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Spatio-Temporal Anomaly Detection for the DQM of the CMS Experiment via Graph Networks

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The Data Quality Monitoring (DQM) is in place to spot and diagnose particle physics data problems as promptly as possible to avoid data loss in the CMS experiment of CERN. Several studies have proposed to leverage the DQM automation using machine learning algorithms. However, only a few efforts explored temporal characteristics to underpin system monitoring automation of the CMS detectors via anomaly detection models thus far. Moreover, the DQM for the HCAL detector of the CMS experiment poses multidimensional challenges, yet it is relatively unexplored with machine learning models. In this study, we propose a time-aware deep learning model for anomaly detection on the multidimensional spatial quantity of the DQM for the HCAL detector. The model employs convolutional, recurrent and graph networks to learn three-dimensional spatial characteristics, exploit physical connections of the QIE channels into RBX of the detector systems, and temporal evolution, respectively. Performance evaluation on artificially generated anomalies such as dead, hot and degrading channels has demonstrated the efficacy of the proposed model in detecting and robustly localizing anomalies in temporal and spatial contexts on digioccupacy histograms. Finally, we have carried-out comparison among several models that shows the substantial gain of the proposed model architecture and temporal modeling.

Primary authors: YU, David (Brown University (US)); WANG, Long (University of Maryland (US)); ASRES, Mulugeta (University of Agder (NO))

Presenter: ASRES, Mulugeta (University of Agder (NO))

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