

**The Hong Kong Polytechnic University  
Department of Applied Mathematics**

**Seminar Series on Young Scholars in Optimization and Data Science**

**Model-robust and efficient covariate adjustment for cluster-randomized experiments**

**By**

**Dr. Fan Li  
Yale University School of Public Health**

**Abstract**

Cluster-randomized experiments are increasingly used to evaluate interventions in routine practice conditions, and researchers often adopt model-based methods with covariate adjustment in the statistical analyses. However, the validity of model-based covariate adjustment is unclear when the working models are misspecified, leading to ambiguity of estimands and risk of bias. In this presentation, we first adapt two conventional model-based methods, generalized estimating equations and linear mixed models, with weighted g-computation to achieve robust inference for cluster-average and individual-average treatment effects. Furthermore, we propose an efficient estimator for each estimand that allows for flexible covariate adjustment and additionally addresses cluster size variation dependent on treatment assignment and other cluster characteristics. Such cluster size variations often occur post-randomization and, if ignored, can lead to bias of model-based estimators. For our proposed estimator, we prove that when the nuisance functions are consistently estimated by machine learning algorithms, the estimator is consistent, asymptotically normal, and efficient. When the nuisance functions are estimated via parametric working models, the estimator is triply-robust. Simulation studies and analyses of three real-world cluster-randomized experiments demonstrate that the proposed methods are superior to existing alternatives.

**Biography**

Fan Li is tenure-track Assistant Professor in the Department of Biostatistics at Yale University School of Public Health. He obtained his Biostatistics PhD degree from Duke University in 2019, and joined the Yale faculty since 2019. Dr. Li's research aims to develop statistical methods for designing and analyzing pragmatic clinical trials, causal inference methods for estimand-aligned analyses of randomized experiments and observational studies. Dr. Li's methodology research has been supported by multiple grants from the United States National Institutes of Health (NIH) and Patient-Centered Outcome Research Institute (PCORI) as a principle investigator and a co-investigator. He has published over 100 peer-reviewed articles.

**Date: 20 July 2023 (Thursday)**

**Time: 15:00-16:00 (Hong Kong Standard Time GMT +8)**

**Venue: HJ303**

**Speaker: Dr. Fan Li, Yale University School of Public Health**

**Host: Dr. Yancheng Yuan, The Hong Kong Polytechnic University**

**\*\*\* ALL ARE WELCOME \*\*\***