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A Convolutional Neural Network for topological fast selection algorithms in FPGAs for the HL-LHC upgrade of the CMS experiment

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The High Luminosity upgrade to the LHC will deliver unprecedented luminosity to the experiments, culminating in up to 200 overlapping proton-proton collisions. In order to cope with this challenge several elements of the CMS detector are being completely redesigned and rebuilt. The Level-1 Trigger is one such element; it will have a 12.5 microsecond window in which to process protons colliding at a rate of 40MHz, and reduce this down to 750kHz. The key attibute of a trigger system is to retain the signals which would benefit from further analysis, and thus should be stored on disk. This upgraded trigger, as in the present design, will utilise an all-FPGA solution. Although rules-based algorithms have traditionally been used for this purpose, the emergence of new generation FPGAs and Machine Learning toolsets have enabled neural networks to be proposed as an alternative architecture. We present the design and implementation of a Convolution Neural Network (CNN) on an FPGA to demonstrate the feasibility of such an approach. Results will be presented for a baseline signal model of a pair of Higgs bosons decaying to four b-quarks. The model architecture, resource usage, latency and implementation floorplan will all be presented. Latest results will also be shown of studies to use domain-specific knowledge to enhance the network's inference capability.

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