**OmniFold: A Method to Simultaneously Unfold All Observables**

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**Motivation**

* *Unfolding*: process of obtaining truth distributions (particle-level) from measured information recorded by a detector (detector-level)
  + *Detector-level*: collisions before the corrections
  + *Particle-level*: collisions after the corrections
* Current Unfolding methods have three key challenges
  + Measured observables must be binned into histograms
    - Done manually
  + Small number of observables can be unfolded simultaneously
  + Features must be used in the unfolding process or else the results will be suboptimal and potentially biased
* The folding equation is where detector-level and truth level; however, is not invertible so there is not unique solution for

**Proposal**

* OmniFold aims to use ML to generalize the Iterative Bayesian Unfolding (IBU) denoted as equation (2) and uses equation (3) for calculating the likelihood ratio.

A diagram of a data flow

Description automatically generated

* Essentially, OmniFold starts with synthetic Monte Carlo dataset composed of pairs (,) where particle-level is pushed through detector simulation to obtain detector-level event
  + The synthetic detector-level “Simulation” is reweighted so that is matches experimental data “Data”
  + The synthetic particle-level “Generation” pulls and evaluates the weights from the simulation
  + The “Generation” further reweights to estimate the particle-level events (“Truth”) and is pushed back to the simulation
* The whole process repeats again

**Key Findings**

* Used a Proof-of-Concept approach for experiments with full radiation pattern of jets
  + Proton-Proton collision
  + Uses one simulator for truth/data and the other for unfolding corrections
  + Particle Flow networks (PFNs) were used for the study
* Measured performance against six jet substructure observables
  + Jet mass
  + Constituent multiplicity
  + N-subjettiness ratio
  + Jet width
  + Jet mass
  + Momentum fraction

A collage of graphs

Description automatically generated

A table with numbers and a number of objects

Description automatically generated with medium confidence

A graph of energy scale

Description automatically generated