



**The Hong Kong University of Science and Technology**  
**Department of Mathematics**

**PHD THESIS EXAMINATION**

**Statistical and Computational Methods  
for Genomic Data Analysis**

*By*

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**ABSTRACT**

The rapid advancement of high-throughput genomic technologies has generated a vast amount of data spanning diverse resolutions, species, tissues, and disease conditions. While these resources provide unprecedented opportunities to reveal the mechanisms underlying complex biological systems and have great potential to guide biomedical and therapeutic applications, they also present huge challenges for systematic and comprehensive investigation. In this thesis, we propose two novel statistical and computational methods and demonstrate their applications in genomic data analysis.

In the first part of this thesis, we present a unified framework, the Mixture of Mixed Models (MMM), designed to directly model RNA count data in spatial transcriptomics (ST) and identify cell-type-specific spatially variable genes (SVGs) while accounting for cell type composition and correcting for platform effects. Through a comprehensive simulation study and the analyses of five publicly available ST datasets from various tissues and technologies with different resolutions, we demonstrate the effectiveness and robustness of MMM in identifying cell-type-specific SVGs.

In the second part of this thesis, we consider a Matrix Factorization problem by utilizing Auxiliary Information (MFAI), which is massively available in real-world applications, to overcome the challenges caused by poor data quality such as high sparsity and low signal-to-noise ratio (SNR). We demonstrate the advantages of MFAI through comprehensive numerical results from simulation studies and real data analyses, including one human brain gene expression dataset.

**Date : 2 Jun 2025, Monday**

**Time : 10:00 am**

**Venue : Room 4472 (Lifts 25/26)**

**Thesis Examination Committee:**

- Chairman** : Prof. Robert KM KO, LIFS/HKUST
- Thesis Supervisor** : Prof. Can YANG, MATH/HKUST
- Member** : Prof. Shiqing LING, MATH/HKUST
- Member** : Prof. Dong XIA, MATH/HKUST
- Member** : Prof. Jiguang WANG, LIFS/HKUST (*via online mode*)
- External Examiner** : Prof. Yingying WEI, Department of Statistics/  
The Chinese University of Hong Kong (*via online mode*)

*(Open to all faculty and students)*

The student's thesis is now being displayed on the reception counter in the General Administration Office (Room 3461).