Vector Embedding: A Machine Learning Tool and its Application in Aerospace Industry

Vector embedding is a powerful tool in machine learning. It transforms high-dimensional data into dense, lower-dimensional representations to capture meaningful relationships within the data. An important application of vector embedding in the aerospace industry is in fault detection and predictive maintenance (Ning S, et al., 2021). The failure of critical components such as engines, avionics, or structural parts can be critical. It can lead to significant safety risks, costly downtime, and expensive repairs.

Traditional maintenance schedules are typically based on fixed intervals. These may not accurately reflect the actual condition of the components. This can result in premature maintenance, leading to unnecessary costs. In addition, it can also lead to delayed maintenance, increasing the risk of failure. An alternate way to do predictive maintenance in aerospace applications is to use vector embeddings. The key steps are (a) collecting sensor data from aircraft components, maintenance logs, and failure reports, (b) preprocessing the data into meaningful intervals, and (c) creating vector embeddings using a sequence-based model such as LSTM.

The vector embeddings can be used to learn the health status of the components over time. Following the above, one can use machine learning techniques to develop anomaly detection models based on vector embeddings. These can detect unusual patterns in the embeddings, indicating potential failures. One can next study historical data for similar patterns to predict the outcomes of these instances. In summary, vector embeddings can provide valuable insights into component performances and failure modes, helping design better maintenance strategies.

Reference

Ning S, Sun J, Liu C, Yi Y. (2021). Applications of deep learning in big data analytics for aircraft complex system anomaly detection. Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability. 2021;235(5):923-940. doi:10.1177/1748006X211001979