

國立中山大學應用數學系

學術演講

講者：杜憶萍教授

中央研究院統計所

講題：Two-stage dimension reduction for noisy
high-dimensional images and application to
Cryogenic Electron Microscopy

時間：2020/10/29 (Thursday) 14:10 ~ 15:00

地點：理學院四樓理 SC 4009-1 室

茶會：13:30 於理 SC 4010 室 (系辦公室)

Abstract

Principal component analysis (PCA) is arguably the most widely used dimension-reduction method for vector-type data. When applied to a sample of images, PCA requires vectorization of the image data, which in turn entails solving an eigenvalue problem for the sample covariance matrix. We propose herein a two-stage dimension reduction (2SDR) method for image reconstruction from high-dimensional noisy image data. The first stage treats the image as a matrix, which is a tensor of order 2, and uses multilinear principal component analysis (MPCA) for matrix rank reduction and image denoising. The second stage vectorizes the reduced-rank matrix and achieves further dimension and noise reduction. Simulation studies demonstrate excellent performance of 2SDR, for which we also develop an asymptotic theory that establishes consistency of its rank selection. Applications to cryo-EM (cryogenic electronic microscopy), which has revolutionized structural biology, organic and medical chemistry, cellular and molecular physiology in the past decade, are also provided and illustrated with benchmark cryo-EM datasets. Connections to other contemporaneous developments in image reconstruction and high-dimensional statistical inference are also discussed.

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