PCTS Seminar Series:

Deep Learning for Physics

November 19, 2019

Jadwin Hall, Room 407

Program Organizers: **Sanjeev Arora, Curtis Callan, and Victor Mikhaylov**

Seminar Speaker: Kyle Cranmer

New York University

Title: Flows three ways

Lunch: 11:45 am ~~~ Seminar: 12:25 pm

The initial breakthroughs of deep learning came in the form of predictive tasks such as image classification, where discriminative models were trained with supervised learning algorithms. More recently, there have been exciting developments for generative models trained with unsupervised learning algorithms. Generative models approximate the distribution of the data and open up a wider range of possible applications. Generative Adversarial Networks (GANs) are the most well known of these models; however, they have drawbacks. I will describe an alternative approach called normalizing flows and discuss them in the context of three physics problems: effective field theory measurements at the LHC, lattice quantum chromodynamics, and modeling the density matrix of a quantum system.

Seminar Speaker: James Halverson

Northeastern University

Title: Deep Learning and String Theory

Time: 2:00-3:00 PM

String theory is a theory of quantum gravity that has had strong impacts on theoretical physics and mathematics. In this talk I will describe ways in which deep learning may lead to progress in string theory, with a special focus on broad applications in the string theory landscape. Known properties of the landscape and its relation to computational complexity will be briefly discussed, including ways in which the structure of the theory allows for the avoidance of worst-case complexity; for instance, networks of extra-dimensional spaces connected by topology changing transitions can aid in solving physically relevant Diophantine problems. The talk will focus on two types of problems in string theory. First, generative models will be discussed as a means for approximating statistical predictions, which are crucial given the large landscape of solutions. As a simple application, a conditional Wasserstein DCGAN will be used to learn random matrix approximations to Kahler metrics on Kahler moduli space, which are relevant for the physics of axion-like particles. Second, we will discuss multi-task search problems that arise in the landscape. A reinforcement learning A3C agent will be utilized to solve a multi-task problem in type IIA compactifications on a toroidal orbifold. Significant improvement over a random walker is achieved, a known human strategy is learned by the agent, but an RL-discovered strategy performs about twice as well.

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This seminar series is coordinated with the "Special Year on Optimization, Statistics, and Theoretical Machine Learning" at the Institute for Advanced Study (under the direction of co-organizer Sanjeev Arora.)