



THE HONG KONG UNIVERSITY OF SCIENCE & TECHNOLOGY

Department of Mathematics

## SEMINAR ON STATISTICS

# Covariate-Adjusted Generalized Factor Analysis with Application to Testing Fairness

By

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### Abstract

In the era of data explosion, statisticians have been developing interpretable and computationally efficient statistical methods to measure latent factors (e.g. skills, abilities, and personalities) using large-scale assessment data. In addition to understanding the latent information, the covariate effect on responses controlling for latent factors is also of great scientific interest and has wide applications, such as evaluating the fairness of educational testing, where the covariate effect reflects whether a test question is biased toward certain individual characteristics (e.g. gender and race) taking into account their latent abilities. However, the large sample size, substantial covariate dimension, and great test length pose great challenges to developing efficient methods and drawing valid inferences. Moreover, to accommodate the commonly encountered discrete type of responses, nonlinear factor models are often assumed, bringing in further complexity to the problem. To address these challenges, we consider a covariate-adjusted generalized factor model and develop novel and interpretable conditions to address the identifiability issue. Based on the identifiability conditions, we propose a joint maximum likelihood estimation method and establish estimation consistency and asymptotic normality results for the covariate effects under a practical yet challenging asymptotic regime. Furthermore, we derive estimation and inference results for latent factors and the factor loadings. We illustrate the performance of this method through extensive numerical studies and an application to a large-scale educational assessment, the Programme for International Student Assessment (PISA). This is a joint work with Chengyu Cui, Kean Ming Tan, and Gongjun Xu.

### Biography

*Dr. Jing Ouyang is an Assistant Professor of Innovation and Information Management at the Business school of the University of Hong Kong. Prior to joining HKU, Jing received a Ph.D. in Statistics from the University of Michigan and a BSc. in Mathematics and Economics from the Hong Kong University of Science and Technology. Jing is generally interested in latent variable models, psychometrics, high-dimensional statistical inference, and statistical machine learning. Specifically, her research focuses on developing statistical theory, novel methodology and efficient computing tool for latent variable models to analyze high-dimensional and complex data, with interdisciplinary applications in large-scale educational assessments, psychological measurements, and biomedical sciences.*

**Date : 14 March 2025 (Friday)**

**Time : 2:00pm**

**Venue : Room 3598 (Lifts 27/28)**

*All are Welcome!*