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Monday, September 5, 2022 12:00 PM

https://arxiv.org/abs/2202.05849

Abstract

Deep learning in order to resolve the "combinatorial problem" in SUSY-like events with 2 invisible particles at the LHC.

Specific example: ttbar events where the "combinatorial problem" becomes an issue of **binary classification**: pairing the correct lepton with each b quark coming from top decays.

Study the performance of a few machine learning algorithms, in particular:

1. Attention-based networks
2. Lorentz-Boost network

Results seem promising.

Introduction

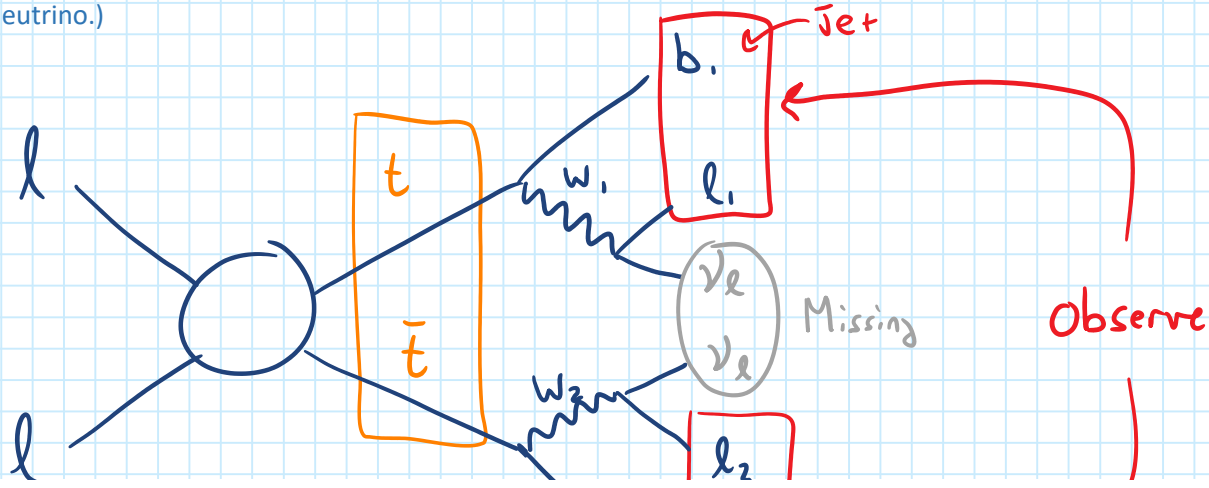
Missing Transverse Momentum (MTM) events are produced by well-motivated scenarios of DM and SUSY, but are difficult to interpret and analyze due to *instrumental effects, unknown nature of invisible particles, and incomplete kinematic information.*

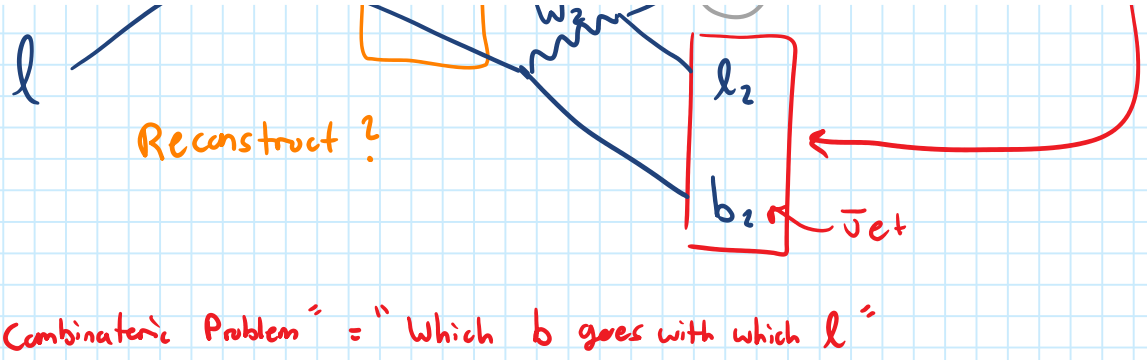
Common approach to analyzing MTM events involves hypothesizing a certain **event topology** and designing certain event variables suitable to this interpretation. The problem with this is ***how to associate the reconstructed objects in the event with the elementary particles in the final state of the event topology?***

> (Using the final state particles, how do we reconstruct the intermediate state particles (assign kinematic quantities) with any confidence given that we are missing information about the final state particles.)

Most common approach to resolving the **combinatorics problem** is to choose the "best" kinematic assignment event-by-event. Attempt to design an algorithm that singles out one or several assignments as the most likely "correct" assignment to be used in future analysis.

This Paper: They studty the combinatorial problem in MTM events using supervised ML. Concrete example, they look at dileptonic ttbar production. The combinatorics are twofold: how to correctly pair the 2 b-quarks with the two leptons in each event? (via the PDG, tops decay via the W to a bottom ~90% of the time. The W must then go to lepton + neutrino.)





"Combinatoric Problem" = "Which b goes with which l"

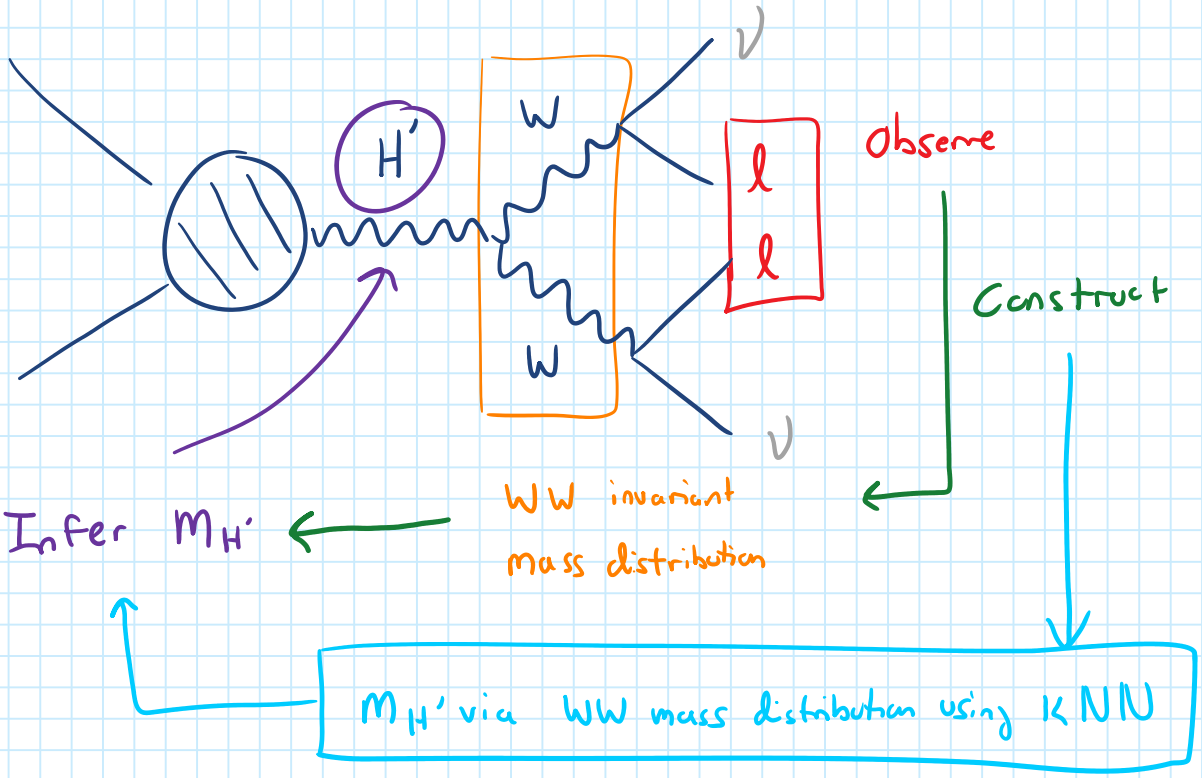
For Nathan: This problem can be recast as an M&M Problem. Suppose you have two packages of M&Ms. Without looking, you open both and pour them out on the table. Which M&M's came from which package?

This two-fold ambiguity can be mapped to a straightforward **binary classification task in supervised ML**.

https://arxiv.org/abs/2203.03662

Abstract

MTM events carry away information that can be used to reconstruct key variables like resonance peaks in invariant mass disributions. In this work, a **k-nearest neighbors regressor algorithm + Deep NN classifiers (kNN) is able to accurately recover binned distributions of the fully leptonic WW mass of a new heavy Higgs using only observable-level detector information.**



Introduction