



Mathematics & Statistics Ingram Lecture General Audience Presentation

Monday, December 12, 4:30pm-5:30pm
204 AB Havener Center

Please join for a reception at 4:10pm!



Dr. Guowei Wei

MSU Foundation Professor

Department of Mathematics

Michigan State University

How Math and AI are revolutionizing biosciences

Abstract. Mathematics underpins fundamental theories in physics such as quantum mechanics, general relativity, and quantum field theory. Nonetheless, its success in modern biology, namely cellular biology, molecular biology, biochemistry, genomics, and genetics, has been quite limited. Artificial intelligence (AI) has fundamentally changed the landscape of science, technology, industry, and social media in the past few years and holds a great future for discovering the rules of life. However, AI-based biological discovery encounters challenges arising from the structural complexity of macromolecules, the high dimensionality of biological variability, the multiscale entanglement of molecules, cells, tissues, organs, and organisms, the nonlinearity of genotype, phenotype, and environment coupling, and the excessiveness of genomic, transcriptomic, proteomic, and metabolomic data. We tackle these challenges mathematically. Our work focuses on reducing the complexity, dimensionality, entanglement, and nonlinearity of biological data. We have introduced evolutionary de Rham-Hodge, persistent cohomology, persistent Laplacian, persistent path Laplacian, and persistent sheaf theories to model complex, heterogeneous, multiscale biological systems and thus significantly enhance AI's ability to handle biological data. Using our mathematical AI approaches, my team has been the top winner in D3R Grand Challenges, a worldwide annual competition series in computer-aided drug design and discovery for years. By further integrating with millions of genomes isolated from patients, we reveal the mechanisms of SARS-CoV-2 evolution and transmission and accurately forecast emerging SARS-CoV-2 variants.

Biographical Sketch. Guowei Wei earned his Ph. D. degree from the University of British Columbia in 1996. He was awarded a postdoctoral fellowship from the NSERC of Canada to pursue his postdoctoral work at the University of Houston. In 1998, he joined the faculty of the National University of Singapore and was promoted to Associate Professor in 2001. In 2002, he relocated to Michigan State University, where he is an MSU Foundation Professor of Mathematics, Electrical and Computer Engineering, and Biochemistry and Molecular Biology. His current research interests include mathematical foundations of data science and biosciences, deep learning, drug discovery, and computational geometry, topology, and graph. Dr. Wei has served extensively in a wide variety of national and international panels, committees, and journal editorships. His work was reported in numerous news and media articles.