World Academy of Science, Engineering and Technology
International Journal of Industrial and Systems Engineering
Vol:19, No:06, 2025

Multi-scale Spatial and Unified Temporal Feature-fusion Network for Multivariate Time Series Anomaly Detection

Authors : Hang Yang, Jichao Li, Kewei Yang, Tianyang Lei

Abstract : Multivariate time series anomaly detection is a significant research topic in the field of data mining, encompassing a wide range of applications across various industrial sectors such as traffic roads, financial logistics, and corporate production. The inherent spatial dependencies and temporal characteristics present in multivariate time series introduce challenges to the anomaly detection task. Previous studies have typically been based on the assumption that all variables belong to the same spatial hierarchy, neglecting the multi-level spatial relationships. To address this challenge, this paper proposes a multi-scale spatial and unified temporal feature fusion network, denoted as MSUT-Net, for multivariate time series anomaly detection. The proposed model employs a multi-level modeling approach, incorporating both temporal and spatial modules. The spatial module is designed to capture the spatial characteristics of multivariate time series data, utilizing an adaptive graph structure learning model to identify the multi-level spatial relationships between data variables and their attributes. The temporal module consists of a unified temporal processing module, which is tasked with capturing the temporal features of multivariate time series. This module is capable of simultaneously identifying temporal dependencies among different variables. Extensive testing on multiple publicly available datasets confirms that MSUT-Net achieves superior performance on the majority of datasets. Our method is able to model and accurately detect systems data with multi-level spatial relationships from a spatial-temporal perspective, providing a novel perspective for anomaly detection analysis.

Keywords : data mining, industrial system, multivariate time series, anomaly detection
Conference Title : ICRM 2025 : International Conference on Reliability and Maintainability
Conference Location : Venice, Italy
Conference Dates : June 21-22, 2025