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Bayesian Neural Networks for Predictions from High Dimensional Theories

Thursday, October 22, 2020 2:45 PM (20 minutes)

One of the goals of current particle physics research is to obtain evidence of physics beyond the Standard Model (BSM) at accelerators such as the Large Hadron Collider (LHC). The searches for new physics are often guided by BSM theories that depend on many unknown parameters, which makes testing their predictions computationally challenging. Bayesian neural networks (BNN) can map the parameter space of these theories to a meaningful distribution of observables. We describe a new package called TensorBNN, built on Tensorflow and Tensorflow Probability, which implements Bayesian neural networks. The utility of TensorBNN is illustrated by modeling the predictions of the phenomenological Minimal Supersymmetric Standard Model (pMSSM), a BSM theory with 19 free parameters. The predicted quantities are cross sections for arbitrary pMSSM parameter points, the mass of the associated lightest neutral Higgs boson, and the theoretical viability of the parameter points. All three quantities are modeled with average percent errors of 3.3% or less and in a time orders of magnitude shorter than the supersymmetry codes from which the results are derived [1]. The posterior densities, provided as point clouds, provide meaningful Bayesian confidence intervals for the predictions, further demonstrating the potential for machine learning to accurately model the mapping from the high dimensional spaces of BSM theories to their predictions.

[1] B. S. Kronheim, M. P. Kuchera, H. B. Prosper, A. Karbo, Bayesian Neural Networks for Fast SUSY Predictions, 2020. arXiv:2007.04506.

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