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Reinforcement learning for automation of accelerator tuning

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For more than half a decade, RadiaSoft has developed machine learning (ML) solutions to problems of immediate, practical interest in particle accelerator operations. These solutions include machine vision through convolutional neural networks for automating neutron scattering experiments and several classes of autoencoder networks for de-noising signals from beam position monitors and low-level RF systems in the interest of improving and automating controls. As active deployments of our ML products have taken shape, one area which has become increasingly promising for future development is the use of agentic ML through reinforcement learning (RL). Leveraging our substantial suite of ML tools as a foundation, we have now begun to develop an RL framework for achieving higher degrees of automation for accelerator operations. Here we discuss our RL approaches for two areas of ongoing interest at RadiaSoft: total automation of sample alignment at neutron and x-ray beamlines, and automated targeting and dose delivery optimization for FLASH radiotherapy. We will provide an overview of both the ML and RL methods employed, as well as some of our early results and intended next steps.

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Footnotes

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