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Surrogate Model for Linear Accelerator: A fast Neural Network approximation of ThomX's simulator

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Accelerator physics simulators accurately predict the propagation of a beam in a particle accelerator, taking into account the particle interactions (a.k.a. space charge) inside the beam. A precise estimation of the space charge is required to understand the potential errors causing the difference between simulations and reality. Unfortunately, the space charge is computationally expensive, needing the simulation of a few dozen thousand particles to obtain an accurate prediction. This paper presents a Machine Learning-based approximation of the simulator output, a.k.a. surrogate model. Such an inexpensive surrogate model can support multiple experiments in parallel, allowing the wide exploration of the simulator control parameters. While the state of the art is limited to considering a few such parameters with a restricted range, the proposed approach, LinacNet, scales up to one hundred parameters with wide domains. LinacNet uses a large-size particle cloud to represent the beam and estimates the particle behavior using a dedicated neural network architecture reflecting the architecture of a Linac and its different physical regimes.

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Footnotes

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Yes

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