Abstract for UK System Research Workshop

Machine Learning Approaches for Forecasting Ammonia Concentrations and Performance Outcomes in Wastewater Treatment Processes

Abduljaber Abdulqader, Newcastle University, Part-time PhD Student

The research focuses on leveraging machine learning (e.g., Random Forest, XGBoost, Prophet, LSTM) to forecast treatment performance metrics in wastewater treatment processes, particularly predicting pass/failure scenarios for ammonia (NH_3) concentration forecasting tasks. The study explores how machine learning can improve predictive accuracy and identify the most influential factors affecting wastewater quality, leading to operational benefits such as proactive process adjustments, cost savings, and environmental compliance.

This research contributes a comparative evaluation of multiple ML approaches to NH_3 concentration forecasting, emphasizing interpretability and robustness under data uncertainty.

Experimentation involves applying various machine learning models to predict NH_3 concentrations up to four weeks in advance. This approach enables a better understanding of bacterial characteristics - such as growth rates and activity patterns - that influence treatment performance and nitrogen removal efficiency.

A five-year dataset (2011–2016) from a local wastewater treatment plant in northeast UK serves for model training and testing. It contains 257 weekly samples across 73 attributes, including chemical composition, operational measurements, and bacterial information. Some records contain missing values, underscoring the importance of assessing data quality, feature relevance, and model robustness.

The research highlights the need for more precise and complete data to build reliable predictive models and determine the optimal number of samples for accurate forecasting. Given sampling costs, time constraints, and environmental variability, developing a unified, generalisable model remains a challenge.

This work presents an ongoing framework for scalable environmental forecasting. As my first external presentation, I seek constructive feedback from the UK Systems Research Group to refine methodological assumptions and enhance practical applicability.