Mathematical Imaging and Beyond:
From Variational Models to Learning in Non-Reflexive Spaces

报告人： Prof. Ke Chen (University of Strathclyde)

时间： 2025.12.29（周一）下午 2:00--2:40

地点： 良乡校区文萃楼D703

邀请人： 李庆娜 教授

摘要： The quest to solve ill-posed imaging problems has driven the field from simple linear filters to sophisticated mathematical frameworks. This talk begins by exploring this journey, starting with classical methods (linear/non-linear filtering, thresholding) and revealing their limitations. We then bridge to the continuous domain, highlighting the pivotal role of variational models and the critical failure of classical Sobolev spaces (like H^1) for realistic imagery. The groundbreaking introduction of the Rudin-Osher-Fatemi (ROF) model and the Space of Bounded Variation (BV) provided a rigorous foundation for handling discontinuities (edges), a theme later extended to segmentation via the Mumford-Shah model. However, new challenges in tasks like image registration demanded even more advanced tools. We discuss how the Beltrami representation emerged as a game-changer, elegantly enforcing diffeomorphic constraints. Today, the field is undergoing another transformation with the rise of deep learning. We will explore this paradigm shift, examining how learning-based methods address longstanding challenges in segmentation and registration. A key focus will be on our novel DL framework for supervised registration, which innovatively solves difficulties in the deformation space (φ) by working in its associated Beltrami space (μ), achieving state-of-the-art, few-shot results. Finally, we will present DL2, a generative model for registration, pointing towards a future where the analytical rigor of variational calculus in non-reflexive spaces is powerfully combined with the adaptability of learned priors.

报告人简介： 陈柯，英国思克莱德大学教授，博导，数学与统计系主任。英国IMA Fellow，英国Clatterbridge肿瘤医院荣誉专家。爱丁堡数学会科研委员会成员。入选英国基金委健康科技国家专家小组。湘潭大学特聘教授。曾任职英国利物浦大学数学图像中心，和国家数学与健康研究中心主任，大连理工大学和南昌大学特聘教授。作为第一导师，培养出25位博士。长期专注于科学与工程计算研究，近十五年着重图像处理的深入研究，累计发表论文200余篇，包括SIAM Journals Numer Anal / Matrix Anal / Imaging Science / Multiscale Modelling/ Sci Comput, IEEE TIP/ TMI / ICI/ TPS, JMIV, Nature SR, IMA J Numer Anal / Appl Math等。现任Numerical Algorithms，International Journal of Computer Mathematics, Journal of Imaging 等期刊编委和Journal of Mathematical Learning and Computation主编。