

## **CRUNCH Seminars at Brown, Division of Applied Mathematics**

**Friday - December 10, 2021**

### **Learning Laws of datasets**

**João M Pereira, University of Texas**

**In this talk, we use machine learning tools for discovering laws and equations that govern high-dimensional datasets. Specifically, I will present two methods, one regarding partial differential equations (PDEs), and the other regarding latent stochastic differential equations (SDEs). Given function values, corrupted by noise, of a function governed by a PDE, the goal of the first method is to recover both the denoised function and the underlying coefficients of the PDE. We use a neural network for approximating the function. Then, we calculate the derivatives of the approximation exactly, using auto-differentiation, and relate those to obtain a PDE that governs the data. The goal of the second method is to learn a latent (unknown) low-dimensional SDE that governs observed high-dimensional data. As an example, consider a video of a circle moving in the 2D plane, where its XY coordinates are governed by an SDE. Our method effectively learns that the latent variables are the XY coordinates of the circle, and the underlying SDE. We formulate the latent SDE model as a probabilistic generative model and use a variational auto-encoder to learn it from observed data. We also provide theoretical guarantees regarding identifiability.**