Centre for AI-Fundamentals
RAEng Google DeepMind Summer Internship Programme 2025

Project proposal

Project Title	Deep Learning Image Denoising of Liquid-Cell Atomic Resolution Scanning TEM Images Using CycleGAN
Lead supervisor	William Thornley
Project Description	This research project aims to develop and evaluate a novel deep learning approach for denoising liquid-cell scanning transmission electron microscopy (TEM) images of 2D materials. The project will implement a recent CycleGAN-based image denoising technique and comparatively assess its performance against our existing Noise2Void model's results. Recent advances in computational materials research have demonstrated the potential of generative adversarial networks (GANs) for image restoration in electron microscopy. Specifically, a recent publication in npj Computational Materials[1] showcased the effectiveness of cycle-consistent GANs in denoising TEM images by training the model to transform noisy images to resemble unpaired electron propagation simulations of the sample. Our novel liquid-cells, engineered from 2D material heterostructures[2], allow us to image dispersed adatoms on 2D material supports in liquid. Being able to view these systems in their natural liquid environment at atomic resolution is of critical importance for the development of novel catalysts. The presence of liquid introduces image-noise that limits this catalyst research, which is crucial for the net-zero energy transition. Project Objectives: - Implement a CycleGAN specifically tailored for multichannel TEM image/video denoising - Train the model using provided electron propagation simulations - Conduct comparative performance evaluation against the existing Noise2Void model - Analyse and document the strengths and limitations of the proposed approach

	Weekly Plan: - Week 1: Literature review, environment setup, familiarize with CNNs, UNets & Noise2Void - Week 2: Implement data pipeline, evaluate baseline Noise2Void model, familiarise with training dataset - Week 3 & 4: Develop and train CycleGAN architecture with simulations, monitor and optimize - Week 5 & 6: Continue to improve model, measure and plot evaluations, comparing with Noise2Void performance - Week 7: Prepare final report and presentation comparing the techniques Learning Outcomes: - Experience in designing and implementing custom advanced deep learning architectures for specialized image processing applications - Familiarisation with processing and manipulating large-scale scientific imaging datasets - Learning to analyse and compare different deep learning approaches for image denoising, demonstrating critical thinking in computational materials science - Hone skills in communicating technical findings effectively through documentation and presentation of results [1] Khan, A., Lee, CH., Huang, P.Y. et al. Leveraging generative adversarial networks to create realistic scanning transmission electron microscopy images. npj Comput Mater 9, 85 (2023). https://doi.org/10.1038/s41524-023-01042-3 [2] Clark, N., Kelly, D.J., Zhou, M. et al. Tracking single adatoms in liquid in a transmission electron microscope. Nature 609, 942–947 (2022). https://doi.org/10.1038/s41586-022-05130-0