Yuqing Wang - What creates edge of stability, balancing, and catapult

Large learning rates, when applied to gradient descent (GD) for nonconvex optimization, yield various implicit biases, including edge of stability, balancing, and catapult. There are lots of theoretical works trying to analyze these phenomena, while the high-level idea is still missing: it is unclear when and why they occur. I will show that these phenomena occur when the objective has some good regularity. This regularity, together with the effect of large learning rate on guiding GD from sharp regions to flatter ones, leads to the control of the largest eigenvalue of Hessian along GD trajectory, which results in various phenomena.

Faharudeen Alhassan - Mathematical modeling of bubbles in flow streams and porous media

In many multi-phase chemical and electrochemical reaction systems, the fluid streams with dissolved gas or gas bubbles flow alongside a thin flat sheet of porous medium, composed of materials with varying surface energies. Chemical and electrochemical reactions occur at the surface and interface between the porous material and fluid. As such, the more surface is wetted, the more reaction can proceed, therefore, it is desirable to completely wet the porous material with the liquid phase. However, the gas bubbles and their dynamics can reduce the surface area of the porous material in contact with the liquid phase. In this poster, we illustrate the dynamics of bubble interactions and dissolved gas within the porous material, in order to optimize processes and designs.

Rhea Shroff - Accelerating the Computation of Tensor Z Eigenvalues

Efficient solvers for tensor eigenvalue problems are important tools for the analysis of higher-order data sets. For the talk, we will introduce, analyze and demonstrate an extrapolation method to accelerate the widely used shifted symmetric higher order power method for tensor Z-eigenvalue problems. We will analyze the asymptotic convergence of the method, determining the range of extrapolation parameters that induce acceleration, as well as the parameter that gives the optimal convergence rate. We will also introduce an automated method to dynamically approximate the optimal parameter and demonstrate its efficiency when the base iteration is run with either static or adaptively set shifts. Finally, we will discuss numerical results on both even and odd order tensors which demonstrate the theory and show we achieve our theoretically predicted acceleration.

Sanjeeb Poudel - A novel technique for minimizing energy functional using neural networks

An energy functional describes the equilibrium state of a system. In this work, we present a novel technique for minimizing the system's energy. Our method utilizes neural networks to process information at discrete grid points, considering their interactions with neighboring grid points, to update the state of the system. The training process involves formulating a loss function based on the system's energy, and with the help of multiple fine-tuning steps, the method employs a progressive energy reduction technique that decreases the energy in multiple steps.

Rauf Somiya - Understanding How SIRPα-Deficient Macrophage and Radiotherapy Together Kill Tumor

The interaction between SIRPα on macrophages and CD47 on tumor cells inhibits phagocytosis, thereby promoting tumor progression. Our study investigates the increased tumor cell death observed in SIRPα-deficient mice undergoing radiation therapy (RT) compared to wild type (WT) mice. The primary focus of our research is to develop a robust mathematical model to understand cancer cell growth in various scenarios involving WT mice, SIRPα-deficient mice, and their combined presence, with and without RT intervention. The analysis compares immune activation levels under RT application across different scenarios, including CD47 knockout, Anti-CD47, anti-SIRPα, and SIRPα deficient mice, for both double and single treatments of radiotherapy. By integrating biological insights with mathematical modeling, our aim is to refine the parameters of radiation therapy, including dose and timing of application, to maximize tumor cell death while harnessing the immune system's anti-tumor potential.