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Convolutional Neural Networks for event classification

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In this study, a new technique for event classification using Convolutional Neural Networks (CNN) is presented. Results obtained using this technique are shown and compared to more traditional Machine Learning approaches for two different physics cases.
The new technique explores the power of visual recognition, which is one of the fastest-growing areas in Artificial Intelligence, as a consequence of the "deep learning" evolution of CNNs. **Since CNNs are fed with images, an original and intuitive way for encoding the event information in images has been developed**, building a one-to-one correspondence that allows us to face the event classification as an image classification.
In order to take advantage of the good performance of existing CNN architectures, **transfer learning has been tested, showing to be a suitable option**. VGG16 has been chosen as the benchmark, which is based on the well-known architecture named AlexNet. Additionally, an alternative approach with a simpler CNN architecture has shown to give also good results when trained from scratch. Nevertheless, a comparison with a more standard technique such as a BDT (using the XGBoost library) is provided in order to confirm that the results obtained with this unexplored technique are satisfactory.
The two classifications studied correspond to **current challenges in Particle Physics**. First, a New Physics example corresponding to a **Dark Matter search** has been performed, considering a mono-top signal and several of its main background processes. The selected events were required to have exactly one lepton and at least one b-tagged jet, together with large missing transverse momentum. Second, with the same selection criteria, a **tt+X classification** is also carried out, in which exotic processes with four top quarks as final state are tried to be identified among other processes such as ttH or ttW.

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