DeepSense: A Physics-Guided Deep Learning Paradigm for Anomaly Detection in Soil Gas Data at Geologic CO2 Storage Sites.

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Abstract:

Driven by the collection of enormous amounts of streaming data from sensors, and with the emergence of the internet of things, the need for developing robust detection techniques to identify data anomalies has increased recently. The algorithms for anomaly detection are required to be selected based on the type of data. In this study, we propose a predictive anomaly detection technique, DeepSense, which is applied to soil gas concentration data acquired from sensors being used for environmental characterization at a prospective CO2 storage site in Queensland, Australia. DeepSense takes advantage of deep-learning algorithms as its predictor module and uses a process-based soil gas method as the basis of its anomaly detector module. The proposed predictor framework leverages the power of convolutional neural network algorithms for feature extraction and simultaneously captures the long-term temporal dependency through long short-term memory algorithms. The proposed process-based anomaly detection method is a cost-effective alternative to the conventional concentration-based soil gas methodologies which rely on long-term baseline surveys for defining the threshold level. The results indicate that the proposed framework performs well in diagnosing anomalous data in soil gas concentration data streams. The robustness and efficacy of the DeepSense were verified against data sets acquired from different monitoring stations of the storage site.