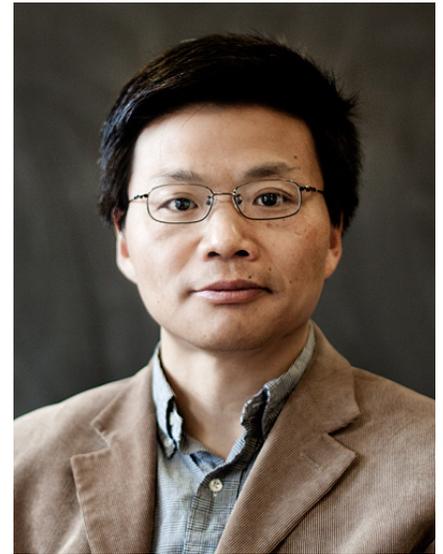


## Distinguished Colloquium in Interdisciplinary & Applied Mathematics

**WEINAN E**  
Princeton University

### “The Mathematical Theory of Neural Network-based Machine Learning”

The task of supervised learning is to approximate a function using a given set of data. In low dimensions, its mathematical theory has been established in classical numerical analysis and approximation theory in which the function spaces of interest (the Sobolev or Besov spaces), the order of the error and the convergence rate of the gradient-based algorithms are all well-understood. Direct extension of such a theory to high dimensions leads to estimates that suffer from the curse of dimensionality as well as degeneracy in the over-parametrized regime. In this talk, we attempt to put forward a unified mathematical framework for analyzing neural network-based machine learning in high dimension (and the over-parametrized regime). We illustrate this framework using kernel methods, shallow network models and deep network models. For each of these methods, we identify the right function spaces (for which the optimal complexity estimates and direct and inverse approximation theorems hold), prove optimal a priori generalization error estimates and study the behavior of gradient decent dynamics.



The talk is based mostly on joint work with Chao Ma, Lei Wu as well as Qingcan Wang.

**Weinan E** received his Ph.D. from UCLA in 1989. After being a visiting member at the Courant Institute of NYU and the Institute for Advanced Study at Princeton, he joined the faculty at NYU in 1994. He is now a professor of mathematics at Princeton University, a position he has held since 1999. Weinan E’s work centers around multi-scale modeling and machine learning. Most recently he has been working on integrating machine learning and physical modeling to solve problems in traditional areas of science and engineering, such as molecular dynamics, PDEs, control theory, etc. Weinan E is the recipient of the SIAM R. E. Kleinman Prize, von Karman Prize, Peter Henrici Prize (to be awarded at ICIAM 2019), and the ICIAM Collatz Prize. He is a member of the Chinese Academy of Sciences, a fellow of the American Mathematical Society, a SIAM fellow and a fellow of the Institute of Physics.

This event is cosponsored by the Center for Foundations of Data Science and the TRIPODs Institute of Columbia University.

**Wednesday, April 3, 2019**  
4:45 pm, Davis Auditorium, CEPSR  
530 West 120th Street  
(Refreshments in 200 Mudd at 4:00 PM)

**Organizing Committee:**  
Qiang Du (APAM)  
Don Goldfarb (IEOR)  
Eitan Grinspun (Computer Science / APAM)  
Ioannis Karatzas (Mathematics)  
Andrei Okounkov (Mathematics)  
Michael I. Weinstein (APAM / Mathematics)