and personalized therapeutic strategies in oncology. The intersection of fractal geometry and PDE modelling thus provides a rich, interdisciplinary approach to studying plasma cell cancer. These methods not only improve our theoretical understanding of tumor biology but also hold promise for personalized medicine, where mathematical models can inform individualized treatment plans based on patient-specific data.

Keywords: Plasma cell; Plasma cancer cell; fractals; box counting dimensions; numerical simulation; partial differential equations

ICNCS2025_2109

A Domination-based Anchor Node Deployment algorithm for Obstacle-Aware Wireless Sensor Network

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Abstract

Localization in Wireless Sensor Networks (WSNs) is a process of estimating the geographical coordinates of sensor nodes and it remains a vital challenge in WSN for effective and reliable monitoring over physical environments. In real-time applications, sensor localization often functions in obstacle-aware environments such as walls, irregular terrain, etc., which obstructs the wireless transmission and reduces network's localization performance. To address this challenge in cost-effective approach, it is essential to deploy optimal number of anchor nodes along with optimal positions and for estimating location of unknown sensor nodes located in the network region, every unknown node must receive the information from neighbor anchor nodes. Hence, this study proposes a Domination-based Anchor Deployment in Obstacle-aware WSN (DAPA-O) which determines the minimum requirement of anchor nodes with optimal anchor coordinates for obstacle-based scenarios. The proposed anchor placement algorithm integrates with traditional DV-Hop, Weighted DV-Hop, and Weighted Hyperbolic DV-HOP algorithms to estimate the location unknown nodes position. Simulation results exhibit that the proposed DAPA-O method attains minimum localization error compared to random anchor deployment in terms of average localization error for three DV-Hop variants

Keywords: Anchor deployment; Domination; Obstacle-aware WSN; Localization; and Wireless Sensor Network

ICNCS2025_2110

Comparative Analysis of Non-Newtonian Rheological Models: Power Law, Casson, Carreau, Giesekus, Oldroyd-B, Bingham Plastic, Herschel-Bulkley, and Phan-Thien–Tanner (PTT)

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Abstract

The non-Newtonian fluids illustrate the complex flow of fluid behaviors that cannot be described by simple linear relationships. There are countable rheological models exists. This paper presents a comparative analysis of eight commonly used models: Power Law, Casson, Carreau, Giesekus, Oldroyd-B, Bingham Plastic, Herschel-Bulkley, and Phan-Thien–Tanner (PTT). These models are analyzed based on their mathematical formulations, physical interpretations like yield stress, shear thinning, and viscoelasticity and typical applications. A comprehensive tabular comparison assists in choosing model selection in research and industry applications that highlights key similarities and differences in research and industry applications. Apparent Viscosity vs. shear rate graphs for each model are included for improved rheological behavior visualization. The Casson model is found to be the best appropriate for simulating blood flow because it accurately captures the moderate shear-thinning tendency and yield stress found in blood.

Keywords: Non-Newtonian fluids; rheological models; Power Law; Casson; Carreau; Giesekus; Oldroyd-B; Bingham Plastic; Herschel-Bulkley; Phan-Thien–Tanner; shear thinning; yield stress; viscoelasticity; blood flow modelling

ICNCS2025_2116

Accretion Flow Around a Black hole with Electromagnetic Fields and Plasma Behaviour

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Abstract

A mathematical model is presented to study electromagnetic effects on black hole accretion flow, incorporating plasma behaviour, magnetic reconnection, and impurity influence. The two-dimensional viscous, incompressible, conducting plasma bounded by porous layers is governed by MHD (Magnetohydrodynamic) equations—Navier–Stokes, continuity, and Maxwell's—supplemented with a dust–plasma reaction term. Using perturbation technique and Beavers–Joseph boundary conditions, the flow is linearized about a steady state. Graphical results for key parameters, including the Hartmann number, electric field number, Reynolds number, Peclet number, and reaction rate constant, are analysed to demonstrate their influence on velocity profiles, concentration distributions, gravitational effects, and jet formation.

Keywords: Black hole accretion; plasma; magnetic reconnection; dust–plasma interaction; Beavers–Joseph condition; perturbation method; jet formation

ICNCS2025_2117

Instability of the swirling radial electric field on heat and mass transfer in Walter-B viscoelastic and viscous fluids

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Abstract

The purpose of this study is to analyse the influence of heat and mass transport on capillary processes at the interface of viscoelastic and viscous fluids. When these processes are interrupted, it may lead to the formation of wave-like patterns and induce instability. The modified equations provide a formula for the quadratic growth rate, which is numerically assessed under the premise of capillary instability while neglecting gravity and fluid flow velocity. Heat and mass transfer both make stability better. On the other side, rotation makes stability even better. The centrifuge number keeps the interface from becoming bigger, which makes it more stable. The Weber number and the density ratio both help make the interface more stable. The perturbation equations derived from potential flow theory and the Walter-B fluid model are used to compute a quadratic growth rate that has undergone numerical validation. This work is done to make spinning more stable and to make heat and mass transmission more stable. Changing certain permittivity-to-conductivity ratios to a radial electric field will cause expansion, decay, or perturbation, and this exposure will have a double impact. The combination of electric fields, rotational effects, and heat transfer makes it feasible to do many things, such as move materials more efficiently, manage fluids at the microscale with precision, and provide medications in a way that is best for each person. By synchronising their movements, these two aspects make it easier to control the fluid's properties and surface shape with greater accuracy and productivity. Capillary instability occurs when liquid jets break apart, droplets develop in inkjet printing, thin liquid films behave differently in microgravity, and other related things happen. This lack of stability may have an effect on both natural and industrial settings.

Keywords: Walter-B viscoelastic; Radial electric field; Quasi-Static approximation

ICNCS2025_2118

Estimating Reachable Sets and H_∞ Filtering for Markovian Switching Systems with Mode-Dependent Time-Varying Delays

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Abstract

This paper discusses the problem of H_∞ filtering for Markovian switching systems exhibiting both discrete and mode-dependent time-varying delays. The main goal is to create a filter that ensures the filtering error system's stochastic stability while also achieving a certain level of H_∞ filtering. The paper presents the notion of reachable set estimation to augment the examination of system state evolution and enhance filter efficacy. Estimating the reachable set provides a more accurate comprehension of the system's state trajectory, resulting in improved robustness and filtering accuracy. The linear matrix inequalities (LMIs) to describe the necessary conditions for the existence of H_∞ filters and reachable set estimates. The Matlab LMI control toolbox can quickly solve these problems. Numerical examples are provided to demonstrate the practical significance, effectiveness, and improved performance of the proposed approach, particularly in terms of filtering accuracy and stability.

Keywords: Lyapunov-krasovskii function; Asymptotic stability; Time varying delay; H-infinity filter; Reachable set estimation; Non linear system

ICNCS2025_2122

Stochastic Analysis of Worm Spread in WSNs: Lyapunov Stability and SE_1E_2IR Modeling for Enhanced Security

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Abstract

In this study, we apply the tools of stochastic calculus to address critical security challenges in wireless sensor networks (WSNs) that arise due to operational constraints, particularly focusing on the rapid spread of worms through network nodes. To achieve this, we present an innovative model that incorporates two exposed states, based on a stochastic susceptible–exposed state 1–exposed state 2–infectious–recovered (SE_1E_2IR) system to describe the dynamics of worm propagation within WSNs. The approach involves establishing the existence and uniqueness of an ergodic stationary distribution using suitably constructed Lyapunov functions. We find that incorporating random environmental perturbations into the model yields a more accurate representation of the dynamics than deterministic models, which often overestimate the propagation potential of these threats. Numerical simulations affirm the effectiveness of the analytical approach in understanding worm propagation within WSNs. This study not only enhances the understanding of worm propagation dynamics in WSNs but also provides a methodological framework for network security applications.

Keywords: Wireless sensor networks; Ergodic stationary distribution; Extinction; Stochastic epidemic model

ICNCS2025_2125

An Advanced Neutrosophic Max-Min Semiring and its Aspects in Network Security

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Abstract

In the ever-evolving landscape of network security, conventional methods often fall short against sophisticated attacks. To address these challenges, we explore the power of algebraic structures—specifically the max–min semiring and the neutrosophic semiring to enhance the resilience and robustness of cryptographic protocols. In this paper we introduce concept of neutrosophic into the concept of max-min semiring. This paper proposes a novel protocol for network security based on neutrosophic block circulant max-min semiring, aiming to enhance resistance against both classical and quantum attacks. Unlike traditional cryptographic methods that rely on number-theoretic assumptions, the proposed protocol utilizes non-invertible operations within commutative semirings, introducing a non-linear key exchange mechanism that is computationally hard to reverse. Theoretical analysis and simulations demonstrate that this approach provides robust security, high scalability, and efficiency, making it a strong candidate for securing next-generation communication networks.

Keywords: Max-min semiring; Neutrosophic semiring; Cryptography; Key exchange protocol

ICNCS2025_2146

Fake news detection using Bert-Based Large language Models (LLMs): A Comparative and Deployable Approach

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Abstract

The widespread of misinformation and propaganda news is a serious social problem in the age of digital communication.There is a pressing need for advanced systems that can reliably and automatically detect misleading content since news spreads quickly in online communities.Traditional detection techniques, such as rule based filters or simple machine learning models, struggle to understand the intricate contextual and linguistic cues inherent in propaganda news posts. This paper compare the performance of state of the art transformer based language models, including BERT, DistilBERT, XLNet, and RoBERTa, for classifying fake news. Based on thorough testing, we find that RoBERTa is the best-balanced model, providing enhanced accuracy and computational efficiency that is adequate for real-time implementation. The optimized RoBERTa model obtained an F1 score of 0.93 and an accuracy of 93.2%. There are performance trade-offs between computational cost and precision. Compared to long-form news stories, certain models generalize well to short-form ones. RoBERTa was the most feasible option for implementation since it offered high accuracy without incurring undue processing costs.To illustrate the practical applicability of our approach, we developed and deployed a lightweight Chrome browser extension powered by the optimised RoBERTa model. The extension scans news headlines directly from web pages and provides instant feedback, labeling content as real or fake with percentage. Tested on benchmark datasets, our system demonstrates high accuracy, low latency, and usability making it an effective solution for curbing the online spread of misinformation.

Keywords: Fake News Detection; RoBERTa; Transformer Models; BERT Variants; NLP; Real-Time Detection; Browser Extension

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IntelliStock: Hybrid Intelligence for Predictive Refill and Smart Shelf Monitoring

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Abstract

Retail inventory management is confronted with key challenges in managing customer demand and cost of operations, resulting in stockouts or overstocking as a result of manual checks and past data. In response, we suggest IntelliStock, a hybrid intelligence solution that combines Long Short-Term Memory (LSTM) networks for forecast-based predictive demand and *YOLOv*8 for real-time shelf surveillance. Through examination of past sales trends, LSTM predicts future demand patterns with great precision ($R^2 = 0.72$), while *YOLOv*8 handles real-time video feeds from cameras to identify and enumerate items on the shelves in real time. The system automatically sends refill notices when inventory falls below specified limits, allowing proactive restocking. This combination obliterates human intervention, lowers operating expenses, and increases customer satisfaction. In implementation with Python, TensorFlow/Keras, and Ultralytics *YOLOv*8, IntelliStock illustrates a scalable, AI-based solution to optimize retail supply chains. This paper is a proof of concept confirms the promise of marrying predictive analytics with computer vision to transform inventory management, setting the stage for further integration with POS/ERP platforms and multi-store deployments.

Keywords: Retail Inventory Management; Demand Forecasting; LSTM Networks; YOLOv8; Computer Vision; Predictive Analytics; Supply Chain Optimization

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Alleviate Latency In Electronic Trading Under Uncertainty: A Neutrosophic Fuzzy Working Vacation Queueing Model

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Abstract

Advancements in technology enable an individual to trade through cloud systems. This opens an opportunity for many individuals to participate in the market investments. On the other hand, risk factors are increasing due to the involvement of many traders, which in turn may cause issues like system throttling and network traffic congestion. Cloud-based servers should build a high-frequency trading system that synchronizes clocks across instances to meet the regulatory demand. Market efficiency is determined by bid-ask price. Faster systems help to keep this price small, which makes the market more efficient. The time delay between placing the ask or sell order and the actual time of execution of the order by the exchange or brokerage is latency, and it is measured in milliseconds/microseconds. The lower the latency, the faster the system will make the market productive. To address the latency in cloud-based market trading, the order request, its execution, and the varied execution rate due to network maintenance or congestion are modelled as a single-server working vacation Markovian queueing model. Factors like network jitters, unpredictable market fluxes may escalate latency, thus the queueing model is framed in the neutrosophic fuzzy background. This will provide the information on the possible profit and loss percentage of trading in a certain period. Traders can avoid high losses, and exchanges/ brokers may take the necessary actions to eliminate technical and hardware issues.

Keywords: Electronic trading; Latency; Working vacation; Neutrosophic Fuzzy set

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Oscillation of Third-Order Composite Trinomial Delay Differential Equations

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Abstract

This article studies the oscillatory behaviour of a class of third-order composite delay differential equation of the form $\eta'''(t) - \mu_1(t)\eta(t) + \mu_2(t)\eta(\delta(t)) = 0$.By using positive solutions of the associated linear differential equations, we transform these composite trinomial equation into a simple binomial form. Through the application of comparison with first-order delay differential equation, new criteria are obtained for the oscillation of all solutions of the studied equation. An example is provided to show the novelty and the originality of the main results.
Keywords: Third-order; Composite; Trinomial; Delay differential equation; Oscillation

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Modeling and heat transport analysis of a time-dependent convection in a Williamson fluid over a permeable cylinder with slip effects

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Abstract

This work explores the natural convection flow of a Williamson-type non-Newtonian fluid over a moving, permeable cylindrical surface subjected to a constant heat flux. The fluid under consideration exhibits both shear-thinning and shear-thickening characteristics. The governing equations describing the momentum and heat transfer processes are formulated and numerically solved using an implicit finite difference method, applying constant heat flux conditions at the boundary. The influence of key physical parameters—namely the Weissenberg number, Reynolds number, Grashof num-ber, Prandtl number, and permeability factor—on the flow

and thermal profiles is thoroughly examined. The findings reveal that an increase in the Weissenberg number induces a reduction in fluid velocity at the time of enhancement in temperature field. Additionally, greater permeability at the cylindrical boundary al-lows more fluid to pass through the surface, thereby improving thermal transport efficiency. To evaluate the sensitivity of the velocity gradient to the Weissen-berg number and permeability parameter, Response Surface Methodology (RSM) is utilized. The accuracy of the numerical results is further corroborated by comparison with experimental data

Keywords: Williamson fluid; cylinder; constant heat flux; porous medium; heat transfer

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A Study of Smart BI for Data Insights and Visual Analytics in Indian Scenario

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Abstract

Business Intelligence (BI) systems are widely used to extract insights from structured databases, but traditional query methods such as SQL remain inaccessible to non-technical users, limiting data-driven decision-making within organizations. To address this limitation, we present SmartBI, a natural language interface for relational databases that allows anyone to access data through conversational queries. The system transforms user inquiries into structured PostgreSQL queries by utilizing an LLM alongside LangChain's SQL agent executor and implements through Streamlit to offer a dynamic, chatbot-style interface. A dataset containing 1000 retail sales transactions was utilized for testing, with outputs evaluated against actual results generated in Excel. Experimental findings show that SmartBI consistently reproduces query outcomes on tasks including city-specific lists, row counts, and customer segmentation. For arithmetic queries, the system arrived at exact ground-truth values, demonstrating reliability in numeric reasoning. In addition to precision, SmartBI generates descriptive insights and interactive visuals like pie, bar, and line graphs, thereby improving understanding for non-technical viewers. These results establish SmartBI as a reliable and user-friendly BI tool that bridges the gap between human language and structured data. In future development, its capabilities will be enhanced to accommodate intricate joins, semantic discrepancies between natural language and schema attributes, as well as improved visualization options to better serve a wider range of analytical applications.

Keywords: SmartBI; Natural Language Processing; Business Intelligence; Conversational Analytics; Data Visualization

ICNCS2025_2155

Multi-Exposure Image Fusion Utilizing HSV, YUV Color Models in a Quintic Fuzzy Environment

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Abstract

Multi-exposure image fusion (MEIF) is a process of merging images with different exposure levels of the same scenario into a single informative image for better visualization and analysis. Conventional MEIF methods often lack the ability to handle uncertainty between the pixels due to a wide range of illumination that varies under certain circumstances, which causes limited adaptability for human observations. To address these kinds of limitations, this study presents a Quintic fuzzy set (QFS)-based MEIF model that incorporates HSV and YUV color models. QFS effectively manages the inherent imprecision of pixel regions across various exposure levels by assigning membership degrees from a higher-order perspective. Whereas, HSV and YUV models are effectively employed to preserve the perceptual attributes for the fusion of dynamic image sets. The proposed method induces a smoother transition between the pixel regions of different images of the same scene by improving robustness against noise and enhancing visual quality. Experimental results demonstrate that QFS-based MEIF outperforms existing approaches in terms of detail preservation and reduced fusion artifacts via some standard image quality analysis.

Keywords: Multi-exposure image fusion; Quintic Fuzzy Sets; HSV and YUV color models

ICNCS2025_2156

Command filter-based adaptive H_∞ asymptotic tracking of delayed networked control systems

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Abstract

This article focuses on adaptive asymptotic tracking in delayed networked control systems. A novel H_∞ controller is successfully constructed to achieve asymptotic tracking by effectively combining the adaptive method with command filter backstepping. A notable aspect of the proposed controller is the use of a smooth function integrated with a positive time-varying function, enabling robust compensation of unknown parameters that vary with time as well as uncertain disturbances. Remarkably, a novel Lyapunov function that incorporates the lower bounds of the control gains is employed to establish the stability of the closed-loop system. In contrast with some traditional command filter-based backstepping methods, the requirements on virtual control coefficients and disturbances are relaxed. Finally, a simulation example is provided to illustrate the effectiveness of the proposed approach.

Keywords: Networked Control Systems; Asymptotic Tracking Control; Delay Compensation; Adaptive Controller; Command Filter Backstepping

ICNCS2025_2166

Deterministic and stochastic modeling of predator-prey dynamics under the combined influence of global warming, wind flow, herd behavior, moonlight, and toxicity

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Abstract

Predator-prey dynamics do not rely entirely on biotic factors, but abiotic components significantly shape the system's behavior, stability, and long-term outcomes. In this study, we develop and analyze both deterministic and stochastic formulations of a tri-trophic predator–prey system that incorporates global warming, wind flow, herd behavior, moonlight intensity, and toxicant exposure. Global warming and wind flow are modeled as factors that decrease reproductive rates throughout the levels of the food chain, while herd geometry and moonlight account for adaptive behavioral responses of prey. Furthermore, the model includes the effect of toxicants impacting both intermediate and top predator species. For the deterministic model, we establish boundedness and positivity of solutions, characterize equilibria, and perform local and global stability analyses. A comprehensive bifurcation study reveals the occurrence of Hopf, transcritical, Bogdanov–Takens, and generalized Hopf bifurcations, demonstrating rich dynamical behavior under varying ecological pressures. The stochastic extension captures environmental fluctuations and provides insights into extinction probabilities, persistence conditions, and noise-induced transitions. Sensitivity analysis highlights the ecological parameters that exert the greatest influence on system stability. Collectively, the results underscore how abiotic drivers, in conjunction with stochasticity, fundamentally alter predator–prey interactions, thereby advancing understanding of ecosystem responses under environmental change.

Keywords: Bifurcation; Global warming; Herd behavior; Moonlight; Toxicity; Wind flow

ICNCS2025_2195

Comparative Study of Ranking Techniques in Solving Pythagorean Fuzzy Transportation Models

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Abstract

Classical crisp models are not as useful in real-world transportation networks due to uncertainty and imprecision. When dealing with such vagueness, Pythagorean fuzzy sets provide a more adaptable and generalized method than intuitionistic and conventional fuzzy sets. This study provides a comparative analysis of a various ranking techniques that are employed to defuzzify and prioritize Pythagorean Fuzzy Numbers in the resolution of Pythagorean Fuzzy Transportation Problems. To compute the initial transportation cost for each case, classical algorithmic approaches are employed and then modified distribution method is applied to obtain the optimal transportation cost corresponding to each ranking technique. The objective of this study is to evaluate and compare the computational efficiency, consistency, and efficacy of various ranking methods when they are integrated with standard transportation algorithms. Finally, the results obtained using different ranking methods and algorithms are compared, and their effectiveness in solving Pythagorean fuzzy transportation problems is critically analysed and discussed.

Keywords: Transportation problem; Pythagorean fuzzy set; Ranking method; Pythagorean fuzzy transportation problem; Optimal solution

ICNCS2025_2197

Graceful coloring in claw-free split graphs

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Abstract

Given a proper vertex coloring $\beta : V(G) \to \mathbb{N}$, an induced edge coloring $\gamma : E(G) \to \mathbb{N}$ defined by $\gamma(uv) = |\beta(u) - \beta(v)|$ for each edge $uv \in E(G)$. If γ is also proper then β is called a graceful coloring of the graph G. If $\beta : V(G) \to \{1, 2, \ldots, r\}$, then G admits a graceful r-coloring. The least integer r required for the graceful coloring of G is the graceful chromatic number, $\chi_g(G)$. We estimate the graceful chromatic number for a forbidden graph, namely claw-free split graphs in this paper.

Keywords: Graceful coloring; Graceful chromatic number; Forbid- den graphs; Split graphs

ICNCS2025_2199

A Neutrosophic Hypersoft WASPAS-Entropy Model for Multi-Condition Crop Suitability in Tamilnadu

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Abstract

Agriculture plays a crucial role in the GDP growth of every country, supporting a wide range of industries from small-scale sectors to large-scale operations such as food processing, handicrafts, and household goods manufacturing. One of the major challenges in Indian agriculture is identifying the most suitable crops for all seasons, particularly given the diverse soil types and fluctuating climatic conditions in Tamil Nadu, which range from low rainfall to severe droughts. To address this issue, we propose an extended WASPAS (Weighted Aggregated Sum Product Assessment) method based on the neutrosophic hypersoft set (NHSS) framework. Unlike the traditional neutrosophic soft set, which only considers main criteria (attributes), the NHSS takes into account subcriteria or attribute values, offering a more granular and accurate decision-making process. In this paper, we introduce a neutrosophic hypersoft WASPAS

approach incorporating entropy-based weights to determine the most suitable crops for summer, winter, and monsoon seasons across three soil types, considering both heavy rainfall and drought tolerance. A sensitivity analysis is conducted to assess the robustness of the results, followed by a comparative analysis that highlights the strengths and limitations of the proposed method.

Keywords: Neutrosophic set; WASPAS method; Neutrosophic hypersoft set; OPtimization techniques; Crop selection

ICNCS2025_2203

Fixed time synchronization for stochastic complex networks with time-delay

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Abstract

This paper investigates the problem of synchronization for complex networks with the effects of external disturbances and time-delay in fixed time. A novel control strategy is applied to design a new controller so as to achieve synchronization for complex networks in a given time. Required conditions are derived with the help of Lyapunov theory and stochastic processes. These results are then validated for the effectiveness through numerical simulation.

Keywords: Synchronization; Complex networks; Time-delay; Lyapunov theory; Fixed-time; Stochastic disturbances

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Generalized Edge Corona of Spider Graphs are Antimagic: An Algorithmic Approach

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Abstract

In this article, we provide an algorithmic approach to prove that the generalized edge corona of a spider graph G with a maximum degree 3 containing uneven legs and graphs H_i, $i \in \{1, 2, ..., |E(G)|\}$ which are connected with at least two vertices are antimagic. This work extends the findings of [**?**] and offers a partial solution to the open problem posed in the same paper.

Keywords: Antimagic labeling; Generalized edge corona graphs; Spider graphs

ICNCS2025_2205

Viscous dissipation and Joule Heating effects on Bioconvective MHD Williamson nanofluid flow with Motile Microorganisms over an inclined stretching surface.

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Abstract

Understanding heat and mass transport in nanofluid systems is crucial for advancing next-generation biomedical and energy technologies. By combining the effects of Joule heating, viscosity dissipation, chemical reaction, heat generation/absorption, magnetic field, and bio-convection of motile microorganisms, this study investigates the magnetohydrodynamic (MHD) flow of a Williamson nanofluid via an inclined stretching surface. Similarity transformations are used to reduce the system's governing equations to nonlinear ODEs, which are then solved using the bvp4c method. It is found that whereas Joule heating and viscous dissipation primarily affect the thermal field, transport parameters control changes in velocity, concentration, and the distribution of microorganisms. The design of bio-inspired cooling systems, nanoscale heat exchangers, microfluidic devices, and diagnostic technologies can all benefit from these ideas.

Keywords: MHD; Williamson nanofluid; stretching surface; thermophoresis; Brownian motion; chemical reaction; heat generation or absorption; Bioconvection; Motile microorganisms; Joule heating and viscous dissipation

ICNCS2025_2206

Stabilization of stochastic discrete-time systems with time delay

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Abstract

This paper investigates the stabilization of discrete-time strict-feedback nonlinear systems subject to time delays and stochastic disturbances. A backstepping control framework is proposed to recursively design a controller that effectively handles the delays and stochastic disturbances. By constructing an appropriate Lyapunov function, sufficient conditions are derived to ensure the stability of the closed-loop system. Finally, a numerical example is presented to validate the effectiveness of the proposed control strategy.

Keywords: Discrete-time; Time delay; Backstepping technique

ICNCS2025_2207

Deep Learning Models for Brain Tumor Classification using Magnetic Resonance Imaging: Comprehensive Review

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Abstract

Detecting and classifying brain tumors through Magnetic Resonance Imaging (MRI) has become a significant focus in research, as timely and precise diagnosis greatly influences patient outcomes. Deep learning (DL) techniques—particularly Convolutional Neural Networks (CNNs) and transfer learning—have achieved top performance on publicly accessible datasets, frequently outperforming traditional methods reliant on handcrafted features. This review compiles insights from thirty significant studies based on deep learning techniques and categorizes approaches into CNNs, transfer learning, recurrent networks (RNN/LSTM), autoencoders, attention/transformers, classical ANNs, and hybrid systems, while also summarizing the datasets employed, preprocessing methods, augmentation strategies, evaluation metrics,

and performance ranges. The review highlights practical challenges such as the limited availability and challenges datasets and class imbalance, variations across multicenter data, the need for model interpretability and calibration, and computational limitations for clinical use. Different methods performed an exceptional accuracy rate in the detection/classification between 94 – 99% subject to datasets. In this paper, a detailed review is presented on the study to explore the future possibility in healthcare research.

Keywords: Brain Tumor; Deep Learning; MRI; CNN; RNN and LSTM

ICNCS2025_2208

LIFT-LLIE: A Lightweight Intuitionistic Fuzzy Technique for Low-Light Image Enhancement

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Abstract

Image enhancement is a significant research area in image processing with broad applications, ranging from surveillance to medical imaging. Low-light image enhancement remains a challenging problem due to the inherent uncertainty, noise and loss of structural details in under-illuminated images. To address this issue, intuitionistic fuzzy generator-based low-light image enhancement models have been developed. However, the existing approaches often rely on additional contrast enhancement methods, which increase dependency on external techniques. To address these limitations, this study introduces a lightweight intuitionistic fuzzy technique for enhancing low-light images without the need for supplementary methods. The proposed method effectively adjusts intensity distributions while preserving local structures and subtle details, ensuring natural and visually pleasing results. Experiments on benchmark datasets, along with comparative analyses against state-of-the-art methods, demonstrate the superiority of the proposed approach in terms of quantitative and qualitative results. These results highlight the model's efficiency, robustness and practical applicability for real-world low-light imaging scenarios.

Keywords: Intuitionistic fuzzy set; Intuitionistic fuzzy generator; Low-light image enhancement; Parameter optimization; Entropy measure

ICNCS2025_2210

A low-light image enhancement approach using Weber's intuitionistic fuzzy generator

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Abstract

Fuzzy logic systems have proven effective in diverse applications, particularly image processing. Enhancing low-light images remains challenging due to high levels of uncertainty. To address this, Weber's intuitionistic fuzzy generator is derived for low-light image enhancement as a novel approach. A low-illumination image is first fuzzified, then transformed into an intuitionistic fuzzy image using Weber's generator. Next, contrast-limited adaptive histogram equalization is applied to obtain the enhanced outcome. Finally, the enhanced image is defuzzified to get the output image. Experimental comparisons demonstrate the superiority of the proposed method over existing techniques.

Keywords: Intuitionistic fuzzy set; Weber's function; Image enhancement; Intuitionistic fuzzy generator; Entropy measure

ICNCS2025_2211

Distance-Hereditary Fuzzy Graphs and their application in theories of mind

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Abstract

Fuzzy graphs serve as a valuable tool in mathematics, enabling specialists to effectively depict fuzzy relationships among various entities. The nature of fuzziness is advantageous in numerous situations, assisting in predictions and problem resolution. Distance-Conserving Graphs represent a category of connected graphs distinguished by the feature that all induced paths preserve isometry. Many challenges encountered in the real world are intricate and frequently involve uncertain information. In this study, we perform a thorough examination and define various types of products on Distance-Hereditary Fuzzy Graphs, focusing on Direct product, Semi Strong Product, and Strong product associated with Distance-Hereditary Fuzzy Graphs.

Keywords: Distance-Hereditary graph; Direct product; Semi Strong Product; Strong product

ICNCS2025_2212

Optimization of Wirelength for Embedding Crossed Cubes into Necklace Graphs

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Abstract

Graph embedding is a vital technique for simulating an interconnection network topology with another. It is used for processor allocation, algorithm porting, and design the physical layout of Network-on-Chip (NoC). Wirelength is an important metric to quantify the quality of graph embedding. In NoC design, minimum wirelength is an indicator of a smaller wiring area and reduced wiring cost. Minimizing wirelength of an embedding solves the problem of designing an interconnection network with the potential to execute parallel algorithms developed for one network in another with minimum time delay. Hypercubes as an interconnection network have many attractive properties, including symmetry, small diameter, strong connectivity and relatively small link complexity. The crossed cube is a variation of the hypercube that exhibits the property of reduced diameter and better dynamic reconfiguration capability. In this work, we consider embedding of crossed cubes into different necklace graphs and windmill graph to obtain minimum wirelength.

Keywords: Embedding; crossed cubes; edge isoperimetric problem; congestion; wirelength

ICNCS2025_2232

Benchmarking Graph Neural Networks for Chaotic Dynamics Prediction: A Study on Lorenz Systems

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Abstract

Chaotic systems such as the Lorenz family of models are widely used as testbeds in climate and atmospheric sciences due to their sensitivity to initial conditions and regime-switching behavior. Traditional numerical solvers provide accurate trajectories but are computationally demanding and limited in generalizing across parameter regimes. Recent advances in Graph Neural Networks (GNNs) offer an alternative by representing system states as nodes and their couplings as edges, enabling relational learning of nonlinear dynamics. This paper presents a benchmarking study of different GNN architectures—including Graph Convolutional Networks (GCN), Graph Attention Networks (GAT), and Graph Recurrent Models—on the Lorenz-63 and Lorenz-96 systems. We analyze their ability to reproduce chaotic attractors, capture long-term predictability, and identify bifurcation-driven regime shifts. The novelty of this work lies in providing the first systematic comparison of GNN variants on canonical chaotic systems, highlighting strengths and weaknesses across architectures. Results demonstrate that while GNNs can effectively approximate short-term trajectories, their ability to capture Lyapunov stability and long-horizon forecasts depends strongly on architectural design. This benchmarking contributes a new perspective on the role of GNNs as lightweight and interpretable surrogates for chaotic dynamics, paving the way for their application in climate and weather modeling.

Keywords: Graph Neural Networks; Lorenz Attractor; Chaotic Dynamics; Lorenz-96; Benchmarking; Nonlinear Systems; Climate Modeling

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On the Mostar indices of the line graphs of the subdivision graphs

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Abstract

The Mostar index of a graph G, denoted $Mo(G)$, is defined as

$$Mo(G) = \sum_{uv \in E(G)} |n_u - n_v|,$$

where n_u represents the number of vertices in G closer to u than v, and n_v is the number of vertices closer to v than u. A Mostar index value close to zero, indicates an approximately balanced partition of the vertex set with respect to an edge. This paper investigates the Mostar indices of the line graphs corresponding to tadpole, star, wheel, and ladder graphs through the application of subdivision operations for structural examination.

Keywords: Mostar index; Line graphs; Subdivision graphs; Tadpole graphs; Star graphs; Wheel graphs; Ladder graphs

ICNCS2025_2248

Star Coloring of Graph Amalgamation

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Abstract

Graph theory is a multidisciplinary area that is placed at the intersection of mathematics and computer science. A key concept in graph theory, graph coloring is a useful tool for examining the structural characteristics of graphs and has several applications in network design, scheduling, and computing issues. Graph coloring has several variants, including vertex, edge and face coloring. A proper vertex colouring of a graph G is called a star colouring if every bicoloured subgraph of G is a star forest. The star chromatic number is the minimum number of colours required to star colour G and it is denoted by $\chi s(G)$. The star coloring of vertex amalgamations of several graph families, such as cycles, trees, bipartite graphs, bistars, and tadpole graphs, is examined in this study. We establish boundaries and exact values of the amalgamated graphs star chromatic number for each class and examine the effects of vertex amalgamation on coloring behavior in comparison to the original graphs.

Keywords: Star Colouring; Star Chromatic number; Graph amalgamation

ICNCS2025_2250

Stability and Domain of Attraction Analysis of Stochastic Nonlinear Delay Systems

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Abstract

This paper investigates the stability of the zero solution of stochastic nonlinear delay systems using a Lyapunov functional approach. By constructing an appropriate Lyapunov functional, sufficient conditions are derived for both mean-square stability and stochastic stability in probability. Furthermore, regions of attraction are analyzed and illustrated to demonstrate the influence of time delays and stochastic perturbations on system behavior.

Keywords: Stability; Stability region; Domain of attraction; Region of attraction; Lyapunov functional; Stochastic systems

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Oscillation of Second-order Differential Equation with Several Non-monotone Advanced Arguments

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Abstract

Consider the second-order advanced differential equation of the form

$$x''(t) - \sum_{i=1}^{m} q_i(t)x(\sigma_i(t)) = 0, \quad t \geq t_0$$

where q_i, $1 \leq i \leq m$ are functions of non-negative real numbers and σ_i, $1 \leq i \leq m$ are functions of positive real numbers such that $\sigma_i(t) > t$, for $t \geq t_0$. Sufficient oscillation conditions are obtained and an example is also given to illustrate the main results.

Keywords: second-order equations; advanced equations; non-monotone arguments; oscillatory solution

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Numerical Study on Electric field induced Magnetization Dynamics in the biquadrant, anisotropic and antisymmetric ferromagnetic nanowire

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Abstract

The propagation of electromagnetic (EM) solitons in low-dimensional magnetic nanostructures has attracted significant attention due to their potential in nanoscale information processing. In this study, we focus on an antisymmetric ferromagnetic nanowire system by incorporating higher-order effects, namely biquadratic and anisotropic interactions, into the governing dynamical equations. To obtain a precise evaluation of soliton dynamics, the multiple-scale perturbation approach is employed, which allows the reduction of the system to coupled ordinary differential equations describing the soliton velocity and amplitude. These equations are solved numerically using the fourth-order Runge–Kutta method, ensuring accurate treatment of the nonlinear and dispersive contributions. The results demonstrate that higher-order interactions significantly modify both the amplitude and velocity of EM solitons, influencing their stability and propagation behavior. Such findings provide deeper insight into the controllability of soliton dynamics in ferromagnetic nanowires and highlight their potential applications in advanced spintronic and magnonic devices.

Keywords: Electromagnetic Soliton; Runge-Kutta Method; Biquadratic Spin Interaction; Anistropic Spin Interaction; Ferromagnetic Nanowire; Mutiple Scale perturbation Approach

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Pythagorean Fuzzy Approach for Transportation Problem Using Parametric Representation

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Abstract

In the field of transportation problem, decision makers aim to minimise the transportation cost. However, due to uncertain and dynamic factors, transportation costs often fluctuate . To address these uncertainties, this paper applies Pythagorean fuzzy sets for modelling transportation costs. The calculations are performed using a parametric representation of Pythagorean fuzzy numbers, incorporating a max min operator. The initial basic feasible solution (IBFS) is obtained directly using fuzzy cost values, without converting them into crisp equivalents. The optimality of the solution is then verified through the modified distribution (MODI) method. A numerical exampleis presented to illustrate the applicability and effectiveness of the proposed approach.

Keywords: Optimization; Fuzzy Transportation Problem (FTP); Generalized Trapezoidal Pythagorean Fuzzy Number (GTrPFN); Parametric Form

ICNCS2025_2259

A Fractional-Order Tumor–Immune Model for Lung Cancer with Combined Therapeutic Strategies

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Abstract

This work presents a fractional-order mathematical model for lung cancer that integrates surgery, immunotherapy, and chemotherapy as a combined treatment strategy. The model describes tumor–immune dynamics under multiple interventions and incorporates a feedback control framework to optimize treatment scheduling. Using the Pontryagin Maximum Principle, necessary conditions for optimal control are derived to minimize tumor burden while reducing treatment intensity. Analytical results show that the basic reproduction number R_0 declines substantially with triple therapy, reflecting its effectiveness in limiting tumor proliferation. Sensitivity analysis identifies chemotherapy efficacy and immune activation as key parameters influencing long-term outcomes. Numerical simulations confirm that the integrated approach yields superior tumor suppression compared to single or dual therapies, with improved immune response and sustained stability. This study highlights the potential of combining fractional calculus, multi-modal therapies, and control theory to design personalized, effective treatment protocols for lung cancer patients.

Keywords: Lung cancer modelling; Fractional-order differential equations; Pontryagin's Maximum Principle; Immunotherapy; Optimal control

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Complexity analysis of Meteorological Drought across the Indian subdivisions of contrasting climate using Recurrence Theory

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Abstract

This study proposes the application of Recurrence theory for analyzing the complexity of Meteorological Drought across six rainfall homogeneous subdivisions in India. Using the longest available records of subdivisional scale rainfall data of 1871 – 2016 the standardized precipitation Inex (SPI) indicator is computed firstly, for diverse time scales of 3, 6 and 12 months representing short, medium and long-term droughts. Then Recurrence theory is applied for developing recurrence matrix after finding the optimal embedding dimension (ED), time delay (TD) and recurrence threshold. The TD and ED requirements are found to be more for droughts of larger time scale. The recurrence matrices of each SPI series are interpreted using Recurrence Quantification Measures (RQMs) in the form of Recurrence Rate (RR), Determinism (DET), Laminarity (LAM), Entropy (ENT) and mean Diagonal Length (L). The analysis shown that DET, LAM and ENT of SPI increase with increase in time scale. It is noted that the complexity in terms of LAM is more for wet regions like Assam-Meghalaya (AM) and Kerala on comparing with the arid and semi-arid and drought prone subdivisions of Chattisgarh, West Rajasthan, Vidarbha and Marathwada. It is also noted that long-term drought (SPI of 12-month scale) is more deterministic than short to medium scale droughts irrespective of the subdivisions. Moreover, the SPI series of drought prone regions are more deterministic than the SPIs of wet regions irrespective of the time scales. The useful insights gained from recurrence analysis and RQMs are helpful for developing appropriate forecasting models of drought of contrasting climatic zones.

Keywords: Drought; Subdivisions; Climate; SPI; Recurrence

ICNCS2025_2261

Optimizing Drag in Hypersonic Turbulent Flow over Cone- Ogive Shape: The Role of Jet for Various Angle of Attack

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Abstract

Aerodynamic drag reduction is a critical challenge in optimizing the performance of launch vehicles during hypersonic atmospheric ascent. This study investigates the efficacy of jet-based active flow control techniques for drag mitigation by manipulating boundary layer dynamics and shock-wave interactions on axisymmetric launch vehicle geometries. Shear stress transport ($k - \omega$) based Computational Fluid Dynamics (CFD) model is employed to characterize the influence of steady and pulsed jet injection on flow separation, pressure gradients, and shock structure modulation. Key parameters of jet, including pressure, Mach number, diameter and injection angle are systematically varied to evaluate their impact on drag reduction. The analysis demonstrates that appropriately timed and positioned jet actuation significantly suppresses boundary layer separation, alters shock-boundary layer interactions and reduces total drag coefficients by up 43.7%. The minimum drag condition occurs at zero angle of attack for this shape. These results underscore the potential of jet-induced flow control to enhance aerodynamic efficiency, reduce propulsive energy requirements, and increase payload capacity for future launch vehicle designs.

Keywords: Drag; Jet; Hypersonic flow; Turbulence model; Angle of attack

ICNCS2025_2265

Hexic Fuzzy Set Approach to handle uncertainty in Multi-Criteria Decision Making Problem

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Abstract

Hexic fuzzy sets (HeFSs) help decision makers to freely chose their membership and non-membership grade preference of an attribute over criteria without any restriction exists in other fuzzy set types. In other words, HeFS provides greater flexibility than the existing fuzzy set extensions. In this research article, the HeFS is introduced as an advanced extension of fuzzy sets, considered to handle complex multi-criteria decision making (MCDM) problems under uncertainty. Also the study validate the practical utility of HeFS, by integrating it with prominent MCDM techniques such as TOPSIS and VIKOR. Further, the research work establishes the integration of score function, accuracy function and distance measures of HeFS into the traditional TOPSIS and VIKOR multi-criteria decision making techniques. HeFS-TOPSIS and HeFS-VIKOR framework were applied to the crop selection problem in Villupuram District, India is presented and results has been compared with the existing multi-criteria decision making frameworks.

Keywords: Hexic fuzzy set; TOPSIS; VIKOR; crop selection; uncertainty modeling; decision support systems

ICNCS2025_2271

Graph Stress Metrics and their Computational Insights

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Abstract

Centrality measures play a crucial role in graph theory and have numerous applications in fields such as sociology, psychology, economics, anthropology, biology, terrorism studies, traffic analysis, neuroscience, and business. Among the centrality measures such as degree, closeness, betweenness and eigenvector centrality, stress is one of such centrality measures which identifies the influential nodes in a network and examines how the flow gets affected in their absence. In this chapter we begin with a brief overview of centrality measures with illustrative examples. We then discuss the stress of graphs and its computation followed by established results. Furthermore, we introduce some new results on stress of graphs, supported by proofs and examples. Finally, applications and scope are also discussed.

Keywords: Centrality; Shortest path; Stress

ICNCS2025_2273

Adaptive Low Light Image Enhancement using Bipolar Fuzzy Set

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Abstract

Digital images captured under a low-light environment often struggle to clearly assign the intensity due to uncertainty and insufficient illumination. To address such issues, fuzzy set theory plays a crucial role. Bipolar fuzzy set, an important extension of the conventional fuzzy set, provides an advanced framework to deal with uncertainty by focusing on positive and negative membership grades. However, handling negative membership grades and developing an image enhancement model that accesses bipolar fuzzy information pose significant challenges. To address this issue, the present study designs a bipolar fuzzy set based low-light image enhancement model by leveraging the one-to-one correspondence between bipolar fuzzy set and two-polar fuzzy set. Additionally, an image fusion approach is employed to combine the images of positive and negative membership grades. Finally, the experimental study revealed that the proposed model is superior to several state-of-the-art techniques in terms of both enhancement quality and computational efficiency.

Keywords: Bipolar fuzzy set; Fuzzy complement; Two polar fuzzy set

ICNCS2025_2290

Embedding and the Spanning Tree Wirelength of $(K_p - C_p)^n$

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Abstract

High-performance parallel computing requires interconnection networks with efficient architectures, where design parameters such as wirelength, dilation, and congestion directly influence scalability and cost. Graph embedding serves as a powerful tool for optimizing these parameters by mapping complex guest graphs into simplified host frameworks. This work investigates the embedding of $(K_p - C_p)^n$, for p is odd, $p \geq 9$ and $n \geq 2$, into grids, generalized book graphs, triangular snakes, and banana tree variants and with emphasis on spanning tree wirelength. By embedding $(K_p - C_p)^n$, for p is odd, $p \geq 9$ and $n \geq 2$, into spanning trees derived from host graphs, for wheel graphs, the study identifies configurations that reduce communication overhead while preserving key topological features. The findings provide strategies for improving efficiency in large-scale parallel systems and support the design of scalable, cost-effective interconnection networks.

Keywords: Graph embedding; Maximum Subgraph Problem; Edge congestion; Wirelength; Spanning tree wirelength

ICNCS2025_2292

Edge Detection of Images Based on the Extraction of Fuzzy Local Binary Pattern

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Abstract

In the modern AI era images always play a indispensable role in medicine, defence, remote sensing etc.. numerous researches developed to finding the edges of an image. But still the thirsty of finding accurate edges of an image increase rapidly. In this present work a new algorithm is presented to find edges of an image based on local binary pattern(LBP) combined with intuitionistic fuzzy logic to reduce unwanted hairline and also a new contrast enhancement operator is used to improve the accuracy of finding tiny changes in the grey level. The hesitation h from 0 to 1 and threshold value T from 0 to 255 are optimised for each $3 * 3$ neighbourhood by high entropy value. Using this optimised h and T values the intuitionistic fuzzy local binary pattern(IFLBP) code is generated. Same procedure is followed to each pixel and corresponding IFLBP code is calculated for entire image. Consolidate all pixels to get crisp edge image. The proposed results are compared with other existing edge detection methods and the performance and efficiency of the proposed method is high when compared with other existing methods

Keywords: Intuitionistic Fuzzy Set; Local Binary Pattern; Contrast Measure; Feature Extraction; Edge detection

ICNCS2025_2323

Stochastic Time Series modelling for Foreign Tourist Arrivals in India

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Abstract

Foreign Tourist Arrivals (FTA) are a key indicator of the performance of the tourism sector in India, influencing economic growth, foreign exchange earnings, and employment generation. The present study focuses on the design and development of an Auto Regressive Integrated Moving Average (ARIMA) model for forecasting FTA in India using historical data from 1981 to 2023. Stochastic modelling and associated forecasting were carried out using the ARIMA methodology. Based on the lowest value of the Normalized Bayesian Information Criterion (BIC), the ARIMA (1,1,2) model was identified as the most appropriate for the given data. Model accuracy was evaluated using statistical measures such as Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF), and Box–Ljung Q statistics. The selected model forecasts an increase in FTA from 9.52 million in 2024 to 10.02 million in 2033. The findings of this study can provide valuable insights for policymakers, tourism planners, and stakeholders to devise strategies aimed at boosting foreign tourist arrivals in India.

Keywords: Foreign Tourist Arrivals; Box–Ljung; BIC; ARIMA

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Explainable Myocardial Infarction Classification using Testing with Concept Activation Vectors: Temporal Concept- Based Interpretability for ECG Models

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Abstract

Myocardial Infarction (MI) is a life-threatening cardiac occurrence that demands immediate diagnosis. Deep learning models have shown reliable results in ECG- based MI detection, however, the challenge of interpretability persists. This research introduces a hybrid approach that combines the efficient Convolutional neural network for feature extraction, anatomical feature extraction, and testing with concept activation vectors (TCAV) to attain class-level interpretability. The undertaking research examines the temporal sensitivity of concept representation and focuses on providing class-discriminative explanations for key MI types, notably anterior MI (AMI) and normal classes (NORM). The methodology includes ECG preprocessing with bandpass and notch filtering, segmentation of ECG signals, anatomical feature engineering, and class balancing using Borderline-SMOTE. The results indicate that class-specific CAVs successfully capture discriminate temporal patterns with accuracy of 99

Keywords: Myocardial Infarction; Deep Learning; Testing with concept activation vectors; ECG; Explainability.

ICNCS2025_2675

A Graph Contrastive Learning based Graph Neural Networks Model for Node Classification

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Abstract

Graph Contrastive Learning (GCL) has emerged as a powerful paradigm for learning robust node representations in a self-supervised manner. Central to its success is the design of effective augmentation strategies to generate meaningful positive sample pairs. However, most existing methods rely on random perturbations which may overlook the intrinsic structural semantics of the graph. In this work, we propose a novel augmentation technique that leverages fundamental graph-theoretical properties to generate positive samples with stronger semantic alignment. Specifically, we design property-aware transformations guided by measures such as node centrality, clustering coefficients, and community structures, ensuring that the augmented views preserve critical topological and contextual information. Our method seamlessly integrates into standard GCL frameworks and is evaluated on multiple benchmark datasets for node classification tasks. Experimental results demonstrate that our augmentation strategy not only enhances representation quality but also improves classification performance. This work highlights the potential of theoretically grounded augmentations in advancing the robustness and effectiveness of graph contrastive learning.

Keywords: Graph Contrastive Learning; Graph Neural Networks

ICNCS2025_2764

A analysis of non-Newtonian MHD fluid flow in the inclined channel along with permeability, pressure, and magnetic field by Python IDE

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Abstract

An analysis of the unsteady non-Newtonian MHD fluid flow with a uniform magnetic field in an inclined channel (constant pressure and permeability) is studied. The problem evaluates the effect of inclination, the Casson parameter of the fluid flow. The governing equations in the present analysis are solved using the Laplace transform techniques. The velocity distribution and temperature profile are analyzed and results are discussed with the help of PyCharm 2025.1.

Keywords: Heat source; inclined channel; Laplace transform; MHD; Pressure; PyCharm

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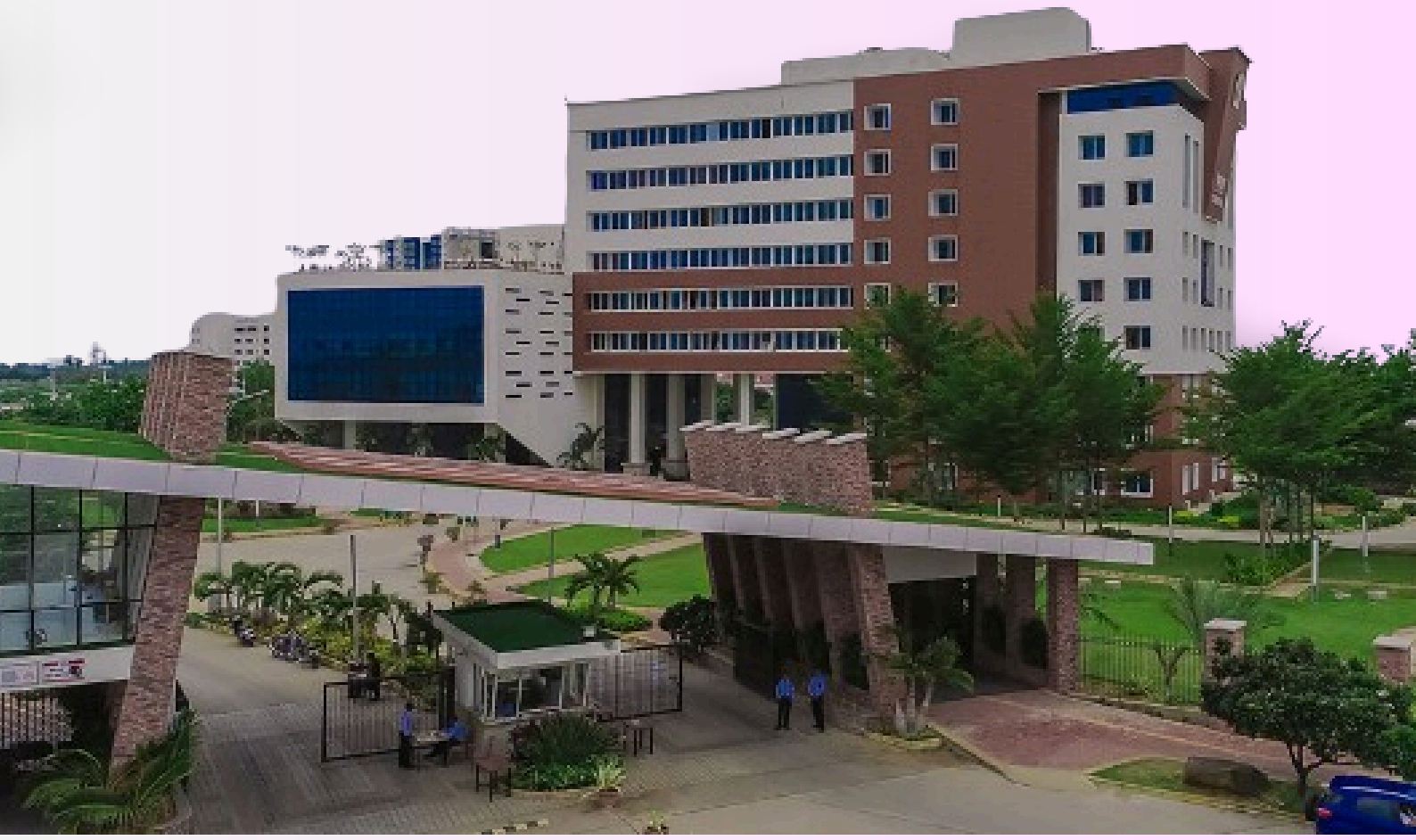

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