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Deep Neural Networks for Physics Analysis on low-level whole-detector data at the LHC

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There has been considerable recent activity applying deep convolutional neural nets (CNNs) to data from particle physics experiments. Current approaches on ATLAS/CMS have largely focussed on a subset of the calorimeter, and for identifying objects or particular particle types. We explore approaches that use the entire calorimeter, combined with track information, for directly conducting physics analyses: i.e. classifying events as known-physics background or new-physics signals.

We use an existing RPV-Supersymmetry analysis as a case study and evaluate different approaches to make whole-detector deep-learning tractable. We explore CNNs and alternative architectures on multi-channel, high-resolution sparse images: applied on GPU and multi-node CPU architectures (including Knights Landing (KNL) Xeon Phi nodes) on the Cori supercomputer at NERSC.

We compare statistical performance of our approaches with both selections on high-level physics variables from the current physics analyses, and shallow classifiers trained on those variables. We also compare time-to-solution performance of CPU (scaling to multiple KNL nodes) and GPU implementations.

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