ACM 270 Partial Differential Equations and Computational Mean Field Games (Spring 2024)

About the course

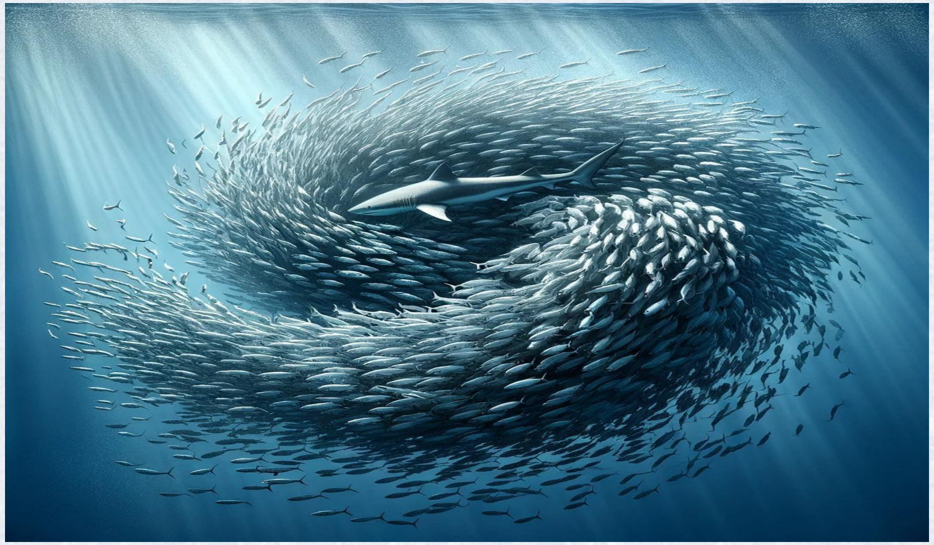
This course comprises two main sections. The first introduces the fundamental theories of Partial Differential Equations (PDEs). We will study different classes of linear and nonlinear PDEs (elliptic, parabolic and hyperbolic) and the behavior of their solutions using tools from functional analysis with an emphasis on applications covering topics such as fully nonlinear first-order PDEs, classifications of second-order linear equations (elliptic, parabolic, hyperbolic), Laplace and Poisson equations, Sobolev spaces, calculus of variations, and Hamilton–Jacobi Equations. The second section focuses on computational approaches to Mean Field Games (MFGs), which analyze the collective behavior of agents in large populations. It delves into the computational techniques for MFGs, including their connections with Optimal Transport and machine learning models like Generative Adversarial Networks (GANs) and Normalizing Flows. Key numerical methods for MFGs, such as finite difference, optimization-based methods, neural network approaches, and Gaussian processes, are also reviewed, providing a comprehensive introduction to both the theoretical underpinnings of PDEs and practical computational strategies for MFGs and their interplay with advanced machine learning.

Prerequisites

This class is designed for graduate students across the mathematical sciences.

Required background: ACM 95/100 ab, ACM 101 ab, ACM 11 or equivalent.

When: Tuesdays and Thursdays, 10:30-11:55
Where: Annenberg 213
Instructor: Dr. Xianjin Yang



Organization

This course is organized in lectures, hands-on problem solving sessions and reading groups. Your grade is based on active participation in the course (attendance, participation in discussions and reading groups), and a small number of graded assignment.