VIRTUAL POPULAR SCIENCE TALK SERIES
A Report

The Centre for Excellence in Mathematical Biology (CEMB) at Sri Sathya Sai Institute of Higher Learning (SSSIHL), in collaboration with the Indian Society for Mathematical Modeling and Computer Simulation (ISMMACS), organized the "Virtual Popular Science Talk Series" as part of the Sri Sathya Sai Centenary Celebrations from February 2025 to August 2025. These sessions were held on the first Saturday of each month.

This initiative brought together eminent academicians and researchers from India and abroad, covering themes such as Mathematical Ecology, Epidemiology, Data Analytics, Artificial Intelligence, Bioinformatics, and Food & Nutritional Sciences. The program aimed to inspire participants and highlight the role of mathematics and science in addressing contemporary challenges.

Structure and Schedule

The series was coordinated by Dr. D. K. K. Vamsi from the Centre for Excellence in Mathematical Biology, Dr. Santanu Bhattacharaya, Dr. Abhijith Ajaya Kumar from the Department of Mathematics & Computer Science, Dr. Ramya E. M. from the Department of Biosciences, Dr. A. Sumana from the Department of Food and Nutritional Science at SSSIHL and Dr. Prashant Srivastava, Joint Secretary, ISMMACS. This initiative aligned with CEMB's mission to enhance national capacity in Infectious Disease Modeling and Mathematical Biology, aiming to leverage mathematical innovation for societal benefit, particularly in developing advanced solutions for public health.

Speaker: Prof. Peeyush Chandra, Retd. Professor, IIT Kanpur, India
Date: February 8, 2025

Speaker Bio

Prof. Peeyush Chandra is a distinguished academician and researcher renowned for his extensive contributions to the field of Biomathematics. He completed his B.Sc. from Meerut College, Meerut University in 1969, followed by an M.Sc. in Mathematics from the Indian Institute of Technology, Kanpur (IIT Kanpur) in 1971, and a Ph.D. in Biomechanics from the same institute in 1976. Following his doctoral studies, Prof. Chandra joined the Mehta Research Institute, Allahabad (now Harish-Chandra Research Institute), as one of its first Post-Doctoral Fellows, later serving as an Assistant Professor. In 1982, he returned to IIT Kanpur as a faculty member, where he continued his illustrious academic career until his retirement in 2015 as Professor (HAG). During his tenure, he also served as Head of the Department of Mathematics and Statistics (2005–2008) and held the prestigious Sanjay Mittal Chair Professorship (2011–2014).

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Prof. Chandra's research spans biofluid mechanics, mathematical ecology, and mathematical epidemiology. With around 90 publications and 12 supervised Ph.D. scholars, his scholarly impact has been both profound and far-reaching.Beyond research, he has contributed significantly to academic leadership, serving on expert committees of DST, SERB, and CSIR. He currently serves as Editor-in-Chief of the Journal of the Indian Mathematical Society and is a member of several editorial boards of reputed journals. A Fellow of the National Academy of Sciences, India, Prof. Chandra has also served as President of the Indian Mathematical Society and the Indian Society for Mathematical Modeling and Computer Simulation. His outstanding contributions have been recognized with numerous honors, including the Distinguished Service Award and the Life-Long Achievement Award from the Vijnana Parishad of India.

Talk Title: "Modeling Infectious Diseases with Mathematics – Why and How!"

Abstract

Infectious diseases have profoundly influenced human history, health, and economy. Despite significant progress in medical research, predicting and managing their spread remains a major global challenge. Prof. Peeyush Chandra's talk, "Modeling Infectious Diseases with Mathematics – Why and How!", focused on how mathematical modeling serves as a crucial tool in understanding disease dynamics and guiding effective control strategies.

The talk highlighted:

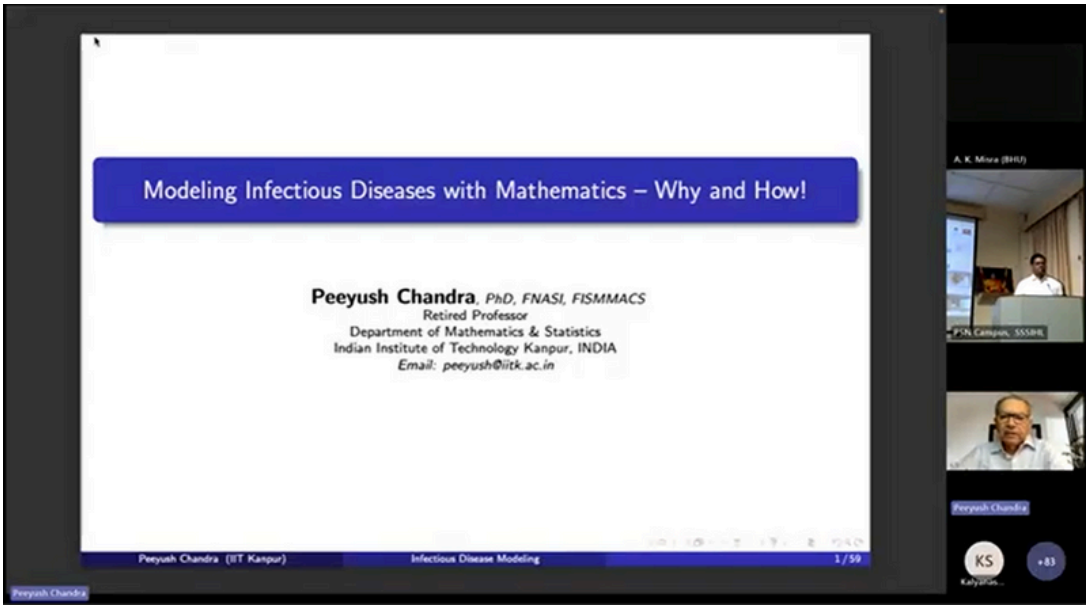
- The evolution of epidemiology from early statistical observations to modern mathematical frameworks
- The development of classical models such as SI, SIS, and SIR, which describe the transitions between susceptible, infected, and recovered populations
- The application of these models to real-world diseases like malaria, HIV, and COVID-19
- The integration of demographic, vaccination, and therapeutic factors to enhance predictive accuracy

Prof. Chandra explained how mathematical equations capture the mechanisms of infection, recovery, and immunity, allowing researchers to simulate outbreaks and evaluate intervention measures. He also discussed advanced frameworks such as the SUTRA model, which combines data-driven analysis with theoretical modeling to forecast pandemic trends more precisely.

Emphasizing the interdisciplinary nature of this field, Prof. Chandra underscored that the collaboration between mathematics, biology, and public health is essential for transforming raw data into actionable insights. His presentation illustrated how mathematical reasoning not only deepens our understanding of disease transmission but also informs resource allocation, vaccination strategies, and preparedness planning, ultimately supporting global efforts to safeguard human health.

Conclusion

Prof. Chandra's session provided a comprehensive understanding of how mathematical modeling bridges theory and practice in infectious disease management. By illustrating real-world applications—from classical epidemic models to data-driven simulations—he emphasized the value of interdisciplinary collaboration between mathematicians, biologists, and policymakers. The talk reinforced that accurate models not only enhance scientific understanding but also contribute to preparedness and resource optimization during health crises. The session inspired participants to view mathematics as a vital partner in safeguarding global health.



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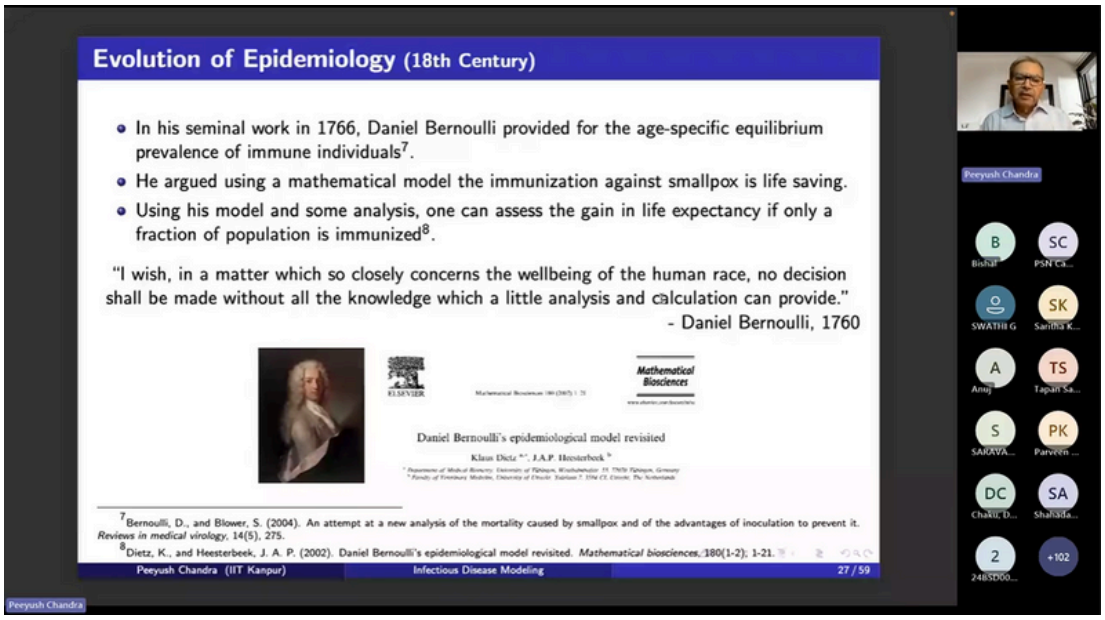


Speaker: Prof. Joydip Dhar, ABV-IIITM, Gwalior
Date: March 1, 2025

Speaker Bio

Prof. Dhar earned his Ph.D. from IIT Kanpur in 1997 and has over 28 years of teaching and research experience. Currently a Professor at ABV-IIITM Gwalior, he has published over 185 papers and guided 24 doctoral students. He has delivered more than 50 invited talks worldwide and co-authored books with international publishers. He is a life member of multiple professional bodies, including ISMMACS, ISTE, and IMS, and has held leadership roles in ACM-ICPC contests at both national and international levels. His academic contributions have been recognized with awards such as the Dewang Mehta National Education Award and the Shiksha Rattan Puraskar.

Talk Title: "Crop-Pest-Natural Enemy Dynamics: Strategies for Organic Farming"

Abstract:

Prof. J. Dhar's lecture, "Crop-Pest-Natural Enemy Dynamics: Strategies for Organic Farming," explored how mathematical frameworks can be effectively applied to ecological and agricultural systems for sustainable pest management. He began by outlining the serious ecological and economic impacts of pest infestations, emphasizing the limitations and long-term consequences of chemical-based control methods.

The talk highlighted:

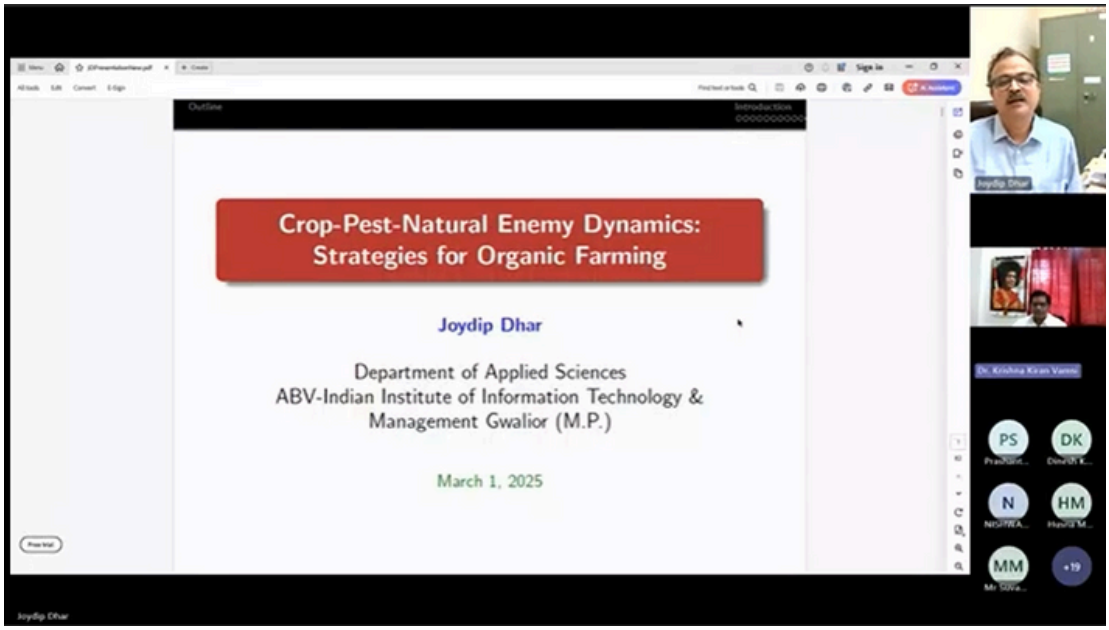
- The need for environmentally friendly alternatives rooted in biological and ecological principles
- The use of predator–prey and host–parasitoid models to understand population dynamics
- The role of parameters such as reproduction rates, carrying capacity, and functional responses in predicting pest outbreaks
- How mathematical modeling aids in designing efficient biological control strategies that minimize pesticide use

Through well-constructed differential equation models, Prof. Dhar demonstrated how interactions between pest and predator populations can be simulated to identify equilibrium points and stability conditions for natural control. He illustrated how such models guide real-world decisions in organic and integrated farming systems, balancing ecological harmony with agricultural productivity.

By bridging theory and application, Prof. Dhar showed that mathematical modeling serves not merely as an analytical tool but as a means to achieve sustainability in agriculture. His presentation underscored that protecting crop yield and environmental health can go hand in hand through precise, model-driven biological approaches.

Conclusion:

Prof. Dhar's session offered valuable insights into the scientific principles underlying pest control and their practical translation into sustainable agricultural practices. By combining ecology with mathematics, he showcased how dynamic models can optimize biological interventions and reduce dependence on harmful chemicals. The talk emphasized that sustainable pest management is best achieved through balance—between growth and regulation, yield and environment. It inspired participants to appreciate mathematics as a transformative force in promoting both agricultural efficiency and ecological responsibility.



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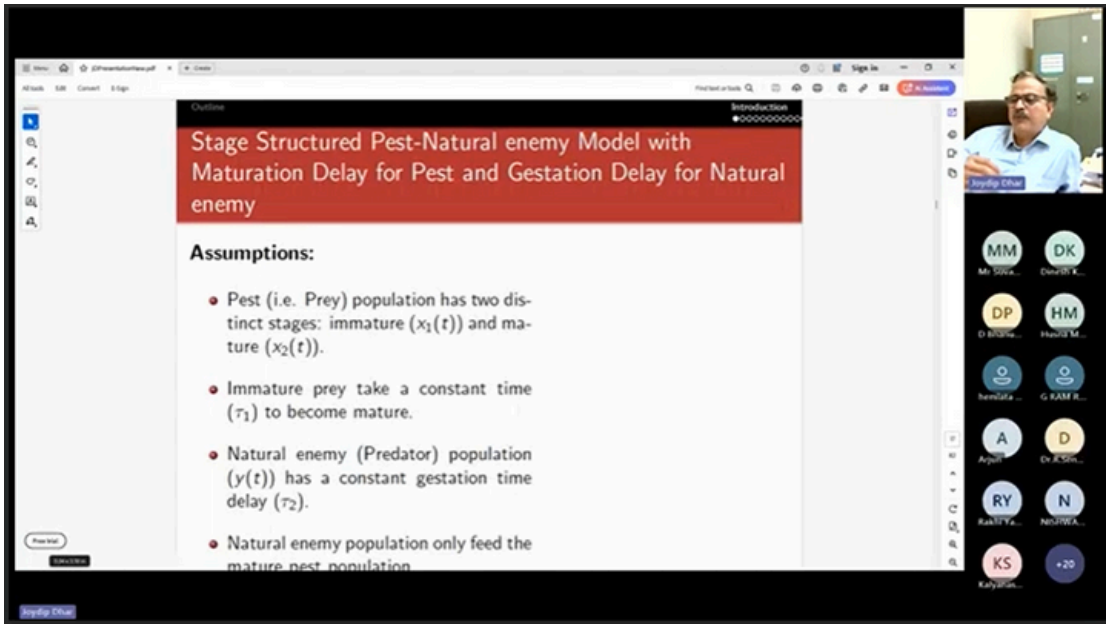
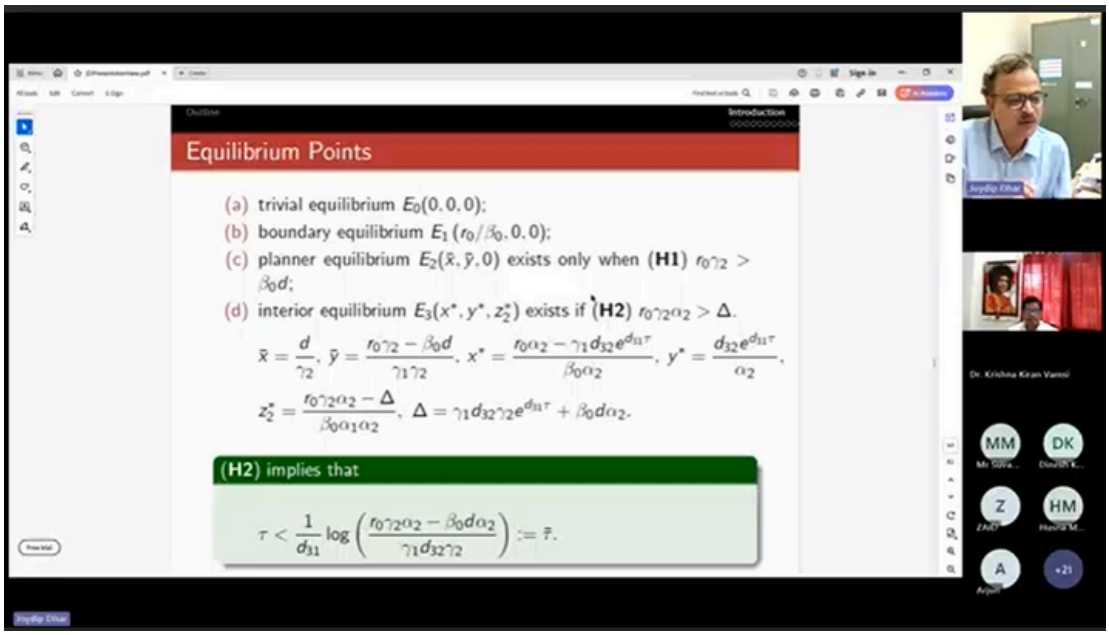




Speaker: Prof. Arni S. R. Srinivasa Rao, Medical College of Georgia, USA
Date: April 5, 2025

Speaker Bio

Dr. Arni S. R. Srinivasa Rao is a Professor and Director of the Laboratory for Theory and Mathematical Modeling at the Medical College of Georgia in Augusta, USA. Until 2012, he held a permanent faculty position at the Indian Statistical Institute in Kolkata. With expertise in Artificial Intelligence, mathematical epidemiology, stochastic processes, and population biology, his research has garnered over 700 media features, profoundly impacting fields such as medicine, public health, mathematics, poultry farming, and civil and computer engineering.

Dr. Rao has conducted research and delivered lectures at renowned institutions, including the Indian Statistical Institute, Indian Institute of Science, Hiroshima University, and the University of Oxford. His mathematical models were instrumental in shaping India's national AIDS control strategy, while in February 2020, he pioneered the world's first AI-based model for detecting COVID-19 cases via mobile apps, inspiring global initiatives like India's Arogya Setu app. He has served as a consultant for agencies across India, the US, and Europe. In 2013, he resolved an open problem in population biology with a theorem proved in just 45 minutes, earning coverage in the American Mathematical Society's Math Digest and other outlets.

Dr. Rao has taught diverse subjects, including real analysis, complex analysis, differential equations, demography, actuarial sciences, and mathematical epidemiology. He is a member of the AI-Enabled Technologies & Systems Domain Expert Group established in 2021 by the Council of Scientific & Industrial Research (CSIR), Government of India. Additionally, he is an elected Fellow of the Indian Society for Mathematical Modeling and Computer Simulation and the Indian Society for Probability and Statistics.

Talk Title: "Exact Deep Learning Machines and AI"

Abstract:
Prof. Arni S.R. Srinivasa Rao's popular science talk, "Exact Deep Learning Machines and AI," explored the theoretical limitations of conventional Artificial Intelligence (AI) and introduced a mathematically rigorous framework, the Exact Deep Learning Machine (EDLM). He began by critiquing the current state of AI technology, characterizing it as being in an "early human baby stage" and asserting that machines cannot incorporate human-like, actual intelligence.

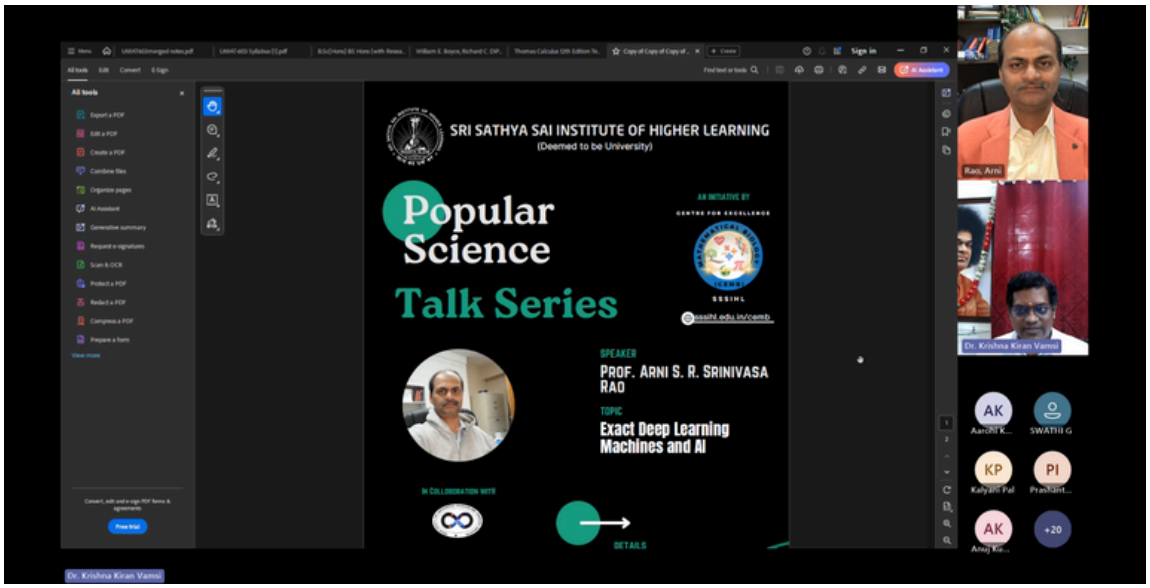
The talk highlighted:

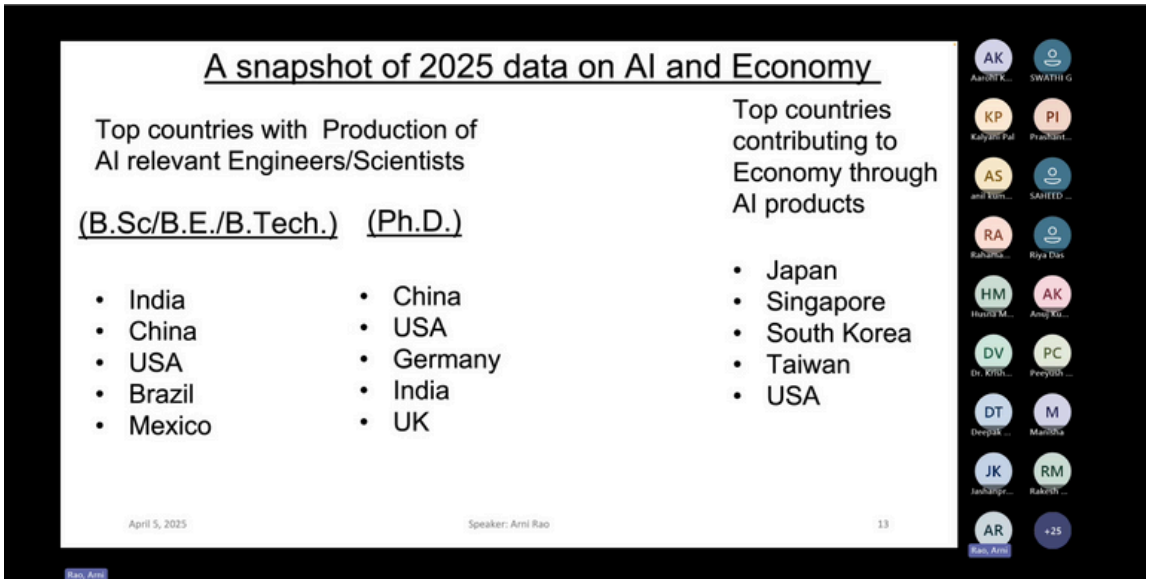
- The fundamental principle that successful, high-end practical utilization of AI is seen only where data associations are mathematically related.
- The central idea of EDLM, established by a theorem, where machines can be trained (with probability one) to detect an object if it can be described by a finite number of distinct, non-dynamic attributes.
- The application of an early AI model for rapid COVID-19 risk stratification using mobile-phone-based survey data during quarantine, demonstrating the power of mathematical and probabilistic approaches in epidemiology.
- The advantage of EDLM as offering 'no uncertainty' in object detection when attributes are matched, distinguishing it from probabilistic deep learning methods.
- Ongoing research utilizing EDLM for challenging problems, such as the prediction of autism in babies

Through a detailed outline spanning theoretical concepts and practical applications, Prof. Rao demonstrated that moving beyond the limitations of general AI requires embracing exact, model-driven, and mathematically-founded machine learning systems like EDLM, providing a path to more reliable and trustworthy machine predictions.

Conclusion:

Prof. Rao's talk highlighted the need to move beyond current, limited AI systems by embracing mathematical rigor. He introduced the Exact Deep Learning Machine (EDLM), a framework that ensures certainty in object detection for attribute-defined problems, contrasting sharply with probabilistic deep learning. Emphasizing that successful AI relies on data with mathematically sound associations, the presentation positioned EDLM as the transformative, theoretical core required to advance AI into a more reliable and responsible computational discipline.





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Speaker: Prof. Ashok Srinivasan, William Nystul Eminent Scholar Chair and Professor, University of West Florida, USA
Date: May 3, 2025

Speaker Bio
Dr. Ashok Srinivasan is the William Nystul Eminent Scholar Chair and Professor at the University of West Florida since 2018 and was a Program Director at the U.S. National Science Foundation from 2022 to August 2024. He obtained his Ph.D. in Computer Science from the University of California, Santa Barbara (UCSB). He performed postdoctoral research at the University of Illinois at Urbana-Champaign, subsequently held faculty positions at IIT Bombay, UCSB, and Florida State University, and is a Fulbright Fellow. His research, on applications of supercomputing to science and public health policy, has been funded by the National Science Foundation, National Institutes of Health, Department of Energy, Department of Defense, etc. He currently leads project VIPRA (www.cs.fsu.edu/vipra), on the spread of infections through air travel. Its results have been highlighted in over 300 news reports around the world and cited in testimony to the US Congress.

Talk Title: "Linking Simulations and Emerging Data Sources to Analyze Infection Risk in Crowded Locations"

Abstract:
Dr. Ashok Srinivasan's talk, "Linking Simulations and Emerging Data Sources to Analyze Infection Risk in Crowded Locations," presented a novel computational methodology to analyze and mitigate infectious disease transmission in dense settings like airports and public transit. He began by addressing the inherent difficulty of conventional predictive modeling, noting that epidemic sizes often follow "fat-tailed" distributions and human behavior introduces inherent uncertainty, leading him to shift the focus from prediction to vulnerability analysis and the comparison of robust policy options.

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The talk highlighted:

- The development of Pedestrian Dynamics Simulations, which use principles akin to Molecular Dynamics, to model the fine-grained movement, social forces, and contact rates among individuals in complex built environments.
- The necessity of supplementing simulations with emerging, high-resolution data sources (e.g., anonymized Location Based Services [LBS] data from cell phones and networked cameras) to accurately model human behavior and estimate critical parameters.
- How this integrated, data-driven approach yields actionable public health interventions, such as demonstrating that certain commercial airplane boarding procedures actually increase contact time and identifying optimized security queue layouts that can reduce contacts by up to 75%.
- Practical findings that confirmed the high efficacy of interventions like N95 mask use in mitigating superspreading events on flights.

By bridging physics-based simulations with real-time human movement data, Dr. Srinivasan demonstrated a powerful, fine-scale framework for identifying non-disruptive policies that enhance public health and operational efficiency in high-risk crowded settings.

Conclusion:

Prof. Srinivasan's talk presented a robust strategy for infection risk analysis that shifts focus from impossible prediction to vulnerability analysis. By integrating Pedestrian Dynamics Simulations with real-time data (LBS), his framework generates actionable, non-disruptive policies like optimized security queues, promoting societal robustness against unpredictable risks. This approach underscores the necessity of a data-informed, interdisciplinary Science of Disaster Mitigation.

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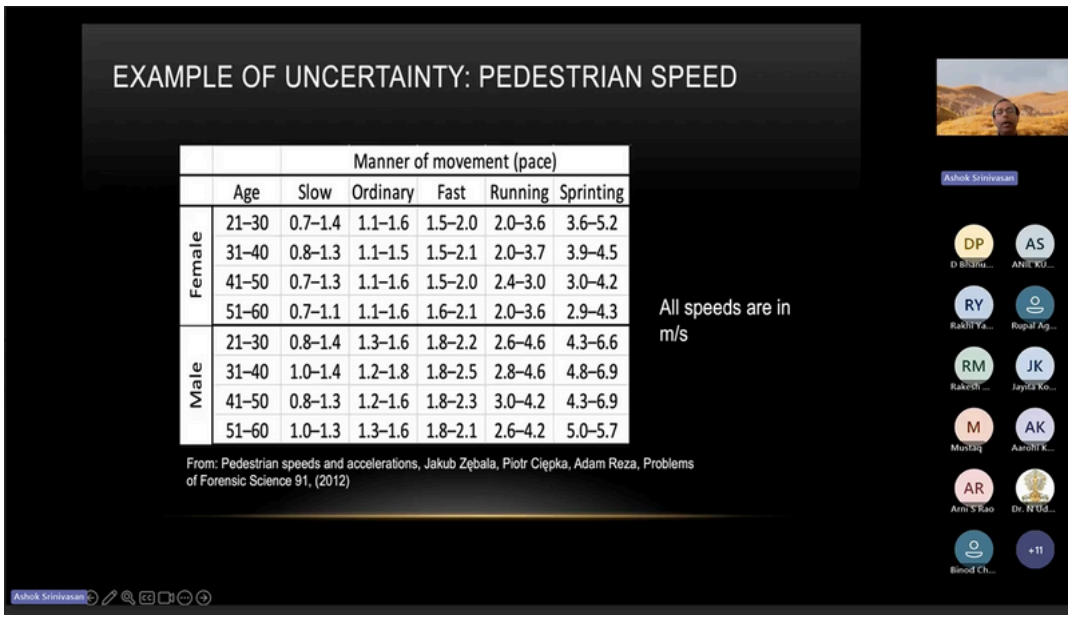

Speaker: Dr. Rani Madhavapeddi Patel, DeVry University, USA
Date: June 7, 2025

Speaker Bio

Dr. Patel has over four decades of experience in nutrition and public health across India and the USA. She served for 16 years at the National Institute of Nutrition, India, and later worked with the CDC in the USA. She has held senior leadership roles in the private sector, including Executive Vice President at Nutracea, and academic positions at San Jose State University and DeVry University. Her research contributions on nutrition, breastfeeding, and public health have been widely cited, and she has authored more than 24 scientific publications.

Talk Title: "The Second Brain – What is it and how does it impact Health and Disease"

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Abstract

Dr. Rani Madhavapeddi Patel's lecture, "The Second Brain: What Is it and How does it Impact Health & Disease (H&D)," explored the critical and complex relationship between the gut and the central nervous system, known as the Gut-Brain Axis (GBA). The DeVry University speaker defined the "Second Brain" as the Enteric Nervous System (ENS) and the gut microbiome, emphasizing its profound, often-underappreciated influence over human health.

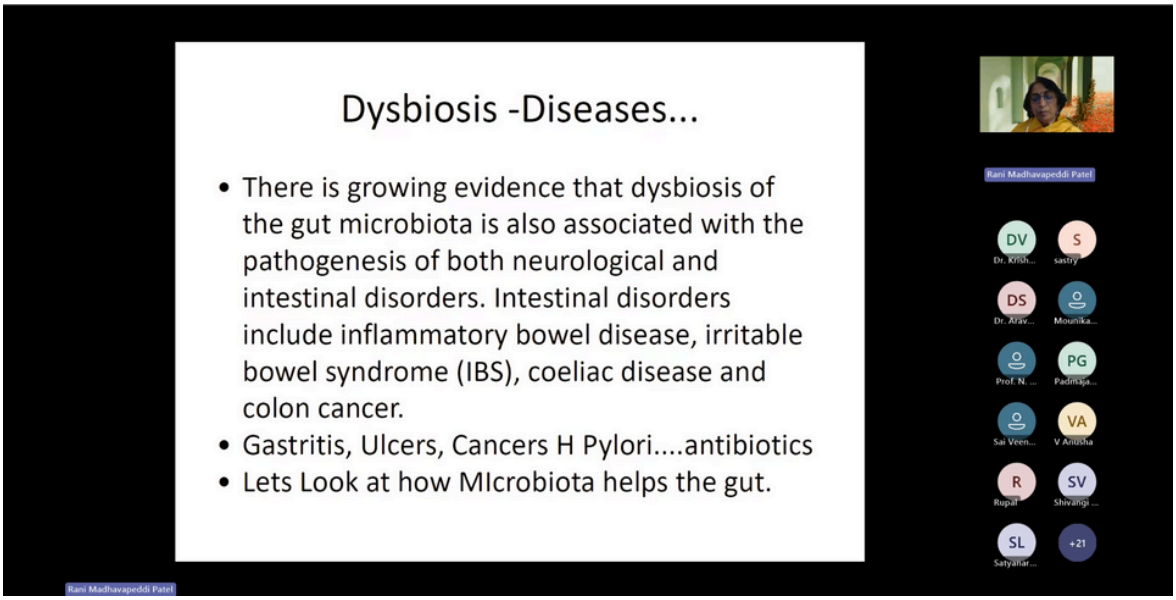
The talk highlighted:

- The bidirectional communication pathways between the gut and the brain, utilizing neural, endocrine, and immune signaling.
- The essential role of the microbiome in producing neurochemicals and modulating emotional and cognitive function.
- The direct link between dysbiosis (microbial imbalance) and a wide spectrum of conditions, from digestive disorders to complex neurological and psychiatric issues (e.g., depression, Parkinson's).
- How insights into the GBA are driving the development of novel therapeutic strategies using targeted prebiotics, probiotics, and fecal microbiota transplantation.

The presentation concluded that the gut is a powerful regulatory center, underscoring the necessity of adopting a holistic, two-brain perspective for managing modern health and disease.

Conclusion:

Dr. Patel's session demonstrated that the Gut-Brain Axis (GBA), or "Second Brain," is a fundamental, bidirectional regulator of human health and disease. Understanding this complex neural and microbial communication is crucial for developing novel, holistic strategies. The insights presented promise to transform therapeutic approaches for both digestive and neurological conditions.



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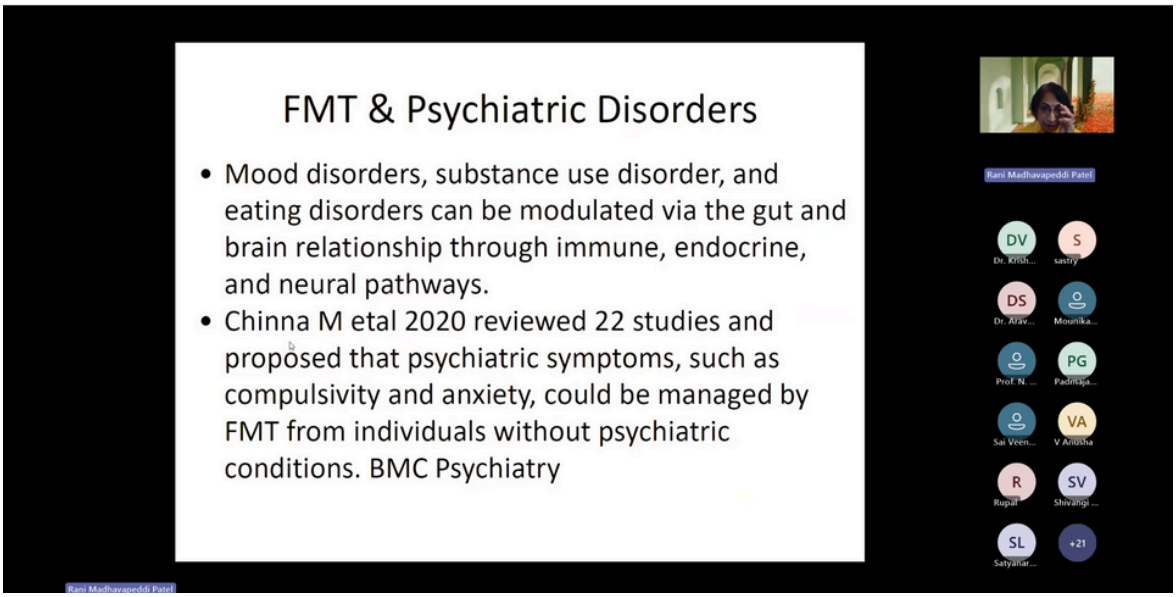

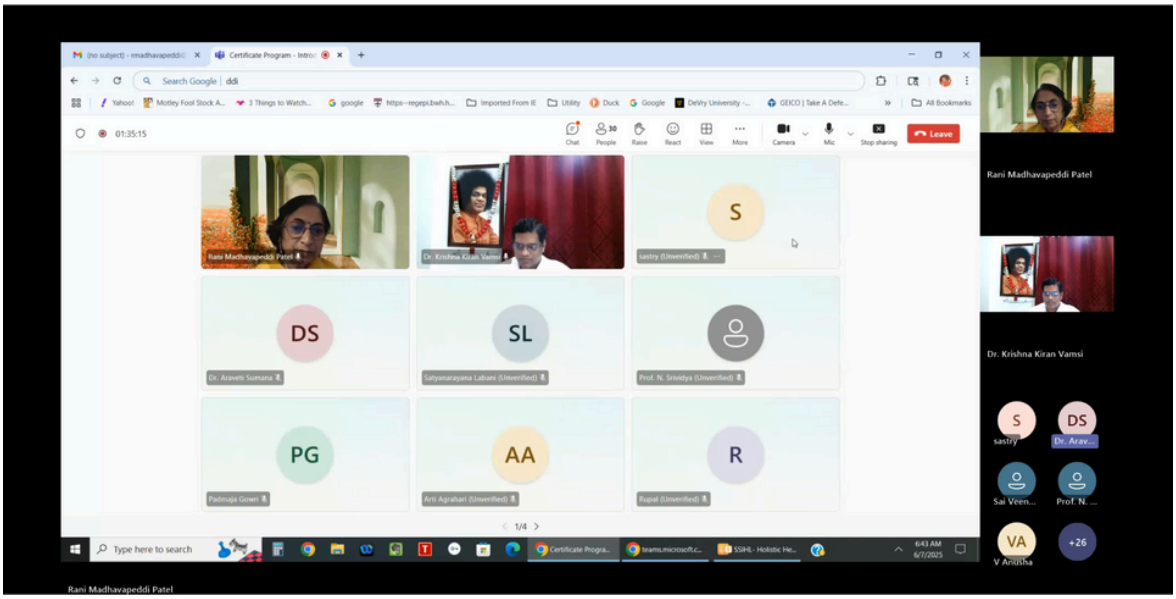

Speaker: Prof. Balram Dubey, BITS Pilani, India

Date: August 9, 2025

Speaker Bio

Prof. Dubey is Professor of Mathematics at BITS Pilani and former Head of Department. He earned his Ph.D. and M.Sc. in Mathematics from IIT Kanpur and has guided eight doctoral students. His research spans mathematical biology, ecology, epidemiology, and applications of ODEs and PDEs in real-world systems. He has published over 99 papers, received the JBS Medal, and is a Fellow of ISMMACS. He has held academic positions at IIT Kanpur and Tezpur University and engaged internationally with institutions in Ireland, Italy, Japan, China, and Nepal.

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Talk Title: " Dynamics of Biological Species under Differential Environmental Factors using Mathematical Modelling"

Abstract:
Prof. Balram Dubey's lecture, "Dynamics of Biological Species under Differential Environmental Factors using Mathematical Modelling," explored how non-traditional ecological factors, such as predator-induced fear and prey refuge, fundamentally alter classical prey-predator dynamics. He began by challenging the long-held conception that predator impact is limited to direct killing, introducing the ecological phenomenon of fear-induced stress in prey that significantly reduces their reproductive rate.

The talk highlighted:

- The development of a detailed mathematical model incorporating both the fear effect and prey refuge in a time-delayed prey-predator system.
- The rigorous analysis of equilibrium points and their local/global asymptotic stability to understand conditions for ecological balance.
- The analytical observation that fear effect in prey population is a mechanism that induces complex oscillatory behavior through a Hopf-bifurcation.
- The counter-intuitive finding that prey refuge, when kept below a specific threshold level, is beneficial for the persistence of both the prey and predator species.
- The incorporation of a gestation time delay in the predator population, which further revealed the existence of stable limit cycles and led to chaotic oscillations, confirmed by analyzing bifurcation diagrams and Maximum Lyapunov Exponents.

Through this dynamic systems approach, Prof. Dubey demonstrated how mathematical modeling is essential for uncovering the intricate, non-linear ways in which subtle environmental and behavioral factors govern population survival and stability.

Conclusion:
Prof. Dubey's work demonstrated that predator-induced fear and prey refuge are critical, non-lethal factors governing ecological stability in prey-predator systems. The mathematical model showed that these factors, particularly when combined with gestation time delay, lead to complex dynamics, including Hopf-bifurcation and chaos. This research underscores the necessity of dynamic, delay-based modeling to accurately inform conservation and wildlife management strategies.

Participants Profiles for Virtual Popular Talk Series - 2025
Number of Registered Participants - 341

The participants for Virtual Popular Talk Series - 2025 included faculty, industry professionals, post-doctoral & doctoral research scholars, post graduate and graduate students etc. who were spread across different parts of India.

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Geo - Tag Pictures