# GRAPH-ENHANCED TEMPORAL FUSION FOR AIR QUALITY PREDICTION

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## Abstract

Exposure to fine particulate matter (PM2.5) is a major environmental health risk, linked to millions of premature deaths each year. Accurate short-term PM2.5 forecasts support public health warnings and policy, yet many forecasting models treat monitoring stations independently and give little insight into what drives their predictions. This study developed a hybrid model, GCNTFT, that combines a Graph Convolutional Network (GCN) for spatial relationships between stations with a Temporal Fusion Transformer (TFT) for multi horizon forecasting. PM2.5 was the only pollutant predicted. The model used hourly PM2.5 data from the Central Pollution Control Board of India for 10 monitoring stations in Delhi, covering 2010 to 2023. Each station was a node in a graph; all stations lay within the 50 km connection radius, so every pair was linked, with edges weighted by inverse distance. The GCN encoded 24 hour windows of station observations into spatial embeddings, which the TFT used as additional inputs for 1 to 24 hour ahead forecasts. The final 48 hours of data were held out for testing, and GCNTFT was compared with ARIMA, LSTM and XGBoost baselines using RMSE and MAE averaged over all test stations and horizons. GCNTFT had the lowest average error, with MAE 40.8% lower than LSTM, 29.7% lower than ARIMA and 17.3% lower than XGBoost, the strongest baseline. These are differences in average test error; no formal significance test was performed, and the short single test period and absence of an ablation study limit how much of the gain can be attributed to the spatial component. The TFT's variable importance weights and attention patterns show which inputs and past time steps each forecast relied on, giving partial insight into model behaviour. The results suggest that graph-based spatial context is a promising addition to station-level PM2.5 forecasting.

**Keywords:** air quality prediction, graph neural networks, temporal fusion transformer, spatiotemporal forecasting, PM2.5 forecasting