



復旦大學
FUDAN UNIVERSITY

Applied Math Ph.D. Seminar

Point Cloud Neural Operator for Parametric PDEs on Complex and Variable Geometries

Speaker: Chenyu Zeng (Peking University)

Time: 2026-04-23, 16:10 to 17:00

Location: Rm 1801, Guanghai East Tower

Advisor: Zhengyu Huang (Peking University)

Abstract: Surrogate models are essential for accelerating computationally expensive simulations in science and engineering, especially for parametric partial differential equations (PDEs) posed on geometrically complex and variable domains that are often represented as point clouds. We present the Point Cloud Neural Operator (PCNO), a neural-operator framework designed for such problems. Starting from the neural-operator paradigm and the Fourier Neural Operator (FNO), we discuss the limitations of FNO on nonuniform discretizations, irregular domains, and the extraction of local geometric information. PCNO addresses these challenges by representing the computational domain as a point cloud and constructing neural layers that couple a density-weighted global integral operator with a gradient-enhanced local differential operator. This design enables the model to capture long-range interactions while remaining sensitive to local geometric variation. Numerical experiments on the 1D Burgers equation, Darcy flow on variable domains, flow over airfoils, and vehicle surface pressure prediction demonstrate that PCNO provides accurate surrogate predictions for PDE problems with complex and changing geometries.