



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

**Department of Mathematics**

**PhD THESIS EXAMINATION**

**Enhancing Performance and Efficiency in Learned Indexes and Adaptive Gradient Compression with Bandwidth Awareness in Distributed Training**

*By*

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**ABSTRACT**

Recent advances in machine learning have spurred innovative approaches to traditional database management systems, with learned indexes emerging as a transformative paradigm. Unlike conventional indexes that utilize static data structures (e.g., B-trees, hash maps), learned indexes harness predictive models to approximate the position or existence of data within a dataset. This thesis introduces Hyper, which leverages unique two-phase hybrid construction to optimize both performance and memory usage. In tests against other learned indexes and conventional structures, Hyper demonstrates substantial gains, improving performance by up to 3.75X and reducing index memory needs by up to 1610X. The second part of the thesis addresses network optimizations in distributed deep neural networks (DNNs). It proposes adaptive bandwidth management and selective compression techniques tailored to DNN layers to facilitate high-speed, low-latency communication. Kimad, our adaptive gradient compression scheme, dynamically adjusts to bandwidth and layer requirements, proving to be highly effective in distributed deep learning settings, paving the way for future adaptive compression technologies.

**Date : 23 April 2024, Tuesday**

**Time : 2:30 pm**

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

**Thesis Examination Committee:**

- Chairman** : Prof. Dimitris PAPADOPOULOS, CSE/HKUST
- Thesis Supervisor** : Prof. Can YANG, 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).