Machine Learning in the Search for Supersymmetric Top Quarks

Onkur Sen
Physics Senior Thesis Proposal

In the paper [1], Dutta et. al. describe a scheme to search for supersymmetric top quarks (also known as stop quarks) by the compact muon solenoid (CMS) experiment at the Large Hadron Collider (LHC). Stop quarks are made via the collision $gg \to \tilde{t}\bar{\tilde{t}}$ at a center-of-mass energy level of $\sqrt{s} = 8$ TeV. It is projected that the stop quark would decay to a regular top quark as well as a χ^0 particle, the lightest stable supersymmetric particle. No evidence for this decay has been found yet. Thus, the goal of this research is to optimize the search for this important decay mode.

We propose to use machine learning techniques to separate stop quark decay events from background. In particular, boosted decision trees have been shown to be quite effective in Higgs searches and other CMS experiments [2]. We plan to collaborate with the authors of [1], who have generated some "phenomenological data" that could be used to study the application of these techniques to the stop quark search. We will apply boosted decision trees to this data to extract characteristics of the events using and see if the jets characterize a decay from stop quarks to top quarks and χ^0 particles.

The implications for this project are significant in that they would strongly suggest the existence of a supersymmetric particle that is light enough to be detected by the LHC at its current energy level—as the authors of [1] point out, gluinos and the heavier stop quarks are too heavy to be detected.

References

[1] Dutta, B. et. al. "Searching for Top Squarks at the LHC in Fully Hadronic Final State." `arXiv:1207.1873v1 [hep-ph]`.

[2] CMS Collaboration. "Search for the standard model Higgs boson decaying to W^+W^- in the fully leptonic final state in pp collisions at $\sqrt{s} = 7$ TeV. `doi:10.1016/j.physletb.2012.02.076`.