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Deep Learning Methods for Uncertainty Quantification at the SLAC Linac Coherent Light Source[1] LIPI GUPTA, University of Chicago, AASHWIN MISHRA, AURALEE EDELEN, SLAC National Accelerator Lab —
Particle accelerators are essential instruments in modern science, and must often provide charged particle beams with different beam parameters (e.g. different beam energies and durations) for each requested experiment. This is accomplished by tuning a wide variety of continuously-variable controllable settings on the accelerator. Tuning is a challenging task, as many particle accelerators are complex machines with thousands of components, each of which may contribute sources of uncertainty, or produce nonlinear responses to setting changes. Fast, accurate models of these systems could potentially aid rapid customization of beams. In order to accomplish this reliably, estimates of predictive uncertainty are essential, as many accelerators are high-regret and safety-critical systems. Here, we obtain quantified uncertainties from learned models of a noisy, high-dimensional, nonlinear accelerator system. We examine quantile regression neural networks (QRNNs) and Bayesian Neural Networks (BNNs) as candidate modeling paradigms. We assess model performance on noisy, high-dimensional data that covers a broad range of operating configurations, with the aim of obtaining an accurate model of the FEL pulse energy and associated uncertainty estimates for use in operation.

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