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Software R&D for Next Generation of HEP Experiments, Inspired by Theano

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In the next decade, the frontiers of High Energy Physics (HEP) will be explored by three machines: the High Luminosity Large Hadron Collider (HL-LHC) in Europe, the Long Base Neutrino Facility (LBNF) in the US, and the International Linear Collider (ILC) in Japan. These next generation experiments must address two fundamental problems in the current generation of HEP experimental software: the inability to take advantage and adapt to the rapidly evolving processor landscape, and the difficulty in developing and maintaining increasingly complex software systems by physicists. I will propose a strategy, inspired by the automatic optimization and code generation in Theano, to simultaneously address both problems. I will describe three R&D projects with short-term physics deliverables aimed at developing this strategy. The first project is to develop maximally sensitive General Search for New Physics at the LHC by applying the Matrix Element Method running GPUs of HPCs. The second is to classify and reconstruct Liquid Argon Time Projection Chambers (LArTPC) events with Deep Learning techniques. The final project is to optimize tomographic reconstruction of LArTPC events, inspired by medical imaging.

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