Special Topics in Machine Learning: Learned Neural Emulators of Physics Simulations

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Course Description: Learned emulators leverage neural networks to increase the speed of physics simulations in climate models, astrophysics, high-energy physics, and more. Recent empirical results have illustrated that these emulators can speed up traditional simulations by up to eight orders of magnitude. However, little is understood about these emulators. While it is possible that recent results are representative of what is possible in most settings, a more likely scenario is that these approaches are more effective for some simulators than others, and that learned emulators achieve strong average-case performance but fail to capture rare but important phenomena.

In this graduate seminar course we will provide an overview and investigate recent literature on this topic, focusing on the following questions:

1. Introduction to learned emulators: how do they work, where have they been successful so far and what are the goals in this field?

2. Two different paradigms of learned emulation: physics vs. data driven. What are the advantages and pitfalls of each?

3. Robustness of emulation to noise: what is known so far?

4. Parameter estimation: how to handle parameter uncertainty?

We will provide a list of papers covering the above topics and students will be evaluated on in-class presentations.

Schedule: see canvas page for link.

Grading: Your final grade will be calculated by 70% presentation + 30% participation