The Chinese University of Hong Kong
Department of Biomedical Engineering

Graduate Seminar – MPhil Oral Defence

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Date	**:**	27 June 2023
Time	**:**	10:00 am
Venue	**:**	ERB 1118, William M W Mong Engineering Building
Zoom Link	**:**	https://cuhk.zoom.us/j/96734448795?pwd=YTVjQy9GNTNsbFQxbG14K0RlSHlwZz09
Meeting ID	**:**	96734448795
Password	**:**	740490

Title: Towards Interpretable and High-fidelity Deep Learning in Quantitative Phase Imaging

Driven by the recent growing demand for cell screening in regenerative medicine and cell-based therapies, label-free imaging has become an important tool for noninvasive live-cell characterization and analysis. Quantitative phase imaging (QPI) is an emerging label-free imaging technique that maps the intrinsic optical path difference (OPD) introduced by transparent objects, such as living cells. Along with many QPI methods, off-axis interferometry-based QPI methods offer high imaging contrast and speed, thus making them suitable for large-scale and high-throughput live-cell analysis. However, two main issues need to be solved in off-axis QPI to tackle applications that involve large-scale cell analysis, namely (i) phase image features of living cells are implicit due to their high spatial complexity and imaging noise, thus making it difficult to interpret the extracted cellular features; and (ii) despite offering high image acquisition rate, the phase retrieval process is relatively slow and also requires additional calibration images, which hindered the capability to realize real-time phase imaging and analysis. Therefore, deep learning is introduced to solve this problem; however, deep learning models usually predict smoothed phase maps. To mitigate the first problem, we present a new cell classification method using QPI and machine learning. Firstly, cell representations are first learned by interpreting pre-trained deep-learning models using gradient-weighted class activation mapping (Grad-CAM) and input activation maximizations. With the prior knowledge of these representations, we then used SVM, a conventional machine learning method with nearly 20 parameters, to achieve comparable accuracy, better interpretability, better robustness, and faster inference speed. To address the second problem, we introduce a high-fidelity and calibration-free phase retrieval method using QPI and deep learning, named SR-PRNet. The SR-PRNet is a generative model which avoids the redundant low-level feature channels and generates the phase maps' details. As a result, compared with the U-Net baseline, the SR-PRNet can retrieve high-fidelity phase maps and converge more quickly and stably.

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

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