

## **A Structured Latent Variable Model for Joint Inference of Cell State Trajectories and Gene Regulatory Networks**

*Elliot Canter (Mentors: Drs. Elham Azizi and Lingting Shi, 2026 IICD SRP)*

Cell differentiation is governed by dynamic regulatory processes that drive transitions between cellular states. While existing computational approaches have provided valuable insights into cellular trajectories and gene regulation, these processes are often studied separately, limiting our ability to understand how regulatory programs shape cell state transitions.

In this study, we will develop a computational framework that integrates multimodal single-cell datasets to characterize cellular dynamics and the regulatory mechanisms associated with cell state change. By integrating complementary sources of information, the model will learn biologically meaningful representations of cellular identity and transition processes while leveraging prior biological knowledge to improve interpretability. Our approach is designed to capture both shared and cell-specific regulatory patterns across heterogeneous populations, enabling the identification of regulatory programs associated with distinct cellular states and transitions. Ultimately, this work seeks to provide a general framework for studying cellular dynamics and generating hypotheses regarding the molecular mechanisms underlying cell fate decisions.