**Summer 2021 Yale Dean's Research Fellowship**

Zhang Liu

**Supervisor:** Prof. Steven W. Zucker (<https://cpsc.yale.edu/people/steven-zucker>)

**Affiliated Lab:** Zucker Lab (<https://www.cs.yale.edu/homes/vision/zucker/steve.html>)

**Project Topic:** Unsupervised Discovery of Functional Neural Circuits in Visual System through Tensor Component Analysis and Non-Linear Dimensionality Reduction.

**Key Words:** tensor component analysis (TCA), diffusion maps, neural data analysis, learning, computational vision

**Project Description:**

To understand perception, one must understand the physiological and computational capabilities of neural networks. We will focus on how the visual system in the mouse responds to an ensemble of stimuli, including artificial (e.g., gratings) and natural (visual flows) examples. We will try to learn which groups of neurons respond similarly to which stimuli using tensor factorization. Since it is likely that these groups are not independent, we will use diffusion map techniques to infer a manifold of neurons. We will explore coordinates on this manifold, to determine functional organization, and we will examine neighborhoods on this manifold to hypothesize local functional circuits. Although focused on data sets from the mouse, we believe these techniques will be applicable to many problems of data analysis in neuroscience.

**Tentative Timeline:** May 10 to Jul 17

* Lectures by Prof. Zucker to learn the necessary background knowledge and computing skills
* Getting familiar with the topic and the neuroscience database
* Implementing the learning algorithms
* Consistent discussions with the supervisor and lab members to adjust the directions
* Writing report