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Towards Neural Charged Particle Tracking in Proton Computed Tomography with Reinforcement Learning

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Proton computed tomography (pCT) is an emerging imaging modality, receiving increasing importance for treatment planning in hadron therapy. One of the core challenges in the reconstruction pipeline for the high-granularity Bergen pCT Digital Tracking Calorimeter (DTC) prototype is the efficient reconstruction of high-multiplicity proton traces throughout the scanner which, in contrast to X-rays used in conventional CT, do not travel in a straight line. For this application, we propose a novel sequential tracking scheme based on model-free reinforcement learning working on graph-structured data, allowing for ground-truth free training of deep neural network architectures. For optimization, we consider only partial-information in terms of a scalar reward function, modeled based on the Gaussian approximation of the underlying theory of multiple Coulomb scattering. Given this information, we aim to find a policy that maximizes the plausibility of reconstructed tracks. We demonstrate on Monte Carlo simulated data the high potential as well as the current limitations of this approach.

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