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Air Handling Units Power Consumption Using Generalized Additive Model for Anomaly Detection: A Case Study in a Singapore Campus

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Abstract : The emergence of digital twin technology, a digital replica of physical world, has improved the real-time access to data from sensors about the performance of buildings. This digital transformation has opened up many opportunities to improve the management of the building by using the data collected to help monitor consumption patterns and energy leakages. One example is the integration of predictive models for anomaly detection. In this paper, we use the GAM (Generalised Additive Model) for the anomaly detection of Air Handling Units (AHU) power consumption pattern. There is ample research work on the use of GAM for the prediction of power consumption at the office building and nation-wide level. However, there is limited illustration of its anomaly detection capabilities, prescriptive analytics case study, and its integration with the latest development of digital twin technology. In this paper, we applied the general GAM modelling framework on the historical data of the AHU power consumption and cooling load of the building between Jan 2018 to Aug 2019 from an education campus in Singapore to train prediction models that, in turn, yield predicted values and ranges. The historical data are seamlessly extracted from the digital twin for modelling purposes. We enhanced the utility of the GAM model by using it to power a real-time anomaly detection system based on the forward predicted ranges. The magnitude of deviation from the upper and lower bounds of the uncertainty intervals is used to inform and identify anomalous data points, all based on historical data, without explicit intervention from domain experts. Notwithstanding, the domain expert fits in through an optional feedback loop through which iterative data cleansing is performed. After an anomalously high or low level of power consumption detected, a set of rule-based conditions are evaluated in real-time to help determine the next course of action for the facilities manager. The performance of GAM is then compared with other approaches to evaluate its effectiveness. Lastly, we discuss the successfully deployment of this approach for the detection of anomalous power consumption pattern and illustrated with real-world use cases.

Keywords : anomaly detection, digital twin, generalised additive model, GAM, power consumption, supervised learning
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