AIAM Project Summary – Advanced Manufacturing

Project Overview

In the context of advanced manufacturing, real-time monitoring of critical equipment such as turbines, compressors, and pumps is essential to ensure uninterrupted operations. Each data point represents the machine's status, capturing both environmental and performance-related readings. The main objective of this project is to identify any unusual patterns that may indicate early signs of equipment failure.

Challenges Faced

One of the main challenges faced during this project was the complexity arising from multiple sensors generating large amounts of data that were difficult to interpret manually. In real-world settings, true failure labels may not exist or may be rare, therefore requiring robust unsupervised anomaly detection methods. Another challenge involved ensuring that the scaling methods and model parameters were tuned to handle outliers and data imbalance effectively.

Methodology

To address these challenges, three scalers — StandardScaler, MinMaxScaler, and RobustScaler — were used to preprocess the data. This comparison allowed for performance evaluation across different scaling strategies and prevented bias from relying on a single preprocessing approach. Five anomaly detection models were implemented: Isolation Forest, DBScan, AutoEncoder, One-Class SVM, and Local Outlier Factor. PCA visualization was used to compare the models' effectiveness in distinguishing inliers from outliers before and after fine-tuning.

Results and Analysis

Before fine-tuning, PCA visualizations showed overlapping between inliers and outliers, implying weaker anomaly detection. DBScan initially performed the best with minimal overlapping clusters. However, after hyperparameter tuning, the Isolation Forest model with RobustScaler achieved the best results. The PCA plots demonstrated dense, compact clusters of inliers and distinct outliers, indicating effective anomaly separation and reduced false positives.

Key Takeaways and Learnings

This project provided a valuable learning journey that deepened my understanding of applying AI in predictive maintenance. I learned the importance of proper preprocessing, model evaluation, and visualization in achieving reliable results. Through challenges such as dealing with noisy data and fine-tuning models, I developed stronger analytical skills and the ability to experiment with unfamiliar techniques confidently. This experience reinforced my independence, curiosity, and appreciation for the role of AI in real-world industrial applications.

Conclusion

Overall, this AIAM project showcased how artificial intelligence can enhance equipment reliability in advanced manufacturing. By leveraging anomaly detection techniques and data preprocessing strategies, potential failures can be detected early, reducing downtime and maintenance costs. The project strengthened both technical and soft skills, leaving me with a mindset for continuous learning and innovation in the field of AI-driven manufacturing.