MATH-IMS Joint Applied Mathematics Colloquium Series
The Chinese University of Hong Kong

This MATH-IMS Joint Colloquium Series is organized by Center for Mathematical Artificial Intelligence (CMAI), under Department of Mathematics and Institute of Mathematical Sciences (IMS) at The Chinese University of Hong Kong. The colloquium series focuses on mathematics and applications of artificial intelligence, big data and related topics.

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Time: 11am – 12noon (Hong Kong Time)
Zoom Link: https://cuhk.zoom.us/j/92775210812

Asymptotic escape of saddles and unified global analysis for low-rank matrix recovery

Speaker: Professor Thomas Yizhao Hou
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Abstract: Manifold optimization has found many important applications in machine learning and data science in recent years. In this talk, we introduce some new results on manifold optimization using the Riemannian gradient descent method with a focus on low-rank matrix recovery. The purpose of our analysis is twofold: to prove the asymptotic escape of strict saddles and convergence to local minima on the manifold, and to obtain the exact convergence rate of a class of low-rank matrix recovery problems using manifold optimization. On the asymptotic side, we analyze the escape of strict saddle sets using the projected gradient descent (PGD) algorithm. We show that PGD is able to escape strict saddle sets that are non-isolated provided that they have certain geometry properties. This is a general result, and as an example, we apply it to the phase retrieval problem and explain the asymptotic behavior of PGD for phase retrieval on the low-rank matrix manifold. On the non-asymptotic side, we propose a unified analysis for a class of low-rank matrix recovery problems. We use PGD with random initialization to minimize the empirical least squares loss function, and study the convergence rate under some mild assumptions. Our results can be further extended to problems such as Gaussian phase retrieval, matrix factorization and matrix sensing.

Bio: Professor Thomas Yizhao Hou received his Ph.D. in Mathematics at the University of California, Los Angeles in 1987 under the supervision of Professor Björn Engquist. From 1989 to 1993, he taught at the Courant Institute of Mathematical Sciences at New York University. He has been on the faculty of the California Institute of Technology since 1993. He is currently the Charles Lee Powell Professor of Applied and Computational Mathematics in the Department of Computing and Mathematical Sciences at the California Institute of Technology. Professor Hou is well known for his research on multiscale problems arising from geophysical applications and fluid dynamics, the Millennium Problem on the 3D incompressible Navier-Strokes equations, model reduction for stochastic problems with high dimensional input variables, and adaptive data analysis. He has also won numerous major awards for mathematicians, including the Feng Kang Prize in Scientific Computing in 1997, James H. Wilkinson Prize in Numerical Analysis and Scientific Computing from the Society for Industrial and Applied Mathematics (SIAM) in 2001, Morningside Gold Medal in Applied Mathematics at International Congress of Chinese Mathematicians in 2004, Computational and Applied Sciences Award from the United States Association of Computational Mechanics in 2005, as well as the Achievement Award from Southern California Chinese American Faculty Association in 2019. He was an invited speaker at the 1998 International Congress of Mathematicians in Berlin, and was a plenary speaker at the 2003 International Congress on Industrial and Applied Mathematics in Sydney. He has also been inducted into several scholarly societies, including the elected Fellow of the Society for Industrial and Applied Mathematics (SIAM) in 2009, the elected Fellow of the American Academy of Arts and Sciences (AAAS) in 2011 and the elected Fellow of the American Mathematical Society (AMS) in 2012.