SOUVENIR

National Workshop

on

Artificial Intelligence and Machine Learning Methods in Advanced Computing (AIMLAC-2025)

November 03-07, 2025

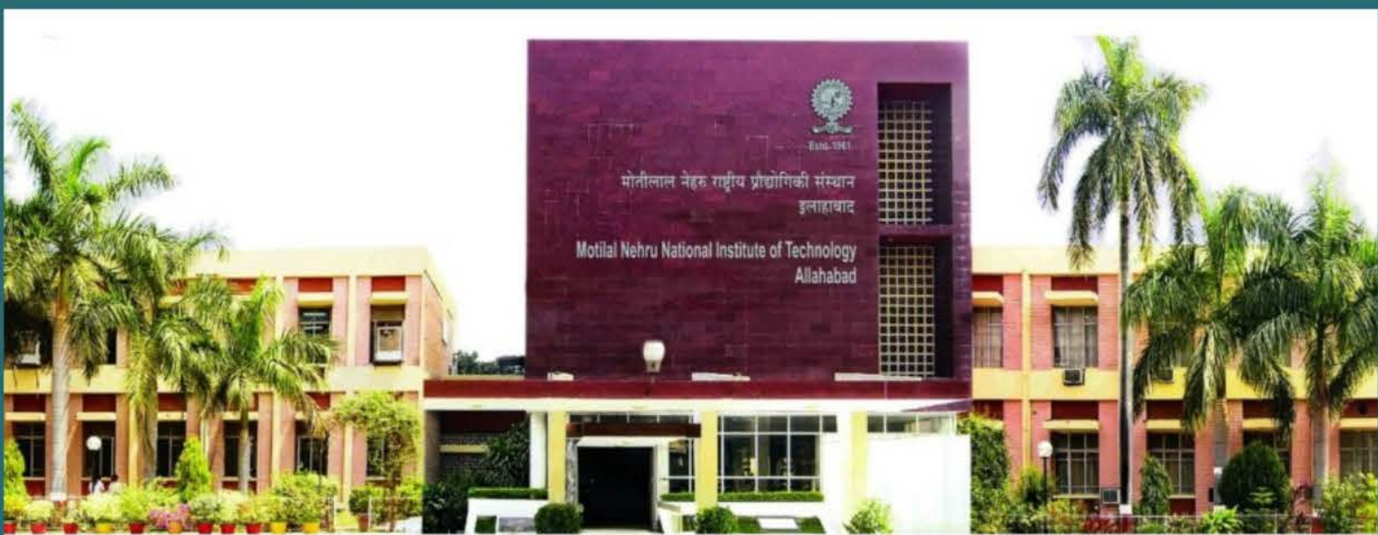
Sponsored by

DHR and ANRF

Organized by

Department of Mathematics

Motilal Nehru National Institute of Technology Allahabad, Prayagraj



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MOTILAL NEHRU NATIONAL INSTITUTE OF TECHNOLOGY
ALLAHABAD

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About the Workshop

The world stands on the brink of a transformative revolution, powered by Artificial Intelligence (AI) & Machine Learning (ML) widely regarded as the defining technology of this century. AI/ML has attracted renewed interest from distinguished scientists and has again raised new, more realistic this time, expectations for future advances regarding the development of theories, models and techniques and the use of them in applications pervading many areas of our daily life. The borders of human-level intelligence are still very far away and possibly unknown. Nevertheless, recent scientific work inspires us to work even harder in our exploration of the unknown lands of intelligence. AI/ML integration into mathematics is a profound and far-reaching transformation, enabling faster, more efficient problem-solving, enhancing mathematical research, and offering new tools for education and real-world applications.

***WORKSHOP THEMES*:**

- ***Foundations of Artificial Intelligence and Python***
- ***Multiscale Modelling & Advanced Computing***
- ***AI&ML for Data-Driven Mathematics and Statistical Analysis***
- ***Artificial Intelligence in Computational Fluid Dynamics & Microfluidics***
- ***AI&ML in Mathematical Optimization***
- ***AI&ML for Image and Video Processing***
- ***AI&ML for Algebraic Geometry***
- ***Hands-on Training***

EXPECTED OUTCOMES:

- Through this workshop, participants will gain a solid understanding of foundational and advanced concepts in Artificial Intelligence (AI) and Machine Learning (ML) methods.
- This workshop empowers individuals to navigate the realms of AI&ML, equipping them with the expertise needed to engage with advanced computing in various applications in both theoretical and applied mathematics.
- Attendees will be able to use popular AI/ML tools such as Python, Scikit-learn, TensorFlow, and PyTorch for model development and deployment.
- Participants will be capable of designing, training, and evaluating machine learning models on real-world datasets.
- Participants will understand how AI and ML are applied in various sectors such as healthcare, biomechanics, finance, manufacturing, cybersecurity, and advanced computing systems.
- The workshop will inspire participants to engage in AI/ML research or initiate innovative projects using these technologies.
- Attendees will be better equipped to identify and solve complex problems using AI/ML techniques in their respective domains.
- Participants will become more aware of ethical, legal, and social implications of AI, promoting the development of responsible AI systems.
- This workshop will strengthen the network for future academic and professional collaborations with peers, researchers, and industry experts in areas of mutual interest and expertise

Director's Message

It is my privilege to welcome, on behalf of the institute, all the delegates and participants to the **National Workshop on "Artificial Intelligence and Machine Learning Methods in Advanced Computing (AIMLAC-2025)"** scheduled to be held during November 03-07, 2025, under the aegis of the Department of Mathematics, Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj.

Mathematics forms the foundational bedrock of all fields in Science and Technology, particularly in the rapidly evolving domains of Artificial Intelligence and Machine Learning. Mathematics plays a central and inspiring role in sustaining modern technologies, with many ground breaking inventions and profound applications emerging directly from core mathematical principles. In this context, the workshop's scope encompassing foundations of AI and Python, multiscale modelling, AI/ML in data-driven mathematics, computational fluid dynamics, optimization, image processing, algebraic geometry, and hands-on training is highly relevant and timely for the current generation of scientists and innovators.

It gives me immense pleasure to note that a number of distinguished experts and researchers from premier institutions like IISC, IITs, NITs and reputed Industry (TCS & Adobe Inc.) have agreed to contribute to this 5-day workshop. As a leading institution in technical education, MNNIT has consistently championed the natural sciences, with a special emphasis on Mathematics and its interdisciplinary applications. I believe the workshop will serve as a vital platform for participants to exchange ideas across various facets of AI, ML, and advanced computing, while fostering opportunities for inter- and trans-disciplinary research grounded in robust mathematical frameworks. Organizing an event of this magnitude is always a formidable task, and I am assured that the Department of Mathematics will meet the expectations of the academic community.

I take this opportunity to extend my heartfelt congratulations to the organizers and wish AIMLAC-2025 a resounding success!

Prof. R. S. Verma
[Ph.D., FNASc, FBRSI, FAMI]

Director, MNNIT Allahabad

Chairman's Message

It is my distinct pleasure to welcome all esteemed delegates and participants to the workshop on "Artificial Intelligence and Machine Learning Methods in Advanced Computing (AIMLAC-2025)" taking place from November 03-07, 2025, under the Department of Mathematics at Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj.

As the Head of the Department, I am proud to oversee this initiative, which highlights the synergy between Mathematics and cutting-edge technologies like AI and ML. The workshop's focus on multiscale modelling, data-driven statistics, optimization, and hands-on AI applications addresses critical needs in advanced computing, empowering participants to tackle real-world challenges in research and industry.

This event underscores MNNIT's commitment to fostering innovation and interdisciplinary dialogue. I anticipate fruitful discussions that will lead to novel insights and partnerships among PG/Ph.D. students, faculties, scientists, and professionals.

I would like to extend my deepest gratitude to Prof. R. S. Verma, our Chief Patron and Director MNNIT Allahabad, Prayagraj, for his visionary leadership and unwavering support in making AIMLAC-2025 a reality.

My heartfelt thanks to Dr. B. Vasu, Convener, and Prof. Shiv Datt Kumar, Coordinator, for their exemplary efforts. Gratitude also to the advisory and organizing committees for their contributions. The funding from DHR and ANRF is highly acknowledged which has been vital, complemented by MNNIT's support.

May AIMLAC-2025 be a milestone of success and inspiration!

Prof. Pitam Singh
Chairman, AIMLAC- 2025

Convener's Message

It is my privilege to welcome all the delegates and participants to the workshop on "Artificial Intelligence and Machine Learning Methods in Advanced Computing (AIMLAC-2025)" during November 03-07, 2025, organized by the Department of Mathematics, Motilal Nehru National Institute of Technology (MNNIT) Allahabad, Prayagraj. This workshop aims to provide a comprehensive platform for researchers, academicians, industry professionals, and students to explore the emerging trends, techniques, and applications of Artificial Intelligence and Machine Learning in advanced computational domains.

In recent years, AI and ML have revolutionized the way we process data, make decisions, and design intelligent systems. From scientific research to industrial innovation, these technologies are driving transformative change across sectors. Through this workshop, we hope to foster meaningful discussions, hands-on learning, and collaborations that will empower participants to apply these methods effectively in solving real-world challenges.

We are privileged to have with us a panel of distinguished experts who will share their deep insights and experiences. I extend my heartfelt gratitude to them for their valuable time and contributions.

On behalf of the organizing committee, I extend my gratitude to Prof. R. S. Verma, Director and Chief Patron for his unwavering support and guidance. I am also thankful to Prof. Pitam Singh, Chairman and Head of the Department of Mathematics, and Prof. Shiv Datt Kumar, Coordinator, for their valuable support.

I also thank the Department of Health Research (DHR) and the Anusandhan National Research Foundation (ANRF) for providing the necessary funding to conduct the workshop AIMLAC-2025.

Finally, I am grateful to all my colleagues in the Department of Mathematics, the advisory committee, sponsors, office staff, student coordinators and all participants whose enthusiasm and support have made this event possible.

I wish the workshop great success and hope it serves as an enriching learning experience for all.

Dr. B. Vasu
Convener, AIMLAC- 2025

Coordinator's Message

It gives me immense pleasure to extend a warm welcome to all distinguished speakers, participants, and delegates to the National Workshop on AI & ML Methods in Advanced Computing (AIMLAC-2025), organized by the Department of Mathematics, Motilal Nehru National Institute of Technology Allahabad, Prayagraj.

In the present era of technological transformation, Artificial Intelligence (AI) and Machine Learning (ML) have emerged as powerful tools driving innovation in both theoretical and applied domains of science and engineering. This workshop aims to provide a comprehensive platform for academicians, researchers, and industry professionals to interact, exchange ideas, and explore the multifaceted applications of AI and ML in advanced computing, data-driven mathematics, optimization, and scientific modelling.

I am confident that the deliberations during this workshop will not only enhance participants' understanding of contemporary AI/ML methodologies but also inspire collaborative research across disciplines. The hands-on sessions and expert lectures by eminent resource persons from leading institutions will enrich our collective knowledge and strengthen our academic community.

I extend my sincere thanks to Prof. R. S. Verma, Chief Patron and Director, Prof. Pitam Singh, Chairman, and Dr. B. Vasu, Convener, for their leadership. Special appreciation to the advisory committee, organizers, and student coordinating team for their dedication. We are grateful for the funding secured from DHR (Department of health research) ANRF (Anusandhan National Research Foundation) which has been instrumental in realising this workshop.

I wish all participants a productive and enriching experience at AIMLAC-2025.

I thank all the resource persons for their invaluable support. I also extend heartfelt thanks to all participants for their enthusiasm and contribution in making AIMLAC-2025 a grand success.

I wish all participants a stimulating and intellectually rewarding experience during the workshop and a pleasant stay at Prayagraj.

Prof. Shiv Datt Kumar
Coordinator, AIMLAC- 2025

About Prayagraj City

Prayagraj is one of the oldest cities in India. It is crowned in ancient scriptures as ‘Prayag’ or ‘Teertharaj’ and is considered the holiest of pilgrimage centres of India. It is situated at the confluence of three rivers- Ganga, Yamuna and the invisible Saraswati. The meeting point is known as Triveni and is very sacred to Hindus. The Kumbh held in every six years and Mahakumbh in every 12 years at Prayagraj (Sangam) are the largest gatherings of pilgrims on this earth.

Historically, the city has been a witness to many important events in India’s freedom struggle such as emergence of the first Indian National Congress in 1885, the beginning of Mahatma Gandhi’s non-violence movement in 1920.

Geographically, Prayagraj is located at 25.45°N 81.84°E in the southern part of the Uttar Pradesh. To its south and southeast is the Bagelkhand region, to its east is middle Ganges valley of North India, or Purvanchal, to its southwest is the Bundelkhand region, to its north and northeast is the Awadh region and to its west along with Kaushambi it forms the part of Doab i.e the Lower Doab region. In the north Pratapgarh, in the south Rewa (M.P.), in the east Sant Ravi Das Nagar and in the west Kaushambhi districts are located. The total geographical area of the district is 5482 Sq. Km. The district is divided into 8 Tehsils, 20 development Blocks and 2802 populated Villages.

About the Institute

Motilal Nehru National Institute of Technology Allahabad, Prayagraj (MNNIT) is an Institute with total commitment to quality and excellence in academic pursuits. It was established as one of the seventeen Regional Engineering Colleges of India in the year 1961 as a joint enterprise of Government of India and Government of Uttar Pradesh, and was an associated college of University of Allahabad, which is the third oldest university in India.

For a short duration of two years (2000-2002), the Institute was affiliated to U.P. Technical University. With over 45 years of experience and achievements in the field of technical education, having traversed a long way, on June 26, 2002 MNREC was transformed into National Institute of Technology and Deemed University fully funded by Government of India. With the enactment of National Institutes of Technology Act-2007(29 to 2007), the Institute has been granted the status of institution of national importance w.e.f. 15.08.2007.

The Institute offers nine B.Tech., nineteen M.Tech. Degree Programmes (including part-time), MCA, MBA, M.Sc. (Mathematics and Scientific Computing) and Master of Social work (M.S.W.) programmes and also registers candidates for the Ph.D. degree. The Institute has been recognized by the Government of India as one of the centres for the Quality Improvement Programme for M.Tech. and Ph.D. The Institute has a very progressive policy towards extending all possible facilities to its faculty members to acquire higher degrees and receive advanced training. As a result, majority of the faculty members possess Ph.D. degrees. The entire campus is networked with 94 Mbps lease line.

In the year 1972, the Institute initiated a self-employment project and established an industrial estate with 68 sheds with the objective of encouraging entrepreneurs and creating additional employment avenues. The Institute was selected as a lead institution in the Design theme under Indo-UK REC Project (1994-99). Under this scheme a Design Centre was established. The Institute has been selected as a Lead Institution under World Bank funded Government of India Project on Technical Education Quality Improvement Programme (TEQIP) (2002-2007). Two state level institutions are networked with MNNIT under the project.

About the Department of Mathematics

The department of mathematics came into existence w.e.f., 1st April, 2003, prior to this it constituted a section of the Department of Applied Mathematics, Applied sciences & Humanities.

The department offers core courses at undergraduate level and several advanced courses at post graduate level. The department also enrolls candidates for Ph.D. programme. There is a wide spread interaction between mathematics department and various engineering departments in the field of teaching and research.

The department of Mathematics started full time M.Sc. in Mathematics & Scientific Computing program since 2008. This two-year programme offers an exciting opportunity to students who are interested in Mathematics and who wish to pursue courses for industry, research and teaching.

S.No.	Name	Designation	Research Area(s)
1.	Prof. Pitam Singh	Professor & Head	Fuzzy Optimization & Applications in GIS and Remote Sensing; Mathematical Modelling in Seismology
2.	Prof. Shiv Datt Kumar	Professor	Commutative Algebra; Algebraic Geometry; Computer Algebra; Hopf Algebra; Operations Research
3.	Prof. Pankaj Srivastava	Professor	Fuzzy Analytics; Soft Computing Intelligent Systems (Medical Diagnosis & Tourism); Ramanujan's Computational Systems
4.	Prof. Mukesh Kumar	Professor	Partial Differential Equations; Lie Group Theory; Similarity Transformations; Fluid Mechanics; General Theory of Relativity
5.	Prof. Pramod Kumar Yadav	Professor	Fluid Mechanics; Bio-Fluid Mechanics; Differential Equations
6.	Dr. Sahadeo Padhye	Associate Professor	Cryptography; Applied Algebra & Number Theory; Real Analysis
7.	Dr. Gorakh Nath	Associate Professor	Fluid Dynamics; Differential Equations; Multiphase Flow; Nonlinear Waves; Magnetogasdynamics
8.	Dr. Buddakkagari Vasu	Associate Professor	Computational Fluid Dynamics; Numerical Simulation of Blood Flows; Numerical Heat & Mass Transfer
9.	Dr. Surabhi Tiwari	Associate Professor	Real Analysis; Topology; Rough Set Theory; Fuzzy Subset Theory
10.	Dr. Supriya Yadav	Assistant Professor	Fluid Dynamics; Bio-Mechanics; Differential Equations
11.	Dr. Prashanta Majee	Assistant Professor	Applied Functional Analysis; Fixed Point Problems; Variational Inequality Problems; Equilibrium Problems
12.	Dr. Naren Bag	Assistant Professor	Computational Fluid Dynamics; Microfluidics & Microscale Transport; Numerical Methods & Analysis for ODE & PDE
13.	Dr. Shubham Gupta	Assistant Professor	Optimization; Evolutionary Algorithms

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Government of India

अनुसंधान नेशनल रिसर्च फाउंडेशन

Anusandhan National Research Foundation

Organising Committee

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Prof. Pitam Singh	**Chairman**
Prof. Shiv Datt Kumar	**Coordinator**
Dr. B. Vasu	**Convener**
Prof. Pankaj Srivastava	**Member**
Prof. Mukesh Kumar	**Member**
Prof. Pramod Kumar Yadav	**Member**
Dr. Sahadeo Padhye	**Member**
Dr. Gorakh Nath	**Member**
Dr. Surabhi Tiwari	**Member**
Dr. Supriya Yadav	**Member**
Dr. Prashanta Majee	**Member**
Dr. Naren Bag	**Member**
Dr. Shubham Gupta	**Member**

Committees for AIMLAC-2025

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ABSTRACTS OF INVITED SPEAKERS

Abstracts of Invited Speakers

Prof. S. Sundar, National Institute of Technology, Mizoram

About the speaker

Prof. S. Sundar is from the prestigious India's Number 1 Indian Institute of Technology Madras. He is a Professor of Mathematics and he was Head of the Department of Mathematics, IIT Madras during the period 2017- 2020. His area of research includes Numerics for Partial Differential Equations (PDEs), Mathematical Modelling and Numerical Simulation. He has on his credit over 70 peer reviewed research publications. He has guided 17 PhDs and currently 8 research scholars are working under his guidance. He has guided over 150 MTech research projects and currently over 10 MTech students are pursuing their research projects.

A Shock-capturing meshless geometric conservation weighted least square method for solving the shallow water equations

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The shallow water equations are numerically solved to simulate free surface flows. The convective flux terms in the shallow water equations need to be discretized using a Riemann solver to capture shocks and discontinuity for certain flow situations such as hydraulic jump, dambreak wave propagation or bore wave propagation, levee-breaching flows, etc. The approximate Riemann solver can capture shocks and is popular for studying open-channel flow dynamics with traditional mesh-based numerical methods. Though meshless methods can work on highly irregular geometry without involving the complex mesh generation procedure, the shock capturing capability has not been implemented, especially for solving open-channel flows.

Therefore, we have proposed a numerical method, namely, a shock-capturing meshless geometric conservation weighted least square (GC-WLS) method for solving the shallow water equations. The HLL (Harten-Lax-Van Leer) Riemann solver is implemented within the framework of the proposed meshless method. The spatial derivatives in the shallow water equations and the reconstruction of conservative variables for high-order accuracy are computed using the GCWLS method. The proposed meshless method is tested for various numerically challenging open channel flow problems, including analytical, laboratory experiments, and a large-scale physical model study on dam-break event.

Prof. P V S N Murthy, Indian Institute of Technology, Kharagpur

About the speaker

Prof. P. V. S. N. Murthy, currently working as a Professor in the Department of Mathematics, Indian Institute of Technology Kharagpur. He completed his Ph.D. in Fluid mechanics from the Department of Mathematics, Indian Institute of Technology Kanpur. He has more than 120 research publications to his credit, in the leading journals such as Journal of Fluid Mechanics, Proceedings of the Royal Society, Physics of Fluids, International Journal of Heat and Mass Transfer, Transactions of ASME-Journal of Heat Transfer, Transport in Porous Media, etc.

Taylor Dispersion in non-Newtonian Blood Flow in Microvessels - Possible Role of AI and ML methods

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This lecture is intended to present the developments on the solute dispersion in circular tubes. Also to explore the possibility of the role of Artificial Intelligence and the Machine Learning methods to boost the understanding and analysing the nanoparticle based drug transport in the blood flow in the microvessels. The study on solute dispersion was initiated by G. I. Taylor for the Newtonian fluid flow. A plethora of literature is available on the solute dispersion in Newtonian and non-Newtonian fluid flow in tubes of various cross-sections. Current research shows the study is lead up to exploring unsteady solute dispersion in the pulsatile flow of non-Newtonian fluids under the periodic body acceleration/deceleration. Several variants of the non-Newtonian fluid models such as the Casson, H-B, K-L, Carreau and Carreau-Yesuda and Ellis models are considered in this lecture.

The time-dependent velocity profile is obtained analytically for smaller values of the Womersley frequency parameter for yield stress fluid such as the K-L fluid or the non-yield stress model such as the Ellis fluid while for larger values of this parameter, a numerical solution is computed using an explicit finite difference method. The generalized eigen function expansion method and the Aris' method of moments are widely used by researchers to examine the solute dispersion; both these methods are discussed here. Estimates for the exchange coefficient due to the irreversible first order boundary reaction, the convection and the dispersion coefficients, the skewness and the kurtosis are examined and their response to the system governing parameters is analysed. The discussion on the solute dispersion is made in the three flow and dispersion regimes: (i) viscous flow with diffusive dispersion regime, (ii) viscous flow with unsteady dispersion regime and (iii) the unsteady flow with unsteady dispersion regime. These regimes are characterized by the interplay between the values of the Péclet number, the Womersley frequency parameter, which is associated with the pressure pulsation, and the oscillatory Péclet number which has inherently the Schmidt number.

For a specific non-Newtonian fluid such as the Ellis fluid, the impact of the body acceleration parameter, the wall absorption parameter, the degree of shear thinning behaviour index, shear stress parameter, the Womersley frequency parameter, and the fluctuating pressure parameter, on the axial mean solute concentration is discussed here. It has been noticed that the value of the dispersion coefficient decreased monotonically in the viscous flow with the diffusive dispersion region, while the skewness and kurtosis both have shown significant variations in the unsteady dispersion regime, which lead to the significant variation in the axial mean concentration. Graphical analysis shows that a leftward shift and also a reduction in the peak of the mean concentration leading to the non-Gaussianity of the solute dispersion in the non-Newtonian fluid flow under the body acceleration/deceleration conditions. The contrast in the axial mean concentration results with and without the higher order moments is tabulated along with the presence and absence of the wall absorption parameter. This analysis can be used in understanding the solute dispersion in blood flow, with specific applications such as nutrient transport and directed drug delivery.

It is seen from the literature that the AI and ML can critically enhance the Taylor Dispersion Analysis by improving data analysis, optimization, and prediction of the outcomes. AI can automate data processing, identify patterns, and even predict the behaviour of samples under different experimental conditions, ultimately making the Taylor dispersion analysis more efficient and accurate. It is the basic idea of this talk to bring the audience to understand that many of the biophysical processes can also be automated for their analysis.

Keywords: Solute dispersion, non-Newtonian fluids, circular tube, higher order moments, non-Gaussianity, ML and AI methods.

Prof. D. V. L. N. Somayajulu, National Institute of Technology, Manipur

About the speaker

Prof. D. V. L. N. Somayajulu, currently serving as Director, NIT Manipur. He has over 35 years of experience in teaching, research, consultancy, and outreach works in the field of Computer Science and Engineering. He joined as Director of National Institute of Technology Manipur on June 1st, 2024. His academic career started in NIT(REC) Warangal in the month of September 1988 and promoted as Professor of Computer Science & Engineering in 2006. He completed his PhD from Indian Institute of Technology Delhi in 2002. He has more than 55 research papers to his credit, such as International Journal of Data Mining, Modelling and Management, Journal of Information & Knowledge Management, IETE Journal of Research, IEEE Transactions on Computational Social Systems, Applied Intelligence (Springer) etc.

Cross Validation Methods

D. V. L. N. Somayajulu
Professor of Computer Science & Engineering, NIT, Warangal) and
Director, National Institute of Technology Manipur, Imphal
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This lecture highlights the need and applicability of various cross validation methods while building statistical models in data science applications. In this lecture presents differences between model accuracy versus model interpretability, process of improving the accuracy of the linear model, how to determine using subset selection methods, various cross validations methods, their advantages and disadvantages of each method over the others and their demonstrations using R or Python.

Prof. B.V. Rathish Kumar, Indian Institute of Technology, Kanpur

About the speaker
Prof. B. V. Rathish Kumar, currently working as a Professor (HAG) in the Department of Mathematics & Statistics, IIT Kanpur, India. He completed his Ph.D. from Sri Sathya Sai Institute (SSSIHL), Prasanthinilayam. He has around 287 research papers to his credit, in leading journals such as Physics of Fluids, Computational Methods in Applied Mechanics and Engineering, Applied Mathematics and Computation, Journal of Porous Media, Computers & Mathematics with Applications, Numerical Heat Transfer, International Journal for Numerical Methods in Fluids etc.

Convergence analysis of PO-DNN-Net and application

B.V. Rathish Kumar and Rajendra Kumar
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In this talk, we will provide a quick overview of physics-informed neural network systems for solving PDEs in general. Next, we focus on the Deep Neural Network Method (PO-DNN Net) developed for the Psi-Omega form of NS equations. We will also provide details on the mathematical convergence analysis of the DNN-PO-Net. Later will discuss the application of the method to solve the Double shear layer problem and Taylor Vortex problem.

Prof. Y. V. Sanyasi Raju, Indian Institute of Technology, Madras

About the speaker

Prof. Y. V. Sanyasi Raju, currently working as a Professor in the Department of Mathematics, IIT Madras, India. He completed his Ph.D. at IIT Madras. He has more than 50 research papers to his credit, in the leading journals such as International Journal of Thermal Sciences, International Communications in Heat and Mass Transfer, Physics of Fluids, Applied Mathematics and Computation, and International Journal for Numerical Methods in Fluids *etc.*

Accurate and Stable Computations for Stefan Problem with moving interfaces

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This lecture discusses computational procedures for obtaining accurate and stable solutions to the Stefan problem involving moving interfaces. The focus is on physical processes in fluid dynamics and heat transfer where either a phase-separating interface or a domain boundary evolves dynamically. A representative example is the dissolution of a solute in a solvent driven by forced or natural convection. The theoretical analysis captures the dynamic nature of phase transition, with the nonlinear governing equations solved using either a stable, second-order accurate grid-free scheme or a boundary fitted alternating direction implicit (ADI) scheme employing a first-order upwind approximation for convective terms.

The numerical schemes are first validated using a natural convection problem without phase transition, for which benchmark solutions exist. The validated models are then used to study the influence of key physical parameters—including the Stefan number (Ste), aspect ratio, Rayleigh number (Ra), and Schmidt number (Sc)—on dissolution rates and flow structures. Results show that, in the absence of temperature effects, solute dissolution is primarily governed by the annulus gap width (L) and the convection rate. Furthermore, for Rayleigh numbers exceeding 10^5, an initially circular solute dissolves uniformly at first, but later evolves into an egg-shaped form due to laminar boundary layer flow effects.

Prof. A. K. Nandakumaran, Indian Institute of Science, Bangalore

About the speaker
Prof. A. K. Nandakumaran is the Chairman & Professor of the Department of Mathematics at the Indian Institute of Science (IISc), Bangalore. He obtained his Master's degree from Calicut University, Kerala, and completed his Ph.D. in Partial Differential Equations from the Tata Institute of Fundamental Research (TIFR), Mumbai, in collaboration with the Indian Institute of Science, Bengaluru. His research spans Analysis Ordinary and Partial Differential Equations ,Controllability, Differential Games. He has published over 65 research papers and co-authored several books.

An Introduction to Tomography Applications to various subjects including Medicine and Spectral Method for a forward Problem

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Tomography is a cross-sectional imaging of an object or tissue from the mathematical modelling and measured experimental data. The study of tomography involves mathematical modelling, analysis, development of numerical algorithms, its implementation and experimental validation. These problems lead to a class of inverse problems, where the mathematical analysis and computations are rather complicated, but has tremendous applications in various branches of science including medical applications like CT scan and other areas. It is truly a multi-disciplinary area and requires help from experts on various subjects.

In this talk, we will give a general introduction to various topographies across disciplines, issues encountered and we model an application from X-ray tomography. At the end of the talk, we briefly describe some computations done for a forward problem via spectral methods and related theorems. Most of the talk will be addressed to cater the general audience both from engineering and science.

Prof. M. Manjunatha, Indian Institute of Technology, Kharagpur

About the speaker

Manjunatha Mahadevappa (M'04–SM'14) received the B.E. and M.Tech. degrees from the University of Mysore, India, in 1990 and 1994, and a Ph.D. degree in Bio-Medical Engineering from the Indian Institute of Technology Madras, in 2001. He is currently a Professor at the Indian Institute of Technology in Kharagpur, India. He has published over 80 peer-reviewed research papers, books, and book chapters on medical imaging and advances in therapeutic engineering. His research interests include biomedical signal & image processing, bio-instrumentation and biosensors, retinal and neural prosthesis, electrical retinal stimulation, rehabilitation engineering, and bio-robotics.

Convolutional Neural networks for classification of optical coherence tomography images

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Optical coherence tomography (OCT) is an imaging modality used to obtain a cross-sectional image of the retina for retinal disease diagnosis. Convolutional Neural Networks is used in modern clinical diagnosis systems. In this presentation the proposed model increases the contrast in the residual connection, so high contrast regions, such as the retinal layers, are prominent in feature maps. In this proposed model which increases the contrast of the derivatives to generate sharper feature maps. This new design replaced the residual connection in standard ResNet architectures. The proposed activation function retains negative weights and reinforces smaller gradients. We have used two OCT datasets with four and eight classes of diseases, respectively. We performed graphical analysis using Precision–Recall curves. We used accuracy, precision, recall, and F1 score for evaluation. In this proposed design, it was observed an increase in the classification accuracy. In confusion matrices, we observed the maximum performance increase when the number of samples is less in one class, which will be helpful if data is imbalanced. The retinal boundary is enhanced, with the background (the region outside the retinal layers) suppressed but not entirely removed. Based on ablation studies, it was found that an average accuracy loss of 0.875% with OCT-C4 data and 1.39% for OCT-C8 data. The p-values from Wilcoxon signed-rank test were also computed for the above two datasets.

Keywords: *OCT, Image Classification, Convolutional Neural Network, Retinal diseases*

Prof. T. V. S. Sekhar, Indian Institute of Technology, Bhubaneswar

About the speaker

Prof. T. V. S. Sekhar is a Professor in the Department of Mathematics at the Indian Institute of Technology (IIT) Bhubaneswar. He obtained his Ph.D in Mathematics from IIT Madras and M.Sc. in Applied Mathematics from Andhra University, specializing in computational fluid dynamics, magnetohydrodynamics, and heat transfer. His research, published in over 40 high-impact journals such as Physics of Fluids and International Journal of Heat and Fluid Flow, focuses on complex flows, including MHD convection and high Reynolds number flows, earning over 525 citations.

Hybrid GFD-RBF Meshless Method for Navier-Stokes Equations

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The Generalized Finite Difference (GFD) method is robust and stable for ill-conditioned systems but requires computation of all derivatives of a given order, even when only a few of them are needed. Accuracy improvements through higher-order terms also become computationally expensive due to numerous derivative evaluations, making the method less efficient for solving PDEs. In contrast, the Radial Basis Function (RBF) method is well-suited for higher-order and high-dimensional problems. Its main strengths are accuracy and extensibility, though performance depends on the selection of the shape parameter. Furthermore, increasing the number of nodes can lead to stagnation, where discretization error saturates. So, we have developed a Hybrid GFD–RBF framework that combines the strengths of both methods and minimizes their limitations. In this work, the hybrid method has been applied to Navier–Stokes equations for the lid-driven cavity flow in the stream function–vorticity (ψ–ω) formulation. In convection-dominated regimes, we have also employed upwind-based selection of neighbouring nodes to suppress oscillations. Numerical results are presented and compared with existing solutions in the literature in terms of stream function and vorticity fields.

Prof. Geetanjali Panda, Indian Institute of Technology, Kharagpur

About the speaker

Prof. Geetanjali Panda, currently working as a Professor in the Department of Mathematics, IIT Kharagpur, India since 22 years. Her area of research is Convex Optimization, Numerical Optimization, Gradient Descent Algorithms, Financial Optimization, Optimization with uncertainty. She has more than 90 research papers to her credit in leading journals such as SIAM Journal of Optimization, JOTA, Optimization Methods and Software, Applied Mathematics and Computation, Optimization, Engineering Optimization, European Journal of Operations Research, Optimization Letter etc.

Gradient Descent Algorithms for Machine Learning

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Gradient Descent is the backbone of machine learning algorithms. These algorithms develop an iterative process for minimizing the cost function of a model. At each iteration of the process, model parameters are decided using the descent direction. This talk will focus on the basic structure of gradient descent algorithms, which can be used in machine learning. The role of convexity, the evaluation of learning rate by several methods, and the global convergence property of the algorithms will be discussed in detail.

Prof. Subrahmanya Sastry Challa, Indian Institute of Technology, Hyderabad

About the speaker

Prof. Subrahmanya Sastry Challa, currently a Professor in the Department of Mathematics, IIT Hyderabad, India. He completed his Ph.D. from IIT Kanpur. His research interests are Wavelets, Inverse problems, Sparse representation theory, AI/ML, Applied Mathematics. He has more than 28 research papers to his credit, in leading journals such as Journal of Networks and Computer Applications, Journal of Inverse and Ill-posed Problems, IEEE Signal Processing Letters etc.

Data-driven learning: Theory and Applications

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While *artificial intelligence* (AI) is a broad science of mimicking human-beings, *machine learning* (ML) is a sub-area within AI. In ML, one's objective is to convert experience (provided in the form of labelled data) into expertise (a decision-rule that maps data samples into their corresponding labels). When building a decision-rule, one is supposed to keep in mind the issues such as scalability, stability and complexity of the underlying algorithms. There are several ways of building the data-driven decision-making rules, which include *support vector machines* (SVMs) and their variants, *artificial neural networks* and their variants (including the current wave of deep networks).

The concept of learned algorithms (or algorithm unrolling) is a recent idea within the domain of deep learning. The idea behind the learned algorithms is to map each step of an iterative process of an algorithm into a network layer. Stacking a finite number of such layers gives rise to a learned (or unrolled) network. This enables the network to learn from the given data via backpropagation. One key advantage of unrolled networks lies in their interpretability. Unlike conventional deep learning architectures, which often function as "black boxes," learned networks retain a direct correspondence to iterative steps of the optimization.

The presentation aims at discussing the ways of building the decision functions, theoretical guarantees, algorithmic issues and some of their applications along with a hands-on coding session.

Prof. Raju K. George, Indian Institute of Space Science and Technology, Thiruvananthapuram

About the speaker

Prof. Raju K. George, currently working as an Outstanding Professor in the Department of Mathematics, Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram. He also serves as Head of the Department of Mathematics. He completed his Ph.D. from the IIT Bombay. His research interests include Functional Analysis Mathematical Control Theory Soft Computing and Machine Learning Industrial Mathematics - Modelling and Simulation Orbital Mechanics. He has an extensive publication record of roughly a hundred papers and conference contributions. He is also a co-author of the textbook Ordinary Differential Equations: Principles and Applications

Modelling of Hopfield Recurrent Neural Network as a Control System and its Controllability and Stability Analysis

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In this talk, we model a recurrent neural network having n neurons into a continuous Hopfield Network with external stimuli. We discuss the controllability of the network under suitable assumptions on the activation functions of the neurons on the network. We also analyse the stability of the network. Here, we employ monotonically increasing functions namely the bipolar sigmoidal functions as the transfer functions for stability properties.

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Prof. Arnab Roy, Indian Institute of Technology, Kharagpur

About the speaker

Prof. Arnab Roy is a Professor at the Department of Aerospace Engineering at the Indian Institute of Technology Kharagpur, India. He has more than 125 publications including book chapters, ebook, journals and conference papers to his credit. His research spreads across Computational and Experimental Fluid Dynamics and Aerospace Propulsion. His current research interests are fixed and flapping wing aerodynamics, shock boundary layer interaction, cavity flows, modal analysis of flows, turbulence in astrophysical flows, energetic solid fuel applications in ducted rockets etc..

From Flow Fields to Feature Spaces: Bridging CFD and AI/ML in Fluid Mechanics

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(1) Matrix Algebra- The Common Thread between CFD and AI/ML based predictive analysis- The advent of high-performance parallel computing paradigms, and dedicated hardware architecture for massively scalable parallel execution in the form of Graphics Processing Units (GPUs) have enabled the routine execution of Direct Numerical Simulations (DNS) and Large Eddy Simulations (LES), unlocking unprecedented resolution of turbulent flows across a wide range of spatio-temporal scales, extending the horizon for multi-physics simulations involving chemical reactions at a wide spectrum of temporal scales. The two Figures 1& 4 are representative of the numerical solution of two problems that are astronomically apart in spatial and temporal scales, yet their solution has been performed using a Finite Volume based hydrodynamics solver running on a high-performance computing platform.

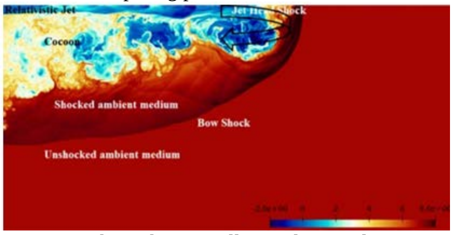

Figure 1: Relativistic jet propagation through interstellar media- A relativistic gasdynamics flow field [1]

At the heart of these solution strategies are efficient formulation and storage of matrices, and solution of the linear system of equations formed by these matrices using physics-informed, robust numerical techniques with low operational count, and which lend itself to very efficient and scalable parallelization. The aim will be to introduce and elaborate on certain matrix based diagnostic techniques that allow for pattern identification, data compression, and development of Reduced-Order Models using concepts which can be extended for development of robust, physics-informed ML models, and AI tools. In this direction, the primary topics of discussion are as follows:

(a) Dynamic Mode Decomposition: An estimation of global eigenvalues and eigenmodes

Dynamic Mode Decomposition (DMD) offers a powerful framework for extracting coherent spatiotemporal structures from high-fidelity simulation data. By decomposing flow fields into modal components associated with distinct frequencies and growth rates, DMD provides interpretable, reduced-order representations of complex dynamics. In the context of AI/ML, DMD serves as both a diagnostic and a bridge—transforming raw simulation output into structured, low-dimensional features that can inform surrogate modeling, training data selection, and hybrid physics-informed learning.

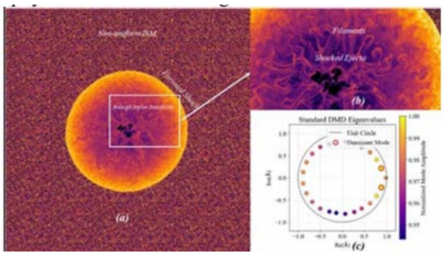

Figure 2: (a) log(ρ) distribution, and (b) filaments formation at t = 80, and (c) Eigenvalues plot [2]

(b) Selective Frequency Damping: A method to derive quasi-steady base flows

Selective Frequency Damping (SFD) is a stabilization technique used to extract steady-state solutions from inherently unsteady flow simulations. By applying a low-pass temporal filter to the governing equations, SFD selectively suppresses oscillatory modes while preserving the mean flow structure. This makes it particularly valuable in transitional regimes or near bifurcation points where conventional solvers struggle to converge.

Figure 3: Base flow profile computed by quenching unstable frequencies through Selective Frequency Damping

(c) Koopman Operator analysis- A systematic framework for pseudo-linearization

Koopman Operator Theory offers a linear perspective on nonlinear dynamical systems by lifting the state space into a higher-dimensional space of observables. In fluid mechanics, this enables the decomposition of complex flow evolution into modes governed by linear dynamics, even when the underlying system is nonlinear. Closely linked to DMD, Koopman-based approaches provide a foundation for modal learning and reduced order modeling. In the context of AI/ML, they inspire architectures that learn interpretable dynamics-bridging physics-based insight with data-driven generalization, and paving the way for operator-theoretic neural networks and hybrid modeling frameworks.

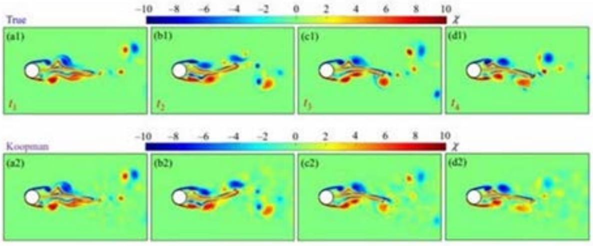

Figure 4. A comparison between the true (first row) and reconstructed (second row) flow fields by Koopman ROM at four different moment t = 40, 80, 120, and 160 [3]

(d) Lagrangian Coherent Structures: A representation of stable and unstable manifolds

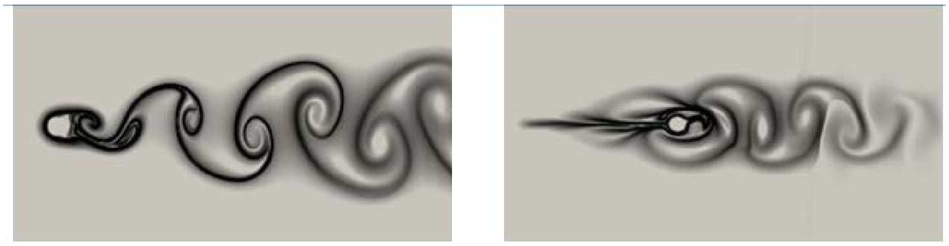
Figure 5: (a) Backward and (b) Forward FTLE fields for flow over a circular cylinder, showing attracting and repelling Lagrangian coherent structures in the unsteady wake

Lagrangian Coherent Structures (LCS) are the hidden skeletons of unsteady flows, delineating regions of maximal transport and organizing fluid motion over time. Identified through finite time Lyapunov exponent (FTLE) fields or variational methods, LCS reveal barriers to mixing, vortex boundaries, and flow separations. In high-fidelity simulations, they offer a dynamic lens into flow topology beyond Eulerian snapshots. For AI/ML applications, LCS can guide feature selection, data segmentation, and training set design—embedding physical interpretability into learning pipelines and enhancing generalization across flow regimes.

(2) Time Series Data analysis: Aerodynamic flows are often analyzed based on time series data. DARSI (Deep Auto-Regressive Time Series Inference), is an advanced architecture and an efficient hybrid of Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) components. It has been recently applied in forecasting coefficient of lift for a symmetric airfoil corresponding to angles of attack across periodic, aperiodic, and chaotic regimes [4], which will be briefly discussed.

Keywords: Dynamic Mode Decomposition, Selective Frequency Damping, Koopman Operator analysis, Lagrangian Coherent Structures, Time Series Data analysis

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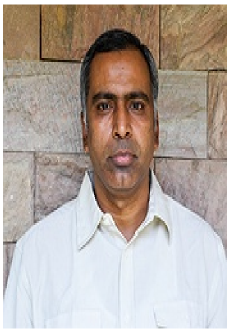
Prof. Natesan Srinivasan, Indian Institute of Technology, Guwahati



About the speaker

Dr. Natesan Srinivasan is a Professor in the Department of Mathematics, Indian Institute of Technology (IIT) Guwahati, India. From 2003 onwards, he is working as a faculty in the Department of Mathematics, IIT Guwahati. His area of research includes Numerical Solution of Differential Equations, multi-scale problems, mainly on singular perturbation problems, and homogenization, domain decomposition methods, computational fluid dynamics and big-data analytics. He has published nearly 150 research articles in reputed international journals, and a few chapters in books. He has been guiding several Ph.D. students in Mathematics for the past 20 years. Fourteen scholars have obtained PhD degree under his guidance and eight more are doing their research. He has research collaborators at various countries.

Efficient Physics-Informed Neural Networks for the Numerical Solution Differential Equations Exhibiting Boundary Layers

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Singularly perturbed differential equations (SPDEs) arise in various areas of applied mathematics and engineering. For example, Navier-Stokes equations is one of the well-known examples of fluid dynamics, where the solution exhibit boundary layers. Obtaining closed form analytical solutions to these differential equations are not possible, and one has to seek numerical approximate solutions. Because of presence of boundary layers, classical numerical techniques, like finite difference, finite element, finite volume methods fail to yield satisfactory numerical approximate solutions on uniform meshes. To overcome these difficulties, in recent years, machine learning techniques, namely, physics informed neural networks (PINNs) are becoming popular to solve various types of differential equations modelling several physical phenomena. Here, we focus the fundamentals of PINNs, and, their performance to solve singularly perturbed differential equations having one and two parameters. Further, we study the shortfalls of classical PINNs in solving two-parameter singular perturbation problems, and how to overcome these difficulties through other variants of PINNs. Several numerical experiments are carried out to see their performance.

Keywords: Singular perturbation problems, boundary layers, uniformly convergent numerical schemes, neural network, PINN.

Prof. S.V.S.S.N.V.G. Krishna Murthy, Defence Institute of Advanced Technology

About the speaker

Dr. Murthy obtained his post-graduation (M. Sc - Mathematics) from Osmania University, Hyderabad and Doctoral degree from Indian Institute of Technology Kanpur, Kanpur. Subsequently he was offered a Post-Doctoral position under Erasmus Mundus – WILL Power (Window India Learning Link Power) Fellowship ‘2010-11’, at Ecole Centrale Paris – France.

He has 25 years of experience in teaching. Dr Murthy is currently a Professor, Department of Applied mathematics, Defence Institute of Advanced Technology, Deemed to be University, Pune, which is Funded by Dept. of Defence R & D, Ministry of Defence, Govt. of India. He served as Head of the Department and Registrar of this University.

His research interests include Applied Mathematics, Mathematical Modeling, Convection in Porous Media, Fractional Calculus in Porous Media, Finite Element Analysis, Numerical Method's for D.E/P.D. E, Numerical parallel Algorithms, Applied Cryptography, AI / ML methods of DE. He has authored more than 50 publications in reputed SCI(E) journals. He was a former Vice President of the Indian Society of Theoretical and Applied Mechanics (ISTAM). Currently he is an editorial board member of Springer -Discover Applied Sciences Journal.

Mathematical Modeling and Advanced Computational Techniques for Engineering Applications

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In the purview of the rapidly increasing complexity, size of data and uncertainty in real-world problems in various fields such as economy, environment, engineering, science, medicine, we need suitable tools for modeling the phenomena in our daily life. Advanced(Soft) computing is a flexible tool for modeling real-world phenomena and is also one of the hot research fields in advanced artificial intelligence, while mathematical modeling and analysis (MMA) plays a key role in soft computing. Modelling and Simulation is a wide-ranging field of study offering a broad collection of methods and applications; the term ‘modeling’ may be found within the military domain, supply chain and logistics research, health care management, transportation planning, operations management, engineering, natural sciences, medicine, social sciences, and finances, among others. It is important to realise at the outset that learning to apply mathe matics is a very different activity from learning mathematics. The skills needed to be success ful in applying mathematics are quite different from those needed to understand concepts, to prove theorems or to solve equations. There is no theory to learn and there are only a few guid ing principles. The difficulty is not in learning and understanding the mathematics involved but in seeing where and how to apply it. There are many examples of very simple mathematics giving useful solutions to very difficult problems, although generally speaking the complexity of the problem and is required mathematical treatment. Therefore, mathematical modeling will attract the attention of several researchers due to its numerous applications. Some of these ap plications include, dispersion of chemical contaminants through water saturated soil, in grain storage units, and in several other geothermal and engineering applications. Also, there are many new areas where modelers are at work: for example in medicine on ultrasonic research, cancer detection and wound healing, various engineering and Science domains.

Prof. Rajesh Kumar Pandey, Indian Institute of Technology (BHU), Varanasi

About the speaker

Prof. Rajesh Kumar Pandey is currently working as a Professor in the Department of Mathematical Sciences, Indian Institute of Technology (BHU) Varanasi. He completed his Ph.D. from the Department of Applied Mathematics at the Indian Institute of Technology (BHU)Varanasi (Jan/2006-Jan/2009). He has more than 100 research publications to his credit, in the leading journals such as Communications in Nonlinear Science and Numerical Simulation, IEEE/CAA Journal of Automatica Sinica, Computers & Mathematics with Applications, Computers in Biology and Medicine etc

Line Detector Based Approach for the Retinal Blood Vessel Segmentation

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Alterations in the retinal blood vessels can assist in diagnosing conditions such as diabetes, hypertension, and arteriosclerosis. To help ophthalmologists make accurate diagnoses more efficiently and reduce treatment costs, we present an automated algorithm for segmenting retinal vasculature. Although the traditional line detector is a well-known method for segmenting vessel-like structures, it has a key limitation in estimating the background intensity around each pixel. In this study, we address and correct this problem by introducing the concept of punctured windows into the classic line detector. This improvement enhances the line detector's ability to identify small vessels in areas with low contrast. The proposed algorithm begins with denoising the image using a fractional filter. Next, the line detector with punctured windows calculates line responses at multiple scales. The final response is obtained by averaging all responses across scales along with the original image intensity. Lastly, hysteresis thresholding is applied to extract the segmented vessels. Our proposed algorithm is tested on four publicly available datasets such as RC-SLO, STARE, CHASE_DB1, and DRIVE using several performance metrics that are not affected by the class imbalance common in vessel classification tasks. The results show that our method is comparable to state-of-the-art techniques and surpasses many of them.

Keywords: Fractional filter, Line detector, Punctured window, Retinal vessel segmentation.

Prof. Ram Prakash Sharma, National Institute of Technology, Arunachal Pradesh

About the speaker

Prof. (Dr.) Ram Prakash Sharma, born in Dholpur District, Rajasthan, is a distinguished Professor of Mathematics in the Department of Mechanical Engineering at the National Institute of Technology (NIT) Arunachal Pradesh, India. He earned his B.Sc. (1990), M.Sc. (1992), and M.Phil. (1994) degrees from the University of Rajasthan and was awarded a Ph.D. in Fluid Dynamics (2003) from the Department of Mathematics, University of Rajasthan, Jaipur. Prof. Sharma has been recognized among the World's Top 2% Scientists by Stanford University/Elsevier (2024 and 2025) for his outstanding contributions in the field of Fluid Dynamics. Till date, he has authored more than 200 peer-reviewed publications in reputed National and International journals such as Physics of Fluids, International Communications in Heat and Mass Transfer, AMSE, Engineering Applications of Artificial Intelligence, and American Chemical Society journal.

The Role of Nanofluids in Recent Industrial Developments

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This analysis explores nanofluids and hybrid nanofluids, focusing on synthesis methods, stability, their thermophysical properties, and potential applications in various industries. This investigation also explores the enhanced heat transfer capabilities of hybrid nanofluids, which combine two or more different nanoparticles, leading to superior performance compared to conventional nanofluids, emphasizing their superior heat transfer capabilities. Nanofluids, created by dispersing nanoparticles into base fluids, enhance thermal efficiency in applications like heat exchangers and solar systems. Factors such as particle size, shape, volume fraction, type of nanoparticles, base fluid properties, temperature, surfactant use, and dispersion methods are examined for their impact on performance. Preparation methods, including one-step and two-step processes, ensure stable dispersion to avoid agglomeration. Key characterization techniques for assessing dispersion, durability, and thermal properties are also discussed. The findings offer insights for engineers on the practical use of nanofluids.

Keywords: Nanofluids; Thermophysical properties of nanofluids; Preparation of nanofluids; Application of nanofluids.

Dr. Dharmendra Tripathi, National Institute of Technology, Uttarakhand

About the speaker

Dr. Dharmendra Tripathi has been working as Associate Professor in Department of Mathematics, National Institute of Technology, Uttarakhand. He has completed his PhD in 2009 from Indian Institute of Technology BHU and MSc in Mathematics from Banaras Hindu University. His research work is focused on the mathematical modelling and simulation of biological flows in deformable domains, Peristaltic flow of Newtonian and non-Newtonian fluids, Membrane Based Pumping Flow Models; Dynamics of various infectious diseases; microfluidics; CFD, Biomechanics; Heat Transfer; Nanofluids; Energy Systems; Numerical methods; etc. He has supervised 09 PhD students and 05 are working under his supervision. He has published more than 200 papers in reputed international journals, 03 edited Books in Springer, 02 edited Book in CRC, 12 book chapters and presented more than 40 papers in International and National Conferences.

Applications of Artificial Intelligence and Machine Learning for Advanced Modeling in Fluid and Biofluid Dynamics

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This lecture presents the application of Artificial Intelligence (AI) and Machine Learning (ML) with classical fluid and biofluid dynamics. It highlights AI and ML applications in biofluids, including blood flow, capillary electrokinetic, and drug delivery. Physics-Informed Neural Networks ensure accurate, interpretable predictions. Challenges include limited data, generalization, and interpretability. Future directions focus on hybrid CFD AI models, real-time clinical support, and adaptive simulations, demonstrating AI’s role in predictive, personalized fluid and biofluid modeling. This lecture also presents the role of magnetohydrodynamic (MHD) flow of micropolar nanofluids over a stretching porous surface. It explores how intelligent computational techniques can improve understanding of nonlinear transport processes, including mixed convection, electroosmosis, melting heat transfer, and chemical reactions, with applications in engineering and biomedical systems. Computational Fluid Dynamics (CFD) offers exact solutions but is computationally intensive and limited in handling multiscale nonlinear interactions. This lecture highlights the potential of Artificial Neural Networks (ANNs) for modeling fluid flow and heat transfer, predicting velocity and temperature distributions, and identifying complex flow behavior beyond conventional approaches. The governing equations for micropolar nanofluid flow incorporate electric and magnetic fields, viscous dissipation, melting heat transfer, and chemical reactions. These nonlinear partial differential equations are converted into ordinary differential equations using similarity transformations and solved numerically with MATLAB’s BVP4c. The resulting solutions are used to develop an ANN model that reproduces the physical behavior of the system, enabling prediction of velocity, temperature, and concentration distributions, while assessing regression accuracy, loss function, and error distribution. The results reveal that the melting parameter slows the flow due to increased heat absorption, while the stretching parameter enhances velocity by raising wall shear. Interactions of the Hartmann number, Prandtl number, thermophoresis, and Brownian motion show how electromagnetic and nanoparticle effects control temperature and concentration fields. Comparisons between ANN and BVP4c solution results demonstrate strong agreement, confirming that AI models can provide accurate solutions with reduced computational cost.

Keywords: Artificial Intelligence, Machine Learning, Artificial Neural Network, Electro-Magnetohydrodynamic Flow, Melting heat transfer, Stretching Porous Sheet, BVP4c Solution

Prof. V. Ramesh Babu, National Sanskrit University, Tirupati

About the speaker

Dr. V. Ramesh Babu is a distinguished Professor in the Department of Mathematics at National Sanskrit University (central university), Tirupati. With a strong academic background, he holds an M.Sc in Applied Mathematics and a Ph.D. in Fluid Dynamics from Sri Venkateswara University, Tirupati. His research focuses on peristaltic flows of physiological fluids, contributing significantly to the field of Fluid Dynamics and Mathematical Modeling. With over three decades of teaching experience, Dr. Babu has served in various academic roles, guiding Ph.D. scholars and leading funded research projects.

The Ciliary Symphony: An AI-Driven Discovery of Metachronal Wave Patterns for Optimal Mucus Transport

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We've long known that coordinated, wavelike motions of cilia—known as metachronal waves—are essential for clearing mucus from our airways. However, the specific wave patterns that maximize transport in diseased, non-Newtonian mucus have remained a mystery, largely because traditional simulations are too slow to explore the vast parameter space of ciliary coordination. In this talk, I will present a novel bio-fluid mechanics framework where we trained a recurrent neural network not just to simulate ciliary motion, but to invent it. By coupling a reinforcement learning agent with a high-fidelity fluid-structure interaction model, we tasked the AI with discovering previously undocumented, non-intuitive ciliary gaits. The results were surprising: the AI did not simply replicate known waveforms but identified asymmetrical and chaotic-looking patterns that outperform biologically observed waves by over 40% in transport efficiency under pathological conditions. This work opens a new frontier for designing therapeutic strategies for conditions like cystic fibrosis and COPD, and suggests that evolution may have only found a subset of optimal solutions for mucociliary clearance.

Keywords: AI-Driven Biomechanics; Metachronal Wave Optimization; Reinforcement Learning in CFD; Non-Newtonian Mucus Transport Active Matter; Cystic Fibrosis Therapy; Computational Bio-Fluidics.

Prof. S. Sreenadh, Sri Venkateswara University, Tirupati

About the speaker

Dr. S. Sreenadh obtained his Ph.D. from Sri Venkateswara University (SVU) in the area of fluid dynamics under the guidance of Prof. P. V. Arunachalam garu. After doctoral program, he worked there as CSIR-RA in SVU and subsequently joined as Lecturer and finally elevated as Professor in 2006. He worked as Dean, University Development; HOD & Chairman, BOS; Coordinator for DST-FIST and UGC-SAP at SVU. He completed two Major and two Minor Projects funded by DST and UGC. He worked as Local Secretary, IMS (2017) and Local Secretary II, Indian Science Congress (2017) held at SVU. He vworked as Associate Professor of Mechanical Engineering in Malaysia and visited Bozwana and Bangladesh. He guided 44 research scholars for Ph.D. and 26 research scholars for M.Phil. He retired from Sri Venkateswara University in 2021 and now he is working as Guest Faculty for BITS-Pilani, Hyderabad Campus for WILP division (Online).

Modelling of biofluid flows through flexible channels

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Biofluid dynamics deals with challenging transport phenomena, including fluid particle dynamics and fluid structure interactions as well as disease etiologies/effects and tissue restructuring. This clearly describes the inherent complexities of biological systems in mammals during normal and pathological conditions. For example, in the study of arterial blood flow, one has to consider several aspects such as pulsatality, laminar/turbulent nature, branching of channels, viscoelastic property of composite walls and heat and mass transfer of biofluids. In small blood vessels studies on tubular elasticity, capillary effects and cell deformation on blood rheology become important. Further, the deformation in the walls of the biological conduits arises due to several aspects. Here two characteristics are considered, one is peristalsis and another is elasticity. It is evident that only few biofluids follow Newton's law of viscosity. In view of this, it is interesting to analyse models for peristaltic flow of multi layered Newtonian/non-Newtonian biofluids incorporating the elastic properties. Some mathematical models for biological flows with deformable/flexible boundaries will be discussed during the lecture.

Keywords: Biofluid, Newtonian fluid, elasticity, peristalsis.

Mr. J. V. R. S. Prasad, Tata Consultancy Services, Hyderabad

About the speaker
Mr. JVRS Prasad, holds a Master Degree in Engineering and has over 35 years of experience in the areas covering Delivery Management, Project Management, Customer Relationship Management & Business Development. Defining and Deploying Quality Management System/Delivery Excellence, Software Quality Consulting& Software Testing and Talent Development and Management. In his 27, years of continuous on-going Journey with TCS, He Performed several Branch and ISU Leadership Roles such as Branch Quality Head, Process Excellence Lead, Delivery Excellence Head apart from Being Project Manager, Delivery Manager, BRM & GL. Currently Heading Regional Talent Development, @ Hyderabad, Responsible for Delivery of Talent Development Activities.

Talent Transformation Thru Gen AI – An IT Industry Perspective

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All of us have experienced various Learning Aspects, Methodologies & Learning Modes over a long period of our Professional Journeys. While we have used many modes of learnings thru a Guru approach, today is the reality of AI transformation, in this interaction with the esteemed Participants, I would be discussing AI's impact on IT industry, especially in the area of learning transformation. Tools, Best Practices and associated challenges as well would surely be a win-win between Industry and Academia in terms of enabling Effective Supply Chain.

Keywords:. Experiencial Learning in IT Industry, Transformation, Supply Chain, Impact, Best Practices, Learning Effectiveness

Prof. Manish K. Gupta, Kaushalya: The Skill University, Government of Gujarat

About the speaker

Prof. Manish K. Gupta received his Ph.D. in Mathematics from the Indian Institute of Technology, Kanpur, India, in 2000. He has also been serving on the editorial boards of the Journal of Applied Mathematics and Computation, Springer and AIMS Electronics and Electrical Engineering, AIMS Press since 2017. His areas of interest are the elegant applications of mathematics in emerging technologies: DNA digital data storage, DNA computing, chemical computing, coding theory, quantum computing, quantum machine learning, quantum error correction, cryptography, blockchain, quantum algorithms, synthetic biology, DNA nanotechnology, bioinformatics. His group (https://www.guptalab.org/) is well known for developing open-source software products (for example, DNA Pen, 3DNA, DNA Cloud) in DNA nanotechnology. His DNA storage project was shortlisted as one of the top 5 innovations for the Prime Minister (India and Israel) demo at the India-Israel Innovation Initiative in January 2018.

Error Correction and AI in Quantum Realms: From Inception to Innovation

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Error correcting codes are the backbone of the current information and communication technology (ICT). In 1994, with the discovery of polynomial time algorithms of discrete log and integer factorization on quantum computers by Shor, there were lots of activities by many researchers to work on the new area of quantum computing. However, fault tolerance in quantum computers was a big challenge. In 1995, Peter Shor himself discovered the [[9,1]] quantum error correcting code that can correct any single bit flip and phase flip in quantum computers. In the first part of this talk I will give an introductory overview of quantum error correction. We will explain the key concepts that led to the discovery of quantum error correction by Shor. Now in the modern era, AI is playing a key role in developing codecs for classical and quantum computing. In the second part of the talk, we will explore how AI will be helpful for quantum error correction.

Dr. Balaji Krishnamurthy, Adobe India, Noida, Uttar Pradesh

About the speaker

Dr. Balaji Krishnamurthy is a Sr. Director at Adobe, where he leads the Media and Data Science Research Lab (MDSR Lab https://adobe.mdsr.live/). The lab focuses on AI/ML research spanning NLP, Computer Vision and Data Science aligned to Personalization and other Marketing applications. Balaji has over Twenty Seven years of experience in Research and Advanced Product Development and has authored 120+ patent applications and 60+ publications in top AI/ML conferences and journals.

From Tokens to Theorems: Lean, LLMs, and the (Re)Invention of Mathematical Practice

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Large language models (LLMs) have matured from clever text predictors into agents that plan, verify, and increasingly co-author mathematics. Many fronter developments in the intersection of Proof Assistants and Language Models are reshaping mathematical practice. For example, DeepMind with Brown/NYU/Stanford introduced a framework that systematically uncovers unstable singularities in model fluid equations, hinting at computer-assisted avenues around **Navier–Stokes** (still unsolved). In parallel, 2025 saw headline results at the **International Mathematical Olympiad**: both DeepMind and OpenAI reported **gold-medal-level** performance (5/6 problems solved within the time limit), a symbolic milestone for contest math.

This talk starts with an introduction to the core ideas behind today's systems—neural networks, attention mechanism, and decoder-only transformers—and explains why these architectures are well-suited to symbolic manipulation, tactic suggestion, and long-horizon reasoning. We then bridge to formal mathematics with Lean Programming Language and mathlib, showing how compiling ideas into proof objects transforms search and reuse by making every step machine-checkable.

The live portion of the talk follows a propose-and-verify workflow. We begin with a Lean warm-up to demonstrate library-aware proving. Next, an LLM produces a concise, Lean-ready proof plan for a classical theorem and we verify a key lemma in the kernel—illustrating the division of labor: models propose, the kernel disposes. A short "reasoning at work" demo highlights structured planning with tool use: the model states invariants, performs a calculation, and supplies a check that can be validated in Lean or Python. We close the demo segment by hunting for counterexamples to plausible but false claims, reinforcing that mathematical progress includes finding and repairing failure cases.

With that scaffold in place, we survey frontier developments that are reshaping mathematical practice. Agentic systems such as AlphaEvolve point to loops that iteratively edit, test, and evolve code and constructions, suggesting analogous pipelines for conjecture generation and proof repair under verification. A new startup wave is assembling a "formal math stack"—for example, efforts focused on auto-formalization, large-scale proof attempts, and expert-in-the-loop workflows—signaling rapid investment in tools that integrate LLMs and proof assistants.

Finally, we discuss how to measure and improve mathematical reasoning in LLMs.
We test models with benchmarks comprising of clean, expert-written problems (frontier problem sets) and auto-generate small perturbations of the same questions to see where the models break. Then we train them to show correct steps, not just the final answer—using step-by-step scoring (process reward models), automatic checkers (reinforcement learning), and training models with lots of math data. This makes them more reliable and lets us sample several solutions and pick the best one.
The takeaway from these developments is pragmatic and optimistic: by combining structured reasoning models with Lean's uncompromising kernel, researchers can iterate faster on ideas with formal checkpoints, and the community can archive trusted results at scale. Taken together, these ingredients point to a genuine golden age for mathematical discovery.

Keywords: Formal Mathematics, Lean, Large Language Models, AI

Mr. Kumar Abhinav, Tata Consultancy Services (TCS)

About the speaker

Mr. Kumar Abhinav is a leading Enterprise Architect in the healthcare business unit TCS. He has been actively working on modernization of legacy systems, cloud adoption and build engineering best practices for DevSecOps. Kumar's focus now is to use the Language models and Generative AI capabilities to accelerate technology debt reduction and legacy modernization in the healthcare ecosystem to reduce healthcare cost, improve access to preventive care and bring the retail experience to healthcare stakeholders. Kumar Abhinav is also actively grooming engineers and architects to develop cutting edge solutions for healthcare customers.

Leveraging AI/ML in Improving Efficiencies & Optimizing Cost in HealthCare Solutions

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Healthcare in both developing and developed countries have their own challenges and the cost of care is escalating at a very high rate. Various value chains in the healthcare ecosystem are inherently legacy and there are a lot of frictions and inefficiencies that lead to delay in access to care and reduce member and provider experience.
The latest development in AI/ML and Generative AI provides a lot of opportunities to improve efficiency and accuracy of the system.
In this session we will look at specific business problems in healthcare and AI based solution elements to address them.

Dr. Rajaram Lakkaraju, Indian Institute of Technology, Kharagpur

About the speaker

Dr Rajaram Lakkaraju is an Associate Professor at the Department of Mechanical Engineering, Indian Institute of Technology Kharagpur-India. He obtained PhD for the work on boiling turbulent Rayliegh-Benard convection using HPC simulations from Physics of Fluids University of Twente, The Netherlands, in 2013. His research is Multi-Phase Flows in the context of geophysical fluid dynamics (the oceans and atmosphere) and industrial applications like aircraft and reactors. He does basically theory and computer simulations. He is passionate about turbulent dynamics of air-sea interactions, bubbly flows, cloud condensation, gas exchange, general circulation, upper ocean dynamics, internal waves and shock-boundary layer interactions

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Autoencoders for Forecasting Nonlinear Systems

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Autoencoders (AEs) enable efficient, data-driven representations of turbulent flows by learning nonlinear mappings between high-dimensional fields and compact latent spaces. Unlike traditional linear methods, AEs can capture the intricate, multiscale structures that govern turbulent dynamics. Convolutional and variational formulations support accurate reconstruction, statistical characterisation, and generative modelling of flow fields. Incorporating physics-based constraints further enhances model stability and interpretability. These latent representations not only compress data efficiently but also provide a basis for forecasting and reduced-order modelling, making autoencoders a central tool for bridging machine learning and turbulence research.

Dr. Rajesh Ranjan, Indian Institute of Technology, Kanpur

About the speaker

Dr. Rajesh Ranjan is a faculty member in the Department of Aerospace Engineering at the Indian Institute of Technology Kanpur. He obtained his Master's degree from the Indian Institute of Science, Bengaluru, and his Ph.D. from the Jawaharlal Nehru Centre for Advanced Scientific Research, India, under the supervision of the late Professor Roddam Narasimha. Prior to joining IIT Kanpur, he was a postdoctoral scholar at The Ohio State University, USA. Dr. Ranjan is also the founder and director of Vayusoft Labs Pvt. Ltd., a startup focused on AI-CFD–based efficient simulations for complex flows. His research interests span turbomachinery, high-speed flows, transition and turbulence, and scientific machine learning.

Physics-Informed Neural Networks for Capturing Discontinuities in Hyperbolic Systems

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Physics-Informed Neural Networks (PINNs) offer an alternative framework for solving partial differential equations by embedding governing physics directly into the learning process. This talk presents the application of PINNs to hyperbolic flow systems characterized by shocks and discontinuities, highlighting challenges in capturing non-smooth behavior and strategies to improve convergence and accuracy. While PINNs demonstrate reasonable accuracy for smooth low-Reynolds number flows, they often struggle to predict flows with strong discontinuities such as shocks, where data-based training is typically required. The added presence of viscosity further complicates predictions due to shock–boundary layer interactions. In this work, we present a novel PINN framework that incorporates features such as domain decomposition, residual-based attention, batch normalization, and dual encoders, among others, enabling accurate prediction of complex engineering flows without relying on data. The framework is first demonstrated on canonical test cases including shock tubes, compression corners, and SBLIs, showing its robustness and potential for high-speed aerodynamic applications. Finally, we show predictions for steady high–Reynolds-number flows, where a Reynolds-number ramping strategy is adopted—starting from a low Reynolds number and progressively increasing it—to achieve stable and physically consistent convergence.

Keywords: Shock, Expansion, Riemann problem, Shock-boundary layer interactions.

Dr. Priyam Chakraborty, Indian Institute of Technology, Kharagpur

About the speaker

Priyam Chakraborty is an Aerospace Engineer with B. Tech., M. Tech. and PhD from the Indian Institute of Technology Kharagpur. He is currently working on smart navigation of active matter in the department of Artificial Intelligence at IIT Kharagpur. His fascination with collective intelligence, initially sparked by the efficiency of bird flocks, has turned into a belief in the power of biomimetic design that invokes automation and machine learning to unlock hidden patterns within complex datasets. By exploring, analyzing, and potentially challenging existing assumptions, Priyam aims to create affordable intelligent systems that can automatically analyze video data, extract meaningful insights about human activities, and potentially be applied in areas like security monitoring, human-computer interaction, and medical diagnostics.

Fundamentals of Artificial Intelligence and Python

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This lecture gives participants a compact, hands-on introduction to core AI ideas and the Python ecosystem used to explore them: after a brief motivation and conceptual primer on what AI means today (supervised vs unsupervised learning, the model lifecycle, and common evaluation concepts), attendees will see a live demonstration of the essential Python toolkit (Jupyter/Colab, NumPy, pandas, matplotlib, and scikit-learn) and follow a guided mini-project that walks through loading data, basic preprocessing, training a simple model (e.g., logistic regression or a decision tree), evaluating performance (accuracy, precision/recall, train/validation/test splits), and interpreting results while highlighting common pitfalls like overfitting and data leakage; the planned flow is 0-10 min for welcome and motivation, 10-30 min for a Python toolkit tour, 30-55 min for AI fundamentals, 55-80 min for live coding and hands-on exercise, and 80-90 min for wrap-up, takeaways, and Q&A. Prerequisites are only basic programming familiarity (variables, loops, functions); participants are encouraged to bring a laptop with Python 3.x and Jupyter or use Google Colab (no install required) with numpy, pandas, matplotlib, and scikit-learn available. Deliverables include a short Jupyter notebook implementing the demo pipeline (data to model to evaluation), a one-page checklist for running simple ML experiments and avoiding common mistakes, and a concise learning path to progress into feature engineering, neural networks, and deployment; by the end of the session attendees should be able to explain core AI concepts, run a minimal end-to-end experiment in Python, interpret basic model outputs, and know concrete next steps for deeper study.

Keywords: Artificial Intelligence, Python, Jupyter/Colab, NumPy, pandas, scikit-learn, supervised learning, model lifecycle, evaluation metrics

Surrogate Modelling for Fast Inference in Medical Diagnostics/Retrieval and Analysis of Images with Vision Transformers

This lecture presents a focused, practice-oriented introduction to building lightweight surrogates and retrieval pipelines that accelerate clinical image inference without sacrificing diagnostic fidelity. We begin by motivating the clinical need for speed and scalability in settings such as triage, point-of-care screening, and large-scale image database searches, then cover the core concepts of surrogate modelling (emulators, knowledge distillation, feature-space regression, low-rank approximations, and practical model compression techniques like pruning and quantization) and how they trade off accuracy, latency, and interpretability. The lecture then gives a concise, intuitive tour of Vision Transformer (ViT) architecture – patch embeddings, multi-head attention, class tokens, and transfer/self-supervised pretraining – and explains why transformer-based representations are especially useful for medical image retrieval and downstream surrogate training. The hands-on portion walks participants through a short notebook where they (1) extract robust image embeddings from a pretrained ViT, (2) train a compact surrogate (e.g., an MLP or small ensemble) to reproduce the heavy model's predictions for fast on-device inference, and (3) build a simple retrieval index over embeddings (approximate nearest neighbors) to demonstrate case-based search and evaluation; we also demonstrate basic explainability (attention visualization / relevance maps) and measure key metrics (latency, AUC/accuracy, precision). By the end of the session attendees will understand when and how to deploy surrogates in clinical pipelines, how ViT embeddings can power both rapid inference and content-based retrieval, and they will leave with a runnable Jupyter notebook, a one-page checklist for designing surrogate systems in medical imaging, and pointers to datasets and libraries to continue experimenting (PyTorch/TensorFlow workflows, pretrained ViTs, and ANN tools). Prerequisites: basic Python and machine-learning familiarity; recommended setup: laptop with Python, Jupyter/Colab, and standard ML libraries installed (or use Colab for an instant environment).

Keywords: surrogate modelling, fast inference, medical imaging, Vision Transformer (ViT), embeddings, knowledge distillation, model compression (pruning/quantization), approximate nearest neighbors (ANN) retrieval, explainability/attention visualization, latency vs. accuracy tradeoffs.

Prof. Shiv Datt Kumar, Motilal Nehru National Institute of Technology Allahabad

About the speaker

Prof. Shiv Datt Kumar, currently working as a Professor in the Department of Mathematics, Motilal Nehru National Institute of Technology Prayagraj. He completed his Ph.D. in Commutative Algebra from Harish Chandra Research Institute and Allahabad University. He has more than 47 research publications to his credit, in the leading journals such as International Journal of Algebra International Mathematical Forum Journal of International Academy of Physical Sciences, Indian Journal of Pure and Applied Mathematics (Springer Publication), Expositiones Mathematicae, Elsevier Publication (SCI Journal) publication (Scopus Indexed), Journal of Algebra and its Applications etc.

Core Mathematical Structures Driving Machine Learning and AI

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The rapid advances in Artificial Intelligence (AI) and Machine Learning (ML) are deeply rooted in rigorous mathematical foundations. In this talk we discuss, how core mathematical concepts drive modern computational intelligence. The lecture begins with an overview of different types of machine learning—supervised, unsupervised, and reinforcement learning before exploring the essential mathematical pillars: linear algebra, calculus, probability, statistics, and optimization. These tools provide the structure for representing data, training models, and making decisions under uncertainty. Key mathematical methods such as eigen decomposition, singular value decomposition (SVD), and principal component analysis (PCA) are introduced, emphasizing their role in dimensionality reduction and data interpretation. The talk also discusses the importance of gradient-based optimization in neural networks, activation functions for non-linear modelling, and probabilistic approaches for reasoning under uncertainty. Finally, it considers recent mathematical trends in AI, including information theory and representation learning, while pointing toward emerging challenges that demand further theoretical insights. The objective is to equip participants with a comprehensive understanding of the mathematical principles underpinning AI systems and to demonstrate their indispensable role in advancing next-generation intelligent technologies.

Prof. Anuj Jain, Motilal Nehru National Institute of Technology Allahabad

About the speaker

Prof. Anuj Jain, currently working as Professor in the Applied Mechanics department, MNNIT Allahabad. He completed his PhD from Indian Institute of Technology, Roorkee (IIT Roorkee) in 2002. He has more than 61 publications in leading journals such as International Journal of Automotive Technology, Journal of Computational Physics, International Journal of Experimental and Computational Biomechanics, Journal of Advanced Research in Applied Mechanics and Computational Fluid Dynamics, International Journal of Bio-Inspired Computation, Journal of Mechanics in Medicine & Biology, Trends in Biomaterials & Artificial Organs etc.

An Introduction to Physics-Informed Neural Networks (PINNs)

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Physics-Informed Neural Networks (PINNs) are an innovative new approach that combines the power of machine learning with the principles of physics to solve complex scientific and engineering problems. Unlike traditional neural networks, which rely solely on data, PINNs are designed to also respect physical laws—such as the conservation of energy or motion— expressed as partial differential equations (PDEs) by incorporating them directly into the learning process.

We will present the theoretical background of PINNs, highlighting their capability to unify data and physics in a single modelling framework. PINNs incorporate domain knowledge through the minimisation of PDE residuals, boundary, and initial conditions as part of the loss function. PINNs leverage known physical laws to guide learning, reduce dependence on large datasets, and ensure physically consistent predictions. This framework enables mesh-free, flexible approximations of solutions in high-dimensional or irregular domains, often outperforming classical numerical methods in challenging settings. This enables accurate, data-efficient, and generalizable solutions to forward (predicting system behaviour from known parameters) and inverse (estimating unknown parameters, material properties, or initial conditions from observed data) problems, across a wide range of scientific and engineering domains. The session aims to foster an understanding of how PINNs can be leveraged for computational modelling and simulation tasks traditionally dominated by mesh-based solvers. This session provides a gentle introduction to the fundamental concepts behind PINNs, with a focus on their application in solving equations that describe real-world systems, such as how heat spreads, how fluids flow, or how structures deform. We will explain how PINNs differ from traditional numerical methods and why they are gaining attention in areas like climate modelling, materials science, and fluid dynamics.

Participants will learn the key components of a PINN, how it is trained, and what makes it useful for solving problems where data is limited but physical knowledge is strong. No advanced background in machine learning or physics is required—this session is designed to help beginners understand the potential of PINNs in modern scientific computing.

Prof. Pitam Singh, Motilal Nehru National Institute of Technology Allahabad

About the speaker

Prof. Pitam Singh is a Professor in the Department of Mathematics at MNNIT Allahabad, Prayagraj, India. He holds a Ph.D. in Mathematics (Operations Research) from MNNIT Allahabad, an M.Phil., and an M.Sc. from CCS University Meerut. His research focuses on fuzzy optimization, operations research, GIS applications, mathematical modeling in seismology, and discrete mathematics. He has over 60 publications, several conference proceeding, and 2 funded projects, including one from the ICSSR.

Fuzzy sets and generalized fuzzy sets in multi-objective optimization

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The real-world problems can be formulated as uncertain optimization during the planning process of the task. The mathematical model of these optimization problems becomes complex due to the uncertain parameters involved. This talk presents the application of fuzzy sets in Multi-objective Optimization Problems. We will explore its theoretical basis, practical applications, and benefits over traditional methods, demonstrating how it enhances decision- making in uncertain environments.

Dr. B. Vasu, Motilal Nehru National Institute of Technology Allahabad

About the speaker

Dr. B. Vasu, presently working as faculty in the Department of Mathematics, Motilal Nehru National Institute of Technology Allahabad. He has completed his Ph.D. from Sri Venkateswara University (SVU). His area of interest is Computational Hemodynamics. He has been authored or co-authored more than Seventy research papers in reputed international journals like, Computers in Biology and medicine, BME Frontiers, IJHMT, ICHMT etc. He has awarded UGC Research Award: 2014-16 by University Grants Commission, India and Early Career Research Award (ECRA)-2018 by Science and Engineering Research Board. He completed two research projects funded by SERB and UGC; one ongoing project of DBT. He has national and international collaborations.

Recent Advances on Artificial Intelligence & Machine Learning for Computational Fluid Dynamics

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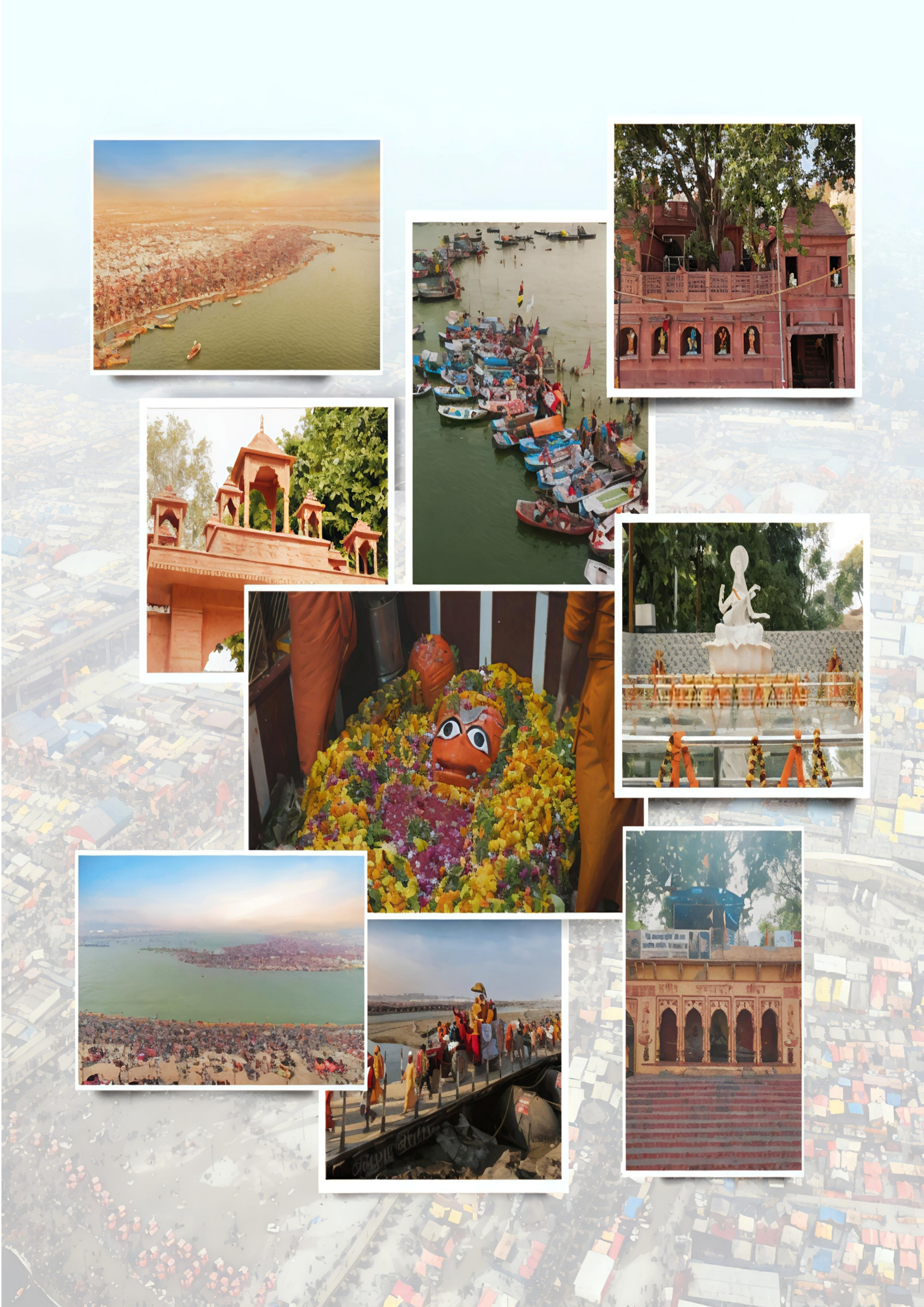
Computational Fluid Dynamics employs mathematical models to simulate fluid dynamics across a wide range of scientific and engineering fields. Despite decades of advancement in research and engineering practice, CFD techniques continue to face significant challenges. This study introducing the fundamental concepts, traditional methods, and benchmark datasets, then examine the various roles Machine Learning (ML) plays in improving CFD. This study explores the recent advancements in enhancing CFD tasks through ML techniques. Additionally, studies integrating artificial intelligence (AI) and machine learning (ML) into in silico models have demonstrated improved predictive accuracy, optimized patient-specific treatments.

This talk covers the role of Artificial Intelligence, Machine Learning, Soft Computing, and Deep Learning in oncology, explaining key concepts and algorithms (like SVM, Naïve Bayes, and CNN) in a clear, accessible manner. It aims to make AI advancements understandable to a broad audience, focusing on their application in diagnosing, classifying, and predicting various cancer types, thereby underlining AI's potential to better patient outcomes. The remarkable benefits of AI-powered algorithms in cancer care underscore their potential for advancing cancer research and clinical practice.

Additionally, it is also discussed the challenges, ethics and future research directions in this rapidly evolving domain. Overall, it is evident that AI and ML has the potential to significantly transform CFD research.

Keywords:
Computational Fluid Dynamics, Cancer, Artificial Intelligence, Machine Learning, Soft Computing, Machine Vision, Deep Learning.



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