



The Hong Kong University of Science and Technology

Department of Mathematics

PhD THESIS EXAMINATION

**Efficient Computational Approaches to
Mean-Field Dynamical Systems and Variational Problems**

By

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ABSTRACT

The studies mainly focus on mean-field games (MFG) and their related applications. MFG describes an infinite number of non-cooperative agents optimizing their own goals within an interacting crowd. It can be regarded as a game between an indistinguishable representative agent and a general agent (population), where the individual agents natively solve variational optimal control problems. The Nash equilibrium of a MFG is characterized by a coupled system of differential equations. The collective macro-system can be cast as a global variational problem under the framework of potential mean-field games (Potential MFG). MFG has been successfully applied in numerous fields, including game theory, economics, social networks, robotics, and epidemic modeling.

The studies cover both continuous and discrete MFG. In the context of continuous mean-field games, we propose an efficient and unified computational strategy based on neural network, which is suitable for both first and second order MFG and is capable to overcome the curse of dimensionality. The method was evaluated on several classical MFG problems across various dimensions and successfully applied to finance and robotics. For the discrete mean-field games on finite graphs (Graph MFG), we propose an initial-value formulation (Graph MFG-IV). We focus primarily on the Potential MFG, featuring an infinite-dimensional constrained optimization structure. We reformulate Potential MFG as an initial-value, finite-dimensional optimization problem with dynamic constraints and design a neural network-based approach to solve the proposed Graph MFG-IV problem.

Date : 6 August 2026, Thursday

Time : 3:00 pm

Venue : Room 4503 (near Lifts 25/26)

Thesis Examination Committee:

Chairman	:	Prof. Ross MURCH, ECE/HKUST
Thesis Supervisor	:	Prof. Yang XIANG, MATH/HKUST
Member	:	Prof. Jianfeng CAI, MATH/HKUST
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(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).