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Learning to Do or Learning While Doing: Reinforcement Learning and Bayesian Optimisation for Online Continuous Tuning

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Online tuning of particle accelerators is a complex optimisation problem that continues to require manual intervention by experienced human operators. Autonomous tuning is a rapidly expanding field of research, where learning-based methods like Bayesian optimisation (BO) hold great promise in improving plant performance and reducing tuning times. At the same time, Reinforcement Learning (RL) is a capable method of learning intelligent controllers, while recent work shows that RL can also be used to train domain-specialised optimisers in so-called Reinforcement Learning-
trained Optimisation (RLO). In parallel efforts, both algorithms have found successful adoption in particle accelerator tuning. Here we present a comparative case study, analysing the behaviours of both algorithms and outlining their strengths and weaknesses. The results of our study help provide criteria for choosing a suitable learning-based tuning algorithm for a given task and will accelerate research and adoption of these methods with particle accelerators and other complex real-
world facilities, ultimately improving their availability and pushing their operational limits, thereby enabling scientific and engineering advancements.

Primary Keyword

ML-based optimization

Secondary Keyword

reinforcement learning

Tertiary Keyword

bayesian optimization

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