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Probes of Anomalous Events at LHC with Self-Organizing Maps

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Self-organizing map (SOM), a special class of artificial neural network (ANN), has found extensive application in many science branches since its discovery in 1982 by Teuvo Kohonen. Inspired by the ability of the brain to map smells, sounds, images, etc., to different neurons in a self-organizing way and segregate them concerning their similarity, SOM is widely used for dimensional reduction, visualization, and clustering of higher dimensional data. These abilities of SOM have remarkable implementations in the field of High Energy Physics not only to identify rare decay processes from the usual Standard Model (SM) ones but also to segregate different SM decays with differences in the decay channel. This work considers a SM top decay process $t \longrightarrow b\ W$ and a di-jet QCD process $p\ p \longrightarrow j\ j$ in the boosted regime ($pT > 350GeV$) and visualizes how these two processes can be mapped in a two-dimensional grid (SOM grid) using their kinematic features. We map the data points to a rectangular grid and try to identify the clusters through the SOM visualization and unified distance matrix(u-matrix). We also tried to interpret the meaning of each boundary in the SOM map Grid, identifying if SOM could find some anomalous cluster of data from these datasets. The algorithm shows promising results by clustering almost 90% of SM top decay dataset in one cluster and 91% of the di-jet QCD process dataset in another cluster.

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