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Measuring a New Class of Jet Observables with Neural Network Based Unfolding

Jets are collimated sprays of hadrons produced in high energy collisions. Jets play an important role in many searches for new physics, and provide an experimental window into the real time dynamics of hadronization, namely the confinement of asymptotically free quarks and gluons into hadrons. With the advent of a new class of theoretical observables, so called energy correlators, that probe the energy flow within jets, it has recently becomes possible, at least in theory, to directly “image” the confinement transition. In this talk, we will discuss the major challenges of realizing this measurement experimentally, and introduce a number of new techniques that will be required to achieve this goal. We first show that the angular resolution necessary can only be achieved using tracking information, and we perform the first measurement of “track functions” that describe the conversion of quarks and gluons into the electrically charged hadrons seen by trackers. We then show that radically new ways of unfolding data are required for these new observables, and show how this can be achieved using novel Neural Network based approaches.

More precisely, observables in high energy particle physics are computed on the distribution of energy imprinted on the detectors. To compare with theoretical calculations, the detector effects must be removed. Remarkably, this energy distribution has many similarities with point clouds, allowing us to leverage data representations used in this more well studied context. We discuss an architecture “Energy flow networks” based on an application of the deep sets theorem to the particle physics context. We then show how one can develop a novel unfolding approach that generalizes iterative Bayesian unfolding, call “Omnifold”, and simultaneously unfolds all observables at the level of the energy distribution. We present preliminary studies, and discuss their power for particle physics measurements.

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