



THE UNIVERSITY OF
CHICAGO

THE COMMITTEE ON
COMPUTATIONAL AND
APPLIED MATHEMATICS

Dissertation Defense:

Yian Chen

Computational and Applied Mathematics
University of Chicago

Structured Low-complexity Matrix and Tensor Approximation with Applications

Wednesday, April 19, 2023 at 3:00 PM-4:00 PM

Jones 303, 5747 S. Ellis Ave. Chicago, IL 60637

or via Zoom

<https://uchicago.zoom.us/j/92732822656?pwd=UnlGNWFOUExlZkhZbEd4S21mOW9KZz09>.

Matrix and tensor operations play a vital role in diverse fields such as machine learning, numerical analysis, computational physics and optimization. As data sizes continue to grow and high-dimensional problems become more challenging, low-complexity matrix and tensor approximations are becoming increasingly crucial. These approximations are essential in providing efficient and robust numerical solutions to these problems.

This thesis focuses on two types of efficient low-complexity matrix and tensor formats, hierarchical matrices for efficient matrix compression and tensor-train for efficient high-dimensional tensor compression. In the first part of the thesis, we utilize hierarchical matrix techniques and propose a scalable algorithm for traditional tasks in Gaussian processes (GPs) applications, including maximum likelihood estimations (MLEs) for parameter identification, computing confidence intervals for uncertainty quantification, and regressions. In the second part of the thesis, we propose a novel approach for compressing Gibbs-Boltzmann distributions in statistical mechanics into TT formats and their downstream applications in computing committor functions.

Low-complexity formats provide a compact representation of matrices and tensors by exploring their numerical structure. This reduces memory usage and enables fast algorithms that exploit the inherent low-rankness of the problem and data. Numerical evidence is provided to demonstrate the scaling of the algorithms, as well as the efficiency/accuracy trade-offs.