



भारतीय प्रौद्योगिकी संस्थान (भारतीय खनि विद्यापीठ), धनबाद Indian Institute of Technology (Indian School of Mines), Dhanbad

For Immediate Release: March 18, 2025

Press Release

IIT (ISM) Hosts Distinguished Lecture by Prof. Mrinal K. Sen on Physics and Machine Learning for Seismic Data Analysis

The Indian Institute of Technology (Indian School of Mines), Dhanbad, was honored to host Prof. Mrinal K. Sen, a distinguished geophysicist and professor at the Department of Earth and Planetary Sciences and the Institute for Geophysics, University of Texas at Austin, USA. Prof. Sen, an awardee of the prestigious INSA Overseas Chair under Sectional Committee (SC)-IV-Earth & Environmental Sciences 2024, delivered an insightful lecture on "Physics and ML for Seismic Data Analysis" at the Golden Jubilee Lecture Theatre of IIT (ISM).

The event commenced with a warm welcome address by Prof. Sanjit Kumar, Head of the Department of Applied Geophysics, while Prof. Saumen Maiti efficiently coordinated the proceedings.

Prof. Sen, a proud alumnus of IIT (ISM), having earned his integrated M.Sc. degree from the institute before completing his Ph.D. at the University of Hawaii at Manoa, USA, in 1987, captivated the audience with his expertise on seismic data analysis. He emphasized the importance of combining model-driven and data-driven approaches for solving inverse problems in seismology.

Key Highlights of the Lecture:

- Prof. Sen explained that inverse problems in seismology are traditionally solved using model-based approaches where the physics of wave propagation is used iteratively to update a subsurface velocity model.
- He pointed out that machine learning approaches are purely data-driven and agnostic to physics, posing both advantages and limitations.
- To bridge this gap, his research has focused on developing hybrid methods that integrate both physics-based and machine learning approaches to improve seismic data analysis.
- In particular, for least squares migration and AVA waveform inversion, he and his team have built Boltzmann machines designed based on their respective forward operators.
- He elaborated on how physics is used to design network architectures and inverse problems are addressed using simulated annealing algorithms and machine learning optimization techniques.
- In a physics-assisted machine learning framework, seismic data are used as input to a deep network whose output is treated as unknown model parameters. These parameters are then fed into a physics-based forward model, with residuals back-propagated to train the network, enabling the deep neural network (DNN) to act as a regularizer and learn the inverse operator.
- This hybrid approach effectively mitigates key challenges of full waveform inversion (FWI), such as the need for an optimal starting model and parameter crosstalk in multi-parameter inversion. The results from field applications of these algorithms have been highly promising.

Prof. Sen is renowned internationally for his groundbreaking contributions to theoretical and computational seismology and geophysical inversion. His exceptional research has earned him multiple accolades, including Honorary Membership of the Society of Exploration Geophysicists and the Distinguished Alumnus Award from IIT (ISM).

The lecture was met with an enthusiastic response from faculty members, researchers, and students, who engaged in insightful discussions on the potential applications of physics-integrated machine learning in geophysics.

Rajni Singh

Dean (Corporate Communications)