



The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

**Online Personalized Decision Making:
Algorithms, Regret and Statistical Inference**

By

Miss Congyuan DUAN

ABSTRACT

Online personalized decision making has become increasingly important in modern applications such as healthcare, recommendation systems, and dynamic pricing. Contextual bandits provide a powerful framework for such problems by sequentially learning reward models and making personalized decisions based on specific personal information. Most existing studies, however, focus primarily on regret minimization under standard low-dimensional contextual settings. In contrast, statistical inference for adaptively collected bandit data remains much less developed, especially in complex settings where covariates are either unavailable or high-dimensional. This PhD thesis develops new methodologies and theory for online personalized decision making in two challenging regimes: covariate-free decision making and high-dimensional decision making. Specifically, this thesis proposes the matrix completion bandit for covariate-free decision making and the high-dimensional sparse bandit framework for high-dimensional decision making. For both settings, we establish comprehensive methodological and theoretical frameworks that integrate online decision making, online parameter estimation, regret analysis, statistical inference, and policy evaluation. Our frameworks enable not only efficient sequential learning and decision making, but also valid statistical inference under the adaptively collected bandit data. More importantly, we characterize a fundamental trade-off between regret performance and inference efficiency, showing that regret minimization would lead to reduced inference efficiency. Building on this insight, we further investigate the simultaneous optimality for both of them based on the novel exploration-free algorithm and debiasing method. Extensive numerical experiments validate the proposed theory and methods.

Date : 27 July 2026, Monday

Time : 10:00 am

Venue : Room 5508 (near Lifts 25/26)

Thesis Examination Committee:

- | | | |
|--------------------------|----------|---|
| Chairman | : | Prof. Hai YANG, CIVL/HKUST |
| Thesis Supervisor | : | Prof. Dong XIA, MATH/HKUST |
| Member | : | Prof. Xinzhou GUO, MATH/HKUST (via online) |
| Member | : | Prof. Shuoqing DENG, MATH/HKUST |
| Member | : | Prof. Lucy XIA, ISOM/HKUST |
| External Examiner | : | Prof. Yuanyuan LIN, Dept of Statistics & Data Science/
The Chinese University of Hong Kong |

(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).