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Real-time Bayesian Optimization with Deep Kernel Learning and NN-Prior Mean for Accelerator Operations*

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The use of artificial intelligence (AI) has the potential to significantly reduce the time required to tune particle accelerators, such as the Argonne Tandem Linear Accelera-tor System (ATLAS). Bayesian optimization with Gauss-ian processes is a suitable AI technique for this purpose, it allows the system to learn from past observations to make predictions without explicitly learning representations of the data. In this paper, we present a Bayesian optimiza-tion method with deep kernel learning that combines the representational power of neural networks with the reliable uncertainty estimates of Gaussian processes. The kernel is first trained with physics simulations, then the model is deployed online in a real machine, in this case a subsec-tion of the ATLAS linac, to perform the optimization. In addition to the kernel, we also modelled the mean of the Gaussian process using a neural network trained with simulation data and later with experimental data. The results show that the model not only converges quickly to an optimal tune, but it also requires very little initial data to do so. These approaches have the potential of signifi-cantly improving the efficiency of particle accelerator tuning, and could have important applications in a wide range of settings.

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Footnotes

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