An Analysis of Standard Model and Supersymmetric Subatomic Particle Events through Deep Neural Networks

Shyam Ravichandran   Ryan Rushing

March 14th, 2022

Abstract

The Standard Model is a theory which classifies elementary particles and details their interaction. However, it fails to explain recorded phenomena such as Dark Matter. It also incorrectly predicts the mass of the Higgs Boson and Neutrinos; predicting the mass of the Higgs Boson as infinite and Neutrinos as massless when both have been confirmed experimentally to have finite and non-zero mass respectively. One theoretical solution addresses these issues by introducing Supersymmetric partners for all elementary particles in the Standard Model. Supersymmetry provides an extension to the Standard Model, which alleviates some differences between theoretical predictions and experimental events. Theoretical calculations regarding Supersymmetry predicts that angular distributions of the particles differ when traveling through the detectors. However, differences between Standard Model and Supersymmetric events are undetectable through human testing, and building a systematic approach by hand would be impossible. Thus leading to the use of Deep Neural Networks to create a dynamic training model to search for differences through binary classification and simulated data created by Monte-Carlo simulations that theorize the properties of Supersymmetric events . While effective, Deep Neural Networks need optimization to its architecture and hyperparameters to achieve high accuracy that can be applied and generalized to new data that will be detected and recorded by the CMS detector at the LHC in Geneva. This research project will show the process of writing and optimizing hyperparameters in a Deep Neural Network in an attempt to detect and classify Standard Model and Supersymmetric Events through their differences in angular distributions.