Causal Inference Engine between Continuous Emission Monitoring System Combined with Air Pollution Forecast Modeling

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Abstract : This paper developed a data-driven based model to deal with the causality between the Continuous Emission Monitoring System (CEMS, by Environmental Protection Administration, Taiwan) in industrial factories, and the air quality around environment. Compared to the heavy burden of traditional numerical models of regional weather and air pollution simulation, the lightweight burden of the proposed model can provide forecasting hourly with current observations of weather, air pollution and emissions from factories. The observation data are included wind speed, wind direction, relative humidity, temperature and others. The observations can be collected real time from Open APIs of civil IoT Taiwan, which are sourced from 439 weather stations, 10,193 qualitative air stations, 77 national quantitative stations and 140 CEMS quantitative industrial factories. This study completed a causal inference engine and gave an air pollution forecasting for the next 12 hours related to local industrial factories. The outcomes of the pollution forecasting are produced hourly with a grid resolution of 1km*1km on IIoTC (Industrial Internet of Things Cloud) and saved in netCDF4 format. The elaborated procedures to generate forecasts comprise data recalibrating, outlier elimination, Kriging Interpolation and particle tracking and random walk techniques for the mechanisms of diffusion and advection. The solution of these equations reveals the causality between factories emission and the associated air pollution. Further, with the aid of installed real-time flue emission (Total Suspension Emission, TSP) sensors and the mentioned forecasted air pollution map, this study also disclosed the converting mechanism between the TSP and PM2.5/PM10 for different region and industrial characteristics, according to the long-term data observation and calibration. These different time-series qualitative and quantitative data which successfully achieved a causal inference engine in cloud for factory management control in practicable. Once the forecasted air quality for a region is marked as harmful, the correlated factories are notified and asked to suppress its operation and reduces emission in advance.

Keywords : continuous emission monitoring system, total suspension particulates, causal inference, air pollution forecast, IoT