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Robust adaptive bayesian optimization

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Particle accelerators require continuous adjustment to maintain beam quality. Several machine learning (ML) approaches are being explored for this task. At the Advanced Photon Source (APS), we have recently proposed the adaptive Bayesian optimization (ABO) algorithm and have shown it to be effective experimentally in the APS injector complex. Further testing has suggested several improvements, on which we report here. We introduce dynamic kernel switching, deep kernel learning, and surrogate model prior means, resulting in improved robustness. We also extend our code with multi-dimensional time kernel support and predictive constraint avoidance to make it applicable to a wider range of systems. These changes also improve the general ABO performance, but more importantly expand ABO applicability to systems with rapid or unexpected changes in either optimization parameters or time properties. Notably, this allows for rapid and automated fallback to conservative parameters when optimizer confidence degrades, with alarms raised for further operator review. These features will permit further operational ML adoption at APS.

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Footnotes

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