Siemens Smart Buildings-Sustainability and Efficiency

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Siemens has enlisted our team to develop a computational model that helps predict and prevent unexpected breakdowns in HVAC systems in VCU's engineering labs. HVAC stands for Heating, Ventilation, and Air Conditioning. These systems control indoor temperature, airflow, and humidity to keep buildings comfortable and safe. Most breakdowns are fixed after they occur, which can cause delays and increase costs. We use an LSTM Autoencoder, a machine-learning model that learns and reconstructs patterns in time-series data. Our model is trained to recognize normal behavior by studying a year's data from a fan coil unit (FCU), a key component in many HVAC systems. An FCU uses a fan to move air over a coil that can heat or cool the air, depending on the need. The data includes things like temperatures, valve positions, and fan activity. We preprocess this data by scaling the values, adding time-related features to help the model understand daily and seasonal cycles, and organizing it into sequences to learn patterns over time. Once the program has learned what normal FCU behavior looks like, we test it on known normal and anomalous data. For example, suppose the FCU starts acting in a way that doesn't match the normal patterns learned during training. In that case, the model detects it as an anomaly—potentially signaling a developing breakdown. The model performs well when we test it on data that is either all normal or all anomalous.

Keywords: Predictive Maintenance, HVAC Systems, LSTM Autoencoder, Anomaly Detection