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Bayesian Optimization Techniques for Accelerator Control and Characterization

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Future improvements in accelerator performance are predicated on increasing capabilities in online control of beams inside accelerators. Machine learning techniques have been the focus of work at SLAC to increase our ability to autonomously optimize and characterize beam dynamics inside accelerator facilities. Bayesian optimization algorithms, which leverage statistical surrogate models of objective functions to effectively address complex optimization challenges, are well situated for solving online optimization challenges in accelerator science. We describe Bayesian optimization techniques that have been developed to solve a wide range of online accelerator control problems, including single and multi-objective optimization, autonomous characterization, with or without constraints, high dimensional parameter spaces, and in the presence of hysteresis effects. These techniques can be used to effectively automate routine accelerator facility processes and enable novel capabilities in current and future accelerator systems.

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