FACULTY MENTOR
Nick Antipa

PROJECT TITLE
Data-Driven Microscope Design

PROJECT DESCRIPTION
Description: All state-of-the-art imaging systems rely on algorithms to post-process captured data; an example everyone is familiar with is the recent popularity of computational photography in cell phone cameras (e.g., portrait mode, HDR). But what if the final output from an imaging system isn't simply an image, but rather semantic understanding of the world? How do we decide what the best capture system is for a semantic task like segmentation? End-to-end optimization is a simulation method for answering this question. By joining a differentiable hardware simulator with a differentiable segmentation algorithm, the hardware and software parameters can be jointly optimized from training examples. The aim of this project is to investigate joint design of 3D microscopes and neural segmentation algorithms using this end-to-end framework. This work would be in collaboration with both the Antipa and Mishne labs.

This project can accommodate both remote and in-person students.

INTERNS NEEDED
2 Students

PREREQUISITES
1. MS or undergrad student with working knowledge of Python and some basic optics (simple ray optics)
2. Strong candidates will have some experience with some of the following: Physical optics and diffraction, Fourier analysis and signal processing, linear algebra (singular value decomposition), or;
3. Some experience with PyTorch or Tensorflow

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PROJECT TITLE
Next Generation Tools for Optical Function Neuroimaging

PROJECT DESCRIPTION
Description: Did you know it's possible to record video data that captures individual neural activity of hundreds of neurons simultaneously in living animals? This has revolutionized the field of experimental neuroscience, but also created multiple exciting data science challenges. The fundamental problem is jointly extracting the spatial presence of neurons with their corresponding time-traces. To this end, this project will address the unique challenges in fast and accurate fluorescence imaging including efficient data storage, motion correction, space-time signal representation, and more. Tools for tackling these challenges will come from a broad array of disciplines, including machine learning, video compression, compressed sensing, optimization and more. This work would be in collaboration with both the Antipa and Mishne labs.

This project can accommodate both remote and in-person students.

INTERNS NEEDED
1 Student

PREREQUISITES
1. MS or undergrad student with working knowledge of Python and an interest in learning about new algorithms
2. Experience with machine learning frameworks (e.g. PyTorch, Tensorflow), and working knowledge of linear algebra (singular value decomposition) will help but are not necessary

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PROJECT TITLE
Backscatter Holography for Oceanographic Imaging

PROJECT DESCRIPTION
Description: Inline holography has been widely adoptics for oceanographic monitoring of zooplankton and other microscopic organisms. This technique requires transmitting a beam through a column of seawater, then capturing light on the other side. This makes the system difficult to deploy in the deep ocean. The aim of this summer project will be to investigate underwater holography in a backscatter configuration: the beam will be directed outward from a window, then the backscattered light collected in a digital hologram. We will capture data in the lab, then use algorithms to computationally reconstruct holographic images. The project will take place in Professor Antipa's optics lab where students will gain hands-on experience prototyping holographic optical systems and will have the opportunity to work on computational holographic reconstructions.

This project will be in person.

INTERNS NEEDED
2 Students

PREREQUISITES
1. A basic working knowledge of optics is needed (refraction) and simulation software (MATLAB or numpy)
2. Experience in any of the following would help but are not necessary: diffraction and wave propagation, optical alignment, signal processing, convex optimization