Graduate Student Paper Presentation 2023

UH AMS, SIAM, and AWM

April 7th, 2022

Schedule

Venue: PGH 232 (in-person) and via Teams (virtual)

02:00 pm	Welcome Remarks
02:10 pm	Existence, Uniqueness, and Long-term Behavior of Solutions to an SIR (Susceptible-Infected-Recovered) Model with a Treatment Term Haseeb Ansari
02:30 pm	Nonlocal Diffusion in Pattern-Forming Systems: The Klausmeier Model for Plant-Water Dynamics Cristian Meraz
02:50 pm	Error estimates for semi-implicit time stepping scheme for incompressible Navier-Stokes equations with variable density. An Vu
03:10 pm	**Break**
03:20 pm	Transfer Learning of GFAP-labeled astrocytes and microglia in micrographs using YOLOv5 Sarah Syed
03:40 pm	Denoising Bio-Oscillators using Distributed Delay Sean Campbell

Abstracts

Existence, Uniqueness, and Long-term Behavior of Solutions to an SIR (Susceptible-Infected-Recovered) Model with a Treatment Term
Haseeb Ansari

We study a dynamic SIR (Susceptible-Infected-Recovered) model with an intermittent treatment term. Results are given for the cases when no components diffuse, only I and R diffuse, and all components diffuse. In each case, we prove global existence and uniform boundedness of solutions, and investigate the long-time behavior.

Nonlocal Diffusion in Pattern-Forming Systems: The Klausmeier Model for Plant-Water Dynamics
Cristian Meraz

In this presentation, we will discuss pattern-forming models with a focus on the Klausmeier model for plant-water dynamics. We will cover nonlocal plant seed dispersal, the fractional Laplacian, and the derivation of nonlocal diffusion equations.

Error estimates for semi-implicit time stepping scheme for incompressible Navier-Stokes equations with variable density
An vu

We introduce a semi-implicit time stepping scheme to approximate the incompressible Navier-Stokes equations with variable density and viscosity. The scheme uses a projection method to enforce the incompressibility of the flow and the momentum, which equals the product of density and velocity, as dependent variable. We prove the stability and establish first order error estimates of this semi-implicit scheme. We also extend our study to thermodynamics setups by investigating a time marching multiphase thermal solver and its stability estimates and temporal error estimates. A fully discretized algorithm is proposed using finite element, and its convergence properties are verified using numerical simulations on various problems involving large ratio of density.

Transfer Learning of GFAP-labeled astrocytes and microglia in micrographs using YOLOv5
Sarah Syed

Studies in data science and machine learning are gaining widespread recognition and acknowledgement in academia. In my research with Dr Labate and Dr Papadakis, I particularly study the concept of transfer learning and the ways in which it could be generalized to study other objects in medical imaging. We focus on astrocytes and microglia cells. For images containing astrocytes, we apply enhancement techniques so that we could improve our PR curves in our already published results. In another set of experiments for transfer learning, we study if a trained model that detects astrocytes could be re-trained to detect glia cells due to similar morphological structure.

Denoising Bio-Oscillators using Distributed Delay
Sean Campbell

Genetic oscillations are generated by delayed transcriptional negative feedback loops, wherein repressor proteins inhibit their own synthesis after a temporal production delay. This delay is distributed because it arises from a sequence of noisy processes, including transcription, translation, folding, and translocation. Because the delay determines repression timing and therefore oscillation period, it has been commonly believed that delay noise weakens oscillatory dynamics. We will see that noisy delay can actually denoise genetic oscillators. Moderate delay noise unexpectedly sharpens oscillation peaks and improves temporal peak reliability, thereby overcoming the injection of noise into the delay distribution.