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Graph Neural Networks for Electron and Photon Reconstruction at CMS

The Compact Muon Solenoid (CMS) detector is one of two general-purpose detectors at
the CERN LHC. Products of proton-proton collisions at a center of mass energy of 13 TeV are reconstructed in the CMS detector to probe the standard model of particle physics and to search for processes beyond the standard model. The development
of precision algorithms for this reconstruction is therefore a key objective in optimizing the precision of all physics results at CMS. While the use of machine learning techniques are now prevalent at CMS for these tasks, they have largely relied on high-level human-engineered input features. However, much of the disruptive impact of machine learning in industry has been realized by bypassing human feature engineering and instead training deep learning algorithms on low-level data. We have
developed a novel machine learning architecture based on dynamic graph neural networks that allows regression directly on low-level detector hits and applied this model to photon energy corrections in CMS. In this work, the performance of our new architecture is demonstrated in the corrections to the the energies of the photons that are used in most analyses at CMS, where we obtain an improvement in energy resolution by a factor of 10\% with respect to the previous state-of-the-art reconstruction method.

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