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Tuning the parton shower parameters with the marginal likelihood

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Tuning parton shower models to data is an important task for HEP experiments. We are performing exploratory research for what tuning the parton shower might look like if the parton shower were described by a generative model with a tractable likelihood, which might be implemented with a hybrid of theoretically-motivated components or generic neural network components. For this work we consider the Ginkgo model, which is a simplified parton shower with 1-to-2 splittings and a tractable likelihood that has been designed to facilitate this research. While the parton shower is traditionally tuned by matching one dimensional projections for various observables, ideally we would tune it with a maximum likelihood fit. The challenge is that the likelihood for the data given the shower parameters must marginalize over the $(2N-3)!!$ possible showering histories, where N is the number of jet constituents. We demonstrate that with the hierarchical cluster trellis we can exactly marginalize over this enormous space of showering histories and fit the parameters of the Ginkgo model.

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