International Conference
on

Computations and Data Science (CoDS-2024)

Organized by
Department Of Mathematics
In Collaboration With Ihub Divyasamapark
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

भारतीय प्रौद्योगिकी संस्थान रुड़की
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From the Desk of the Director IIT Roorkee

Personally and on behalf of the Indian Institute of Technology Roorkee, I extend a hearty welcome to the delegates and participants in the International Conference on Computations and Data Science (CoDS-2024) during March 08-10, 2024 organized by the Department of Mathematics in collaboration with iHub DivyaSampark. This gathering stands as evidence of our collective dedication to the progression of knowledge, the promotion of cooperation, and the exploration of novel approaches in computational algorithms and data science. It is critical that, as we commence this intellectual expedition over the course of the following three days, we acknowledge the paradigm-shifting influence that computations and data science will have on the future of numerous disciplines.

During CoDS-2024, you will have the opportunity to engage in discussions with prominent scholars from India and around the world, exchange thoughts with your peers, and investigate the most recent advancements in the thematic areas. Undoubtedly, the presence of a wide range of perspectives and expertise will incite fresh collaborations and challenge conventional limits. I urge you to engage proactively in the diverse sessions, thereby cultivating a vibrant interchange of ideas that surpasses boundaries of disciplinary concentration.

I congratulate Department of Mathematics and Organizing Committee for hosting the conference and welcome all the delegates at IIT Roorkee campus.

(K. K. Pant)

About the Institute:

IIT Roorkee erstwhile Thomason Engineering College, the first engineering institution of India is now one of the leading educational institutes in the country imparting quality technical education and overall development of the society. IIT Roorkee (earlier known as the University of Roorkee) has celebrated 175 years (1847-2022) of its rich educational heritage. The Roorkee College was established in 1847 AD as the First Engineering College in the British Empire. The College was renamed as The Thomason College of Civil Engineering in 1854. It was given the status of University by Act No. IX of 1948 of the United Province (Uttar Pradesh) in recognition of its performance and its potential and keeping in view the needs of post-independent India. Pandit Jawahar Lal Nehru, the first Prime Minister of India, presented the Charter in November 1949 elevating the erstwhile college to the First Engineering University of Independent India. On the 21st of September 2001, the University was declared an institute of national importance, by the Government of India, changing its status from University of Roorkee to Indian Institute of Technology Roorkee. Thus, another jewel was added to the already glittering crown in the History of this Institute.

About the Department of Mathematics:

The Department of Mathematics from its inception in 1960 has grown into an active centre of quality teaching and research. Today it stands as one of the leading departments in the country, well known for its excellence in teaching and research. The Department runs five years BS-MS Program in Mathematics and Computing, two year M.Sc. and PhD programs in Mathematics. The faculty members of the Department are actively carrying high quality research in different areas of pure mathematics, applied and computational mathematics, operations research and statistics. The research activity in the department is well recognized by NBHM, DST, SERB, CSIR, ISRO, DRDO and many more agencies, and a number of research projects funded by national and international agencies are in progress in the department.

About iHUB DivyaSampark :

The Indian Government's Department of Science and Technology is executing the National Mission on Interdisciplinary Cyber-Physical Systems (NM-ICPS), approved by the Union Cabinet in December 2018. As part of the mission, iHUB DivyaSampark at IIT Roorkee, focused on technology development, human resources, technology incubation, startups, and international collaborative research.

The hub fosters research innovation towards product/technology development and commercialization in CPS with relevant and next-generation Devices and Materials in the areas of Healthcare, Industry 4.0, Smart Cities, Defence. The hub envisions that the smart devices and materials are the key enablers for CPS which includes sensors, actuators, computing, communication and control devices built on the smart engineering of the existing and novel materials intelligently coupled with frontier trends like artificial intelligence, machine learning, augmented/virtual reality etc. The ability to interact with cyber world and expand the capabilities of the physical world through smart devices and materials would be the core for future technology developments. The HUB continuously identifies research trends and need areas in the market place and Indian social sector and will liaison with both government and industries to map the needs with the key technologies developed in the HUB and working towards self-reliant India.

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Contributory Talks

Abstract
Keynote/Invited Speakers

Title: Scalable solvers for the Helmholtz problem
Author(s): Prof. C. Vuik
Affiliation(s): TU Delft Netherlands

Abstract: A matrix-free parallel multi-level-deflation preconditioner combined with the Complex Shifted Laplacian preconditioner(CSLP) for the two-dimensional Helmholtz problems is presented. The Helmholtz problem, widely studied in seismic exploration, is hard to solve both in terms of accuracy and convergence, due to the scalability issues of the numerical solvers. For large-scale applications, high-performance parallel scalable methods are also indispensable. In our method, we use the preconditioned Krylov subspace methods to solve the linear system obtained from finite-difference discretization. The CSLP preconditioner is approximately inverted by one parallel geometric multigrid V-cycle. Motivated by the observation that the eigenvalues of the CSLP-preconditioned system shift towards zero for large wavenumbers, deflation with multigrid vectors and further high-order vectors were incorporated to obtain wave-number-independent convergence. We also compare Galerkin coarsening method and high-order re-discretization on the coarse grid. The matrix-vector products and the inter-grid operations are implemented based on the finite-difference grids without constructing the coefficient matrix. These adjustments lead to direct improvements in terms of memory consumption. Numerical experiments show that wavenumber independence has been obtained for medium wavenumbers. The matrix-free parallel framework shows satisfactory parallel performance and weak scalability.

Title: Optimization and Reduced Order Models for Digital Twins
Author(s): Prof. Harbir Antil
Affiliation(s): George Mason University, USA

Abstract: This talk begins by discussing the role of partial differential equation-constrained optimization in the development of digital twins. In particular, applications to identify weaknesses in structures and aneurysms are considered. Next, we analyze a data-driven optimization problem constrained by Darcy's law to design a permeability that achieves uniform flow properties despite having nonuniform geometries. We establish the well-posedness of the problem, as well as differentiability, which enables the use of rapidly converging, derivative-based optimization methods. The second part of the talk will focus on an inexact adaptive and provably convergent semi-smooth Newton and Trust-Region methods for general-purpose optimization problems. In particular, dynamic optimization problems, which are known to be highly expensive are the focus. A memory-efficient reduced-order modeling approach based on randomized matrix sketching is introduced.

Title: Old Polytopes, New Valid Inequalities for Cutting-Plane Methods
Author(s): Prof. Sachin Jayaswal
Affiliation(s): IIM Ahmedabad

Abstract: In this talk, we revisit the extensively studied binary knapsack polytope, for which there exist several well-known valid inequalities (VIs) in the literature. We discuss a new class of VIs for the binary knapsack polytope based on the idea of partitioning non-minimal covers, which are overlooked in the literature as they are known to produce (cover) inequalities that are dominated by those generated from minimal covers. Our proposed class of VIs is a generalization of the well-known cover inequalities, extended cover inequalities (CIs), and generalized (1, k)-configuration inequalities, and can be obtained through neither sequential nor simultaneous lifting of any minimal CIs. We further provide conditions under which our proposed VIs define facets of the binary knapsack polytope. We show the effectiveness of the proposed VIs in efficiently solving instances of the fixed-charge transportation problem, which is a generalization of the classical transportation problem and is

known to be NP-hard. The talk ends with some discussion on how the idea of cover partitioning is extended to flow covers to discover new VIs for the well-known single-node flow polytope.

Title: Computational and Modelling Challenges in Simulating Particulate Systems: Insights from Pharmaceutical Applications
Author(s): Prof. Jitendra Kumar
Affiliation(s): IIT Ropar

Abstract: Mathematical modelling of particulate systems presents challenges arising from the complex mechanisms influencing the system. Two primary approaches for simulating particulate systems are continuum and discrete methods. This presentation addresses both aspects of computational and modelling challenges associated with each approach. The primary focus of this talk is on addressing two specific problems within the pharmaceutical industry: sonocrystallization and granular flow. The presentation will delve into the specific modeling challenges related to incorporating the physics of the processes into the kinetic model and ensuring computational efficiency. Additionally, potential solutions to these challenges will be discussed, providing valuable insights for researchers working in related areas.

Title: VMSFEA of MHD-NS Equations with application
Author(s): Prof. B.V.R. Kumar, Anil Rathish and Dipak Sahoo
Affiliation(s): IIT Kanpur

Abstract: In this work, a thorough investigation of the transient magnetohydrodynamic Navier-Stokes (MHD-NS) equations is carried out applying variational multiscale stabilized finite element (VMSFE) technique. The convergence characteristics of VMSFE scheme (Apriori Estimate) has been derived in this study. The VMSFE method's credibility is established by numerical experiments on multiply driven cavity flow. The flow pattern is traced for various Hartmann, Reynolds, and magnetic force inclination angle values.

Title: The impact of Deep Learning on Visual Object Tracking
Author(s): Prof. Christian Micheloni
Affiliation(s): University of Udine

Abstract: In the rapidly evolving landscape of computer vision, deep learning has emerged as a transformative force, revolutionizing also the field of visual object tracking. This keynote speech will delve into the profound impact of deep learning on the intricate task of tracking objects in visual data. We will explore the intriguing phenomenon of how deep learning, while introducing revolutionary advancements, is also rekindling interest in and reproducing principles from traditional object tracking techniques. By revisiting the foundations of visual tracking, we will examine how deep learning architectures seamlessly incorporate and enhance classical methods such as feature engineering, motion estimation, and temporal modeling. This convergence of old-school wisdom with cutting-edge technology underscores the synergy between time-tested principles and modern computational prowess. As we navigate through this synthesis of the old and the new, the audience will gain a holistic perspective on the dynamic interplay between tradition and innovation in the realm of deep learning for visual object tracking.
Through a comprehensive overview of cutting-edge deep learning techniques, attendees will gain insights into the significant advancements achieved in robustness, accuracy, and real-time performance for visual object tracking systems. The speech will spotlight case studies and practical applications across diverse domains, showcasing how deep learning has elevated the efficacy of tracking algorithms in scenarios ranging from surveillance and autonomous vehicles to augmented

reality.
In conclusion, the audience will depart with a profound understanding of the transformative influence that deep learning has wielded upon visual object tracking. By embracing the potential of these advancements, attendees will be better equipped to navigate the evolving landscape of computer vision, contributing to the seamless integration of intelligent tracking systems into our daily lives.

Title: An efficient DWR-type a posteriori error bound of SDFEM for singularly perturbed 2D elliptic BVPs
Author(s): Prof. Natesan Srinivasan
Affiliation(s): IIT Guwahati

Abstract: In this talk, we focus on the residual-based a posteriori error estimation in the standard energy norm for the streamline-diffusion finite element method (SDFEM) for singularly perturbed two-dimensional elliptic PDEs of convection-diffusion type. The well-known dual-weighted residual (DWR) technique has been adopted to elevate the accuracy of the error estimator. Our main contribution is finding an efficient computable DWR-type robust residual-based a posteriori error bound for the SDFEM. The local lower error bound has also been provided. An adaptive mesh refinement algorithm has been addressed and lastly, some numerical experiments are carried out to justify the theoretical proofs.

Title: Coupling methods for solving interface problems
Author(s): Prof. Cristoph Erath
Affiliation(s): University for Teacher Education Vorarlberg, Austria

Abstract: Partial differential equations describe models in engineering and natural sciences. Numerical methods have to be applied for solving them. However, these schemes must be chosen with care due to various physical properties of the solution in different parts of the domain. Therefore, we consider couplings of the finite element or finite volume methods for interface problems with the boundary element method to get the best possible numerical approximation. For different models, we discuss our coupling approaches and provide rigorous mathematical analyses of well-posedness and quasi optimality. Numerical examples illustrate the predicted (optimal) convergence rates and underline the potential for practical applications.

Title: Eigenpair computation to extract relevant information from data
Author(s): Prof. Arindama Singh
Affiliation(s): IIT Madras

Abstract: We consider many problems tackled in data science that lead to extracting relevant information from given data. It is observed that the relevant and dominant information contained in data requires computation of singular values, singular vectors, and eigenvalues and eigenvectors of associated matrices. We discuss modern numerical methods to compute eigenvalues and eigenvectors of large matrices.

Title: Integer intervals and DEA. Slacks-based model to solve DEA and inverse DEA
Author(s): Prof. M. Arana Jimenez
Affiliation(s): Universidad de Cádiz

Abstract: We recall some concepts and properties of the arithmetic and LU-partial orders for integer

intervals. By means of them, we can describe inputs and outputs for a set of Decision-Making Units (DMUs) under uncertainty in data. Thanks to an axiomatic derivation of the production possibility set (PPS), we offer an additive slacks-based data envelopment analysis (DEA) model, with an efficiency assessment. Furthermore, and under the previous uncertainty conditions, we discuss an inverse DEA model, with necessary and sufficient conditions for input estimation when output is increased. We illustrate with an example the new model and methodology.

Title: Optimality conditions for smooth programme using Nonsmooth functions.
Author(s): Prof. V. Vetrival
Affiliation(s): IIT Madras

Abstract: With suitable alternative theorem, we shall establish the necessary optimality conditions for nonlinear smooth programmes in a simpler way using some nonsmooth functions.

Title: Exploring Kernel Collaborative Learning for Multitasking: Advances at the Intersection of Kernel Methods, Collaborative Learning, Online Learning, and Multitasking
Author(s): Prof. Sumitra S.
Affiliation(s): Indian Institute of Space Science and Technology Thiruvananthapuram

Abstract: This talk explores “Kernel Collaborative Online Learning for Multitasking” an emerging research area at the intersection of kernel methods, collaborative learning, online learning, and multitasking. With the continuous growth of data in modern applications, scalable and efficient learning algorithms are becoming increasingly essential. Kernel collaborative learning offers promising solutions by leveraging kernel methods to capture intricate data patterns, collaborative learning to share information between related tasks, and online learning to adapt models to streaming data in multitasking environments. The discussion will elucidate-date the foundational concepts, methodologies, and practical applications of kernel collaborative learning for multitasking, highlighting its potential impact across various domains and inspiring future innovations in machine learning research and practice.

Title: SEMI-NEWTON METHOD IN DIFFERENCE PROGRAMMING
Author(s): Prof. Boris Mordukhovich
Affiliation(s): Wayn State University USA

Abstract: This talk addresses the study of a new class of nonsmooth optimization problems, where the objective is represented as a difference of two generally nonconvex functions. We propose and develop a novel Newton-type algorithm to solving such problems, which is based on the coderivative generated second-order subdifferential (generalized Hessian) and employs advanced tools of variational analysis. Well-posedness properties of the proposed algorithm are derived under fairly general requirements, while constructive convergence rates are established by using additional assumptions including the Kurdyka-Lojasiewicz condition. We provide applications of the main algorithm to solving a general class of nonsmooth nonconvex problems of structured optimization that encompasses, in particular, optimization problems with explicit constraints. Finally, applications and numerical experiments are given for solving practical problems that arise in biochemical models, constrained quadratic programming, etc., where advantages of our algorithms are demonstrated in comparison with some known techniques and results.

Title: Fuzzy Rough Missing Value Imputed Feature Selection

Author(s): Prof. T Som[1], Pankhuri Jain[2] and Anoop K Tiwari[3]

Affiliation(s): [1,2]Indian Institute of Technology (BHU) Varanasi, [3]Central University of Haryana, Mahendragarh

Abstract: Presence of missing values and irrelevant features are common place issue that need to be handled effectively. Missing value imputation and feature selection is an efficient technique for redressing such problems. Fuzzy rough set based approaches provide handful of solution for further dealing with vagueness and uncertainty present in the data. The present paper introduces the notion of imputing missing values followed by feature selection utilizing fuzzy rough set based approaches. The idea of missing value estimation and instance ignorance is combined for fuzzy rough missing value imputation employing only correlated features followed by feature selection with a search heuristic. The experimental evaluation on benchmark datasets demonstrates the applicability and robustness of the proposed work. It significantly reduces data dimensionality after imputing missing values maintaining high performances. A comparative analysis demonstrates the superiority of the proposed methodology.

Title: A shock-capturing meshless geometric conservation weighted least square method for solving shallow water equations.

Author(s): Prof. S. Sundar, D.Satyaprasad and Soumendra Nath Kuiry

Affiliation(s): Indian Institute of Technology Madras

Abstract: The shallow water equations are numerically solved to simulate free surface flows in two-dimension (2D). The convective flux term in the shallow water equations needs to be discretized using a Riemann solver to capture shocks and discontinuity for certain flow situations such as hydraulic jump, dam-break wave propagation, or bore wave propagation. The approximate Riemann solver can capture shocks and is popular for studying open channel flow problems with the traditional mesh based methods. However, meshless methods can work on structured and unstructured grids and even for points irregularly distributed over a computational domain. Moreover, approximate Riemann solvers is not reported to be implemented within the framework of meshless methods for solving the shallow water equations. Therefore, we have proposed a numerical method, namely, a shock-capturing meshless solver for the shallow water equations for simulating 2D flows on a highly variable topography even in presence of shocks and discontinuity.

The HLL (Harten-Lax-Van Leer) Riemann solver in the proposed meshless method is used to evaluate convective flux. The spatial derivatives in the shallow water equations and the reconstruction of conservative variables to calculate flux terms are computed using a geometric conservation weighted least square (GC-WLS) approximation. The proposed meshless method is tested for a range of numerically challenging problems and laboratory experiments.

Title: QUASIOPTIMAL CONVERGENT ADAPTIVE FEM FOR AN INDEFINITE ELLIPTIC PDE

Author(s): Arnba Pal, Prof Thirupathi Gudi
Affiliation(s): IISc Banglore

Abstract: Adaptive finite element methods (AFEM) employ automatic local mesh refinement based on reliable and efficient a posteriori error bounds. These methods provide accurate and optimally convergent numerical solutions even when the solution does not have full regularity. In this talk, we discuss the convergence and quasi-optimal rate of convergence of an adaptive finite element method(AFEM) for a general second-order non-selfadjoint elliptic PDE:

$$-\nabla \cdot (A\nabla u) + b \cdot \nabla u + cu = f, \text{in } \Omega$$
$$u = 0, \text{on } \partial\Omega$$

with convection term $b \in [L^{\infty}(\Omega)]^d$ and using minimal regularity of the dual problem i.e. the solution of the dual problem has only H^1 regularity. The PDE is assumed to satisfy a Garding type inequality and thereby requires subtle arguments when the convective term is only an L^{∞} function. The results derived here extends the result of J. M. Cascon, C. Kreuzer, R. H. Nochetto and K. G. Siebert, SIAM J. Numer. Anal., 46:2524-2550, 2008. The theoretical results are illustrated by numerical experiments.

ABSTRACTS
Contributory Talks

ID: OT01
Title: Enhanced Indexing Portfolio Optimization based on Prospect Theory with Expectile
Author(s): Divyanee Garg, Aparna Mehra
Affiliation(s): Indian Institute of Technology, Delhi

Abstract: News and observations regarding both domestic and international markets impact and shape the cognitive processing processes of investors. Incorporating investor behavior into a model is difficult. An investor makes decisions based on the potential value of losses and gains; the gains and losses are perceived differently. We can introduce these human sentiments through the prospect theory utility function.
An expectile is a minimizer of the expectation of an asymmetric quadratic scoring function. The negative of the expectile, employed as a risk measure, is the expectile value at risk (EVaR). Its recent emergence in risk management has drawn attention for its coherent and elicitable property. Recently, the EVaR is explored as an alternative risk measure for value at risk (VaR) and conditional value at risk (CVaR). We introduce a portfolio optimization (PO) model using EVaR that outperforms a specified benchmark index and incorporates prospect utility functions to capture investor sentiments.
The Prospect theory introduces a natural nonlinear and non-differentiable structure induced by the prospect theory utility function in the model. We construct a model utilizing the EVaR risk metric to preserve risk in the portfolio that outperforms a benchmark index and captures investor sentiment. The model is non-convex and nonlinear, thereby imparting challenges in solving it. We use a heuristic solution approach (genetic algorithm) to solve it. We empirically analyze the proposed model on several global financial data sets and compare it with closely related models based on CVaR in a similar setting.

ID: AP01
Title: Computational Cardiology :Forecasting Heart diseases with Neural Networks
Author(s): Sayyed Afnan, Saket Tabhane
Affiliation(s): Government College of Engineering Nagpur

Abstract: One of the most life-threatening diseases is cardiovascular diseases. A very large number of people are affected by cardiovascular disease, and death rates of such diseases are very high. This shows the importance of early detection and diagnosis of such diseases. Today, the technologies of data science and deep learning have developed such that they have a wide variety of applications. One of the major applications of data science and deep learning methods is in the field of biomedical engineering to predict cardiovascular diseases at an early stage. The main objective of this paper is to predict cardiovascular diseases at an early stage using deep learning techniques such as artificial neural networks. Another objective of this research is to generate meaningful insights from the data that can help in further diagnosis. This paper uses the Cardiovascular Disease dataset which is accessed from Kaggle. This dataset consists of 70000 records of patient data, 11 clinical features, and a target.

ID: DS02
Title: Multi-output deep FOSLS neural network for solving phase-field model governed by the Allen–Cahn equation
Author(s): Anjali Singh and Rajen Kumar Sinha
Affiliation(s): Indian Institute of Technology Guwahati

Abstract: The Allen-Cahn equation is a fundamental partial differential equation that describes phase separation and interface motion in materials science, physics, and various other scientific domains. The presence of a small parameter $\epsilon > 0$ (interfacial width) between two stable phases and the

nonlinear term makes the problem challenging to solve as ϵ approaches zero. The Allen-Cahn equation also satisfies the energy dissipation property. So it is essential to understand the physical significance of each term. In this work, we utilize feed-forward neural networks to approximate solutions and their scaled gradients of the Allen–Cahn equation. A first-order system least-squares (FOSLS) formulation is used to split the problem into a first-order system and then the converted minimization problem is approximated by using a deep learning approach. This approach helps us in dealing with the difficulty which arises due to the small parameter ϵ. As the phase separation process proceeds over time, the interfaces evolve, making the neural network difficult to approximate the solution and its gradients accurately. To overcome this difficulty, instead of approximating the problem in the large time interval, we divide it into a finite number of time segments and approximate both the solution and its gradients over each time segment. The solution found in the previous time segment is used as the initial condition for the current time segment. A novel transfer learning is incorporated by training the network into successive time segments to improve the accuracy and efficiency of the network. The present approach not only provides a direct approximation of the solution but its gradient as well. Numerical results for one, two, and three space dimensions are presented, and the energy law, an essential property of the Allen–Cahn equations, is also verified.

ID: OT11
Title: Multi-objective interval-valued optimization problems: A parametric approach
Author(s): Ajeet Kumar, Anurag Jayswal
Affiliation(s): Indian Institute of Technology (Indian School of Mines), Dhanbad

Abstract: In the present study, we consider the vector optimization problem with interval-valued objective and constraint functions and derived a minimal criteria of optimality for a feasible point of the primal problem to be an efficient point. Further, we formulate a dual model in Mond-Weir sense and prove several duality results which show relations between the solution of the primal and dual programs. In addition, counter-examples are also provided in order to justify the established results.

ID: NA07
Title: Efficient Finite Element Computations of Mechanical Fatigue through a Combination of Initial Stiffness and Localizing Gradient Damage
Author(s): Sandipan Baruah, Indra Vir Singh
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: An efficient computational strategy for simulating mechanical fatigue behaviour is investigated in the present work through a combination of initial stiffness and localizing gradient damage, implemented using finite element analysis. The standard computational technique of localizing gradient damage evaluates the elemental stiffness matrices in every Newton-Raphson iteration. The elemental matrices are assembled to form the global stiffness matrix in every iteration for all simulated fatigue-cycles, which increases the computational burden. In the present work, an initial stiffness method is utilized with localizing gradient damage so that the computation and assembly of stiffness matrices has to be performed only once during a load-step. This strategy increases the number of iterations needed for convergence. However, the time needed for all iterative calculations within a load-step decreases, thereby making the strategy efficient by reducing the overall computational time. The strategy is tested on two example problems of high-cycle mechanical fatigue, and it is observed that RAM and CPU usage is lesser than the original method of simulation. Furthermore, the overall computational time also reduces by 15-20% percent, while maintaining a reasonable accuracy of the simulations.

ID: DS04

Title: ON THE COMPUTATIONAL ASPECTS OF OSCILLATORY AND NON OSCILLATORY ACTIVATION FUNCTIONS FOR OPTIMIZATION IN DEEP LEARNING

Author(s): Linu Pinto

Affiliation(s): Cochin University of Science and Technology, Cochin-22

Abstract: Deep learning models are a type of machine learning models used in the field of AI to analyse large volumes of data for pattern recognition, prediction, classification, and natural language processing problems. These models make decisions through self-learning strategies. Mathematical optimization is an important branch of computational mathematics that helps deep learning models optimally identify the best suitable function for better decision-making on the problem. AI models based on deep learning are extensively used nowadays to analyse any complicated problems. Due to the size and complexity of the data, there is a high demand for more advanced optimization algorithms in the field of computational mathematics. Deep learning models are built on specific structures called computational units. To bring nonlinearity to the optimization function, these computational units are activated with a function called activation function. The ability of the model to identify complex patterns in the data is highly dependent on the activation functions designed for the models. The proposed work investigates the computational aspects of various oscillatory and non-oscillatory activation functions and their impact on the convergence of optimization algorithms used in Deep Learning. Analysis on the computational aspects of various activation functions helps the machine learning practitioners to suitably design the deep learning models for better performance accuracy.

ID: NA14

Title: Impact of Induced Magnetic Field in Thermophoretic Bioconvection under Convective Boundary Condition and non-Uniform Heat Source

Author(s): Rakesh Choudhary

Affiliation(s): Bhartiya Skill Development University Jaipur

Abstract: The current study deals with the effects of induced magnetic fields in thermophoretic bioconvection under convective boundary conditions and non-uniform heat source past a stretching vertical plate. Coupled partial differential equations are reduced into nonlinear ordinary differential equations using similarity transformation. The Runge-Kutta Fehlberg method with the shooting technique is used to solve these systems of differential equations with suitable boundary conditions. Improved mass transfer is one of the benefits of adding motile microorganisms to the solution, promoting microscale mixing, particularly in microvolumes, and upgrading nanofluid stability. Essential results such as the density of microorganisms increase for induced magnetic field parameters, and other important results obtained for velocity profile, temperature profile, concentration profile, and motile microorganism profile have been evaluated through graphs and tables.

ID: AP03

Title: A Comparative Study on Training Performance of Linear and Tree based Regression for Blood Pressure Prediction

Author(s): Manas Saha[1], B. N. Chatterji[2]

Affiliation(s): [1]Siliguri Institute of Technology, Siliguri, [2]B. P. Poddar Institute of Management and Technology, Kolkata

Abstract: Every year a large number of people die of high blood pressure. Researchers predict blood pressure using different machine learning algorithms. Two very popular machine learning algorithms are linear regression and tree based regression. The four and three variants of linear and tree

regression models are linear, interaction linear, robust, stepwise linear and fine, medium, coarse tree respectively. This work demonstrates a comprehensive cum comparative study of the linear and tree based regression models for predicting blood pressure. It is also experimentally found that stepwise linear and medium tree regression are the best variants of linear and tree based regression models. When compared stepwise linear regression model outperforms medium tree regression for blood pressure prediction. The other aspect of the work is the improvement of training performance of the stepwise linear regression model using feature ranking algorithms-MRMR and F Test algorithms. Using MRMR algorithm, the stepwise regression model predicts blood pressure with 90% accuracy which is better than contemporary results obtained from Naïve Bayes Theorem, Simple Logistic Regression, J48 algorithm and Random Forest. In the future, batch optimization training consisting of all variants of a regression model could be implemented to save training and prediction time.

ID: NA35

Title: Numerical Investigation of Imprecisely Defined Static Structural Problem using Interval Type 2 Fuzzy Finite Element Method

Author(s): Paresh Kumar Panigrahi, Sukanta Nayak

Affiliation(s): VIT-AP University, Amaravati, Andhra-Pradesh

Abstract: Over the past few decades, it is seen that the finite element method is an effective tool to investigate various structural engineering problems. However, the major significant associated effects of strain and stress due to the structural rearrangement and physical characteristics of materials may be uncertain. Therefore, this paper investigates the uncertain analysis and study of physical field variables defined with structural problems using interval type 2 fuzzy finite element method. To address these exclusive features, the interval type 2 fuzzy finite element method (IT2FEM) is incorporated to discretize the domain and transform the governing differential equation into algebraic equation. Then, we propose a technique to solve the obtained interval type 2 fuzzy system of equations. The parametric form of the interval type 2 triangular fuzzy number (IT2TFN) is introduced to estimate the field variables that are affected by uncertain parameters.

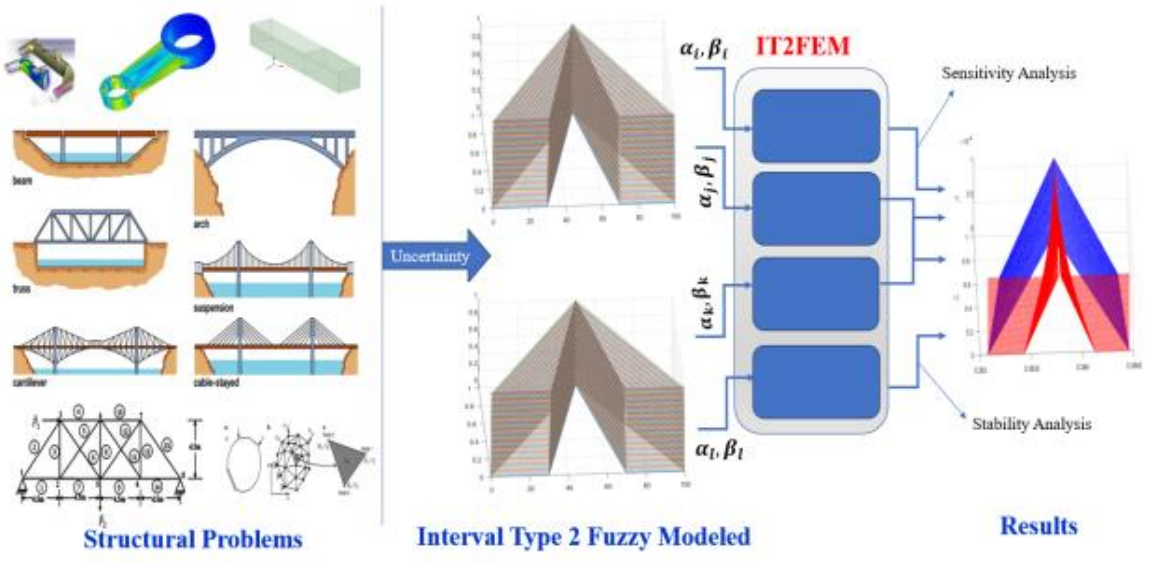

Fig. 1. The Graphical abstract of uncertain structural problem.

Then, the same approach is used to solve the modeled interval type 2 fuzzy structural problem. In addition, with the help of α-cut, we transformed the interval type 2 fuzzy system into a crisp system. Furthermore, two possible cases were considered to solve the system. Using the proposed approach, those two cases were analyzed to quantify the uncertainty and discuss the stability analysis of the

system. Fig. 1 illustrates the uncertain modeling of a structural problem using interval type 2 fuzzy finite element analysis. Subsequently, the static response of the uncertain structural problems and their sensitivity analysis are presented. Finally, the results are shown here to understand the significant differences and uncertain analysis of structures in different cases. Comparisons were made to validate the proposed technique.

ID: DS20

Title: Non-Probabilistic Approach to Study the Uncertain Spectrum of Field Variables in a Triangular Porous Cavity

Author(s): Sudipta Priyadarshini, Sukanta Nayak

Affiliation(s): VIT-AP University, Amaravati, Andhra-Pradesh

Abstract: In recent developments, many industrial and scientific problems have contained epistemic uncertainties. These uncertainties arise due to imprecise parameters, boundary conditions, material properties, etc. Consequently, the governing equations of the system become uncertain. In practice, solving crisp coupled Partial Differential Equations (PDEs) is challenging, and with epistemic uncertainties, it becomes even more so. In this investigation, we have employed fuzzy set theory to address the impreciseness. Therefore, the main objective is to develop a method that simplifies the process and computation. With the help of the Fuzzy Finite Element Method (FFEM), the uncertain involved PDEs are converted into algebraic equations, and the same has been solved through the Gauss–Seidel iterative method. Then, the proposed approach is analyzed, and convergence is established. To observe the variation in field variables, errors of 5% and 8% in the Rayleigh number (Ra) are considered.

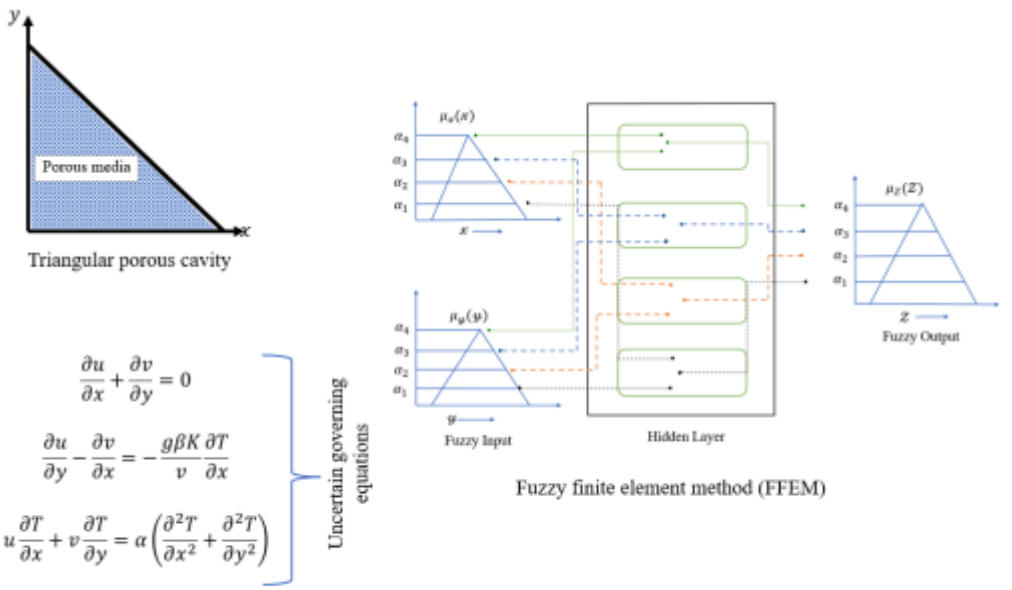

Fig. 1 Graphical presentation of the proposed approach

Then, the sensitivity of these involved uncertain parameters and their uncertain analysis are discussed. This approach can be utilized effectively in various science and engineering problems, such as fluid flow in porous medium, mechanics, geoscience, and structural dynamical problems, etc. Fig. 1 illustrates the architecture of the proposed approach.

ID: NA02

Title: ALTERNATING DIRECTION IMPLICIT APPROACH FOR THE TWO-DIMENSIONAL TIME FRACTIONAL NONLINEAR KLEIN-GORDON AND SINE-GORDON PROBLEMS

Author(s): Sarita Kumari, Rajesh K. Pandey

Affiliation(s): Indian Institute of Technology (BHU) Varanasi

Abstract: The aim of this article is to establish a numerical scheme to achieve the theoretical accuracy near the weak singularity at $t = 0$ in solving the two-dimensional time-fractional nonlinear mixed diffusion-wave equation (TFNMDWE). The governing problem involves diffusion term with time-fractional Caputo derivative (TFCD) of order $\alpha(0 < \alpha < 1)$, and wave term with TFCD of order $\beta(1 < \beta < 2)$. To handle the singularity at $t = 0$, we use linearized $L1$ method to discretize both the TFCDs on nonuniform time meshes. By using the nonuniform$L1$ method to approximate TFCD and central difference operator for the space derivative approximation, the considered problem is converted to an equivalent system of equations. Then, we use the Alternating Direction Implicit (ADI) approach to develop a numerical scheme for solving the resulting system of coupled equations. Further, we prove stability analysis of the scheme. Numerical examples are given for one-dimensional (1D) and two-dimensional (2D) TFNMDWEs with smooth and non-smooth exact solutions to describe the accuracy of numerical scheme. The illustrated examples confirm that the scheme has second-order accuracy in space, and order of convergence (OC) in time direction is $min\big(2-\alpha, 3-\beta, \gamma\alpha, \gamma(\beta-1)\big)$, where γ is the mesh grading parameter used in construction of the nonuniform meshes. The corresponding absolute error is plotted to see the advantage of nonuniform time meshes at the initial singularity $t = 0$.

ID: DS11

Title: A comparative study of encrypted coloured images using an interference method in the Gyrator & Fourier domain

Author(s): Sakshi Arora, Nupur Prakash, and Hukum Singh

Affiliation(s): The NorthCap University

Abstract: This research paper conducts a comprehensive comparative study of coloured images encrypted using the interference method in the gyrator and Fourier domain. The study thoroughly analyses traditional matrices, including Mean Squared Error (MSE), Structural Similarity Index (SSIM), and graphical analysis. The focus lies in the meticulous exploration of silhouette effects inherent in the encryption process, emphasizing the security of images without explicitly resolving silhouette concerns. The research methodology involves a detailed comparison of encryption outcomes in both Fourier and Gyrator domains elucidating the relative strengths and limitations of each approach.

The findings of the study contribute to a broader understanding of optical image encryption techniques and the efficacy of interference methods. Moreover, the research highlights that the Gyrator domain, with its rotational sensitivity and enhanced security measures, emerges as a promising technique for secure optical image encryption of coloured images.

ID: OT26

Title: Optimized adaptive meshes using Modified Particle Swarm Optimization algorithm for Singularly Perturbed Problems

Author(s): Aneesh Panchal, Vivek Kumar

Affiliation(s): Delhi Technological University, Delhi

Abstract: This paper aims to contribute to the domain of numerical computations and error minimization of convection-dominated singularly perturbed problems. Non-uniform meshes are required to solve these problems to minimize the error due to 2nd order finite difference schemes.

Hence, the proposed approach to create such a mesh is based on the particle swarm optimization algorithm, which is a metaheuristic technique involving specific adaptation parameters to identify layer positions inside the domain. The robustness of the proposed method lies in its ability to not require any initialization of the number of points. The particle swarm algorithm dynamically generates the mapping parameters required for mesh allocation. Numerical solutions to various test problems, including both linear and nonlinear ones, are performed and compared with existing Ajeet Singh methods, showcasing superior performance. This research not only significantly contributes to the existing body of knowledge but also addresses a critical gap in the literature by merging metaheuristic algorithms with the challenges of singularly perturbed problems, opening avenues for further exploration and application in related domains.

ID: OT09
Title: Optimality conditions for semi-infinite equilibrium problems via tangential subdifferentials
Author(s): Mahamad Sohil Arora, Indira P. Tripathi
Affiliation(s): Sardar Vallabhbhai National Institute of Technology, Surat

Abstract: In this paper, we have considered semi-infinite equilibrium problems (SEP). In order to find the Karush-Kuhn-Tucker (KKT) necessary optimality conditions, the Abadie constraint qualifications and tangential subdifferentials have been used. Also, we have derived sufficient conditions using pseudo and quasi convexity assumptions. Non-trivial examples have also been presented at suitable places to verify the results obtained in this paper.

ID: AP17
Title: A Priori Error Estimates of HHO Method for Semilinear Sobolev Equation on Polygonal Meshes
Author(s): Ajeet Singh[1], Hanz Martin Cheng[2], Naresh Kumar[3], Ram Jiwari[4]
Affiliation(s): [1,3,4]Indian Institute of Technology, Roorkee, [2]Lappeenranta–Lahti University of Technology, Lappeenranta

Abstract: In the present study, we design and analyze a hybrid high-order (HHO) method for a semilinear Sobolev equation on polygonal meshes. The HHO method offers distinct advantages over traditional approaches, demonstrating its capability to achieve higher-order accuracy while reducing the number of unknown coefficients. We derive error estimates for the semi-discrete formulation using HHO discretization. Subsequently, these convergence rates are employed in fully discretization with the Crank-Nicolson scheme. The method is demonstrated to converge optimally with orders $O(\tau^2 + h^{k+1})$of in the energy-type norm an $O(\tau^2 + h^{k+2})$in the L^2 norm. The reported method is supported by a series of computational tests, encompassing a linear model, a semilinear model, and an application of the AllenCahn equations.

ID: OT13
Title: Approximate solutions of multiobjective semi-infinite programming problems having vanishing constraints
Author(s): Bishal Biswas, Tamanna Yadav, Shiv Kumar Gupta
Affiliation(s): Indian Institute of Technology, Roorkee

Abstract: In this work, we introduce a model that addresses a multi-objective semi-infinite programming problem with vanishing constraints. By considering objective functions as well as constraint functions that are locally Lipschitz functions under the limiting constraint qualification, we obtain the approximate necessary and sufficient optimality criteria for our proposed model in terms of the (basic) subdifferential. Additionally, we develop approximate forms of Wolfe's and Mond-Weir dual for the proposed model and establish the approximate weak, strong, and converse duality

results for the proposed approximate dual models under the assumptions of pairwise generalized convexity. Furthermore, some non-trivial numerical examples have been provided at suitable places for the model to support the results.

ID: AP20
Title: Quantum Algorithm for data fitting of under-determined system
Author(s): Neeshu Rathi, Sanjeev Kumar
Affiliation(s): Indian Institute of Technology, Roorkee

Abstract: We propose a quantum algorithm for efficiently assessing the quality of a least squares fit for under-determined linear systems. The algorithm incor- porates a linear equation system solving method that is effective for solving under-determined systems. We also propose a procedure for determining the fit parameters and finding a succinct function that accurately represents the data to be fitted, with bounds on the approximation error. Our algorithm uses a modified version of the HHL method and recent advances in quantum simulation algorithms to carry out the matrix multiplications and inversions. The proposed algorithm has several advantages over classical algorithms, including efficient assessment of the quality of a least-squares fit for extremely large data sets and efficient parametric estimation of the quantum state when the input data consists of pure quantum states. Our work opens up new avenues for exploring the potential of quantum computing in solving real-world problems, including data analysis and machine learning.

ID: NA08
Title: Epsilon-Uniform Robust Analysis of Weak Galerkin Finite Element Method for Semi-linear Singularly Perturbed Parabolic Problems on Bakhvalov-type mesh
Author(s): Jasbir Singh[1], Naresh Kumar[2], Ram Jiwari[3], Narendra Singh Yadav[4]
Affiliation(s): [1, 2, 3]IIT Roorkee, [4]SRM University, Andhra Pradesh,

Abstract: In this present study, we analyse the ε-uniform convergence of a weak Galerkin finite element method (WG-FEM) employed to solve a parabolic semilinear singularly perturbed equation (PSL-SPPs) on a Bakhvalov-type mesh. This finite element technique utilizes piece-wise polynomials of degree k ≥ 1 within each element, and piece-wise constants at the nodes of each element. The presented fully-discrete approach here utilizes a combination of the WG-FEM and the Crank-Nicolson scheme for spatial and temporal discretization, respectively. A standard Lagrange interpolation with simple representation R is introduced on the problematic region, which is contained in the last interval of the fine part and adjacent to the coarse part of the mesh. The main result of this study reveals that the weak Galerkin solution on the Bakhvalov mesh maintains a parameter-robust error bound of $O\left(N^{-k}\right)$ in the spatial direction and second order of convergence in the temporal direction. The heoretical results have been validated through several numerical experiments.

ID: DS29
Title: A Study of Linear Alkanes Using Graceful and Biconditional Cordial Graph Labelings and Edge-Labeled Adjacency Matrices
Author(s): Paresh Andharia, Anjali Trivedi
Affiliation(s): M K Bhavnagar University, Bhavnaga

Abstract: Our research explores the graph-theoretic properties of linear alkanes, which are saturated hydrocarbons with the general formula C_nH_{2n+2}. We demonstrate that linear alkanes exhibit both graceful and biconditional cordial labelings. Additionally, we derive various graph-labeled topological indices from them. We also propose a novel method of constructing edge-labeled adjacency matrices from biconditional cordial labelings to compute their eigenvalues. Our work contributes to the fields

of graph theory, computational chemistry, and data science by providing new insights into the applications of graph labeling techniques for spectral graph theory.

ID: OT21
Title: E-fractional semi-infinite optimization model having equilibrium constraints
Author(s): Tamanna Yadav**,** S. K. Gupta
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: A semi-infinite optimization problem is characterized by an optimization model that involves a finite number of variables and an infinite number of constraints. This type of problem has garnered significant attention in research due to its distinctive structural characteristics and its wide-ranging applications in engineering, production, marketing, finance, and management. This work delves into a specific aspect of semi-infinite optimization, focusing on a non-smooth semi-infinite fractional model with equilibrium constraints.
The exploration begins with the derivation of E-necessary and E-sufficient optimality conditions for the optimization model, considering E-convexity assumptions. Furthermore, the Wolfe type dual model is formulated for the semi-infinite optimization problem and weak, strong, and converse duality results are established under the framework of E-convexity assumptions.
To illustrate and validate the findings presented in this work, numerical examples are provided at appropriate junctures. These examples serve to support and enhance the comprehension of the theoretical results derived in the context of the non-smooth fractional semi-infinite optimization model having equilibrium constraints.

ID: AP29
Title: Physics Informed Neural Networks for Predicting the Stability Number of Rubble-Mound Breakwaters
Author(s): Susmita Saha[1], Soumen De[2], Satyasaran Changdar[3]
Affiliation(s): [1, 2]UNIVERSITY OF CALCUTTA, [3]University of Copenhagen, Copenhagen

Abstract: Estimating the stability number of the armor block is a crucial aspect in the design and stability analysis of rubble-mound breakwaters. This study introduces an innovative methodology known as Physics Informed Neural Network (PINN) for estimating the stability number of rubble-mound breakwaters. An approach for amalgamating theoretical or physical models with deep neural network architectures is introduced, harnessing the strengths of both physics and data. This framework integrates the results from physics-based simulations and observational characteristics into a hybrid modelling configuration. Moreover, physics-based loss functions are incorporated into the learning objectives of these hybrid deep neural networks. It exhibit reduced errors on the training set and conform to the established physical relationships. The present study has effectively addressed the existing limitations in this field, achieving the utmost precision in estimating the stability number.

ID: OT17
Title: Fundamental arithmetic operations for interval-valued intuitionistic fuzzy values/sets with their applications in MCDM problem
Author(s): Manisha Malik[1], S. K. Gupta[2]
Affiliation(s): [1]UPES Dehradun, [2]Indian Institute of Technology Roorkee

Abstract: To deal with the inherent uncertainties and vagueness involved while solving various practical problems, the notion of fuzzy sets plays a vital role. Another significant development in this direction came up in the form of Atanassov's intuitionistic fuzzy sets which associates a non-membership degree along with a membership degree, to each element of the universal set. Taking a

step further, interval-valued intuitionistic fuzzy (IVIF) sets are more generalized quantities in this direction as they use intervals ($\subset [0,1]$) to define the membership and non-membership grades of each element of the set. However, the study is incomplete without defining basic arithmetic operations on the IVIF values/sets. This work contributes on two fronts: Firstly, it focuses on deriving generalized expressions for subtraction and division operations on IVIF values/sets, employing the concept of Hamming distance. After that, the fundamental properties and relationships associated with these operations are also examined extensively. In the second aspect, the discussion shifts to solving and analyzing a multi-criteria decision- making (MCDM) problem characterized by ambiguous or ill-defined input data. Decision-making problems are a prominent class of optimization problems in which one needs to choose the best alternative from a given set of feasible alternatives. However, uncertainty may creep into the input data of a realistic MCDM problem due to various uncontrollable factors such as recording errors, judgment errors, etc. Under such circumstances, representation of all the data of an MCDM problem in terms of IVIF values/numbers proves to be an efficient approach for handling the uncertainties. Consequently, in this work, an MCDM problem is solved under the IVIF environment and sensitivity analysis has been carried out using the proposed operations.

ID: OT05

Title: On Finiteness of the Solution Set of Extended Horizontal Linear Complementarity Problem

Author(s): Punit Kumar Yadav[1], K. Palpandi[2]

Affiliation(s): [1]Malaviya National Institute of Technology Jaipur, [2]National Institute of Technology Calicut

Abstract: Consider an ordered set of matrices $C := \{C_0, C_1, \ldots, C_k\} \subseteq R^{n\times n}$, vector $q \in R^n$ and ordered set of positive vectors $d := \{d_1, d_2, \ldots, d_{k-1}\} \subseteq R^n$. The *extended horizontal linear complementarity problem* (for short EHLCP), denoted by EHCLP(C, d, q), is to find a vector $x_0, x_1, \ldots, x_k \in R^n$ such that

$$C_0 x_0 = q + \sum_{i=1}^{k} C_i\, x_i,$$

$$x_0 \wedge x_1 = 0 \text{and } \left(d_j - x_j\right) \wedge x_{j+1} = 0, 1 \le j \le k-1.$$

In this paper, we first introduce Column Nondegenerate-W property for the set of matrices which is a generalization of nondegenerate matrix and the column-nondegenerate property for a pair of square matrices. We then prove the compactness of solution set for the EHLCP when the involved matrices have this property. As the main result, we proved that the involved set of matrices have the column nondegenerate-W property is equivalent to the corresponding EHLCP have the finiteness property of the solution set. In addition, we prove some equivalent conditions for the column nondegenerate-W property.

ID: AP21

Title: A Novel 3D Chaotic Map-Based Quantum Image Encryption Algorithm

Author(s): Vivek Verma, Sanjeev Kumar

Affiliation(s): Indian Institute of Technology Roorkee

Abstract: The advent of quantum computers could enable the resolution of complex computational problems that conventional cryptographic protocols find challenging. As a result, the formidable computing capabilities of quantum computers may render all present-day cryptographic schemes that rely on computational complexity ineffectual. Inspired by these possibilities, in this research, we have developed a quantum image encryption algorithm that introduces a novel 3-dimensional chaotic map, demonstrating superior performance in terms of randomness and key space when benchmarked against existing chaotic maps. Our algorithm commences by encoding a square grayscale image into the Novel Enhanced Quantum Image (NEQR) format. To diminish pixel

correlation, we apply a 2-dimensional non-uniform generalized Arnold transformation for initial scrambling. Subsequently, the algorithm leverages chaotic sequences derived from our proposed chaotic map to perform controlled DNA encoding, effectively obfuscating the grayscale information of the scrambled image. To further augment randomness, the image undergoes two bit-level scrambling procedures: bit-level swap operations and quantum cyclic XOR-shift operations. The final cipher image is produced by employing quantum XOR operations with pseudo-random sequences generated by the proposed 3D chaotic map. Our encryption algorithm capitalizes on the computational efficiency of fundamental quantum gates, such as the Controlled-NOT gate, modular adder (ADDER-Modulo 2^n), and the SWAP gate. Both theoretical and numerical simulation analyses affirm that our algorithm holds significant promise for image encryption applications on quantum computers, offering a substantial advancement in the field of quantum cryptography.

ID: AP19
Title: Authenticable quantum secret sharing scheme based on generalized unitary operators
Author(s): Deepa Rathi, Sanjeev Kumar
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: This work introduces an authenticable (t, m) threshold multi-dimensional quantum secret sharing (QSS) scheme. The scheme is founded on generalized unitary operators and the Bell state. In this approach, the dealer shares both classical and quantum secrets. The dealer generates a Bell state and transmits the first particle to the participants, then t out of m participants perform the unitary operations on the Bell state's first particle. The dealer can detect any dishonest behavior from a participant through the use of a generalized Bell state. After verifying any eavesdropping and dishonest participant, the dealer transforms a unitary operation on the second particle of the Bell state and sends it to the participant to regenerate the secret. The participants combine the particles and regenerate the secret. The security analysis illustrates that the protocol is capable of withstanding intercept-resend, entangle-measure, and participant attacks, including denial, forgery, and collusive attacks. The effectiveness of the scheme is assessed by evaluating quantum fidelity under various noise models. The protocol demonstrates reliability in detecting dishonest participants and negating any eavesdropping. The proposed work exhibits greater adaptability, effectiveness, and practicality compared to the pertinent quantum secret-sharing schemes.

ID: OT24
Title: Multi-Objective Optimization of Mathematical Models with Multi-population Strategy: A Case Study in Soil-Water Flow Parameter Estimation
Author(s): Anoop Pandey, Nirali Vashishth, Richa Ojha
Affiliation(s): Indian Institute of Technology, Kanpur

Abstract: Genetic algorithms (GAs) are commonly used to find solutions to complex optimization and search problems. The choice between single and multi-objective function depends on the nature of the optimization problem. For non-linear optimization problems, most of the time multi-objective GAs are used. In the present study, a case study on the parameters estimation of dual porosity model has been performed with multi-objective function involving daily soil moisture and 7-day average soil moisture. The results have been compared with the single objective optimization techniques and it has been found that optimizing with several objectives leads a faster convergence rather than single objective optimization. Among two selection method in case of multi-objective optimization, pareto front of the NSGA-2 selection-based optimization was observed to be closely packed, forming clusters in a wider range, while the Pareto front of the Tournament Selection-based optimization was found to be spread across a broader range, indicating a diversity of solutions with varying trade-offs. The results obtained using this whole analysis suggest the use of NSGA-2 selection with multi-population

strategy for multi- objective optimization. The talk will also discuss the optimization results reporting technique in such evolutionary algorithm techniques.

ID: AP32
Title: A PINNs Algorithm for Parameters Estimation with Applications in Post-Surgery Rehabilitation Evaluation
Author(s): Sumit Kumar Vishwakarma, Sanjeev Kumar
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: Differential equation models serve as valuable tools for studying the intricate dynamics exhibited by bio-mechanical systems. The parameters within these models possess scientific significance, yet their values remain unknown and require estimation using noisy observed data from the system. This study aims to perform parameter estimation for the differential equation model which describes the movement of mimetic muscles in individuals with facial paresis resulting from surgical complications. A second-order ordinary differential equation is utilized to model the oscillation of facial muscles in patients undergoing rehabilitation for facial paralysis after the surgical procedures around head and neck area. The movement of various points on the face is recorded during specific set of exercises involving facial muscles using Kinect sensor camera, various indicators are calculated based the facial movement during the exercise. The method follows a two-step approach; the first step involves smoothing the observed noisy data (indicators) using the basis function, the second step involves the parameter estimation of the model form the smooth indicators using a recently developed scientific machine-learning method called PINNs. Physics-informed neural networks (PINNs) is a class of machine learning techniques that integrate physical laws into neural networks for solving forward and inverse problems. The results indicate that the parameter values exhibit consistency with minimal fluctuation among the majority of patients with identical degrees of paralysis, as assessed by clinicians using the House-Brackmann (HB) scale. On the other hand, patients with varying levels of paralysis show considerably greater discrepancies in the model parameters. This observation could contribute to a deeper comprehension of how mimetic muscle oscillation varies among individuals experiencing different degree of paralysis.

ID: NA09
Title: Towards Robust Electrolyte Modeling: A Conforming Finite Element Approach
Author(s): Ankur
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: Electrolytes play a crucial role in facilitating ion transfer between electrodes within batteries. Understanding their behavior is essential for optimizing battery performance. This study investigates electrolyte dynamics by incorporating a thermodynamically consistent coupling between mechanics and diffusion. By reformulating the resulting equations using dimensionless parameters, we employ finite element methods to simulate electrolyte behavior across one, two, and three-dimensional scenarios. Numerical simulations explore a range of influential factors, including temperature and bulk modulus. Our approach marks a significant advancement in electrolyte modeling, offering insights into ion transport dynamics crucial for battery design.

ID: NA13
Title: A Hypersingular Integral Equation Approach to Study the Effect of Edge Conditions on the Motion of a Submerged Disc
Author(s): Tapas Mal[1], Souvik Kundu[2], Sourav Gupta[3]
Affiliation(s): [1,3]Sardar Vallabhbhai National Institute of Technology (SVNIT), [2]Amity University, Kolkata

Abstract: The importance of studying the motion of a structure in wave structure interaction problems for different edge conditions increased in recent times due to their huge application in coastal regions. The edge conditions of a floating or submerged structure play a significant role in understanding the motion of a structure in a fluid environment.
A brief literature related to this study is given here. The effect of different edge conditions of a floating elastic plate on the hydrodynamic characteristic was investigated by Sahoo et al. [1]. Selvan and Behera [2] examined the energy dissipation by a floating circular flexible porous membrane in both single and double-layer fluid for three different edge conditions, such as (i) free edge, (ii) moored edge, and (iii) clamped edge. The significance of different edge conditions in real-world applications can be found in Kamble and Patil [3], Cheng et al. [4], Duncan [5].
In the context of linear water waves theory, the motion of a disc horizontally submerged in deep water is investigated for various edge conditions in the present study. Free edge, simply supported edge, and clamped edge are three different edge conditions that are taken into consideration. The governing boundary value problem (BVP) has been solved using the hypersingular integral equation approach. From the given boundary value problem, a two-dimensional hypersingular integral equation has been developed. The two-dimensional integral equation is then transformed into a one-dimensional Fredholm integral equation of the second kind using Fourier series expansions. Finally, the Nystrom technique based on Gauss-Legendre quadrature nodes is used to solve the one-dimensional integral problem numerically.
The physical quantities such as added mass and damping coefficient are computed for different physical parameters and depicted for different edge conditions mentioned above. This analysis may help engineers and scientists to understand the impact of edge conditions on the hydrodynamic quantities related to the problems of wave interactions with submerged horizontal structures.

Reference:

1. T Sahoo, T L Yip, and A T Chwang. Scattering of surface waves by a semi-infinite floating elastic plate. Physics of Fluids, 13(11):3215–3222, 2001.
2. S A Selvan and H Behera. Wave energy dissipation by a floating circular flexible porous membrane in single and two-layer fluids. Ocean Engineering, 206:107374, 2020.
3. R Kamble and D Patil. Artificial floating island: Solution to river water pollution in india. Case study: Rivers in pune city. In Proceedings of the International Conference on Environmental, Biomedical and Biotechnology, Dubai, UAE, pages 136–140. Citeseer, 2012.
4. L H Cheng, C Y Fen, Y H Li, and W Y Jiang. Experimental study on a new type floating breakwater. In Proceedings of the 7th International Conference on Asian and Pacific Coasts (APAC 2013) Bali, Indonesia, 2013.
5. O D Duncan. Introduction to structural equation models. Elsevier, 2014

ID: DS31

Title: Intuitionistic fuzzy twin proximal SVM with fuzzy hyperplane and its application in EEG signal classification

Author(s): Yash Arora, S.K. Gupta
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: The Twin Support Vector Machine (TSVM) is a contemporary machine learning technique used to address classification and regression problems. However, TSVM has limitations in distinguishing between support vectors and noises due to its neglect of positional information of input data samples, making it sensitive to noises. Additionally, it fails to account for uncertainties associated with the data, thereby reducing its capacity for generalization. To overcome these shortcomings, we propose a novel approach: the fuzzy hyperplane-based Intuitionistic Fuzzy Twin Proximal Support Vector Machine. The proposed approach introduces an intuitionistic fuzzy number

based on the relevance to each data vector. This efficiently reduces the impact of noise and outliers by incorporating membership and non-membership weights, leveraging local neighborhood information within the data points. Furthermore, all parameters in the model, including the offset term and elements of the normal vector, are treated as fuzzy variables. This allows the suggested fuzzy hyperplane to successfully reflect the inherent ambiguity prevalent in real-world categorization problems through the use of fuzzy variables. The efficiency of the model is enhanced by solving two systems of linear equations to obtain two non-parallel classifiers instead of solving two quadratic programming problems as in standard TSVM. Additionally, the utilization of non-linear kernel functions within the feature space enables the method to effectively identify complex patterns or non-linear relationships within the datasets. To demonstrate the effectiveness of the proposed approach, extensive computer experiments have been conducted on a set of fourteen UCI benchmark datasets with both linear and non-linear kernels. Rigorous statistical analysis, including Friedman and post-hoc Nemenyi tests, has been employed to assess the significance of the observed performance differences. Furthermore, numerical experiments utilizing linear, Gaussian, and polynomial kernels to classify electroencephalogram (EEG) signals have been performed. The outcomes of the experiment are analyzed in terms of average accuracy, processing time, and F-measure, demonstrating that the proposed method outperforms existing methods and achieves better generalization.

ID: AP02
Title: Disease diagnosis in plants based on Deep learning
Author(s): Sarthak Kumar
Affiliation(s): Roorkee Institute of Technology Roorkee

Abstract: The agricultural industry is vital to the world's food supply, and the health of crops plays a crucial role in supporting this critical sector. Early and precise identification of plant diseases is essential to optimizing crop productivity and effectively managing illnesses. Plant disease detection has become more accurate and automated with deep learning techniques in recent years. Plant disease identification and classification using deep learning algorithms is the subject of a thorough investigation presented in this research article. Convolutional Neural Networks (CNNs) are utilized in the suggested approach to extract detailed characteristics from high-resolution photographs of the leaves of potato plants. This allows the model to identify minute patterns that correspond to the illnesses late blight and early blight. The experiment outcomes show how well the deep learning method works to diagnose diseases in various plant species with excellent sensitivity and accuracy. By using visualization approaches, the model becomes easier to understand and highlights the key characteristics that go into classifying diseases. By offering a scalable and flexible method for early disease identification, the research advances existing efforts in precision agriculture. It opens the door for prompt intervention and successful disease management techniques. Future research will focus on tackling issues related to real-time deployment in field settings, broadening the dataset, and investigating different deep learning architectures.

ID: OT18
Title: Developing a TOPSIS algorithm for Q-rung orthopair Z- numbers with applications in decision-making
Author(s): Manish Kumar[1], S.K. Gupta[2]
Affiliation(s): [1]Maharaj Singh College, Saharanpur, [2]Indian Institute of Technology Roorkee

Abstract: No decision can be made without first considering the decision-making process. Multi-criteria decision-making (MCDM) seeks to identify the optimal alternative by considering multiple criteria during the selection process. Numerous tools and techniques from MCDM can be used in a

variety of sectors, including engineering design and finance. Recently, because of the generalization ability and flexibility of Q-rung orthopair fuzzy sets (Q-ROFS), it has been used widely to solve MCDM problems. However, under uncertainty, evaluating an alternative in the form of Q-ROFS with full reliability is not always possible. Therefore, in this work, we have introduced the notion of Q-rung orthopair Z-numbers (Q-ROZN), in which the reliabilities of an evaluated Q-ROFS have also been considered to make decision-making more comprehensive regarding the uncertainty. Further, arithmetic operations on these Z-numbers have been introduced. Moreover, a series of dice similarity measures have been defined for Q-ROZN. To solve the MCDM problems, a TOPSIS method based on these distance measures has also been discussed. Further, an application of the proposed method has been studied to solve an industrial problem. Furthermore, a sensitivity analysis of the involved parameters has been done to illustrate the stability and efficiency of the proposed approach. Finally, a case study was conducted to investigate healthcare resource allocation using the proposed Q-ROZN technique, accompanied by a comparative analysis to establish its validity and superiority, demonstrating that it enhances decision-making by offering greater freedom in assessing the reliabilities of evaluated Q-ROFS.

ID: OT07
Title: Slack-based Inverse Data Envelopment Analysis Models for Merging Units with Interval Data
Author(s): Anjali Naik, Aparna Mehra
Affiliation(s): IIT Delhi

Abstract: The paper proposed non-radial slack-based measure (SBM) models for the inverse data envelopment analysis (InvDEA) when dealing with data involving uncertainty represented by interval values. The models are specifically developed to ascertain the optimal inputs or outputs for the merged decision-making unit (DMU) to attain its desired efficiency level.
The optimistic approach is employed to establish the input interval for the merged DMU, when the outputs of the merging units are combined by summing their respective outputs, and a certain target efficiency is defined. In addition, the pessimistic perspective is employed to identify the range of outputs for the merged unit, where the inputs are the cumulative inputs inherited from the merging units, and a specified efficiency objective is established.
Younesi et al. proposed a novel inverse DEA model based on SBM, specifically designed to handle integer and continuous interval data. These models expand the use of inverse DEA to other forms of data and efficiency objectives, offering decision-makers a wider range of choices for assessing possible mergers and acquisitions.
Ghobadi formulated inverse DEA models for estimating inputs and outputs in merging units with interval data. The model applied the radial DEA model (BCC). However, the radial model sometimes misleads the decision-making; hence, there is a need to define a model using the non-radial approach. In this article, we propose slack-based inverse DEA models using an optimistic and pessimistic approach to determine the input and output levels of merged DMUs. The benefits of the SBM InvDEA models are recognized. The suggested models are implemented in a practical scenario of a few public sector banks in India witnessed a merger in 2017 with one of the largest banks in India.

ID: DS07
Title: Strategies to curb attrition in Airline Industry using Analytics
Author(s): Dhruv Chowdary
Affiliation(s): Indian Institute of Management Kashipur

Abstract: The study aims to establish a quantitative demonstration of the causal relationship between ticket prices and consumer churn in the airline industry and enhance the pricing model by introducing transparency and emphasizing the key factors that contribute to both the escalation and reduction

of prices. The study uses two models to comprehend and optimize the complex interactions between customer turnover and price. The study's first model employs a Decision Tree Classifier to disentangle the intricate network of variables causing customer churn in the airline industry, while the second model employs Regression Analysis to build an optimization model for pricing to complement the first model and incorporates findings from previous research to promote consistency, openness, and effectiveness. The research findings suggest that while ticket prices impact consumer churn, they are not the sole determining factor. The study also highlights the significance of transparency in pricing models and the need to align pricing strategies with customer expectations and industry competitiveness. The approach aims to enhance the number of promoters, elevate consumer satisfaction, and significantly reduce the churn rate. The study employs different data science and machine learning methodologies to assess features accurately and conduct assessments for optimizing airline prices. The research ultimately aims to contribute to developing more informed and customer-centric pricing strategies within the airline sector.

ID: OT19

Title: Novel goal programming approach for fully intuitionistic fuzzy multiobjective quadratic problems

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Abstract: Many real-world problems are solved as optimization problems using appropriate parameters and variables reflecting the associated data as well as the mindset of a decision-maker. Conventional problems in operations research use fixed values of parameters and variables. However, modelling real-life problems with the help of precise data is not possible when the conditions giving rise to a specific problem are uncertain. To overcome this dilemma, fuzzy theory is used for the inclusion of non-crisp representation by associating a membership degree. In recent times, intuitionistic fuzzy (IF) set theory is becoming more and more popular since it emphasises non-membership degree in addition to membership degree. In this article, a simplified novel goal programming (GP) method under an intuitionistic fuzzy environment using both linear as well as non-linear membership/ non-membership functions is developed. After that, it is used to solve a multiobjective quadratic programming problem (MOQPP) with variables and parameters as intuitionistic fuzzy numbers, to obtain a Pareto optimal solution. The relations between the IF MOQPP and its equivalent crisp GP problem are also established by proving theorems at appropriate places. membership functions are employed to solve the problem.

The main objective of this study is to develop and theoretically establish a consistent GP model for Pareto optimal solution of fully IF MOQPPs that in-corporates the IF aspect of the problem in a comprehensive manner. The study develops a simplified form of the GP approach for MOQPPs with IF parameters and variables in contrast to linear MOPPs. As an alternative to Angelov's fuzzy programming technique, the suggested method would allow the inclusion of both membership and non-membership functions in the final reference function without ignoring the IF aspect. Our aim is to offer a standardized and reliable GP method in an IF setting. Additionally, a numerical example is presented to show the steps in the suggested approach. Moreover, verification of the outcomes is carried out through comparison analysis with Angelov's fuzzy programming technique.

ID: NA15

Title: The impact of non-orthogonal geometry and cells on convection in oblique angle cavities using OpenFOAM

Author(s): Anoop Rathore[1], Tanmoy Mondal[2]

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Abstract: This study analysed the impact of non-orthogonal geometry and cell shapes on forced, natural, and mixed convection using the Navier-Stokes equation for unsteady and incompressible flow. The Finite Volume Method (FVM) with Boussinesq approximation and PISO scheme was employed, capturing the effects of temperature gradients on fluid density through buoyancy terms. We analysed non-dimensional velocity and temperature profiles in oblique angle cavities using a mid-plane comparison with square cavities. Our numerical results for natural and mixed convection were validated against benchmark results from Bubnovich et al. (2009) and Iwatsu et al. (2011), respectively. We observed increased flow instability and distinct temperature gradients in highly skewed geometries across forced and natural convection regimes. In natural and mixed convection scenarios, oblique angle cavities exhibited unique flow and temperature behaviour at varying Rayleigh numbers (Ra) and Richardson numbers (Ri). A grid independence test revealed that the 129x129 grid is optimal for square and oblique angle cavities. Our analysis revealed a significant impact of non orthogonal geometry and cell shape on achieving steady-state solutions. Calculating gradients and divergences becomes challenging when mesh faces are not aligned with the flow. This highlights the importance of considering geometric orthogonality for efficient numerical simulations.

ID: OT16

Title: Design of Economical Fuzzy Logic Controller for Washing Machine

Author(s): Kriti A.Dheerawat[1], Umme Salma M. Pirzada[2], Haribhai R.Kataria[3]

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Abstract: The washing machine is the most commonly utilized household appli ance. The automatic washing machines are developed using Fuzzy Logic Controller by several authors. The amount of water, electricity and detergent are more effec- tive parameters for developing economical washing machines. In this work, we design an economical fuzzy logic controller for washing machine which optimize consumption water, electricity and amount of detergent. We employ Mamdani approach to develop the algorithm as this approach gives higher accuracy. In
the fuzzy-rule basis system, 36 rules are created based on expert user knowledge. The algorithm has been implemented and simulated using python programming language. The simulation results show that the proposed algorithm for washing machine provides better performance at a lower computational cost. The comparative analysis of proposed work with the previous work shows that our input-output control sys tem optimises performance of the washing machine.

ID: AP18

Title: QUANTUM SECRET SHARING BASED ON MODIFIED SIMON'S ALGORITHM

Author(s): Vidhaan Sinha[1], Apoorv Tiwari[2], Farhan Musanna[3]

Affiliation(s): [1,2]Birla Institute of Technology, Mesra, [2]Thapar Institute of Engineering and Technology Patiala

Abstract: The application of quantum computers holds immense promise when it comes to real-world applications of information sharing, cryptography, and key distribution. Quantum computers could offer a new paradigm for secure communication by leveraging the principles of quantum mechanics, such as entanglement and superposition[1]. Our objective here was to work with Simon's algorithms and develop a secret-sharing scheme. The overall idea of Simon's Algorithm is to determine a "secret string" which corresponds to the periodicity of a function, and to find the nature of the said function that has been defined. The original iteration of Simon's Algorithm is applied to functions with either a one-to-one mapping or a two-to-one mapping. This enables the sharing of a single secret string[2].
Our work introduces a novel iteration of Simon's Algorithm that works for any 2^n-to-1 function,$n \in N$, and n corresponds to the number of secret strings that could be shared using our novel approach.

Moreover, we have also proposed the analytical method of determining the secret string, which alleviates the use of Gaussian Elimination, saving computational costs and making the retrieval process efficient. Our introduced novel approach helped us to introduce a (n, n)-threshold quantum secret-sharing scheme, capable of verifying any eavesdropping attempts. Our designed scheme has been simulated on IBM-QE (QISKIT) for potential applications[3].

References:

[1] Michael A Nielsen and Isaac L Chuang. Quantum computation and quantum information. Cambridge university press, 2010.

[2] Daniel R Simon. On the power of quantum computation. SIAM journal on computing, 26(5):1474–1483, 1997.

[3] IBM Quantum. Ibm quantum computing platform. https://www.ibm.com/quantum-computing/.

ID: AP26

Title: Non-isotropic Angular Fractional Stockwell Transform: Properties with Comparative Examples

Author(s): Km. Neeraj Singh, Sanjeev Kumar

Affiliation(s): Indian Institute of Technology, Roorkee

Abstract: We propose a new transformation of signals in reference to time-frequency analysis in two dimensions. The transform is the generalization of the non-isotropic angular Stockwell transform (NIAST) and is known as the non-isotropic angular fractional Stockwell transform (NIAFrST). The proposed transform inherits excellent mathematical properties of NIAST along with some thumping features of its own. The work focused on mathematical properties such as linearity, anti-linearity, translation, scaling, parity, and conjugation property.

ID: NA03

Title: ERROR ANALYSIS FOR NIPG METHOD FOR NONLINEAR TIME-FRACTIONAL BURGERS' EQUATION

Author(s): Sandip Maji, Srinivasan Natesan

Affiliation(s): Indian Institute of Technology Guwahati

Abstract: Our primary goal is to suggest a fully discrete numerical scheme for the time-fractional Burgers' equation. We consider the fractional derivative in the Caputo sense. The time derivative of this equation will be discretized using the L2-type discretization formula. The spatial variable is approximated by using non-symmetric interior penalty discontinuous
Galerkin method. We established that the proposed method is globally and unconditionally stable. The accuracy of the solution is evaluated using a convergence analysis. Computational experiments further confirm the accuracy and stability of the suggested strategy.

ID: NA06

Title: Efficient Normal Derivative Estimation: Sixth Order Compact Scheme for Three- Dimensional Poisson Equation

Author(s): Niranjan

Affiliation(s): South Asian University, New Delhi

Abstract: In this research effort, we introduce a compact implicit numerical algorithm designed to compute$(\partial u/\partial n)$with sixth-order precision. This algorithm is developed to handle the three-dimensional Poisson equation $\Delta^2 u = f$, which is commonly encountered in the realms of mathematical physics and engineering. In this context, Δ^2 signifies a Laplacian operator applicable to three dimensions. Our primary contribution entails the presentation of an inventive numerical algorithm, achieving sixth-order accuracy and specifically tailored for solving the 3D Poisson equation.

This algorithm operates on 19- and 27-point compact stencil customized for the three dimensions. Subsequently, building upon the numerical solution u, we introduce a new compact sixth-order implicit numerical algorithm devoted to estimating$(\partial u/\partial n)$. Importantly, our proposed algorithm eliminates the necessity to rely on derivatives of the source functions f, thereby enhancing computational efficiency. To facilitate computation, we utilize appropriate iterative techniques and rigorously demonstrate the sixth-order convergence of the proposed algorithm. The computed numerical results confirm the practicality and effectiveness of the suggested numerical algorithm, underscoring its utility across a variety of applications.

ID: DS18
Title: Free axisymmetric vibration analysis of porous annular plate using the Haar wavelets and the DQM
Author(s): Yajuvindra Kumar
Affiliation(s): Government Girls Degree College Behat

Abstract: Free axisymmetric vibration of a porous annular plate is presented in this paper. The mathematical model is developed using the classical plate theory. The mechanical properties are assumed to be varying in radial and thickness directions. The Haar wavelets and the differential quadrature method (DQM) are used to solve the mathematical model. The first three frequencies for clamped-clamped, clamped-simply supported, clamped-free, simply supported- clamped, simply supported-simply supported and simply supported-free boundary conditions are obtained. A convergence study of both the methods is performed to check the validity of the present mathematical model.

ID: NA20
Title: Numerical solution of a non-linear integral equation when the reciprocal of the solution lies in the integrand
Author(s): Indranil Sarkar, Gaurav Singh
Affiliation(s): Indian Institute of Technology Delhi

Abstract: Non-linear integral equations arise in many fields of mechanics, mathematics, and physics, including analysis, partial differential equations, numerical analysis, and mathematical modeling. There are many different motivations for studying non-linear integral equations with singularities in the reciprocal of the solution, and the specific reasons for studying these equations will depend on the context and application at hand. Some important applications of these equations occur quite frequently in the physical phenomena arising in signal theory, boundary layer theory in fluid mechanics, chemical phenomena, singular second-order boundary value problem, elliptic problem, Hartfiel's problem etc.
The present work deals with developing a numerical method for solving a non-linear integral equation given by

$$y(t) = f(t) + \int_0^1 k\,(t,s)\frac{1}{[y(s)]^{\alpha}}\,ds$$

where $y(t) \in C^2[0,1]$ with $y(t) > 0$, $f(t) \in C[0,1]$ with $f(t) \geq 0$, the kernel function $k(t,s)$ is non-negative and continuous on $[0,1] \times [0,1]$, and $\alpha > 0$. The non-linearity in the equation arises from the singularity at $y = 0$. The existence of a continuous positive solution of this equation is well-established in the literature. However, there is no reported method to solve it numerically for any $\alpha > 0$. To attain the desired objective, the renowned Chebyshev collocation method is used. This method converts the integral equation into a matrix equation that produces a set of non-linear algebraic equations having unknown Chebyshev coefficients. To solve these equations

computationally, the well-established Newton's method is employed. To validate the effectiveness and precision of the method, various numerical examples with well-defined exact solutions are examined. Obtained numerical solutions confirm the accuracy and validity of the numerical method. solutions are examined. Obtained numerical solutions confirm the accuracy and validity of the numerical method.

ID: OT15
Title: Well-posedness of multidimensional quasi variational inequality problems
Author(s): Pallabi Samal, Anurag Jayswal
Affiliation(s): Indian Institute of Technology (Indian School of Mines), Dhanbad

Abstract: In this work, we provide a new class of multidimensional quasi variational inequality problems and use the ideas of monotonicity and hemicontinuity of the associated functionals to analyze the well-posedness and generalized well-posedness of the problems. In addition, we examine a multidimensional variational problem where the above-mentioned quasi variational inequality is considered as a constraint. For this, we derive the existence and uniqueness of the solution, which are related to the well-posedness of the problem. Further, we give a few examples to demonstrate the theoretical results.

ID: DS22
Title: Multiresolution Analysis on the space of Analytic functions and Processing of ECG signals
Author(s): Anusree Sreedharan
Affiliation(s): Cochin University of Science and Technology, Keral

Abstract: This work focuses on studying Blaschke functions to construct the Multi Resolution Analysis on the Hardy space of unit circle. Similar to the Whitney cube decomposition of the unit disc, we determine a decomposition using a non Blashke sequence. This decomposition will be helpful to reconstruct an analytic function from the sample values measured at the non-Blaschke sequence. We study the frame structure of the reproducing kernel corresponding to the non Blaschke sequence selected and will discuss the Banach frame structure of these sequence and derive a series representation of any operator in the space in terms of the sampling sequence. The orthonormal basis for this space, the Malmquist Takenaka system is the most frequently used rational orthogonal system in ECG processing and its compression. We studied the MATLAB toolbox RAIT which is used for this purpose.

ID: DS12
Title: Regularization for Image Restoration: A Two Level Tight Framelet Approach
Author(s): Sruthi Raghoothaman
Affiliation(s): Cochin University of Science and Technology(CUSAT)

Abstract: Restoring the original image from the observed noisy-blurred image is always an ill-posed problem. Regularization techniques are the best ways to overcome this ill-posedness. A new regularization method is proposed for this image restoration problem using a two level tight framelets. Numerical experiments show that the model is effective and efficient as compared to other existing models. In this work we tried to review and compare their results by using alternate filter banks. Also we tried to extend the two level regularization method to three level for better results.

ID: OT20
Title: Differentiability and optimality of a fuzzy function of fuzzy variable
Author(s): U. M. Pirzada[1], Debdas Ghosh[2]
Affiliation(s): [1]Navrachana University, [2] Indian Institute of Technology (BHU) Varanasi

Abstract: In this article, we introduce an idea of differentiability for fuzzy functions of fuzzy variables. Explicitly, we define a first order and a second order derivative of a fuzzy function $f: F(\mathbb{R}) \to F(\mathbb{R})$, where $F(\mathbb{R})$ is the set of all fuzzy numbers. In the sequel, we analyze algebra of derivatives of the fuzzy functions under consideration. With the help of the proposed notion of differentiability, we prove a necessary and sufficient condition for optimality to obtain a non-dominated solution of a fuzzy optimization problem. Several numerical examples are given to support the introduced ideas. As an application of the proposed results, a solution to the minimum risk portfolio optimization problem is studied.

ID: AP09
Title: Improving Consumer Safeguards: Harnessing Computer Vision to Identify Counterfeit Merchandise
Author(s): Anshul Ujlayan
Affiliation(s): CCS University, Meerut

Abstract: Authenticating products, particularly within the domain of medical goods, is a challenging and often precarious undertaking. The susceptibility to counterfeit products infiltrating the market is exacerbated when meticulous scrutiny of product specifications is lacking. This research endeavours to present an advanced methodology employing computer vision and artificial intelligence (AI) to facilitate discernment of product authenticity, particularly catering to consumers with limited technological proficiency. Through the application of this methodology, consumers can ascertain the legitimacy of a product by conducting a comprehensive scan.
The research protocol incorporates a dataset comprising twenty distinct original product images juxtaposed with corresponding counterfeit images. The primary emphasis of this investigative approach lies in the precise identification of logos presented in both visual and textual formats on the product, supplemented by a thorough analysis of other pertinent information derived from the product's packaging.
This pioneering strategy aims to fortify consumer protection measures by impeding the proliferation of counterfeit goods. The meticulous utilization of computer vision and AI technologies in this study not only seeks to enhance the accuracy of authentication processes but also serves as a proactive measure to curtail the dissemination of fraudulent products in the market.

ID: DS24
Title: TIME SERIES FORECASTING USING NEURO-FRACTAL INTERPOLATION METHOD
Author(s): ANUPAMA K, SASI GOPALAN
Affiliation(s): Cochin University of Science and technology, Kochi, Kerala

Abstract: Barnsley introduced the fractal interpolation function based on the theory of iterated function systems (IFS), which is a mathematical technique used to generate smooth curves that approximate a finite set of data points. In this paper we developed new approximation method for dataset using Hidden variable Fractal Interpolation Function based on the vertical scaling factors. We use the interpolated time series data from the original time series data as inputs to the neural network and design the neural network architecture suitable for time series forecasting, such as recurrent neural networks (RNNs) in particular Long Short-Term Memory (LSTM) networks.

ID: OT03
Title: The Gamma connective scalarization for multiobjective polynomial optimizations
Author(s): Sujeet Kumar Singh
Affiliation(s): Indian Statistical Institute, Hyderabad

Abstract: Although multiobjective optimization problems have a rich literature on scalarizing methods, the existing weighing scalarization methods have some deficiencies in assigning the weights and then finding the solution per the objectives' priority to tackle the incom mensurability in heterogeneous objectives. Further, the weighing methods are unable to generate the Pareto points, which fall on the non-convex part of the Pareto front. We consider these issues and propose the Gamma-connective scalarization technique to solve the multi-objective optimization problem. The underline functions are considered to be the higher degree polynomials and the recently developed sum of squares(SOS) techniques is used for equivalent PSD conversion. The positive semidefinite (PSD) optimization has efficient tools like YALMIP and SOSTOOLS to efficiently work with. These tools make PSD a tractable convex optimization problem. The performance of the proposed method would be evaluated using some closeness measure to the ideal solution for several test problems.

ID: DS03
Title: A New Back Propagation Idea for Optimizing the Weights of a Neural Network with Fractional Calculus
Author(s): SAMBHU RAJ P. R[1], ATHIRA VINAY[2], and SASI GOPALAN[3]
Affiliation(s): COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY, KERALA

Abstract: The primary goal of optimization techniques in Neural Networks is to discover optimal weights and biases to enhance approximation. Current approaches, such as gradient descent, rely on classical derivatives. However, the evolving nature of this field neces- sitates novel perspectives on optimization techniques. This emphasizes the importance of an in-depth exploration of the gradient descent algorithm and activation functions. In this paper, we introduce an approach wherein the conventional application of partial derivatives in the gradient descent algorithm during the back-propagation of neural networks is replaced with fractional derivatives. To address this, we have done a study to identify the suitable fractional operator and activation function for the proposed approach. We have also done a review and comparative study on the existing fractional models in neural networks.

ID: DS28
Title: Navier-Slip Jeffrey Fluid Flow with Inclined Magnetic Field Through a Vertical Channel Using ANN-based Computational Approach
Author(s): Ravi Mahla, K. Kaladhar
Affiliation(s): National Institute of Technology, Warangal

Abstract: This article discussed the impact of Hall current and angled magnetic field on natural convection Jeffrey fluid flow through a vertical channel with Navier-slip condition. The investigation utilizes the backpropagation technique within an artificial neural network framework, employing the "Levenberg-Marquardt technique'' (BANN-LMT). Through appropriate mathematical transformations, the governing equations representing the given problem are converted into a set of ordinary differential equations. The dataset required for the BANN-LMT model is generated using the spectral quasi-linearization method (SQLM) by varying inclination angle, Magnetic parameter, Jeffrey fluid parameter, and Hall parameter. To assess the efficacy of the introduced BANN-LMT methodology, a validation process is conducted, employing assessment metrics including the computation of Mean Squared Error (MSE), an analysis of error histograms, and regression analysis.

All key results are displayed graphically to analyze the influence of various thermophysical parameters. The magnitudes of velocity and cross-flow velocity increase in response to higher values of the inclination angle, Jeffrey fluid parameter, and magnetic parameter. The temperature profile demonstrates an elevation with an increase in the Hall parameter and the Jeffrey fluid parameter while experiencing a reduction as the inclination angle and magnetic parameter increase.

ID: NA27

Title: Application of septic Hermite interpolation polynomial for solving Burgers type equation

Author(s): Archna Kumari, V.K. Kukreja

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Abstract: In the universe, the exchange of mass, heat, and momentum are treated to be the fundamental transfer phenomena and it has much application in various engineering disciplines and applied science. The convection-diffusion equation plays an important role in describing several physical phenomena where energy is transformed inside a physical system due to two processes: convection and diffusion. The term convection means the movement of molecules within fluids, whereas, diffusion describes the spread of particles through the random motion from regions of higher concentration to regions of lower concentration. The convection-diffusion has various applications such as water transfer in soils, heat transfer in draining film, the spread of pollutants in rivers, dispersion of tracers in porous media, spread of solute in a liquid flowing through a tube, long-range transport of pollutants in the atmosphere, flow in porous media and many others. In this work, the convection-diffusion Burgers' type equation is solved numerically using the septic Hermite collocation method (SHCM). In SHCM, the combination of orthogonal collocation on finite element method with septic Hermite interpolating polynomials as a basis function is used which are C^3 continuous. The stability analysis of the proposed method is discussed and found to be unconditionally stable. Also, the convergence analysis of SHCM is given. The proposed method has six order convergent in space direction and second-order convergent in the time direction. The proposed algorithm is implemented on various test problems and the computed results are reported in form of tables and figures. The results are compared with the previous data available in the literature. The comparison shows that the SHCM gives better results as compared to the other ones. Hence the results proved that the use of the proposed algorithm in the simulation is very applicable.

ID: NA21

Title: Numerical Simulation of Sine-Gordon Equation Using Cubic B-Spline Quasi-Interpolation Method

Author(s): Sudhir Kumar

Affiliation(s): Sant Longowal Institute of Engineering and Technology, Longowal

Abstract: The nonlinear sine-Gordon equation arises in various problems in science and engineering. This work presents a numerical algorithm based on the cubic B-spline quasi interpolation method for the simulation of one and two-dimensional Sine-Gordon equations. In this method, cubic B-spline quasi interpolation method is used for the approximation of spatial derivatives, which produces a system of second-order ordinary differential equations. Further, the obtained system is decoupled into a system of first-order ordinary differential equations, and then forward difference approximation for time derivative is used to get final solutions. Some well-known problems from the literature are considered to check the accuracy and efficiency of the proposed method. Numerical results are also obtained for various cases involving line and ring solitons. The stability analysis of the method has also been discussed.

ID: NA04

Title: A high-precision finite difference method for a time fractional Black-Scholes equation

Author(s): Nizamudheen V[1], Noufal Asharaf[2], Shefeeq T[3]

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Abstract: Within the realm of financial markets, futures, forwards, swaps, and options represent diverse categories of financial derivatives that play a pivotal role in risk management, liquidity provision, and the facilitation of price discovery.The pricing of options poses a significant challenge due to the complex interplay of various factors such as volatility, time decay, and underlying asset movements, requiring sophisticated models and careful consideration of market dynamics.The classical Black-Scholes model, introduced in 1973 [1], offers a formula for determining the value of an option. Its simplicity and clarity contributed to a surge in options trading. However, the classical Black-Scholes equation was developed based on stringent assumptions. To address these limitations, researchers have proposed several enhanced models, including the stochastic interest model [2,3], Jump-diffusion model [4,5], stochastic volatility model [6] and model with trans- action costs [7], and those incorporating dividend payments [8].

Over the last few decades, numerous researchers have investigated the existence of solutions to the Black-Scholes model using various methodologies. Realistic modeling of a physical phenomenon, which relies on both instantaneous time and the preceding time history—referred to as memory—can be successfully accomplished through the application of fractional calculus. Therefore, fractional calculus has been employed in the financial market to derive fractional Black-Scholes models, replacing the standard Brownian motion present in the classical model with fractional Brownian motion. As fractional order models gain widespread application in the financial sector, an increasing number of researchers are developing an interest in solving them.

This paper explores the discretization of the fractional Black-Scholes equation [9] using a five-node finite difference approximation, in contrast to the conventional three-node approach. A comprehensive analysis compares the performance of the newly introduced five-node finite difference approximation with the established three-node finite difference method.

References

[1] F. Black, M. Scholes, The Pricing of Options and Corporate Liabilities, Journal of Political Economy, 81(3), 637–654, 1973.

[2] G. Deng, Pricing American Continuous-Installment Options under Stochastic Volatility Model, Journal of Mathematical Analysis and Applications, 424, 802–823, 2015.

[3] F. Angelini, S. Herzel, Delta Hedging in Discrete Time under Stochastic Interest Rate, Journal of Computational and Applied Mathematics, 259, 385–393, 2014.

[4] Xu Weidong, Wu Chongfeng, Xu Weijun, Li Hongyi, A Jump-Diffusion Model for Option Pricing under Fuzzy Environments, Insurance: Mathematics and Economics, 44, 337–344, 2009.

[5] D. Dang, D. Nguyen, G. Sewell, Numerical Schemes for Pricing Asian Options under State Dependent Regime-Switching Jump–Diffusion Models, Computers & Mathematics with Applications, 71(1), 443–458, 2016.

[6] U.S. Rana, A. Ahmad, Numerical Solution of Pricing of European Option with Stochastic Volatility, International Journal of Engineering, 24, 189–202, 2011.

[7] D.C. Lesmana, S. Wang, An Upwind Finite Difference Method for a Non-linear Black–Scholes Equation Governing European Option Valuation under Transaction Costs, Applied Mathematics and Computation, 219, 8811–8828, 2013.

[8] C. Ballester, R. Company, L. Jodar, An efficient method for option pricing with discrete dividend payment, Computers & Mathematics with Applications, 56, 822-835, 2008

[9] H. Zhang, F. Liu, I. Turner, Q. Yang, Numerical Solution of the Time Fractional Black-Scholes Model Governing European Options, Computers & Mathematics with Applications, 71, 1772–1783.

ID: AP11
Title: Detection of Veer and Narcolepsy tendencies using Machine learning algorithms and big data monitoring
Author(s): Saurav K Dubey, Dilip K Singh
Affiliation(s): Birla institute of technology Mesra, Ranchi

Abstract: In recent years, road safety has been a matter of great concern world-wide with increasing number of accidents annually. Narcolepsy and Veer tendencies are a major source for the cause of accidents in today s world. The Drowsiness and Fatigue levels affect the mindset of the drivers which causes accidents. The proposed system shown in figure 1 uses a hybrid network of computer vision and physical sensor equipped on a prototype [1]. The system uses Haar Cascade Classifier to detect the eye iris state and the sensors work as a confirmatory test to validate the results. CHT (Circular Hough Transform) is used to detect the circular shape of the eye and to detect the eye iris state detection. The algorithm localizes tracks and analyses both the driver face and eyes to measure the eye iris visual state. The sensor ADXXL 335 sensor measures the veer tendencies using g force experienced by the prototype during traversing from one direction to the other.

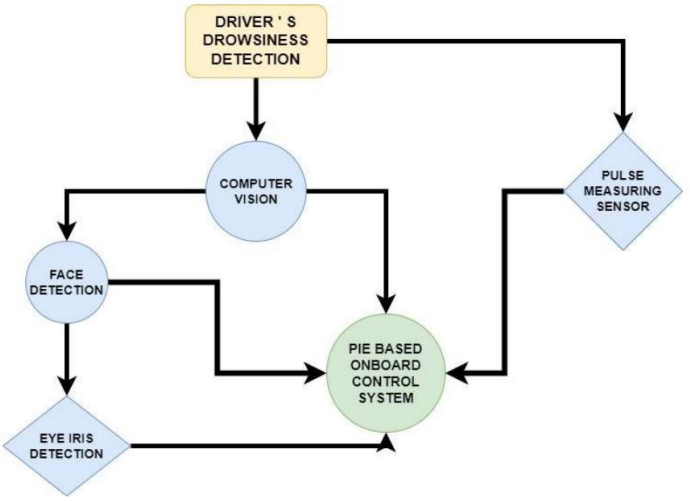

Figure: Flowchart of the working system

References
[1] A. Malla, P. Davidson, P. Bones, R. Green and R.Jones, "Automated Video-based Measurement of Eye Closure for Detecting Behavioral Microsleep", in 32nd Annual International Conference of the IEEE, Buenos Aires, Argentina, 2010.

ID: AP22
Title: An Automatic Speech Recognition System in Odia Language Using Data Augmentation
Author(s): Malay Kumar Majhi, Sujan Kumar Saha
Affiliation(s): National Institute of Technology, Durgapur

Abstract: Automatic Speech Recognition (ASR) is the task of converting speech signals into text. ASR technology has become increasingly popular in various fields, such as voice-enabled devices, customer service automation, and many other applications. Due to its immense importance, a substantial amount of effort has been given to develop ASR systems in many languages, including

English and Hindi. The ASR systems and open speech resources are available in many languages. However, sufficient research effort has not been devoted to develop ASR systems in many resource-poor Indian languages, including Odia. This paper introduces an automatic speech recognition system for the Odia language utilizing deep learning techniques. In this research, we have specifically focused on addressing the challenges of data scarcity. Deep Learning has been pivotal in advancing ASR systems across various languages. However, the effectiveness of these models primarily relies on the amount of training resources, primarily annotated speech corpus. This study explores the effectiveness of data augmentation in addressing the challenges associated with data scarcity in the development of the Odia ASR system. Our baseline system employs a Bidirectional Long Short−Term Memory (BiLSTM) network within a Sequence−to−Sequence (Seq2Seq) architecture. The baseline system is trained on a dataset comprising 25.3 hours of speech. To enhance the performance, we specifically selected 3.04 hours of phonetically rich segments from the training data and applied a few data augmentation techniques, including pitch alteration and time stretching with various parameter adjustments. This augmented dataset was then integrated with the original training data to enhance it. Now, the BiLSTM model is trained with the extended training data to estimate the effect of data augmentation.

Our baseline model demonstrated a Word Error Rate (WER) of 33.29% and a Character Error Rate (CER) of 17.30%. Given the limited size of the training dataset, the system's accuracy was not optimal. Introducing data augmentation techniques into the training pipeline led to notable improvements. The enhanced model, upon combining the augmented data, showed a reduction in WER to 28.60% and CER to 16.67%. Moreover, a comparative analysis with other state-of-the-art Odia ASR models reveals that our system, despite being trained on a dataset of just over 28 hours, shows competitive performance against existing models, which have WERs ranging from 21.65% to 36.15% and were trained on substantially larger datasets, often exceeding 75 hours. This demonstrates the efficiency and potential of our model in the context of low-resource ASR systems. The significance of this work lies in its dual contribution. Firstly, it presents an ASR system for the Odia language that utilizes smaller training data to outperform some existing models of Odia ASR. Secondly, it demonstrates the impact of data augmentation techniques in the context of automatic speech recognition in Odia.

ID: DS09

Title: Returns Premonition: A Machine Learning Approach in Predicting Pre-Order Return Probability

Author(s): Piyush Goyal, Heera Lal, Deepak Rawat, Senthil Nathan, Akansha Kumar

Affiliation(s): Jio Platforms Ltd.

Abstract: This research addresses the prevalent challenge of product returns for an E-commerce platform. Utilizing machine learning techniques, we predict the likelihood of a product being returned before placing the order on the platform.

The methodology involves a thorough analysis of historical e-commerce data to identify key predictors for returns and subsequently building a multi-class classification model which provides the probabilities for RTO (Return to Origin), RVP (Reverse Pickup), and non-return scenarios as per business requirements. Key challenges and areas where the research focuses on include building and deploying the machine learning model which is scalable and robust to handle millions of transactions while maintaining optimal latency. Thus, this comprehensive research offers practical insights for retailers aiming to optimize returns, improve profitability and enhance customer satisfaction.

ID: OT25

Title: Optimizing Inventory Management for Perishable Items: Integrating Trapezoidal Demand, Weibull Amelioration, Preservation Technology, and Learning Effects

Author(s): Vijender Yadav, Ankur Saurav, Chandra Shekhar

Affiliation(s): Birla Institute of Technology and Science, Pilani

Abstract: In today's intensely competitive business environment, the management of product quality, shortage, and demand fluctuations across a product's lifecycle are pivotal in inventory management. This research presents an innovative approach, employing a trapezoidal demand profile for items undergoing both amelioration and deterioration. The integration of preservation technologies into our proposed model verges the rate of deterioration. This study introduces an inventory optimization challenge aimed at enhancing product quality through the incorporation of Weibull amelioration, accounting for evolving product quality over time. By factoring in learning effects and associated costs, we ensure economic viability, while allowing partial backlogged shortages and retailer-borne transportation expenses. Emphasizing warehouse capacity constraints, this research's primary goal is to establish optimal order quantities and inventory cycles, minimizing retailer costs.

ID: AP24
Title: Development of Computational Algorithms for Evaluation of Teaching - Learning Process
Author(s): Rahul T S H[1], Srinivas T[2]
Affiliation(s): [1]LeadSquared, Bengaluru, [2]Dr B R Ambedkar National Institute of Technology Jalandhar

Abstract: A computational model with algorithms has been developed and presented for evaluation of the teaching and learning process through a course with a focus on outcome-based education (OBE). The operation of the computational model is easy compared to the existing methods and gives more elaborate analysis with the quality loop. For the effective use of computational tools, MATLAB programming for evaluation and a Python model for user operation and instruction were used. The main objective of the proposed work is to result in course and program outcome attainment with the support of a computational tool. A case study is presented with results to demonstrate the procedure and outcomes. The computational tool also produced the quality loop and attainment analysis.

ID: AP04
Title: Predicting Wait Time in Radiology Department: A Machine Learning Approach with Recursive Feature Selection Technique
Author(s): Jagriti Gupta, Naresh Sharma
Affiliation(s): GD Goenka University, Gurugram

Abstract: The escalating patient flow in hospitals, coupled with overcrowding in critical departments like emergency, radiology, laboratory, and ICU, has prompted the need for effective strategies to enhance patient satisfaction. Specifically focusing on the radiology department, where patients experience varying wait times for getting X-ray services, this study aims to predict waiting times of patients. The dataset used for this study encompasses information related to current patient queues, examination type, and resource utilization within X-ray facilities. Utilizing a variety of linear and non-linear machine learning techniques, we applied linear regression (LR), k-nearest neighbors (KNN), and decision tree (DT) models with the objective of modelling and predicting waiting times.
The recursive feature elimination (RFE) algorithm is used to reduce the dimension of the dataset and reduce the complexity of model to predict waiting time of patients and select optimal features that are more important.

In this paper, a waiting time prediction model is proposed by using machine learning models and integrated with the RFE feature selection algorithm. The linear LR-RFE model with 30 features predicted waiting time with mean absolute error 3.63 minutes as compared to LR model with 63 features. While the DT and KNN models give 3.77 minutes and 3.81 minutes respectively and comparable with feature selection technique RFE. Furthermore, the feature revealed key contributors to waiting times, such as the sum of patient queue wait times, the number of patients

waiting in line, wait time for the most recent patient, and the median wait time for the five most recent patients. This approach aims to provide actionable insights for proactive patient queue management, ultimately improving overall patient satisfaction in the Radiology department.

ID: OT06

Title: Analytical and Monte Carlo Simulation Methods for Uncertainty-Driven Stability Analysis Problem

Author(s): Subrat Kumar Jena
Affiliation(s): Indian Institute of Technology Delhi

Abstract: In this study, Monte Carlo Simulation techniques and double-parametric form-based Navier's method are employed to investigate material uncertainties' impact on the stability of Timoshenko nanobeams, considering variations in diameter, length, and Young's modulus through Symmetric Gaussian Fuzzy Numbers (SGFNs). Stability analysis of the uncertain model involves the integration of Timoshenko beam theory, Hamilton's principle, and a double-parametric form incorporating fuzzy numbers. Eringen's elasticity theory addresses the nanobeam's small-scale effect, while the double-parametric form-based Navier's method calculates the lower bound (LB) and upper bound (UB) buckling loads for uncertain models. Validation involves comparisons with deterministic models and Monte Carlo simulation results, showcasing strong agreement. In the double parametric form of solution, the uncertain parameters are taken as Symmetric Gaussian Fuzzy Numbers (SGFN). Further, by applying single- parametric form, the uncertain parameters degenerate into interval parameters. These interval forms of uncertain parameters are later converted into crisp form or deterministic form by incorporating double-parametric form. In case of Monte Carlo simulation, the Symmetric Gaussian Fuzzy Numbers are converted into interval form; then, 1000 random points are generated for interval form of uncertain parameters from their lower bounds to upper bounds. Then, these random values of uncertain parameters are used in deterministic analysis of critical buckling load. By repeating deterministic analysis for all the random points, lower bound and upper bound of critical buckling loads are computed. A parametric study explores the buckling load variations concerning different uncertain parameters, shedding light on their fuzziness or spreads.

ID: DS06

Title: A BFGS-Optimized Approach with Polynomial Smooth Support Vector Machines for Rapid and Effective Classification

Author(s): Bhubaneswari Mishra and S. Chakraverty
Affiliation(s): National Institute of Technology Rourkela

Abstract: Data smoothing, which is an essential component in the field of predictive modelling, proves to be a potent tool in extracting subtle variations and enabling the prediction of various trends and patterns. This research undertakes an investigation into the diverse range of uses that smoothing techniques have, with a particular emphasis on their widespread implementation in the resolution of intricate mathematical challenges. The core of this research revolves around the utilization of smoothing methodologies to define and address Support Vector Machine (SVM), which have been cleverly recast as unrestricted optimization challenges. The present formulation incorporates a flexible smoothing parameter set and a fourth-order polynomial function, which are referred to collectively as the Polynomial Smooth Support Vector Machine (PSSVM). The complexities and details of the PSSVM method are systematically examined and enhanced via optimization applying the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm. The BFGS method, which is well-known for its ability to rapidly converge, plays a critical role in providing the effectiveness and accuracy of the PSSVM technique. PSSVM is distinguished in this regard by its exceptional capacity for generalization. The remarkable capability of generalization is conferred upon PSSVM through the coordinated interaction of the fine-tuned smoothing parameters and the

fourth-order polynomial function. The aforementioned attribute establishes PSSVM as an essential implement within the framework of predictive analytics. This study presents an innovative methodology for predictive modelling, demonstrating how the BFGS method optimizes Polynomial Smooth Support Vector Machines to achieve an outstanding effect. The outcomes highlight the efficacy, accuracy, and ability to generalization of PSSVM, establishing it as a leading solution in the field of SVM problem-solving. This study introduces novel opportunities for predictive analytics and agile data smoothing, thereby altering the mathematical problem-solving domain within the framework of Support Vector Machines. Several experiments are performed and from the numerical results it is concluded that PSSVM is better classifier. It is more effective and faster than the previous methods for solving SVM with better generalization ability.

ID: AP12

Title: Application of machine learning in solving dynamic flow problems.

Author(s): Ayush Ganguly, Sayan Biswas, Ananya Majumdar, Biplab Ranjan Adhikary, Partha Bhattacharya

Affiliation(s): Jadavpur University

Abstract: The lid-driven cavity problem is a classic benchmark in computational fluid dynamics that involves simulating the flow within a square cavity with a moving lid. The present study addresses the lid-driven cavity problem using two different approaches: Physics-Informed Neural Networks (PINNs) running in a cloud-based Python environment, and the Finite Difference Method (FDM) running in MATLAB. The main goal is to investigate and contrast how well these methods work to simulate fluid flow inside a cavity driven by a lid. The Navier stokes equations are discretized using the Finite Difference Method, which is implemented in MATLAB. The discretized equations are then solved numerically on a staggered grid, providing a baseline numerical solution for the fluid flow within the cavity. In parallel, without using grid discretization, powerful machine learning technique Physics-Informed Neural Networks (PINNs) are employed in a cloud-based Python environment to learn and approximate the underlying fluid dynamics. Three different neural network architectures-multilayer perceptrons, convolutional neural networks, and recurrent neural networks-within the PINN framework are used in this study to analyze the lid-driven cavity problem. Because each architecture is specifically designed to capture the complex flow behavior inside the cavity, their abilities to anticipate fluid flow phenomena can be compared. Additionally, a thorough comparison is made between the outcomes achieved using PINNs and the Finite Difference Method. Evaluation criteria include accuracy, computational efficiency, and flexibility to changing circumstances like Reynolds numbers and aspect ratios. Comparisons of the pressure distributions, vorticity patterns, and velocity fields obtained from the two approaches are included. To determine the computational efficiency of each method, the computing time and resource needs for convergence or desired precision are also carefully examined. By shedding light on the trade-offs between contemporary machine learning techniques and more conventional numerical methods, this study will help practitioners and researchers choose the best methodologies for a given set of computational fluid dynamics simulation requirements, and thus, contributing to advancements in fluid dynamics simulations and machine learning applications in computational physics.

ID: AP13

Title: Challenges in Design of Flight Control Algorithms from Nonlinear Dynamical Equations of Generic Aircraft / UAVs.

Author(s): Dhan Jeet Singh[1], Lakshman Singh[2], Sandeep Kumar Singh[3]

Affiliation(s): [1]Indian Institute of Technology Kanpur, [2]Hindustan Aeronautics Limited, [3]Indian Air Force

Abstract: This paper presents an application of Nonlinear Differential Equations (NDEs) for

formulation of flight control algorithms of Generic Aircraft/ UAVs. The authors also tries to present a brief overview on design approach of flight control algorithms based on mathematical representation of aircraft dynamics. Modern aircraft can perform various types of flight maneuvers over a wide range of flight conditions within its flight envelope. The flight envelope of a particular type aircraft, defines its boundary within which it can fly. The operating boundaries of the flight envelope are generally defined in terms of aircraft altitude, speed (or Mach number) and normal load factor. The low- speed limit is set by the maximum lift that can be generated (Angle of Attack limit), and high-speed limit follows the structural limits, including temperature. At the higher altitudes the speed becomes limited by maximum engine thrust. The altitude limit on flight envelope is determined with the airframe and engine characteristics of the aircraft and it is termed as service ceiling limit. While performing various types of flight maneuvers, the unsteady aerodynamics and flow-field separation make the dynamic behavior of the aircraft extremely nonlinear and complex. This nonlinearity and uncertainty are one of the complicated parts which need to be considered during control system design and analysis. The flight control system (FCS) must tailor the dynamic characteristics of the aircraft at every point of the operating envelope along with the desired level of stability and controllability. Before the formulation of flight control algorithms, the nonlinear dynamic behaviour of the aircraft needs to be completely specified at all operating points of the flight envelope. The dynamic behaviours are represented by a set of differential equations, which describe the force and moment components acting on the aircraft during flight. For describing longitudinal aircraft dynamics, these differential equations are expressed in terms of various state parameters such as aircraft speed, angle of attack, pitch angle and pitch rate. In lateral-directional dynamics representation, the differential equations are expressed in terms of other state parameters such as side slip angle, roll rate, yaw rate and roll angle. The aerodynamic, geometrical, mass properties and propulsive data of air vehicle are entrenched as a parametric set inside these differential equations and known as stability and control derivatives. These stability and control derivative are nonlinear function of flight parameters. With the varying flight conditions, these aerodynamic, mass properties and propulsive parametric data set changes and effect the air vehicle stability and controllability. Thus, parameter uncertainties arose due to variations in mass, inertia and other aerodynamic properties along with changes in flight configurations must be catered during formulation of flight control algorithms (FCA). The FCA are designed to provide good aircraft handling qualities, a low pilot workload and a high degree of resistance to pilot-induced oscillations. For analysis and design of flight control algorithms, the state-space representation of aircraft dynamics is generally preferred. This representation is obtained by linearizing the nonlinear aircraft dynamics about trimmed equilibrium flight conditions using small perturbation theory. After obtaining the linearized version of longitudinal and lateral-directional dynamics, the sub mode behaviour of each dynamic are analysed to fulfil the control system design requirements as per flying qualities levels. In longitudinal dynamic analysis, the short period mode and phugoid mode behaviour of air vehicle are analyzed with reference to their natural frequency and damping ratio parameters. Similarly in lateral-directional dynamic analysis, the roll subside mode, spiral mode and Dutch-roll mode behaviour of air vehicle are analysed. The roll subside and spiral modes are characterized by their time constant parameters, whereas dutch roll mode is characterized by its natural frequency and damping ratio. The location of open loop poles and zeros of bare airframe longitudinal and lateraldirectional model should also be investigated at trimmed equilibrium flight conditions. After analysis and simulation of open loop airframe behaviour of air vehicle from its dynamical equations / transfer function models, the integration of actuator, accelerometers, and rate gyros (roll, pitch and yaw) dynamics are initiated. The actuator transfer function model is inserted in forward path, whereas accelerometers and rate gyros transfer function models are inserted in feedback path. In classical control design the PI or PID based compensator are utilized and design method is based upon root locus and Bode plot analysis. The closed loop performance must be as per design requirements and compensators gains should be adjusted to achieve the desired level of gain and phase margins. In modern control design the LQR and LQG based methods

are generally adopted. The stability and control matrices of bare airframe dynamics is augmented with actuator, rate gyros and accelerometers dynamics. In LQR/LQG based design, the selection of Q and R matrices are critical steps and they should be selected skilfully to achieve the desired performance. The above design activity should be performed at various identified equilibrium points of fight envelope to obtain the gain parameters which fulfils the design requirements. Further, these gain parameters should be scheduled with respect to some scheduling parameters such as dynamic pressure or mach number. In short, the design of flight control system is a critical activity in aerospace industry, which requires a pool of engineering / mathematical knowledge. There are numerous challenging steps such as formulating vehicle dynamics using set of differential equations, segmenting flight envelope, estimation of stability and control derivatives from wind tunnel and CFD data, inclusion of rate gyros, accelerometer and actuator dynamics, selection of control strategies and gain scheduling etc.

ID: NA28

Title: Solution of Porous media equation by Laplace Differential Transform Method

Author(s): Sahu Nagesh, Saroj R. Yadav

Affiliation(s): Sardar Vallabhbhai National Institute of Technology Surat

Abstract: Porous materials characterized by their solid matrix housing interconnected pores that may contain fluids serve as a critical focal point for research. To capture the intricate dynamics of fluid flow in such media the Porous Medium Equation (PME) provides a fundamental mathematical framework. Traditionally, PME formulations have incorporated the capillary effect arising due to interfacial tension at the fluid-solid boundary. However, as our understanding of these phenomena deepens it becomes evident that the inclusion of dynamic effects is essential for accurately modeling real-world processes.

From an extended study on non-equilibrium effects of capillary pressure with dynamic effects, the capillary pressure (P_c) is given by $P_{c_{stat}} + \tau \frac{\partial S_w}{\partial t}$, where the first term represents traditional static capillary pressure. Incorporating dynamic capillary effects into the traditional PME with the time-dependent behavior of capillary pressure results in additional terms in the governing equation.

$$\frac{\partial S_w}{\partial t} = \frac{-\partial}{\partial x}\left(K(S_w)\frac{\partial}{\partial x}p_{c(S_w)}\right) + \frac{\partial}{\partial x}\left(K(S_w)\tau\frac{\partial^2 S_w}{\partial x \partial t}\right)$$

where τ is the capillary damping coefficient. Analytical solutions of non linear PDEs play crucial role in mathematical modeling of real world phenomena. Combination of the Laplace transform method and the Differential Transform Method (LDTM) proves to be a powerful tool for addressing PDEs characterized by variable coefficients. This research focuses on applying the Laplace Differential Transform Method (LDTM) to solve nonlinear partial differential equations (PDEs). The study demonstrates the applicability and effectiveness of this hybrid technique through illustrative examples and presents a new approach to solve the porous medium equation, a partial differential equation that describes the flow of fluids through porous materials. These examples showcase how LDTM is useful to solve non-homogeneous PDEs with initial and boundary conditions revealing its capacity to overcome challenges posed by complex mathematical problems.

ID: AP30

Title: Physics-Informed Machine Learning for Subsurface Flow: A Study using Neural Network-Based Solvers

Author(s): Shankar Lal Dangi[1], Mayur Pal[2] and Ravi Sharma[1]

Affiliation(s): [1]Indian Institute of Technology Roorkee, [2]Kaunas University of Technology Kaunas

Abstract: This study focuses on the development of physics-informed machine learning models

tailored for subsurface flows, particularly addressing pressure variation in the subsurface within a given permeability field. The primary objective is to replace the numerical elliptic operator with a neural network operator, offering a novel approach to solving the elliptic partial differential equation governing single-phase Darcy flow. To construct an effective machine learning model, an extensive collection of case studies is essential to create training datasets. These datasets rely on parameters influenced by permeability, identified through sensitivity parameter analysis. Key parameters impacting permeability include pressure, flow rate, viscosity, area of grid block, and thickness of grid block. Recent research recommends solving partial differential equations (PDEs) using Physically Informed Neural Networks (PINNs). PINNs leverage the expressive power of neural networks while incorporating the physical laws described by PDEs. This combination allows PINNs to learn and approximate PDE solutions with relatively small datasets. Our study generates datasets through simulations on a 2D grid using a classical finite volume model for Darcy flow. A machine learning model is then constructed to capture pressure variation for a given permeability using neural networks and machine learning techniques. Optimal methods for training and validation are selected based on simulation data. Model accuracy is assessed and compared using graphical and statistical indicators, with emphasis on achieving low mean square error (MSE) and mean absolute error (MAE). The best-performing models are further validated through blind tests to evaluate accuracy and efficiency.

ID: NA05

Title: Study of non linear conformable fractional order reaction diffusion equation using cubic Hermite splines

Author(s): Abdul Majeed[1], Dereje Alemu Alemar[2], Shelly Arora[3]

Affiliation(s): [1]Punjabi University, [2]Jigjiga University, [3]Bolgatanga Technical University

Abstract: A nonlinear conformable fractional order reaction diffusion equation has been proposed to study numerically. Orthogonal collocation technique is merged with finite difference method to discretize the proposed equation. The spatial domain has been discretized using cubic Hermite splines as basis whereas time direction has been discretized using implicit finite difference technique. The proposed technique is found to be unconditionally stable and is convergent of order h^4 in space direction and of order Δt^2 in time direction. The proposed technique has been implemented on different problems to verify the results.

ID: AP34

Title: LiDAR and RGB Camera Fusion for Object Detection using Transformers

Author(s): Virendra Singh Kaira, Yogeshwar Singh Dadwhal

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Abstract: Sensor Fusion is the process of integrating sensory data from different information sources. Sensor fusion aims to mitigate limitations and errors associated with individual sensors and provide a more comprehensive understanding of the world. It enables these systems to operate effectively, make informed decisions, and respond to complex, real-world challenges. Sensor fusion offers several advantages that includes real-Time decision making, enhanced fault tolerance, holistic environmental perception uncertainty mitigation, and cross-domain applicability. Artificial perception methods rely on multiple modalities to overcome shortcomings of individual sensors. There are a wide range of sensors used by autonomous perception system passive ones, such as monocular and stereo cameras, and active ones, including LiDAR, radar and sonar. Fusing LiDAR and RGB Camera is a powerful approach that leverage the unique advantages of each sensor type, significantly improving a system's overall perception capabilities. The fusion of LiDAR and RGB

Camera for object detection requires a collaborative merging of visual and depth information. RGB cameras excel in capturing detailed colour images, providing a wealth of visual data, while LiDAR sensors employ laser beams to measure distances and analyse reflections, delivering precise depth information. This integration results in a holistic understanding of the environment. RGB data contributes a visually rich context, facilitating detailed object recognition based on colour and texture. Simultaneously, LiDAR enhances this understanding by providing accurate depth information, enabling the creation of a 3D representation of the scene. This integration proves particularly advantageous in scenarios with varying lighting conditions or where visual cues alone may be insufficient. LiDAR's ability to measure distances and detect objects, especially in low-light conditions or scenarios with occlusions, complements the limitations of traditional cameras. LiDAR and cameras as two sensors with different perspectives capturing the same environment. The challenge arises from spatial misalignment, where their viewpoints don't perfectly match. This misalignment can impact the precision of object localization – determining exactly where objects are in the combined data. Resolution disparities between LiDAR and camera sensors present another obstacle. Balancing the level of detail in the integrated data becomes paramount to avoid loss of information or the introduction of noise. Several Lidar and RGB camera based sensor fusion method are available broadly it is classified into three category early fusion based, intermediate fusion based and late fusion based. Early-fusion (PointPainting, SaccadeFork) methodologies aim to integrate information from images into point clouds before inputting them into a LiDAR-based system. Methods based on intermediate fusion (BEV pooling) work to combine image and LiDAR features at different points in the process of a LiDAR-based 3D object detector. This could happen in the backbone networks, during proposal generation, or at the RoI refinement stage. Late-fusion methods concentrate on combining information at the instance level and only merge outputs from different modalities. The typical approach of early-fusion methods involves sequentially combining various types of information and then detecting 3D objects. This sequential process adds extra time to the overall operation. Camera and LiDAR features inherently differ and originate from different perspectives, leading to challenges in fusion mechanisms and view alignments. Whereas late fusion based method don't utilize deep features from both camera and LiDAR sensors, they struggle to integrate diverse semantic information, limiting their potential. There is a good scope to increase the semantic info by using a good segmentation network and increase precision by introducing transformer based detector. The method we're exploring is early fusion based method which combines Lidar data with semantic details of RGB using a transformer based system for detecting objects. Here's how it works: first Lidar points are projected onto the results of a semantic segmentation network (DeepLabV3+ with MobileNetV3) designed for images. After that, we attach scores representing the object type to every Lidar point, basically adding a layer of information about what things are in the surroundings to the point cloud. This upgraded point cloud is then inputted into a Lidar-only transformer method for additional processing and object detection. The KITTI 3D object detection benchmark consists of 7481 training images and 7518 test images as well as the corresponding point clouds, comprising a total of 80,256 labelled objects. For evaluation, we compute precision-recall curves. To rank the methods we compute average precision. We require that all methods use the same parameter set for all test pairs. Mean Average Precision is used for evaluating the performance of the object detection framework. It measures how well model has detect object in image. mAP considers both precision and recall based on IoU(Intersection over union), providing a good understanding of the model's detection capabilities. Higher mAP means the model is better at recognize objects in image. This model has shown comparative result with state of the art models and can be explored further.

ID: AP37

Title: A Review on Approaches, Challenges for Aircraft Engines Prognostics from a Data Science Perspective

Author(s): Nalla Krishna, Bharath R, S.V.S.S.N.V.G. Krishna Murthy

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Abstract: Aircraft engines are intricate engineering systems integrated with multiple interconnected subsystems. They often operate for long periods under varying or harsh conditions. The malfunctioning of engines or the occurrence of anomalies is directly linked to their efficiency and affects the engine's life expectancy. Predicting the remaining useful life is a crucial aspect of Prognostic and Health Management, as it plays a significant role in maintaining equipment health, identifying faults, optimizing maintenance schedules, reducing costs, and ensuring the safety and reliability of aviation engines. In this paper, we briefly review some of the algorithms proposed in the literature in estimating the remaining useful life of the engines, open-source datasets available and used in the approaches, metrics used for analyzing the performance of the algorithms, challenges involved in particular to estimate the remaining useful life of the aircraft engines. In addition to the review, the latest advancements in Artificial Intelligence algorithms to estimate the remaining useful life of aircraft turbofan engines.

ID: DS13

Title: Computational study on 2D three-phase lag bioheat model during cryosurgery using RBF meshfree method

Author(s): Sushil Kumar, Rohit Verma
Affiliation(s): S. V. National Institute of Technology Surat

Abstract: Understanding heat transfer inside biological tissues, particularly heat transfer involving temperature reduction or elevation, is critical for many therapeutic behaviors such as cancer hyperthermia, burn injury, cryosurgery, cryopreservation, brain hypothermia resuscitation, disease diagnostics, and thermal comfort analysis. Cryosurgery, or cryotherapy, is a type of surgery in which abnormal tissue is destroyed by generating extremely low temperatures inside it with cryoprobes. Successful cryosurgery treatment requires the high cooling efficiency of cryoprobes for destroying target tumor tissues. To minimize the destruction of neighboring healthy tissue, proper knowledge of heat distribution is required for freezing treatments. There is a need for a good mathematical model and effective simulation techniques to predict the effectiveness of the therapy. The present study concerns the numerical study of phase change phenomena during cryosurgery using the three-phase lag (TPL) bioheat model in arbitrary soft tissue domains, i.e., circular (Γ_1), ameba-like (Γ_2), and multiconnected (Γ_3). We employ the effective heat capacity formulation to solve the nonlinear governing equation. The Gaussian radial basis function and Crank–Nicolson finite difference approximation are applied for spatial and time derivatives, respectively. Using the present algorithm, we study the impact of phase lag (τ_v) due to thermal displacement involved in the TPL model on phase change interface position and thermal distribution in all three domains. The obtained results may be beneficial in the field of oncology.

ID: DS14

Title: Lightweight Texture Classifier for Land-cover Classification on Low-resolution Remote Sensing Imagery

Author(s): Sakthipriya. G, Padmapriya N.
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Abstract: Remote sensing data has attracted considerable attention in classifying and mapping diverse land types, such as water bodies, urban areas, forest, and agricultural land. Some land-cover classes, such as different kinds of vegetation or water bodies, are particularly difficult to discriminate due to their identical spectral signatures. Texture of a land regions provides necessary information regarding its spectral characteristics by gathering unique spatial patterns. This paper analyses the effectiveness of a well-known lightweight texture classifier named the Parallel Texture Convolution

Neural Network (PTCNN) for land-cover classification. The proposed work examined the behaviour of five customized PT-CNN frameworks on three low-resolution land-cover datasets. Aerial Image Dataset (AID), PatternNet, and RSI-CB256 dataset are utilized to thoroughly study the effectiveness of the customized network. The classification accuracy is compared with several sophisticated state-of-the-art architectures. The findings shows that PT-CNN can effectively categorize low-resolution land-cover aerial images using less powerful system with limited memory.

ID: AP10

Title: Prediction of Surface Wettability with Water Droplet Placed on Smooth Surfaces using LSTM Models

Author(s): Ganesh Sahadeo Meshram
Affiliation(s): IIT Kharagpur

Abstract: Ascertained through the interaction between the liquid and the solid, surface wettability denotes a liquid's capacity to adhere to a solid surface. This property is predominantly impacted by the surface tension of the liquid and the properties of the solid. Surfaces can be classified into three distinct categories based on their wettability: hydrophilic, hydrophobic, and superhydrophobic. Surface wettability is a critical factor in tissue engineering, drug delivery systems, and medical implants, among other applications. Additionally, it is utilised extensively in solar panels, microfluidics, textiles, and surface coating materials. Experiments utilising conventional methods to determine surface wettabilities can be timeconsuming and expensive. Therefore, we present a novel approach that combines the deep learning methodology with the pseudo-potential lattice Boltzmann method to assess and forecast surface wettability. Initially, an LBM model is constructed to gather surface wettability data encompassing a multitude of parameters. When assessing wettability, the solid-fluid interaction parameter and droplet radius are taken into account. Then, for the performance evaluation, we conduct numerous experiments to determine which deep learning models have the highest R^2 score and Mean-Squared Error (MSE) using LSTM. We furnish comprehensive model designs that have the potential to expedite research in a multitude of engineering disciplines.

ID: AP25

Title: Data Delivery Based Adaptive Congestion Aware Load Balanceing Routing for Wireless Networks.

Author(s): Nidhi Rathor, Manvi Gupta, Maitreyee Vatsa, Deepak Arya, Vikas Arora, Bhupal Arya
Affiliation(s): Roorkee Institute of technology Roorkee

Abstract: Ad hoc networks tend to have congestion basically due to loss of packets, link failures, limited bandwidth. To recover from congestion, it costs lot of energy & time which ultimately degrades network performance. We have multiple techniques to minimize the effect of congestion. The major principle of the paper is to suggest a new routing protocol known as Load_Balanced_Congestion_Adaptive_Routing (LBCAR) protocol making use of random route point model in Mobile AdHoc Networks. In this paper, we are using adaptive load balanced routing technique with congestion control. A new hybrid protocol is proposed for congestion control as well as for best performance results. The proposed algorithm uses the techniques of metrics traffic density, routing path lifetime and link failure detection to increase the performance of network. The end results of proposed work are compared with the other routing protocol.

ID: OT04

Title: Invalidity of "Solving matrix games with hesitant fuzzy payoffs"

Author(s): Kirti, Tina Verma, Amit Kumar
Affiliation(s): Thapar Institute of Engineering & Technology Patiala

Abstract: Seikh et al. (Iranian Journal of Fuzzy Systems 17(4) (2020), 25-40) pointed out that there does not exist any method to solve triangular hesitant fuzzy (THF) matrix games (matrix games in which payoffs are represented by a triangular hesitant fuzzy element (THFE)). To fill this gap, Seikh et al. proposed a method, based upon an existing scalar multiplication, to solve THF matrix games. It is pertinent to mention that the existing scalar multiplication, used in Seikh et al.'s method, is only defined to find the multiplication of a positive real number with a THF element. While, in Seikh et al.'s method, there is need to find the multiplication of a nonnegative real number with a THF element. Therefore, the existing multiplication cannot be used in Seikh et al.'s method. However, Seikh et al. have used the existing scalar multiplication in their proposed method. Hence, Seikh et al.'s method to solve THF matrix games is not valid. To propose an expression for evaluating multiplication of a THF element with a non-negative real number and hence to propose a valid method to solve THF matrix games is a challenging open research problem.

ID: OT02

Title: Invalidity of arithmetic operations of interval-valued bipolar q-rung orthopair fuzzy sets

Author(s): Parul Tomar and Amit Kumar

Affiliation(s): Thapar Institute of Engineering & Technology Patiala

Abstract: Kamacı and Petchimuthu (Environment, Development and Sustainability (2022) https://doi.org/10.1007/s10668-022-02130-y), firstly, proposed interval-valued bipolar q-rung orthopair fuzzy number by generalizing the definition of an interval-valued q-rung orthopair fuzzy number (Journal of Intelligent and Fuzzy Systems (2018), 35(5), 5225–5230). Then, Kamacı and Petchimuthu proposed some arithmetic operations of interval-valued bipolar qrung orthopair fuzzy numbers. Thereafter, using the proposed arithmetic operations, Kamacı and Petchimuthu proposed weighted averaging aggregation operator and weighted geometric aggregation operator to aggregate interval-valued bipolar q-rung orthopair fuzzy numbers. Finally, using the proposed aggregation operators, Kamacı and Petchimuthu proposed a multicriteria decision-making method to select the best supplier in supply chain management problems. It is obvious that Kamacı and Petchimuthu's aggregation operators and multicriteria decision-making method will be valid only if the proposed arithmetic operations are valid. However, in this note, it is pointed out that the arithmetic operations of intervalvalued bipolar q-rung orthopair fuzzy numbers, proposed by Kamacı and Petchimuthu, are not valid. Hence, the aggregation operators and the multicriteria decision-making method, proposed by Kamacı and Petchimuthu, are not valid. Furthermore, it is pointed out that to propose valid arithmetic operations and hence, to resolve the invalidity of Kamacı and Petchimuthu's aggregation operators and multicriteria decision-making method are challenging open research problems.

ID: NA22

Title: Numerical Study of MHD Jeffrey Ternary Hybrid Nanofluid flow over a Porous Wedge with Surface Catalysed Reactions

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Abstract: The fusion of nanometre sized metallic or non-metallic particles with traditional fluid turnout to nanofluids. The upgraded nanofluids are the resultant of the union of two or more different types of nanoparticles with the traditional fluid. Following this, the fusion of three distinct types of nanoparticles possesses the ternary hybrid nanofluid. The ternary hybrid nanofluid have admired the investigators due to immense engineering applications. Jeffrey fluid is a non-Newtonian viscoelastic model which helps in the study of relaxation and retardation behaviours of fluids. This

fluid characterises the linear viscoelastic character of fluids, having wide application in polymer industries. In behalf of such broad applications in mind, the proposed study aims to provide a numerical simulation of heat and mass transfer of MHD Jeffrey Ternary Hybrid Nanofluid over a porous wedge with surface catalysed reactions. In addition, thermal radiation, activation energy with binary chemical reactions, thermophoresis and Brownian motion are being considered. Blood is used as the traditional fluid, while Single Walled Carbon Nanotube $(SWCNT)$, Silver (Ag) and Cupric Oxide (CuO) are the three nanoparticles. The numerical simulation utilizing shooting technique and the Runge-Kutta Fehlberg fourth-fifth order (RKF-45) scheme, enabled by MATLAB software, was conducted to describe the physical flow problem that has been modelled in similar differential equations. The physical engineering parameters like Skin Friction, Nusselt number and Sherwood number were calculated numerically. The impacts of interesting engineering parameters on velocity, temperature, and concentration along with the surface catalysed reactions of homogeneous and heterogeneous behaviours are presented through graphs and surface plots. The heat and mass transfer enhancement of upgraded nanofluids are being compared with the nanofluid, are presented in 3D bar plots. The computed result shows that the heat and mass transfer are highly appreciated in this ternary hybrid fluid flow than the previous upgraded nanofluids.

ID: DS26

Title: Construction of stable underwater sensor network using status unequal domination integrity in graphs

Author(s): G. Parvathy, P. Srinath and R. Sundareswaran
Affiliation(s): Srisivasubramaniya Nadar College of Engineering, Kalavakkam

Abstract: As underwater sensor networks (UWSN's) are proliferating, the surveillance and management of aquatic life beneath the waves is becoming increasingly savvy. The advent of the UWSN explores and analyses the ocean for various activities, including the detection of non-renewable energy sources, monitoring of marine pollution, surveillance and reconnaissance of the maritime border and navy, perceiving earthquakes and tsunamis, and so on. These networks are composed of a multitude of sensor nodes and vehicles deployed to execute collaborative tracking of events and scientific data gathering over a specific area. Located at varying depths and either anchored or unanchored in the ocean's bottom surface, these sensor nodes serve as both the data sender and receiver through an acoustic signal to the surface station. Such nodes are often vulnerable to a variety of malevolent assaults and security hazards, raising uncertainties about the network's connectivity. In such scenarios, consistent surveillance of the nodes that are vulnerable to be recognised for the smooth strengthen of network resilience. In this proposal, an endeavour has been made to construct the connected graph network for UWSN based on the acoustically linked sensor nodes and the vulnerable nodes are identified for the robustness of the network based on the status unequal domination integrity, which affirms that the network's connectivity is safe for the data transmission.

ID: NA26

Title: Capturing non-equilibrium effect in normal shocks within hypersonic flows: Insights from a two-temperature model

Author(s): Anil Kumar and Anirudh Singh Rana
Affiliation(s): Birla Institute of Technology and Science, Pilani

Abstract: In recent developments, an extended two-temperature model has been proposed to enhance the accuracy in describing flows within polyatomic rarefied gases. Derived through extended second-law thermodynamics, this model represents a significant advancement in

understanding the intricate dynamics of polyatomic gases. This study focuses on examining shock structure calculations using the newly introduced extended two-temperature model, with comprehensive comparisons made against experimental data, direct-simulation Monte Carlo (DSMC) solutions, and existing models in the literature. The midpoint method is employed to solve the system of ordinary differential equations. The objective is to assess the validity and reliability of the extended two-temperature model, particularly in contrast to alternative approaches, and to explore its effectiveness in capturing the nuanced behavior of polyatomic rarefied gas flows. The outcomes of the present model equations for Nitrogen gas are compared with DSMC simulations and experimental results, considering Mach numbers up to 10.

ID: NA23
Title: Study of hybrid nanofluid flow over stretching wedge with suction effect
Author(s): Renu Jindal, Kushal Sharma
Affiliation(s): Malaviya National Institute of Technology, Jaipur

Abstract: The study of fluid flow and heat transfer over a wedge is very crucial in various engineering problems such as aerospace engineering, automotive design and heat exchanger design etc. The present paper investigates the effect of suction and blowing over the stretching wedge conveying ternary hybrid nanoparticles in the presence of viscous dissipation. The findings of this paper also highlight the effect of different concentrations of the considered nanoparticles assuming the total concentration of the mixture as constant. The mathematical model for this problem is solved with the help of similarity transformations and then solved numerically with the help of bvp4c package in MATLAB. It is observed that when we increase the concentration of MgO nanoparticle in the ternary hybrid nanofluid, temperature rise up as compared to the case when we increase the concentration of $Al \wedge TiO_2$ nanoparticles. Also, temperature falls down with the increase in suction and rise up with increase in blowing. The values of skin friction coefficient and Nusselt number also decrease with the increase in blowing parameter. Moreover, the flow is boosted with an increase in the wedge angle when stretching parameter $\lambda = 0.2$, and depressed when $\lambda = 2.2$.

ID: NA24
Title: Generalized power-law model of hybrid non-Newtonian nanofluid with Cattaneo-Christov heat flux, thermal radiation, and convective boundary condition
Author(s): Jyoti Deshwal and Santosh Chaudhary
Affiliation(s): Malaviya National Institute of Technology Jaipur

Abstract: A computational study of heat and mass transfer of magnetohydrodynamic (MHD) flow of a viscous non-Newtonian fluid past a stretching surface has been taken into account. A generalized power-law fluid model has been employed to incorporate the non-Newtonian behavior. Cattaneo-Christov heat and mass flux model has been used to study thermal and mass transport. Hybrid nanofluid has been used to increase the thermal performance. The impact of thermal radiation, Ohmic heating, and convective boundary condition has been scrutinized. Governing equations have been transformed into ordinary differential equations by similarity transformation. Numerical scheme bvp4c in Matlab has been applied to find the numerical solutions. Consequences of various controlling parameters on velocity, temperature, and concentration have been reported by graphs and tables. Analogy of the presented results with previously published data has been established.

ID: AP33
Title: Surveillance Video Summary Generation Using Transformers
Author(s): Chandra Prakash and Bharath Ramkrishna
Affiliation(s): Defence Institute of Advanced Technology, Pune

Abstract: The scale at which the cameras are used for surveillance leads to the generation of large

volumes of video data. Manually reviewing hours of these video footage is infeasible which may lead to missing some critical events. To address this issue, we propose a novel deep learning based transformer architecture, which can summarize the entire surveillance video. The output of the proposed algorithm will be a text document explaining the critical events that occurred in the video. The proposed algorithm will capture both temporal and spatial information from video sequences highlighting key events and activities while discarding redundant or irrelevant events. The proposed model leverages the strengths of the attention mechanism in Transformers in handling long sequences and capturing complex relationships between frames, leading to concise and informative summaries. In the proposed algorithm, firstly, we extract important keyframes in the form of images from the video using keyframe selection techniques. Thereafter, we feed these images to a transformer-based image captioning model, which will generate text captions for these images. Finally, we apply text summarization techniques to the textual descriptions obtained in the previous step to generate coherent, fluent sentences summarizing the video segments. The experimental evaluation of the proposed approach will be conducted on diverse datasets, such as MS COCO and Flickr, using established metrics like BLEU, METEOR score for assessing the quality of the generated summary.

ID: DS01
Title: Utilizing deep learning for identification of various placental cell types
Author(s): Sivappriya K, PratitiBadra, and N. Sukumar
Affiliation(s): Amrita Vishwa Vidyapeetham,Coimbatore

Abstract: Primary function of the placenta is to provide essential life support and nourishment to the developing fetus during pregnancy. Identification of placental cell types is crucial for understanding the complex structure and functions of the placenta during pregnancy. The placenta is a temporary organ that plays a vital role in supporting fetal development and maintaining a healthy pregnancy. Histology utilizes microscopic examination and staining methods to distinguish placental cell types, providing valuable insights into their structure, function, and potential presence of abnormalities. In this context, deep learning can facilitate placenta cell type identification by autonomously analyzing histological images, recognizing intricate patterns, and providing accurate classifications, aiding in research and diagnostic applications.Develop a proficient Deep learning model to identify different types of placental cells from histology images.We introduce a model based on vision transformers designed for the identification of five distinct placenta cell types: cytotrophoblast, fibroblast, Hofbauer, syncytiotrophoblast, and vascular. The proposed model achieves a test accuracy of 88.10%, demonstrating an increased HOF accuracy of 77%, surpassing the previous 73% with the implementation of up-sampling. Additionally, we evaluated various deep learning and machine learning models for comparison with our proposed approach. Hofbauer cells (HOFs) are important in the placenta for their potential contributions to immune regulation, phagocytosis, and the support of fetal development through cytokine production. Alteration in the quantity of HOFs contributes to certain pregnancy-related disorders or complications, such as intrauterine infections, preeclampsia, and other placental pathologies. The proposed deep learning model will facilitate the diagnosis and treatment of deficiencies in Hofbauer cells efficiently.

ID: DS08
Title: Predicting NIFTY50 index price using machine learning models
Author(s): Shubhangi Porwal, Namita Srivastava, Manoj Jha
Affiliation(s): Maulana Azad National Institute of Technology (MANIT) Bhopal

Abstract: Artificial intelligence (AI) has become more and more popular in the finance sector in modern era. The advancements in artificial intelligence in recent times, including machine learning techniques, have made the process of optimizing target values more straightforward. As a result, a

number of academics, traders, and investors started using artificial intelligence in different kinds of option pricing. In contrast to traditional parametric methods, non-parametric approaches for option pricing have been found to offer higher prediction quality and need less computing time. Calculating the price of an option is thought to be one of the trickiest financial problems. Option pricing accuracy and profitability could be greatly increased by using machine learning (ML) models, especially when combined with huge amounts of high-quality data and cautious validation and interpretation. In this article we are using machine learning models for option pricing on the National Stock Exchange FIFTY. In order to forecast the closing values of the National Stock Exchange FIFTY (NIFTY50) index, the study compares two machine learning models: Random Forest (RF) and Support Vector Regression (SVR). The basic assessment measures, Root Mean Square Error (RMSE), Mean Absolute error (MAE), Mean Square error (MSE), Mean Absolute Percentage Error (MAPE) and R-Squared (R^2), are used to compare the performances of the models. For pricing European-style options, the experimental findings demonstrate that machine learning models—like the random forest—perform better with sufficient precision also high prediction accuracy and excellent fit is offered by the RF model design. This is the capable method for predicting NIFTY50 index price hence is potentially suitable for option pricing for financial sector.

ID: NA25

Title: Heat Mass Transport of Unsteady Convective MHD Flow over a Stretching Porous Sheet under thermal Radiation and Temperature Dependent Thermal Conductivity with Chemical Reaction

Author(s): Ambrish Kumar Tiwari[1], Matsyendra Nath Shukla[2], Priyanka Kaushal[3]
Affiliation(s): [1,2]Rajkiya Engineering College, Mainpuri, [3]Chandigarh Engineering College-CGC, Landran (Mohali)

Abstract: In this paper, the problem of unsteady convective MHD flow over a stretching sheet in a fluid through a porous medium with chemical reaction under temperature dependent thermal conductivity and thermal radiation is considered. The coupled non-linear governing equations for momentum, thermal energy and mass diffusion are first transformed into ordinary differential equation via similarity transformations and their numerical solution is obtained using the numerical shooting technique with fourth-fifth order Runge-Kutta method under the associated boundary conditions. The interesting outcomes for variant physical parameters are exhibited through plots and numerical tables. Comparison with known results is presented and it is found excellent.

ID: NA19

Title: Numerical Approaches for Study of the Nonlinear Klein Gordon Equation

Author(s): Aditi Singh[1], Nadeem Malik[2], Sumita Dahiya[3]
Affiliation(s): [1]Dayalbagh Educational Institute, [2,3]Netaji Subhas University of Technology

Abstract: The present manuscript deals with the nonlinear Klein-Gordon equation which is a relativistic wave equation describing the interaction of scalar fields in quantum field theory, relativistic quantum mechanics, plasma physics and condensed matter physics etc. The inclusion of a higher-order nonlinear term poses a challenge to numerically simulate the solutions of K-G equation. In this paper, we present a methodology to construct approximate solutions of the K-G equation by a fourth order collocation method that utilizes the cubic B-splines functions. Crank-Nicolson scheme has been used for time discretization and non-linearity has been dealt with using the quasi-linearization techniques. This manuscript provides a systematic way to calculate and classify approximate solutions of the K-G equation. We include some well-known special cases such as solitary waves and periodic waves, along with the analysis of certain properties that may be useful for further investigations of the nonlinear phenomena associated with this PDE. Comparing our results with the exact solutions or with solutions obtained via alternative numerical methods, the

efficiency and accuracy of our approach has been verified for several numerical test problems.

ID: AP28
Title: Physics-informed neural networks: A deep learning approach for solving porous medium and Korteweg-de Vries equations
Author(s): Pavan Patel, Saroj R.Yadav
Affiliation(s): SVNIT SURAT

Abstract: A popular area of study in mathematics is the study of partial differential equations. PDEs solution is a crucial and challenging problem among them. PDEs are frequently solved using numerical techniques, as many partial differential equations lack analytical solutions. Researchers are always looking for novel approaches to solving partial differential equations, even though numerical methods have been applied extensively and have shown good results. In several domains, including image classification and natural language processing, deep learning has seen significant success in recent years. Deep neural networks are a promising tool for studying partial differential equations because of their strong function-fitting capabilities. Physics informed neural networks (PINNs) have enabled significant improvements in modeling physical processes described by partial differential equations (PDEs), and capable of modeling a large variety of differential equations. PINNs are based on simple architectures and learn the behavior of complex physical systems by optimizing the network parameters to minimize the residual of the underlying PDEs. In this paper, Physics-Informed Neural Networks (PINNs) are presented with the aim of solving higher-order PDEs. Indeed, this deep learning technique is successfully applied for solving PDEs, namely the well-known second order Porous medium equations, and third-order Korteweg-devries equations. Basically, porous medium equations are nonlinear evolution equations of parabolic type, which appear in the description of different natural phenomena related to diffusion, filtration, or heat propagation. Korteweg-devries equations are nonlinear partial differential equations emerging in the study of a variety of different physical systems, e.g., water waves, anharmonic lattices, plasma physics, and elastic rods. It depicts the long-term development of dispersive waves with modest but finite amplitude. In addressing the forward problem without the need for additional labeled data within the domain's interior, we employ the Physics Informed Neural Networks (PINNs) strategy. Our model integrates Mean Squared Error (MSE) loss, the Adam optimizer and computes gradients through backward propagation. The implementation of PINNs yields commendable results, and we substantiate the accuracy of these outcomes by validating them against exact solutions. This approach not only streamlines the process but also ensures the robustness and reliability of our model in solving complex problems without the reliance on extensive labeled data within the domain.

ID: DS30
Title: Missing Data Imputation using Data Depth
Author(s): Mahesh Shivaji Barale
Affiliation(s): Central University of Rajasthan, Ajmer

Abstract: The results of the machine learning models depend on the quality of the data used for building the model. There are multiple issues with massive data like missing values, inconsistent observations, etc. Such problems occurring frequently while performing data science tasks. Imputing these missing values are required before performing modeling. The present work focusing on the dealing with missing values with help of the data depth based missing data imputation procedure. A multivariate data depth measure which assigns the central outward ranking to the multivariate observations and useful for checking different aspects of the multivariate data. The proposed method utilizes the concept of the data depth for imputing the missing observations in multivariate data. The performance of the proposed method was compared with the existing

methods through simulated and real-life data sets.

ID: NA11

Title: Love-type wave propagation in piezo-magnetic fiber-reinforced Composite layered structure with magnetically high and weak conducting imperfect interfaces

Author(s): Pratiksha Singh, Abhishek Kumar Singh

Affiliation(s): Indian Institute of Technology (Indian School of Mines) Dhanbad

Abstract: The present paper deals with the micro-mechanical modeling of a piezomagnetic fiber-reinforced composite structure (PMFRC) using analytical techniques of Strength of Materials and Rule of Mixtures. Thereafter, the propagation of Love-type wave in a layered stratum-substrate structure comprising of distinct PMFRC stratum and PMFRC substrate with two imperfect interfaces viz., a mechanically complaint magnetically highly conducting interface and mechanically complaint magnetically weakly conducting interface, which accounts for various real-life engineering applications, has been studied. The closed-form expressions of the dispersion relations have been established to enlighten the impact of various parameters like volume fraction and magneto-mechanical coupling on the phase velocity of Love-type wave. Numerical results and graphical demonstration have been carried out and validated with the extant literature and have been found to be in well agreement as a special case of the problem.

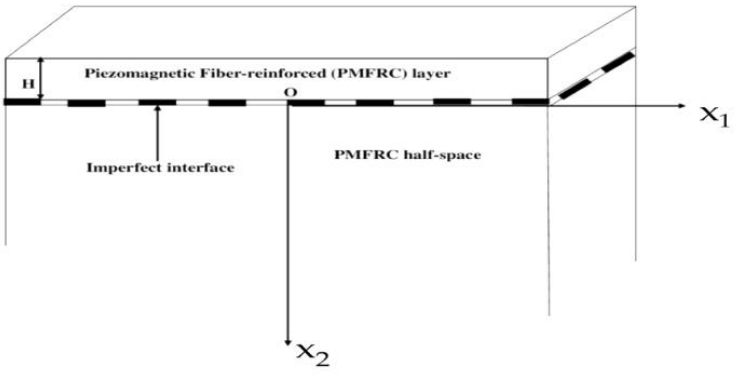


Figure:- Schematic of the layered Stratum-Substrate Structure

To formulate the problem, we have used strength of material and rule of mixture techniques to derive the effective material constants of PMFRC. Further, governing equations of motion with imperfect boundary conditions for wave propagation as per considered geometry has been established. Separation of variable method has been employed to solve the arising second order linear differential equation to derive the closed form of dispersion relations. Analysis of various parameters like fiber volume fraction and magneto-mechanical coupling on phase velocity is conducted. The study founds its application in improving the performance of various SAW devices.

ID: NA12

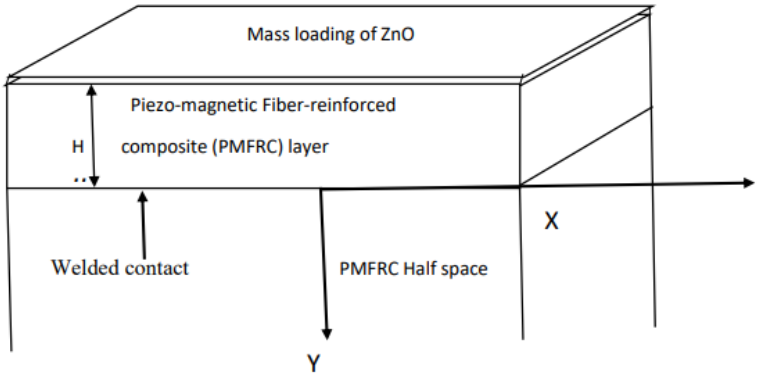
Title: Love-type wave propagation in PMFRC composite structures with mass loading sensitivity

Author(s): Aditya Kumar Kanaujiya and Abhishek Kumar Singh

Affiliation(s): Indian Institute of Technology (Indian School of Mines), Dhanbad

Abstract: The study of dispersion of waves refers to the phenomenon where different components of wave, such as different frequencies or wavelengths, travel at different speeds in different mediums under different conditions. This paper aims to study the Love-type wave propagation in stratum-substrate structures with welded contact comprising of distinct piezomagnetic

fiberreinforced composite (PMFRC) materials. Closed-form expressions of the dispersion relations have been established when the air is overlying the stratum-substrate structures (case 1) and when there is mass loading on the uppermost surface of stratum (case 2). The impact of the fiber volume fraction in layer and half-space on phase velocity in both case 1 and 2 is studied under magnetically open and shorted conditions. For the sake of validation, obtained result has been matched with classical and pre-established results as a special case of the problem. The findings of this study are useful in communication system, and in designing wave devices like sensors and actuators.



In the existing literature, Love-type waves in piezomagnetic fiber reinforced layered structures with mass loading has not been explored till date. Authors attempt to fill this research gap through the present study. To formulate the problem we have used strength of material and Rule of Mixture techniques to derive the effective material constants of PMFRC. Further, governing equations of motion with boundary conditions for wave propagation as per considered geometry has been established. Separation of variable method has been employed to solve the arising second order linear differential equation to derive the closed form of dispersion relations.

ID: DS05
Title: A Novel Security Framework for Secret Data Sharing using Deep Learning and Visual Cryptography
Author(s): Ilaiah Kavati and Aditya Vinod Mirajkar
Affiliation(s): National Institute of Technology Warangal

Abstract: Transmitting sensitive data has been a challenge these days due to the increase in number of cyber attacks. Sensitive data can be referred to any data which can cause harm to someone's identity or can leak some information. Initially for this purpose the method of Reversible Data Hiding was used. This allowed sharing data in a way that only the intended recipient can extract it. Further the cover image was also encrypted to provide more security as now the malicious user cannot access the plain text cover image with embedded data. But the proposed solution aims to embed the data within the image using deep learning methodology. The proposed framework uses an encoder network which takes a cover image and secret data as input and outputs a steganographed image. To add more security, the proposed solution also makes use of the concept of visual cryptography. The proposed solution aims to protect confidentiality and integrity of the sensitive data. On the receiver side a decoder network will help to extract the data from the received stego image and the receiver can access the secret data.

ID: NA01
Title: Numerical Simulations for Time-Fractional Black Scholes Equations
Author(s): Neetu Garg[1], A.S.V. Ravi Kanth[2]
Affiliation(s): [1]National Institute of Technology Calicut, [2]National Institute of Technology Kurukshetra

Abstract: The purpose of this paper to develop an efficient numerical algorithm for the time-fractional Black-Scholes model governing European options. The proposed method comprises the Crank-Nicolson method to discretize time variable and exponential B-spline approximation for space variable. The proposed method is unconditionally stable. We present few numerical examples to confirm the theory. Numerical simulations with comparisons exhibit the superiority of the proposed algorithm.

ID: AP14
Title: Innovative AI-Based Fault Diagnosis in Commercial Induction Motors through Advanced Computational Techniques
Author(s): Bhavishya, Nikhar, Sudhendu and Asim Tewari
Affiliation(s): Indian Institute of Technology, Bombay

Abstract: Machine condition monitoring has become increasingly significant in the domain of commercial electronic appliances for enhancing motor reliability, minimizing potential production losses and operational disruptions, and reducing repair time. This paper introduces a complete multimodal fault diagnosis pipeline for induction motors. An extensive (largest in the domain) dataset of fans and pumps is obtained, encompassing a wide range of parameters, including current, vibration, magnetic field, rpm, pressure, etc. Various signal processing techniques, along with machine learning algorithms, are utilized to deal with the high-dimensional-low-sample-size (HDLSS) behavior of the data. Results from all modalities are processed, and Distributed optimization and parallel computing are performed to find the frequency bands responsible for various kinds of faults. The findings contribute significantly to the advancement of machine condition monitoring and have the potential to revolutionize the electronic and automobile industries, paving the way for further research in advanced fields like AI-based machine prognostics and advanced computational algorithms for high dimensional low sample size data.

ID: NA29
Title: Thermal nonequilibrium convection in a nanofluid saturated porous enclosure
Author(s): Brinda R.K. and Saravanan S.
Affiliation(s): Bharathiar University, Coimbatore.

Abstract: Energy is neither created nor destroyed yet the global demand for it increases. Energy requirement in our society which teams with heat transfer problems are not so uncommon. Energy efficiency has been one of the tested and tried method to address the issue and it is also omnipresent necessity in every field of engineering. Be it energy source or energy storage or energy consumption, it is undeniable that one always covet for energy efficiency. With the recent advancement in material engineering the designing of equipment can felicitate to almost meet the requirements. However the challenge lies in the modeling and study of the transport of mass momentum and energy in the physical system which becomes complex, interesting and yielding. Recent trends indicate most studies have been reported the use of nanofluids in porous medium to address the heat transfer enhancement as porous material are common and one can have liberty over the colloidal suspensions(nanoparticles) depending on the thermophysical property requirement for the system. Accurate description of fluid flow behaviour in the porous media is essential to the successful design and operation of equipments in various engineering disciplines. In this accord natural convection in a nanofluid saturated porous medium has been studied extensively owing to its numerous applications in geophysical systems and engineering industries. Post accident heat removal (PAHR), Thermal storage systems, design of porous insulation for a nuclear power reactor core and heat transfer from chips via porous metal foams are just few wherein thermal natural convection occurs in porous media. The large number of recently published papers and review articles on fluid flow through porous media demonstrate clearly that this area of fluid

mechanics is studied extensively. The aim of the present work is to study the influence of heat generation on natural convection flow in a square enclosure filled with a nanofluid-saturated porous medium by considering Buongiorno model and by adopting a two-temperature model for heat transfer.

ID: NA30

Title: An efficient numerical technique to Study sine-Gordon Equation with Collocation Method using Hermite Splines

Author(s): Priyanka, Shelly Arora, Saroj Sahani
Affiliation(s): Punjabi University, Patiala

Abstract: Over the past few years, sustainability has been one of the most discussed topics considering the environmental conditions and government mandates. There are numerous segments where the concept of sustainability is being implemented by industries. This paper majorly talks about "Sustainable Packaging" across three major industries i.e., FMCG, Fashion, and Pharmaceutical by considering consumer's buying behaviour. Even so, there has been much anticipation on a few industry-specific consumer decision-making for green packaging but still, there have never been any direct comparisons considered between these major booming sectors. The main objective is to identify attributes responsible for impacting buying patterns across different age groups, people with various education levels, and how their occupation and city of residence set things apart for everyone. Logistic Regression is used to identify the impact of the said independent variables i.e., age group, gender, level of education, residency, occupation, price, and quality (aesthetics) of the product, and the direct effect of campaigns/ influencer marketing. Primary data for the same was collected considering 03 major focus groups namely "teen agers living alone, youngsters to old age personnel for FMCG", "Working married women with their infants, and old retired/ pensioners for Pharmaceutical" and lastly the "Fashion industry working professionals/ influencer or fashionista with prior knowledge of green packaging and have deep pockets: residing in Tier 1 or premium cities". To grasp the influence of omitted variable bias all the variables were regressed individually as well as clubbed together to figure out the combined significance. As a result, "Quality (make/aesthetics)" and "Occupation of an individual" were the most prominent attributes. Furthermore, a comparative analysis of these 03 sectors was executed to understand and make the companies aware of how to stand and invest more in which industry to earn profits and get an edge over their competitors.

ID: AP36

Title: Analysis of Consumer Awareness about Certified Labels in the Beauty and Personal Care Industry (Using Analytics)

Author(s): Amrutha Varshini
Affiliation(s): Indian Institute of Management Kashipur

Abstract: The growing demand for credible beauty products necessitates navigating the intricate realm of green claims and labels. This research explores consumer perceptions and awareness of certified labels, aiming to bridge the gap between consumer expectations and brand offerings. Leveraging decision tree models, we delve into the complex interplay of demographic and lifestyle factors influencing consumer choices.

ID: DS23

Title: HT-EEGAN: Hilbert Transformed Generative Adversarial Network for Effective Removal of Artifacts from EEG Signal

Author(s): Banovoth Raja Sekhar, K V Kadambari
Affiliation(s): National Institute of Technology Warangal

Abstract: A Brain-Computer Interface (BCI) is a system that processes cerebral activity based communication between the brain and external devices. BCI has found its finding extensive usage in fields like Neurorehabilitation, Neurological disorders, Prosthetics, etc. To capture the cerebral activity of human brain Electroencephalography (EEG) stands out as one of the most used noninvasive methods. Despite being the most used technique for acquiring signals, EEG captures artifacts due to the non-linear nature of humans, physiological movements. These artifacts may be generated from various sources like blinking of the eye, muscle and heart movements as well as non-stationary nature of signals, which diminish the performance of BCI. Therefore, removal of these artifacts from the EEG signal is a major challenge. To tackle the aforementioned problem, we propose an effective way of noise-removal technique called Hilbert Transformed Generative Adversarial Network (HT-EEGAN). In the proposed model, Hilbert transformation is used as the pre-processing step that converts real-valued time series to complex-valued time series data. The complex valued data is then fed into Generative Adversarial Network (GAN) for further processing. GAN contains two components Generator and Discriminator. The Generator uses the Convolution Neural Network (CNN) in which Gaussian distribution is incorporated for additive noise to generate synthetic data closely resembling the real counterpart. The second component of GAN, the Discriminator utilizes CNN and tries to discriminate between the original input i.e. HTtransformed signals and the synthetic dataset generated from the Generator. Doing so, results in removing outliers and noisy artifacts present in the original signal. The performance of the model is compared with the existing models on three different datasets showing promising results and reduced Root Mean Square Error (RMSE) along and Signal-to-Noise Ratio (SNR) metrics.

ID: NA33

Title: Model To Study Interdependent Calcium and IP3 Distribution Regulating NFAT Production in T Lymphocyte.

Author(s): Hemant Bhardwaj

Affiliation(s): Sardar Vallabhbhai National Institue of Technology

Abstract: The cooperative system of calcium (Ca^{2+}) and inositol 1,4,5-trisphosphate(IP3) plays a crucial role in maintaining the structure and functions of T lymphocyte cells including the production of Nuclear factor of activated T cells (NFAT) as an immunological response. NFAT regulates several mechanisms and dysregulation in this process can lead to various disorders like inflammatory bowel diseases etc. In this study, the two-way feedback model of Ca^{2+} and IP3 dynamics regulating NFAT production in T ymphocytes has been constructed. A system of nonlinear reaction-diffusion equations for calcium and IP3 for a one-dimensional case have been employed in this proposed model. The numerical simulation is performed using finite element and the Crank-Nicholson method. The effects of the parameters like Ryanodine Receptor(RyR), source amplitude and buffers on active NFAT production have been analyzed. The novel insights about regulatory and dysregulation events and mechanisms of Ca^{2+}, IP3 and NFAT are concluded from these results.

ID: DS19

Title: Integrating GRACE Satellite Data and Machine Learning for Groundwater Level Analysis and Prediction in the state of Uttar Pradesh, India: A Way Forward

Author(s): Mridul Sharma, Prahlada V. Mittal, Kaustubh Raj, Mohd. Taqi Daqiq, Anuradha Karunakalage, Ravi Sharma

Affiliation(s): IIT Roorkee

Abstract: In pursuit of a comprehensive analysis of groundwater dynamics in the state of Uttar Pradesh, India, this study integrates Gravity Recovery and Climate Experiment (GRACE) satellite data and machine learning approaches for groundwater level (GWL) analysis and prediction, charting a

progressive course for water resource management. Leveraging the continuous data stream from the GRACE mission, we used a GRACE-derived Groundwater Storage Anomaly (GWSA) dataset from 2002 to 2021. While GRACE satellites provide a valuable panoramic view of large-scale changes in total water storage (TWS), including groundwater, the necessity for direct measurements of GWL persists. The GWL measurement offers a more nuanced and detailed understanding of aquifer conditions at local and regional scales, capturing insights beyond the scope of satellite data alone. Real-time monitoring of GWL is pivotal for swift responses to dynamic changes induced by factors such as pumping, climate variations, or contamination events. Furthermore, GWL measurements contribute crucial information for evaluating aquifer recharge patterns, thereby facilitating an assessment of water resource sustainability. The limitation on resources and facilities by the groundwater management authorities cause a lack of consistent data measurement over the year. In the state of Uttar Pradesh, the GWL data is observed in two seasons (pre-monsoon and post-monsoon). With this, the data GWL data is not available on the other months of the year. To address this, Machine learning algorithms, a subset of data science play a pivotal role in developing predictive models for groundwater level estimation using GRACE data and known GWL data. Data science methodologies provide tools for cross-validation and model evaluation, helping you assess the performance of your predictive models. It also provides methods for quantifying uncertainty in predictions associated with groundwater level that can be crucial for decision-making and risk assessment. This research aims to explore the feasibility of leveraging Gravity Recovery and Climate Experiment (GRACE) satellite data to predict groundwater level changes in the Uttar Pradesh region, with the overarching goal of enhancing sustainable water resources management. In addressing this challenge, machine learning algorithms, a subset of data science, assume a pivotal role in constructing predictive models for GWL estimation. These models utilize both GRACE data and known GWL data. Leveraging the capabilities of data science methodologies, the research incorporates tools for cross-validation and model evaluation, enabling a thorough assessment of the predictive models' performance. Moreover, this study provides robust methods for quantifying uncertainty in predictions associated with GWL, an aspect crucial for informed decision-making and risk assessment. This study aims to delve into the feasibility of harnessing GRACE satellite data for predicting groundwater level changes in the Uttar Pradesh region. The overarching objective is to contribute to the enhancement of sustainable water resources management through the integration of advanced machine-learning techniques and satellite-derived information. Furthermore, the findings will offer critical perspectives on the limitations and uncertainties associated with using GRACE data for predicting groundwater level changes, thereby informing future research directions and methodological refinements.

ID: NA36

Title: Numerical simulations of 2D unsteady advection-diffusion equation utilizing a meshfree approach based on radial basis functions and differential quadrature method.

Author(s): Sanjay Kumar

Affiliation(s): Bennett University

Abstract: In this article, the authors proposed a meshfree approach for simulation of 2D unsteady advection diffusion equation. There are various applications of convection and diffusion phenomena in science and engineering, such as in-fluid dynamics, hydraulics, groundwater pollutants, oil reservoir flow, chemical separation process, modeling of semiconductors and transport of air. First of all, spatial derivatives are discretized by using local radial basis functions based on differential quadrature method (LRBF-DQM) and, subsequently, the obtained system of non-linear ordinary differential equations (ODEs) is solved by fourth-order Runge–Kutta (RK-4), RK45 and Admoian Decomposition methods. The stability analysis of the proposed approach is discussed by the matrix method. Numerical experiments ensure that the proposed approach is accurate and computationally efficient.

ID: OT08
Title: Parallel-series data envelopment analysis: Efficiency evaluation of banks
Author(s): Alka Arya
Affiliation(s): IIM Kashipur

Abstract: This paper incorporates the parallel-series data envelopment analysis (DEA) approach to measure the overall, system (stage), and sub-stage efficiencies in the Indian banking sector. In order to show that public sector banks in India are less efficient than private sector banks, the research will concentrate on the internal operations of both public and private banks when there is missing, undesirable, or negative data. The two stages of bank operations are profit and premium acquisition. The deposit and income-generating activities are connected in parallel during the premium acquisition stage. These connections are made in series to reach the profit stage. The following are the research objectives to follow:
What are the financial efficiency ratings of Indian banks in the case of missing, undesirable, and negative data where internal processes are connected in two stages (parallel series)?
Did public and private banks' financial efficiency ratings differ significantly during the study period?
Are the means of the efficiencies of the banks in the public and private sectors the same during the research period?
The outcome reveals that Indian banks' efficiency metrics range from 0.0045 to 0.8242. In order to improve bank efficiency in India, this analysis would present a fantastic opportunity to further streamline the production process. According to the results, NBL Bank has the lowest efficiency at (1-0.8242) 17.58 percent, while SIBL Bank has the highest efficiency at 99.55 %. The presented models yield several intriguing conclusions. For instance, the LVBL bank's inefficiency in its deposit and income-producing operations prevents it from being efficient at the premium acquisition stage. It is interesting to observe that this bank is efficient at the premium acquisition stage, while the PASB bank is inefficient at operations that generate money. On the other hand, it seems that while UBI and SBI banks are effective at deposit-producing activities, they are inefficient at the premium acquisition stage. Conversely, the bank IndusInd, while effective in its revenue-generating activities, is inefficient when it comes to premium acquisition. These specifics are essential for improving system-wide operational efficiencies as well as stage-specific (deposit, income, and profit operations). These findings also suggest that if the internal mechanisms of the first stage are taken into consideration, the coordination of the system is evaluated with a superior efficiency performance.

ID: OT23
Title: Optimal Hardware Generation for Neural Network Acceleration
Author(s): Rohit T P, Vaishnav Vimal, and Sasi Gopalan
Affiliation(s): Cochin University of Science and Technology

Abstract: The advancement of neural network acceleration has predominantly hinged on software optimizations tailored for general-purpose hardware. This research introduces an innovative methodology to generate custom hardware modules, specifically optimized for executing neural network models. These modules are designed such that they can be directly synthesised without any modification on hardware devices like FPGAs. The approach involves transforming a trained neural network model into an optimized Verilog code, specifically designed to complement the model's structure and trained weights. The process unfolds in three distinct steps: Complexity Reduction, Parallelization, and Implementation/Code Generation. In the Complexity Reduction phase, a novel approach for model quantization is introduced. Instead of the standard practice of uniform quantization across the network, each neuron is quantized independently, preserving only the necessary bits of precision. This method involves a specialized extra epoch after training to determine the range of activation at each neuron, which in turn informs the required bit length. The

process also identifies and removes 'dead' neurons, and merges neurons with approximately the same activations for all inputs, optimizing the hardware footprint and energy efficiency. The Parallelization step involves a more intricate analysis of the optimized network. The objective is to identify components of the network that can operate in parallel, this enables the efficient utilization of the parallel nature of FPGA-like devices. This is achieved by constructing the dependency graph of the network. The graph is then analyzed, and edges are selectively pruned where parallel processing can be introduced without markedly affecting the network's output. This process results in a series of disjoint graphs, each representing a segment of the network that can be processed concurrently. The identification of these parallel segments is a crucial step, as it directly influences the efficiency and speed of the resulting hardware implementation. Relevant literature on neural network optimization for FPGA implementation and efficient neural network inference provide context and validation for these techniques. In the final phase, Implementation/Code Generation, the discrete graph elements are translated into corresponding Verilog units. Nodes with two or fewer connections are realized through combinational logic, while more complex nodes are developed as separate Verilog modules. The network graph is then restructured into a unified graph, incorporating special nodes that signify a set of input and output points. The edges of this graph are weighted according to the cumulative signal time delays of each node. A critical aspect of this phase is ensuring uniformity in the edge weights to guarantee consistent signal propagation. In cases of weight discrepancies, additional dummy nodes are introduced to balance the uneven edges. This graph is then used to directly generate synthesizable Verilog code for a given hardware constraint. The method of directly producing synthesizable Verilog code for arbitrary neural networks aims to significantly simplify the hardware design process that is required to create custom accelerator cards. The method proposed can be used in developing accelerator boards that are highly customised to specific use cases or as a low-cost redundancy for systems that require high availability.

ID: AP08

Title: Analyzing the Impact of Modulation Transfer Function (MTF) on Computer Vision: A Multi-Faceted Exploration

Author(s): Varsha Shaheen , Karthik P, and Sasi Gopalan

Affiliation(s): Cochin University of Science and Technology, Kalamassery

Abstract: This research paper delves into the relationship between Modulation Transfer Function (MTF) and its apparent impact on computer vision, particularly in the fields of image perception and detection accuracy. Our research bridges the fields of optical engineering and data science, providing unique insights on how variations in MTF can affect the accuracy of computer vision algorithms across different cameras and fields of view. Central to our analysis is the mathematical representation of MTF, which is defined as the magnitude of the Optical Transfer Function (OTF). The OTF itself is a Fourier transform of the Point Spread Function (PSF), which describes the response of an imaging system to a point source. Mathematically, this relationship is expressed as:

$$MTF(\lambda_f) = |OTF(\lambda_f)|$$
$$OTF(f) = F\{PSF(x)\}$$

λ_f represents spatial frequency, F denotes the Fourier transform operation.

To analyze MTF's variation with distance, we consider the concept of defocus, which affects the PSF and consequently the MTF. The relationship between defocus and MTF can be approximated as:

$$MTF(f, \Delta z) = MTF(f)e^{-\alpha(f)\cdot(\Delta z)^2}$$

Δz is a function representing the sensitivity of MTF to defocus at different spatial frequencies. Focus was given to working with cameras with varying FOVs – low, high, and fisheye – to analyze the effect of MTF on image perception at different distances and field positions. These experiments were aimed to measure detection accuracy, factoring in the differing spatial frequencies and contrast details captured by each camera type. The core of this paper's investigation lies in contrasting the

performance of computer vision systems when subjected to images with varying levels of MTF, the study demonstrates that lower MTF values, often found in wider FOV and fisheye lenses, can lead to a noticeable decrease in detection accuracy. On the other hand, higher MTF values, typically associated with narrower FOV, tend to enhance the performance of computer vision algorithms, especially in terms of detail recognition and accuracy of object detection. In summary, this study not only contributes to a deeper understanding of the impact of MTF on computer vision but also provides the basis for future research aimed at optimizing imaging systems for enhanced computer vision applications. The insights obtained from our research can be influential to the design and selection of cameras for specific computer vision tasks, marking a significant step forward in the field of high-fidelity image processing and analysis.

ID: NA31

Title: Enhanced Numerical Solutions to Burgers' Equation: Combining Differential Quadrature, Trigonometric Tension B-Splines, and Artificial Bee Colony Optimization

Author(s): Simran Sahlot, Geeta Arora

Affiliation(s): Lovely Professional University, Punjab

Abstract: This research paper presents an innovative approach to enhance the numerical solutions of Burgers' Equation, a nonlinear partial differential equation with wide applications in fluid dynamics and nonlinear acoustics. The methodology combines three powerful techniques: Differential Quadrature Method (DQM), Trigonometric Tension B-Splines, and Artificial Bee Colony Optimization (ABC). The DQ Method provides a robust numerical framework for solving partial differential equations by discretizing the spatial domain into a set of discrete points. Trigonometric Tension B-Splines, employed in the spatial discretization, introduce flexibility and accuracy capturing the complex behavior of the solution with improved precision. The novelty of the approach lies in the incorporation of ABC optimization technique. By utilizing the collective intelligence of artificial bee colonies, key parameters of the numerical scheme are optimized, enhancing convergence rates and solution accuracy. The algorithm dynamically adapts to the evolving characteristics of the solution space resulting in improved computational efficiency and solution quality.Through comprehensive numerical experiments and comparisons, the effectiveness of the proposed methodology in providing accurate and efficient solutions to Burgers' Equation is demonstrated. The combined synergy of DQM, Trigonometric Tension B-Splines, and ABC optimization offers a promising avenue for tackling non-linear partial differential equations in various scientific and engineering domains. This research contributes to the field by introducing a comprehensive and adaptive numerical framework that not only advances the understanding of Burgers' Equation but also establishes a template for approaching similar nonlinear problems. The proposed methodology showcases the potential for synergy between numerical methods and optimization algorithms paving the way for further exploration in the realm of computational mathematics and scientific computing.

ID: OT12

Title: An Entropy-based Intuitionistic Fuzzy Granular Structure for Feature Subset Selection

Author(s): Priti Maratha[1], Anoop Kumar Tiwari[1], Tanmoy Som[2], Yasharth Singh[2]

Affiliation(s): [1]Central University of Haryana, [2]Indian Institute of Technology Varanasi

Abstract: Selecting features is crucial for enhancing model effectiveness by removing irrelevant or redundant attributes, decreasing computational intricacy, and improving interpretability. It helps in averting overfitting, enhancing data quality, and facilitating streamlined model training and deployment. The efficacy of fuzzy rough concepts in feature selection has been substantiated, showcasing their notable effectiveness in handling data uncertainty with proficiency. However, prevailing fuzzy rough-based feature selection methods typically select features from the entire

feature set, this approach may include non-significant features that contribute to a decline in useful information. Moreover, due to use of fuzzy set theory, it is found incapable in handling later uncertainty. To address this, a partition-based approach by using intuitionistic fuzzy (IF) and rough sets notions is employed to eliminate irrelevant features, consequently reducing the dataset size for the subsequent feature selection process to eliminate redundancy in the conditional features. Next, entropy-based IF rough feature selection method is discussed by incorporating the essential criteria of monotonicity and dependency. Further, a novel IF granular structure approach is discussed based on IF information entropy to identify the optimal feature subset by removing or minimizing noise, which emphasize in enhancing the learning performances. Moreover, mathematical theorems are used to validate the theoretical concepts of the entire work. Finally, a comprehensive experimental study is presented for the practical validation of the entire methodology.

ID: DS27

Title: A Hybrid Intuitionistic Fuzzy Granular Structure for Partition based Feature Selection

Author(s): Anoop Kumar Tiwari[1], Priti Maratha[1], Tanmoy Som[2] , Harshdeep Kohali[2]
Affiliation(s): [1]Central University of Haryana, [2]Indian Institute of Technology Varanasi

Abstract: The process of data reduction is an important step in alleviating computational complexities associated with learning techniques when dealing with high-dimensional datasets. This is particularly relevant in the context of the increasingly prevalent massive datasets due to advancement in internet-based technologies. It plays an essential role in the world of information processing and data mining to deal with several issues such as irrelevancy and/or redundancy. Nevertheless, the majority of automated methodologies tend to focus solely on the relevance factor among samples, neglecting the diversity factor. This oversight may hinder the effective utilization of concealed information due to uncertainty and noise. Fuzzy rough concepts have demonstrated notable effectiveness in proficiently handling concealed information within datasets by handling these issues. However, existing fuzzy rough attribute selection approaches often choose features from the entire dataset, leading to the inadvertent selection of irrelevant and redundant attributes. Moreover, these approaches fail to cope with uncertainty and noise due to identification. To circumvent these issues, a novel partition-based approach utilizing intuitionistic fuzzy (IF) and rough sets is introduced. Initially, an IF rough set model is established with a new hybrid IF similarity relation. Next, an IF granular structure is presented based on lower approximation of IF rough set model. This idea aims to eliminate irrelevancy and redundancy by effectively reducing the irrelevant dimensions of the dataset before proceeding with subsequent attribute selection tasks to deal with redundant features, thereby enhancing their efficiency. Within feature selection phase, a new IF c-mean clustering approach by using IF rough concept is presented to establish a feature partitioning concept for feature subset selection based on dependency function. Moreover, mathematical theorems are used to validate the theoretical concepts of the entire work. Finally, a comprehensive experimental study is presented for the practical validation of the entire methodology.

ID: AP23

Title: Sound Based Smart Canes: Better Experience for Visually Impaired

Author(s): Archana B Saxena, Deepti Sharma
Affiliation(s): JIMS Rohini, Delhi

Abstract: This study provides a framework for a smart cane that offers an object recognition system for visually impaired people which assist them in a better walking experience. Framework will explain the details how this system will identify the object and communicate it to the through sound based system. For the working of the system, a moveable camera is attached at the smart cane. Using Bluetooth images clicked through camera will be transferred to the phone connected with the smart cane. Phone is installed with application that can process images using required API for ML

(Machine Learning) and NLP (Natural Language Processing). Outcome of the algorithm processing is text that will be further converted into a voice and object name is communicated to the user by using an earpiece. Through this framework visually impaired people can be aware about the objects coming on the way and they can be more independent during their movements.

ID: AP35
Title: Single Image Super-Resolution using T-GAN
Author(s): Sahil Dharme, Smit Gala, Abhishek Bharti, Omkar Barbadikar
Affiliation(s): Visvesvaraya National Institute of Technology (VNIT) Nagpur

Abstract: Developing a model architecture for Single Image Super Resolution by merging the generative ability of Generative Adversarial Networks (GANs) with the attention mechanism of Transformers. Single image super-resolution plays a crucial role in enhancing the visual quality of images, benefiting various applications such as content creation, image editing, surveillance and security, satellite imaging and medical imaging. By leveraging the combined power of GANs and Transformers, the proposed model aims to generate high resolution output images from the low resolution input images, offering more realistic and visually appealing high-resolution reconstructions. We have trained the model using a combination of perceptual loss and adversarial loss to ensure content preservation and similarity to ground images.

ID: DS25
Title: EfficientNet and Transformer Fusion for effective Classification of Bleeding and Non-Bleeding in Wireless Endoscopy Videos
Author(s): Anisha Gupta and Vidit Kumar
Affiliation(s): Graphic Era Deemed to be University

Abstract: Gastrointestinal (GI) bleeding, encompassing a diverse spectrum of disorders impacting the digestive tract, presents a significant global healthcare challenge. Its diagnosis often relies on invasive procedures, and delayed intervention due to its complex presentation, highlighting the need for noninvasive and objective diagnostic tools. Millions suffer from this condition, characterized by diverse symptoms: localized pain, abdominal distension, nausea or vomiting, pallor, diaphoresis, dyspnea, thirst, and even unconsciousness in severe cases. The spectrum of GI bleeding bifurcates into upper and lower tract origins. Upper GI bleeding often stems from peptic ulcers, hypertension, or esophageal inflammation. Lower GI bleeding, on the other hand, is associated with angiodysplasia, ischemic colitis, colorectal polyps, or coagulation disorders. Immediate symptoms can lead to anemia and iron deficiency, further compromising health and hindering recovery. Wireless Capsule Endoscopy (WCE), a minimally invasive technique for visualizing the GI tract, offers a promising alternative to conventional endoscopy. To address this critical need, we propose a novel deep learning framework utilizing the WCEbleedGen, a wireless capsule endoscopy dataset containing bleeding and nonbleeding frames consisting of 2618 images with annotations obtained through endoscopic procedures. Building upon the strengths of pre-trained models, we integrate EfficientNetB0 (EffB0) and the Vision Transformer (ViT) into our proposed framework. This synergistic fusion seamlessly integrates interpretability, efficiency, and scalability, enhancing gastrointestinal (GI) diagnostics. The model's performance was rigorously evaluated on a separate test set of 519 bleeding and non-bleeding scenarios, employing standard accuracy metrics and statistical tests. It achieved an accuracy of 80% with distinct F1 scores of 81% for the bleeding class and 79% for the non-bleeding class, demonstrating generalizability on unseen data. The study advocates for validating the clinical impact of deep learning, emphasizing potential improvements in bleeding detection rates. This showcases the practical integration of advanced techniques, highlighting the transformative role of deep learning in colorectal gastrointestinal bleeding diagnostics.

ID: DS17

Title: Bridging the Data Gap: A Machine Learning Approach for Enhancing Groundwater Data Consistency between GRACE and GRACE-FO Missions in Uttar Pradesh, India

Author(s): Kaustubh Raj, Prahlada V. Mittal, Mridul Sharma, Anuradha Karunakalage, Mohd. Taqi Daqiq, Ravi Sharma

Affiliation(s): IIT Roorkee

Abstract: The monitoring of global mass variations has undergone a transformative evolution with the implementation of the Gravity Recovery and Climate Experiment (GRACE) and its successor, GRACE Follow-On (GRACE-FO). Despite their revolutionary impact, the observational continuity is challenged by inherent gaps, such as the uninterrupted 11-month interval between the two missions between 2017 and 2018. This temporal disruption has impeded seamless observations, affecting the comprehensive analysis and practical application of the valuable data generated by these missions. This study aims to bridge the data gap between these two missions and assess the groundwater storage variations (GWSA) in the state of Uttar Pradesh, India. With changing climatic conditions and an uneven distribution of rainfall in the region, there has been an increased reliance on groundwater for agricultural, industrial, and domestic purposes. Approximately 80% of agricultural demands in Uttar Pradesh are currently met through groundwater. However, the rapid depletion of groundwater due to increasing population and ineffective utilization needs reassessment and strategies to address the growing concerns. This study is an attempt in the direction of addressing this issue by utilizing satellite-based remote sensing information to understand groundwater variations. The research will focus on filling the data gap between the GRACE and GRACE-FO using various Machine-learning techniques to obtain a continuous GWSA series. We used a published GWSA dataset which was derived from the GRACE Terrestrial Water Storage (TWS). Additionally, the GRACE-derived GWSA will be calibrated with the groundwater well data (groundwater level) to understand the nature of the relationship between in-situ and remotely sensed data. By leveraging advanced computational and data science techniques, the study aims to comprehensively assess groundwater storage variations over the last two decades and fill the data gaps. The proposed methodology involves leveraging GRACE (Gravity Recovery and Climate Experiment) satellite data, specifically Total Water Storage (TWS) measurements. Additionally, TWS data derived from other satellite sources within the same timeframe will be incorporated. The primary objective is to train the machine using various Machine Learning algorithms such as SVM, Logistic Regression, and CNN to make our model ready firstly, to predict TWS values for the timeframe where GRACE TWS data is unavailable. This extends the utility of the models beyond the initial training period. We collect GRACE TWS data for the available timeframe up to 2017 and from 2019 onwards. Simultaneously, gather TWS data from other satellite sources covering the same temporal span, including the gap period (2017-2018). Then we use other satellite sources' TWS data as input and available GRACE TWS data being the output to make a robust model. Furthermore, the findings will offer critical perspectives on the uncertainties associated with using other satellites' TWS data for predicting GRACE TWS data, thereby informing future research directions and methodological refinements. The anticipated results of this study will provide valuable insights for policymakers and water resource researchers to facilitate the sustainable utilization and management of groundwater resources in the state of Uttar Pradesh, India. The insights gained from this study have the potential to inform evidence-based policies and interventions aimed at ensuring the long-term sustainability of groundwater resources in the state of Uttar Pradesh and beyond.

ID: OT14

Title: Solving Interval-Valued Multiobjective Optimization Problems using Techniques of the Multiobjective Optimization Problems

Author(s): B.B. Upadhyay, Rupesh K. Pandey
Affiliation(s): IIT Patna

Abstract: In this article, we delve into a new category of problems referred to as interval-valued multiobjective optimization problems, abbreviated as (IVMOP). We formulate an associated multiobjective optimization problem, abbreviated as (MOP) and establish that any Pareto optimal solution of the associated MOP is also an effective solution of IVMOP. Utilizing these connections, we will employ existing multiobjective optimization techniques to solve multiobjective interval-valued optimization problems. The result presented in this paper extends the idea of Ishibuchi and Tanaka from interval-valued optimization problems to a more general class of interval valued multiobjective optimization problems. Sufficient numerical examples are furnished to illustrate the effectiveness of our developed methodology. Furthermore, we utilize the proposed algorithm to address a practical portfolio optimization problem.

ID: DS16

Title: Intuitionistic Fuzzy Set Assisted GAN-oversampling Technique

Author(s): Tanmoy Som[1], Anoop Kumar Tiwari[2], Masetty Gayathri[3]
Affiliation(s): [1, 3] Indian Institute of Technology (BHU), Varanasi, [2]Central University of Haryana

Abstract: Class imbalance is a key issue in machine learning applications, particularly when dealing with large volume of imbalanced data. Oversampling approaches such as SMOTE have been proven influential in the recent years, but they have limitations such as failing to consider the probability distribution of minority class samples due to absence of variety in generated samples, and significant overlap when oversampled. To cope with these issues, this study presents an innovative framework based on Generative Adversarial Networks (GANs). The suggested framework uses probabilistic intuitionistic fuzzy (IF) concepts to improve the oversampling method, taking into account the likelihood range of minority data points and incorporating diversity into the generated samples. The GAN-based oversampling is coupled with a two-class imbalanced classification of data approach that employs classifier fusion using a probabilistic IF integral. This fusion method accurately depicts interactions between basic classifiers trained on balanced data sub-groups generated with the suggested oversampling method. Comprehensive evaluations, which include G-means, AUC-area, and F-measure, are used for comparing the suggested probabilistic IF-based methods to existing approaches. The results illustrate the suggested framework is superior as it is consisted of effectiveness and efficiency in addressing class imbalance obstacles in imbalanced data classification scenarios. The incorporation of intuitionistic fuzzy ideas creates a versatile and nuanced model for dealing with later uncertainty and vagueness in decision-making, increasing the overall robustness of the suggested approach.

ID: DS21

Title: A Hybrid Intuitionistic Fuzzy Granular Structure based GAN-oversampling Technique for Data Balancing

Author(s): Tanmoy Som[1], Anoop Kumar Tiwari[2], Gatla Sushmitha[3]
Affiliation(s): [1, 3] Indian Institute of Technology (BHU), Varanasi, [2]Central University of Haryana

Abstract: Class imbalance is a ubiquitous challenge, which degrades the overall performance of learning models. Effective models require pre-processing of imbalanced information systems to improve the prediction performance. Random under-sampling and oversampling attempts to equalize class representation to enhance model robustness. Specifically, Generative Adversarial

Network (GAN)-based oversampling has shown an exceptional capacity to address class imbalance by considering the original minority class data distribution and generating new data points. Nevertheless, the class overlap and probabilistic distribution is a problem for GAN-based oversampling. Consequently, we present a novel intuitionistic fuzzy (IF) granular structure to improve GAN-based sampling technique. Initially, an IF granular structure is introduced based on the probabilistic notion. Then, the new method creates a balanced dataset using IF granules and GAN-based oversampling. Next, it uses a unique adaptive neighbourhood-based weighted under-sampling method to eliminate generated redundant data points and original majority class data points. This concept is employed to produce data points that match with the real data distribution while also significantly reducing the class overlap and probabilistic distribution based on proposed IF-granular structure. Based on experimental results, we can observe that the established IF aided GAN-based hybrid sampling technique performs better than previous approaches in terms of both overall accuracy- and average profit-based evaluation parameters.

ID: AP05
Title: Deep learning based recommended system and disease outbreak alert system
Author(s): Parag Jain, Nitin Kumar Tripathi
Affiliation(s): Asian Institute of Technology, Thailand

Abstract: It is now essential to use artificial intelligence to maximize public health treatments in the age of expanding digital data and networked systems. To strengthen public health monitoring capabilities, this research study offers an inventive combination of a disease outbreak alarm system with a recommender system based on deep learning. The recommender system analyses past health data, such as patient records, symptoms, and demographic data, using sophisticated deep learning architectures, including Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks. Early identification and prompt reaction to new health concerns are made possible by the model's ability to adapt to changing data sources thanks to the inclusion of deep learning techniques. With its strong potential for integration into current healthcare frameworks, the suggested approach might promote a comprehensive, data-driven paradigm for public health surveillance. Subsequent efforts will focus on broadening the recommender system's application, integrating real-time data sources, and optimizing the alert system's accuracy by ongoing model optimization.

ID: DS10
Title: Disease future out Break COVID-19 in Uttarakhand Region – Data science, for Proactive Testing
Author(s): Parag Jain, Nitin Kumar Tripathi
Affiliation(s): Asian Institute of Technology, Thailand

Abstract: This paper discusses the escalating frequency of reported infectious disease outbreaks with expectations of a continued upward trend. Despite this rise, outbreak response is noted to adhere to nine fundamental principles. The paper likely delves into the specifics of these principles, providing insights into the strategies and approaches employed in responding to infectious disease outbreaks in the face of their increasing occurrence. It addresses the persistent challenge of emerging pathogen epidemics despite global efforts to enhance health systems. It emphasizes the necessity for an effective response to outbreaks, highlighting the importance of timely intervention based on comprehensive data sources. The complexity of collecting, visualizing, and analyzing outbreak data is acknowledged, spanning from data collection to analysis, modeling, and reporting. The article assesses the current state of the field by examining the context of outbreak response. It critically reviews various analytics components, explores their inter-dependencies, discusses data requirements, and evaluates the type of information they can offer to enhance real-time operations

during outbreaks. It provides an overview of data science, describing it as a process that begins with the collection, cleaning, and transformation of raw data into a structured format suitable for analysis. The key focus is on utilizing statistical and machine learning techniques during the analysis phase to extract meaningful information and identify patterns within the data. Overall, the summary highlights the fundamental steps in data science, emphasizing the importance of converting raw data into actionable insights through analytical methods. Proactive approaches to risk management encompasses both qualitative and quantitative methods. Qualitative methods, such as Hazard and Operability (Haz Op) and Failure Mode and Effects Analyses (FMEA), are highlighted for their well-developed nature. On the quantitative side, the article introduces Structural Reliability Analyses (SRA), Probabilistic Risk Analyses (PRA), and Quantified Risk Analyses (QRA) as effective tools. These methods play a crucial role in systematically identifying, evaluating, and mitigating risks in various contexts, contributing to a comprehensive risk management strategy.

ID: NA10
Title: An efficient numerical technique for solving fractional order advection diffusion equation
Author(s): Anita Devi, Archna Kumari, and V K Kukreja
Affiliation(s): SLIET Longowal

Abstract: The main objective of this manuscript is to investigate the numerical solution of non-linear fractional order advection diffusion equation by utilizing a novel approach based on improvised cubic B-splines as basis functions. The time fractional derivative is formulated in terms of Caputo's definition. The approximation of fractional derivative is done via finite difference based L^1formula and improvised cubic B-splines are taken for discretization of space derivatives. The convergence and stability of presented approach is examined and proved that the approach is unconditionally stable together with order of convergence$O(h^4 + \delta t^{2-\alpha})$. Moreover numerical simulation of some test problems is also performed to confirm the accuracy and computational efficiency of improvised cubic B-spline approach. Finally representation of obtained numerical results in the form of tables and graphs indicates that the proposed approach is elegant, simple for solving non-linear fractional differential equations.

ID: OT10
Title: A Generalized Fuzzy Best Worst Method for Multi-Criteria Decision-Making
Author(s): Harshit M Ratandhara, Mohit Kumar
Affiliation(s): Institute of Infrastructure, Technology, Research And Management, Ahmedabad

Abstract: The best-worst method is a well-known multi-criteria decision making method. To deal with uncertainty in decision data due to lack of complete information and the ambiguity arising from the qualitative judgement of decision maker, best-worst method was extended to fuzzy best-worst method. In this paper, we generalize existing fuzzy best-worst method by using concept of α-cut intervals for α ∈ [0, 1]. The pairwise comparisons for the best (most preferable) and the worst (least preferable) are described as linguistic terms provided by decision-makers, which can be quantified by triangular fuzzy numbers. Non-linear optimization problem having fuzzy optimal weights as solution is constructed. Consistency ratios as a measure of reliability of pairwise comparisons and resultant fuzzy weights are proposed. The capability of the proposed method to produce better optimal weights than existing methods is because of its nature to approach pairwise comparisons, which are in the form of triangular fuzzy number, for all the values with non-zero membership along with base values. Another massive advantage is independence of resultant fuzzy weights from defuzzification technique as no such technique is involved in calculation. Finally, numerical examples are considered to demonstrate the proposed method.

ID: NA16
Title: Composite Finite Element framework for Evolution equation in nonsmooth domain
Author(s): Anjaly Anand, Tamal Pramanick
Affiliation(s): NIT Calicut

Abstract: The adaption of the Composite Finite Element for the evolution equation in the nonsmooth domain is covered in this article. The proposed method which is abbreviated as CFE, is one peculiar section of the classical Finite Element method. The benefit of the method is that it discretizes the domain on two scales: a coarse scale grid with mesh size H and a fine scale grid with mesh size h. The fundamental idea behind the CFE approach is to approximate the Dirichlet boundary conditions by discretizing the near boundary triangles by a fine-scale parameter h and approximating the solution in the domain's interior at a proper distance from the boundary by a coarse-scale parameter H. For the computational purposes only the coarse scale mesh parameter H is taken, which eventually decreases the computational effort. This makes it easier in decreasing the size of the domain space under consideration. It is also to be noted that the domain is having nonsmooth behaviour and hence this reduction is degrees of freedom can prove useful. In this article we discuss the fully discrete estimation for the error analysis, where both the time and space coordinates gets discretized. The CFE method is used to investigate the convergence of an initial boundary value problem for a Volterra type integro-differential equation. It is seen that the outcomes are optimal. For verification of the theoretical results, we have conducted numerical experiments.

ID: AP15
Title: TAMED EXPLICIT SCHEME OF ORDER 2.0 FOR STOCHASTIC DIFFERENTIAL EQUATIONS WITH SUPER-LINEAR DRIFT AND DIFFUSION COEFFICIENTS
Author(s): TEJINDER KUMAR[1], CHAMAN KUMAR[2]
Affiliation(s): [1]Alliance University, Bangalore, [2]Indian Institute of Technology Roorkee

Abstract: This work is focussed on the numerical approximations of the stochastic differential equations wherein both drift and diffusion coefficients can grow super-linearly. We have developed the tamed explicit scheme of order 2.0 for stochastic differential equations under general conditions that allow the drift and diffusion coefficient having polynomial growth while adhering to monotonicity and correctivity assumptions. We establish a strong convergence rate of 2.0 and validate our theoretical results through numerical experiments.

ID: AP07
Title: Efficientnet and attention fusion for effective classification of knee osteoarthritis severity
Author(s): Ananya Pandey and Vidit Kumar
Affiliation(s): Graphic Era deemed to be university, Dehradun

Abstract: Osteoarthritis (OA) entails enduring degeneration, particularly affecting weight-bearing joints, with knees being exceptionally vulnerable due to their central role in supporting the body. A nuanced understanding of molecular and biomechanical aspects is imperative for developing targeted therapeutic strategies. Knee osteoarthritis (KOA) manifests localized symptoms, impeding daily activities with pain, swelling, and movement restrictions affecting flexibility during weight-bearing tasks. A comprehensive KOA diagnosis involves clinical, imaging, and functional assessments. The Kellgren-Lawrence (KL) grading system, utilizing X-ray imaging, categorizes severity from 0 to 4. Artificial Intelligence (AI) and Deep Learning (DL) are transformative forces in KOA detection, enabling early identification through meticulous image analysis. DL technologies, incorporating Convolutional Neural Networks (CNNs), contribute to real-time assessments, advancing diagnostic capabilities and transforming KOA management for enhanced precision and

personalized care, thus significantly impacting the landscape of musculoskeletal healthcare. The proposed model entails the customization of **EfficientNetB0 for knee osteoarthritis (KOA) detection by incorporating an attention mechanism (Channel and Spatial Attention Modules). This adaptation involves integrating attention into the last layer of block 7** and adding supplementary layers for enhanced feature representation. Leveraging the OAI dataset, we divided it into training (5000 imagesa) and testing (1656 images). The model achieved an impressive **accuracy of 67% (which is better than state of the art)**, and its performance was rigorously assessed using diverse evaluation metrics, including accuracy, precision, F1-score, and recall. Our proposed model achieved notable accuracy in classifying knee conditions, spanning from early to severe stages. Beyond knee osteoarthritis, the model showcased its potential for effective image-based classification across various bone health issues, underscoring its versatility and significance in medical diagnostics. This comprehensive approach demonstrates a promising advancement, providing accurate and versatile diagnostic capabilities in the field of musculoskeletal healthcare.

ID: NA17
Title: Two efficient techniques for analysis of fractional Tricomi equation
Author(s): Lalit Mohan, Amit Prakash
Affiliation(s): National Institute of Technology, Kurukshetra

Abstract: In this paper, the fractional Tricomi equation is investigated via two efficient computational techniques. This equation is used to explain the nearly sonic speed gas dynamics phenomenon. The Homotopy perturbation transform technique, which is a combination of Laplace transform and a semi-analytical technique, and Homotopy analysis method are used to solve the time-fractional Tricomi equation. The existence and uniqueness of the solution is analyzed by using two different fixed-point theorems. Finally, the effectiveness of the proposed techniques is illustrated through test examples by comparing the absolute error of proposed techniques with the existing techniques.

ID: DS15
Title: Random Sampling of Mellin Band-limited Signals
Author(s): Shivam Bajpeyi
Affiliation(s): Sardar Vallabhbhai National Institute of Technology Surat

Abstract: In this talk, we address the random sampling problem for the class of functions in the space of Mellin band-limited functions B_T, which are concentrated on a bounded cube. It is established that any Mellin band-limited function can be approximated by an element in a finite-dimensional subspace of B_T. Utilizing the notion of covering number and Bernstein's inequality to the sum of independent random variables, we prove that the probabilistic sampling inequality holds for the set of concentrated signals in B_T with an overwhelming probability provided the sampling size is large enough.

ID: OT22
Title: An optimization approach for managing airline disruptions
Author(s): Deepmala
Affiliation(s): PDPM Indian Institute of Information Technology, Design & Manufacturing Jabalpur

Abstract: In the airline industry, the aspirations of aircraft and crew scheduling optimization problems are very noticeable and economically exceptional. An efficient scheduling structure is needed to reduce the significant cost associated with aircraft and crew members, which is financed by airline companies. The objective of the airlines scheduling problem is to perceive the best schedule i.e. a group of minimum cost sets of pairings such that each flight is covered by exactly one

rotation and satisfies the set of applicable work rules. Some meta-heuristic optimization algorithms have been considered as a solution procedure to solve different kinds of classical optimization problems, especially the travelling salesman problem (TSP). But due to some uncertainty factors which significantly disturb the system performance in many real- life systems, there is a need to find a powerful method to handle such vagueness of nature. Airlines ultimate objective is to maximize their profits. The use of optimization technique is crucial in obtaining feasible, cost-minimizing plans that allow airlines to recover from disruptions and their associated delays. Various models have been proposed over the past decades for airlines disruption management by optimization techniques based on different criteria. We will discuss some mathematical models to address the problems that arise in managing airline disruptions and recovering aircrafts. The main goal of the paper is to discuss the computational difficulties of proposed models with some real life large scale data. In the end, we will discuss the open challenges and future research scope for management systems in the airline industry.

ID: OT27
Title: Optimal System and Invariance analysis of extended BLMP equation via the Lie group method
Author(s): Akshita Bhardwaj and Rajan Arora
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: It has been possible to analyze the extended Boiti-Leon-Manna-Pempinelli (eBLMP) equation using Lie symmetry. This system represents the information exchange between two waves with different dispersion properties. The equation under consideration has been simplified to facilitate the computation of analytical solutions. Graphs have been drawn to evaluate better and comprehend and the solutions display a distinct profile in the graph. The optimal system of the corresponding Lie algebra has been constructed.

ID: AP27
Title: Dynamics of cloud droplet evolution using super droplet model
Author(s): Nita H Shah[1], Jyoti Chahal[2], and Bipasha Paul Shukla[3]
Affiliation(s): [1, 2]Gujarat University, Ahmedabad, [3]Space Applications Centre, ISRO, Ahmedabad

Abstract: This study investigates the intricate evolution of cloud droplets, pivotal in precipitation formation, through an exploration of microphysical processes like nucleation, condensation, evaporation, and coalescence. A series of 200 experiments based on Monte-Carlo Algorithm, categorized into 20 different size bins of Disdrometer, is conducted by using python based Super Droplet Model (PySDM) to unravel the dynamic behavior of cloud droplets. The coalescence time, a key parameter in this process, is observed to follow a Gaussian distribution and is fitted by a Multi-Gaussian 2-Parameter Fitting Curve. The curve's parameters provide detailed insights into the mean mass density, standard deviation, and amplitude of each bin. Through the rate of change in mass density over time, we found a recurring pattern across droplet size bins. Using disdrometer size ranges to study cloud droplet behavior provides a bridge between what can be directly observed (raindrops) and what occurs higher in the atmosphere (cloud droplet dynamics). This approach enables scientists to improve models, validate hypotheses, and enhance our understanding of cloud microphysics, ultimately leading to more accurate weather and climate predictions.

ID: DS32
Title: Green cloud adoption for sustainability: Mining key drivers
Author(s): Akanksha Upadhyaya[1], Disha Garg[2], and Manoj Kumar Mishra[3]
Affiliation(s): [1]JIMS, Delhi, [2]RDIAS, Delhi, [3]OP Jindal University

Abstract: In the 21st century, a global movement focused on sustainability is taking shape. The realization of sustainable development hinges upon the transformation of cloud computing into an environmentally friendly energy source. Thus, safeguarding the environment through "Green Cloud Computing" is of utmost importance, signifying a shift for businesses worldwide from non-renewable energy to sustainable and eco-friendly alternatives. This study aims to pinpoint the factors that influence the acceptance of green cloud computing to promote sustainable development, utilizing association rule mining. The survey was conducted with IT professionals from leading IT companies. Data analysis was carried out using Weka 3.8.6 and NVivo QSR 12. The pivotal factors extracted from the association mining rules underscore critical elements associated with the adoption of green cloud computing, sustainable practices, and environmental considerations within the cloud computing context. These factors are aligned with themes that emerged from thematic analysis, affirming that the objective of green cloud computing is to curtail energy consumption while concurrently attaining efficient processing.

ID: NA34
Title: Uniformly convergent computational method for singularly perturbed Semilinear Parabolic Problems with Boundary and Weak Interior Layers
Author(s): Narendra Singh Yadav[1] and Kaushik Mukherjee[2]
Affiliation(s): [1]SRM University AP, [2]Indian Institute of Space Science and Technology, Thiruvananthapuram

Abstract: This work focuses on a class of singularly perturbed semilinear parabolic partial differential equations (PDEs) of convection-diffusion type with discontinuous source function. PDEs of such types often appear in the mathematical modeling of various phenomena in physics and engineering, for instance, semi-conductor device modeling. As the analytical solutions of these PDEs often possess a weak interior layer and a boundary layer, finding uniformly convergent numerical solutions becomes a challenging task. To fulfill this objective, we devise a higher-order time-accurate computational method for solving the considered nonlinear PDE on a suitable layer-adapted mesh. Firstly, we discuss the existence, stability, and asymptotic behavior of the analytical solution of the continuous nonlinear problem. We then show that the discrete solution is stable and ε-uniformly convergent in the supremum norm. This finding is confirmed by the numerical experiment.

ID: AP16
Title: Milstein scheme for jump-diffusion SDEs with Markovian switching
Author(s): Divyanshu Vashistha, Chaman Kumar
Affiliation(s): Indian Institute of Technology Roorkee

Abstract: We derive Itô's formula for jump-diffusion SDEs with Markovian switching, which is further used to derive a first-order scheme(Milstein scheme). The interaction between the càdlàg process and the discontinuous dynamics of the Markov chain create some challenges which are resolved using some new techniques. Further, moment stability and rate of convergence of the Milstein scheme are evaluated when the coefficients and their derivatives are Lipschitz continuous. A practical implementation of the proposed Milstein scheme is also discussed under the diffusion and jump commutativity condition.

ID:AP31

Title: Plant health assessment through multispectral sensing technique: A novel and cost effective approach using NDVI

Author(s): Harsh Kumar

Affiliation(s): Kilkari Bihar Bal Bhawan, Bihar

Abstract: Chlorophyll, the green pigment in plants crucial for photosynthesis, plays a pivotal role in maintaining oxygen levels and energy production while containing ample sugars. Monitoring chlorophyll levels in leaves serves as a vital indicator of overall plant health and vitality, particularly in agriculture, horticulture, and forestry. Traditional chlorophyll measurement methods are invasive, time-consuming, and impractical for large-scale assessments. This research presents a non-destructive approach for rapid and accurate chlorophyll measurement using multispectral light sensing, combining red and infrared LEDs, light-dependent resistors (LDRs), infrared receivers, and arduino microcontrollers. Our methodology includes device design, calibration, data collection, and Normalized Difference Vegetation Index (NDVI) calculation. Experimental results demonstrate the device's effectiveness in distinguishing between healthy and stressed leaves based on NDVI values and establishing a linear relationship between NDVI and chlorophyll content. Discussion highlights the device's potential applications in precision agriculture, environmental monitoring, and the advantages it offers over traditional and existing methods. The non-destructive nature of our device allows for repeated measurements, making it a valuable tool for long-term plant health monitoring. The significance of this research lies in its potential to revolutionize plant health assessment, enhance agricultural practices, and contribute to environmental sustainability. Future research directions include technology refinement, correlation with additional plant health parameters, field trials, and machine learning integration to further advance plant health assessment and broaden its scope in various domains.

ID:NA37

Title: A Haar wavelet scheme for solving fractal fractional differential equations

Author(s): Harpreet Kaur[1], Amanpreet Kaur[2]

Affiliation(s): [1]I.K. Gujral Punjab Technical University (Mohali Campus-I), [2]Chandigarh University Gharuan, Punjab

Abstract: A wavelet theory is developed through dilation and translation of a mother wavelet, a mother wavelet generates a family of functions which are known as wavelets. There are many wavelets like Morlet wavelet, Legendre's wavelets, Bernoulli wavelets and Haar wavelets which can be applied to find solutions of differential equations. A piecewise continuous wavelet function, the Haar wavelet is the simplest wavelet which is used in proposed study. Haar wavelet has been found effective in analyzing local behavior of a function. In order to overcome the discontinuous nature of Haar wavelets, Chen and Hsiao expanded the higher derivative of the differential equation as a Haar series and obtained the lower derivatives by integration. This paper describes the construction of novel Haar operational matrix for fractal fractional derivatives. A numerical scheme with scale-3 Haar wavelets with collocation method is proposed and applied to solve fractal fractional ordinary differential equations. The differential equations have always been used as an efficient tool to represent real world problems in mathematical manner in order to find various possible solutions in analytical and numerical forms. A wide range of different type of differential equations can be found in existing literature such as equations with non-integer order derivatives, fractal order derivatives, linear and nonlinear differential equations etc. In order to test the efficiency of the scheme, some numerical examples of ordinary fractal differential equations are solved and results are compared with available results. It is shown that the proposed method is working well and produces the satisfactory results.

ID: AP06

Title: Feature Extraction from Normalized signals using Daubechies Wavelet Transformation for AI Models

Author(s): Savitha K N

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Abstract: Normalization is a crucial preprocessing step in AI models that aids in converting the feature values into the same scale. The study on the impact of different normalizations on the feature values and their performance is very significant in AI models. In this work we are considering the normalization techniques such as Minmax, Standard, Robust, Maxabs, and L-R Gaussian. In the real world, the dataset contains redundant and irrelevant information. The improved performance of machine learning models may be achieved by extracting significant and relevant information. Moreover, model accuracy and generalization to new, unknown data are enhanced when key features of the data are emphasized. Also, identifying the underlying structure and relationships within the data may be facilitated by turning the data into a collection of relevant features, which makes it simpler to comprehend the behavior of the model. Therefore, extracting relevant and informative features from the raw data is also an essential step in AI models. Different feature extraction methods are available in the literature, and the choice of feature extraction method depends on the type of information needed for the models. In many signal processing applications, extracting frequency components from the signals or time-series data is essential for speech recognition, audio analysis, etc. Fourier Transform is an important mathematical tool for extracting such frequency components from the data. Fourier Transform (FT) can also identify the periodic pattern in the signals, which is essential for classification and regression problems. FT effectively extracts features from stationary signals. However, many signals in the actual world are non-stationary, meaning their frequency content varies with time. Moreover, FT is inadequate to capture those changing behaviors. Also, FT fails to capture the complex temporal patterns and non-linear relationships present in the data merely by their frequency components. In FT, the signals are transformed from the time domain to the frequency domain, thus losing time information. This loss of temporal information makes it more difficult to extract features accurately in some applications where frequency and time information are essential. In these circumstances, time-frequency feature extraction is improved using a more sophisticated method called wavelet transform.
A comparative study is carried out on features extracted using Daubechies wavelets on normalized signals. Moreover, the analysis reveals that features of Daubechies wavelet transform of normalized signals give better classification results. Furthermore, Daubechies wavelets' approximation coefficients of normalized signals capture most of the information of the original signals, thus increasing the performances of AI models.

ID: NA32

Title: Bleustein-Gulyaev(BG) type wave propagation in PEMFRC stratum substrate structure with welded contact interface.

Author(s): Rahul Meher and Abhishek Kumar Singh

Affiliation(s): Indian Institute of Technology (Indian School of Mines), Dhanbad

Abstract: The present work deals with two objectives. The primary objective is the micromechanical modeling of piezo-electro-magnetic fiber-reinforced composite (PEMFRC) using analytical techniques of Strength of Materials and Rule of Mixtures. The secondary objective is to study the Bleustein-Gulyaev (BG) type wave propagation in a stratum-substrate structure comprising of distinct Piezo-electro-magnetic fiber-reinforced composite (PEMFRC) stratum and PEMFRC substrate with welded contact interface. Several studies related to the propagation of B-G wave in monolithic piezoelectric materials have been conducted. However, to the best of author's knowledge no work has been conducted considering the propagation of B-G type wave in PEMFRC.

To formulate the problem,we have used strength of material and rule of mixture techniques to derive the effective material constants of PEMFRC. Further, governing equations of motion with boundary conditions for wave propagation as per considered geometry has been established. Separation of variable method has been employed to solve the arising second order linear differential equation to derive the closed form of dispersion relations for BG type wave.

ID: NA18

Title: Numerical solution of nonlinear Sine-Gordon equation using modified cubic B-spline-based differential quadrature method

Author(s): Noufal Asharaf

Affiliation(s): Cochin University of Science and Technology

Abstract: Here is the nonlinear Sine-Gordon problem that we solved using modified cubic B-spline differential quadrature. Because the modification of B-splines described in literature couldn't produce the entire polynomial space P_3 of degree up to 3, the modified elements cease to possess the optimal approximation property of the cubic B-splines. We propose a new modification of cubic B- splines with optimal polynomial reproduction property with tridiagonal matrix structure. In this work, we utilize all the advantages of this new modification to solve the nonlinear Sine - Gordon equation in one and two dimensions.

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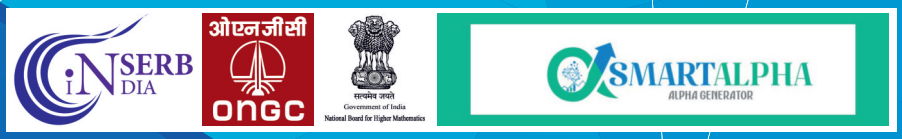
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