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A Case Study on Fault Type Classification and Action Prediction Using Unstructured Text Data from Automotive Parts Manufacturers

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Extended Abstract

Effective equipment management in manufacturing requires accurately identifying malfunctions and defects by analyzing their causes and patterns. This involves classifying failure types, monitoring trends, and implementing appropriate resolutions to improve operational efficiency. Precise classification plays a crucial role in enabling data-driven decision-making and proactive maintenance. Manufacturing Execution Systems (MES) collect extensive data on equipment failures, incorporating both structured machine-generated logs and unstructured operator-reported text, providing valuable insights into failure mechanisms and responses. This study utilizes real-world manufacturing data to develop machine learning models for classifying equipment failure types and recommending response strategies. Specifically, classification models based on Bidirectional Encoder Representations from Transformers (BERT) and Random Forest were trained to identify ten distinct failure categories. Additionally, T5-based models were constructed and optimized to generate effective response strategies. A comprehensive performance evaluation was conducted to assess the effectiveness of these models in real-world applications. Natural Language Processing (NLP), a key component of artificial intelligence, enables the extraction of insights from unstructured text, bridging the gap between human language and computational analysis. While early NLP approaches relied on statistical methods, recent advances in deep learning have significantly enhanced its capabilities. These advancements are particularly valuable in manufacturing, where unstructured textual data is abundant but often underutilized in failure analysis. Equipment downtime, a major challenge in manufacturing, is categorized as either planned or unplanned. Unplanned downtime is particularly problematic due to its unpredictability and negative impact on productivity. Effective management requires integrating structured and unstructured data to diagnose failure causes and prioritize resolutions efficiently. This research proposes a deep learning-based framework that leverages unstructured failure logs from an automotive parts manufacturing facility to classify equipment failure types and predict optimal response strategies. By integrating advanced NLP and deep learning techniques, this study introduces a standardized, data-driven approach to equipment failure classification and resolution. The proposed methodology has the potential to reduce unplanned downtime and enhance manufacturing efficiency, contributing to the development of intelligent maintenance systems applicable across various industrial environments.

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