HYKE meeting 2024

August 22nd (Thursday)

10:30	Opening
11:00 - 11:40	윤재영 박사 (서울대)
Lunch	
14:00 - 14:40	이재용 교수 (중앙대)
14:50 - 15:30	양효선 교수 (경희대)
Break	
15:50 - 16:30	고승찬 교수 (인하대)
16:30 - 17:00	Discussion
Dinner	

• 11:00 - 11:40 윤재영 박사 (서울대)

Winfree Dynamics with Higher-Order Coupling in Deterministic and Stochastic Regimes

Abstract: In this talk, we introduce the Winfree dynamics under a higher-order coupling regime. We analyze the diverse asymptotic behaviors associated with a fixed-order coupling and compare our theoretical results with numerical simulations. Additionally, we study the dynamics when the coupling order is regarded as a random variable. We provide a sufficient framework for the emergence of the death state.

• 14:00 - 14:40 이재용 교수 (중앙대)

Deep learning approach for solving kinetic equations

Abstract: Recently, deep learning-based methods have been developed to solve PDEs with many advantages. In this talk, I introduce our recent results on the deep neural network solutions to the kinetic equation. We study Vlasov-Poisson-Fokker-Planck equation and its diffusion limit via the deep learning approach. Also, we propose a new framework to approximate the solution to Fokker-Planck-Landau equation which has a nonlinearity and a high dimensionality of variables.

• 14:50 - 15:30 양효선 교수 (경희대)

Order enhanced numerical schemes through non-polynomial approximation

Abstract: We introduce an approximation method that establishes certain order enhancements by leveraging radial basis functions (RBFs) in the numerical solution of conservation laws. The use of RBFs for interpolation and approximation is a well developed area of research. Of particular interest in this work is the development of high order finite volume (FV) weighted essentially non-oscillatory (WENO) methods, which utilize RBF approximations to obtain required data at cell interfaces. The aforementioned improvement in the order of accuracy is addressed through an analysis of the truncation error, resulting in expressions for the shape parameters appearing in the basis. This paper seeks to address the practical elements of the approach, including the evaluations of shape parameters as well as a hybrid implementation.

• 15:50 - 16:30 고승찬 교수 (인하대)

Mathematical Theory of Neural Network Approximation and its Application to Scientific Machine Learning

Abstract: In recent years, modern machine learning techniques using deep neural networks have achieved tremendous success in various fields. From a mathematical point of view, deep learning essentially involves approximating a target function, relying on the approximation power of deep neural networks. Therefore, it is important to understand the approximation and generalization properties of neural networks in high dimensions. The primary objective of this talk is to mathematically analyze the approximation of neural networks within the classical numerical analysis framework. We will explore the proper regularity of target functions which is suitable for the neural network approximation, and investigate how these properties are reflected in the approximation and learning complexity of neural networks. Next, I will apply these theories to my recent work on the operator learning method for solving parametric PDEs. I will analyze the intrinsic structure of the proposed method through the theory described above, deriving some useful results both theoretically and practically. Furthermore, I will demonstrate some relevant numerical experiments, confirming that these theory-guided strategies can be utilized to significantly improve the performance of the method.