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Predictive Modelling of Aircraft Component Replacement Using Imbalanced Learning and Ensemble Method

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Abstract : Adequate monitoring of vehicle component in other to obtain high uptime is the goal of predictive maintenance, the major challenge faced by businesses in industries is the significant cost associated with a delay in service delivery due to system downtime. Most of those businesses are interested in predicting those problems and proactively prevent them in advance before it occurs, which is the core advantage of Prognostic Health Management (PHM) application. The recent emergence of industry 4.0 or industrial internet of things (IIoT) has led to the need for monitoring systems activities and enhancing system-to-system or component-to- component interactions, this has resulted to a large generation of data known as big data. Analysis of big data represents an increasingly important, however, due to complexity inherently in the dataset such as imbalance classification problems, it becomes extremely difficult to build a model with accurate high precision. Data-driven predictive modeling for condition-based maintenance (CBM) has recently drowned research interest with growing attention to both academics and industries. The large data generated from industrial process inherently comes with a different degree of complexity which posed a challenge for analytics. Thus, imbalance classification problem exists perversely in industrial datasets which can affect the performance of learning algorithms yielding to poor classifier accuracy in model development. Misclassification of faults can result in unplanned breakdown leading economic loss. In this paper, an advanced approach for handling imbalance classification problem is proposed and then a prognostic model for predicting aircraft component replacement is developed to predict component replacement in advanced by exploring aircraft historical data, the approached is based on hybrid ensemble-based method which improves the prediction of the minority class during learning, we also investigate the impact of our approach on multiclass imbalance problem. We validate the feasibility and effectiveness in terms of the performance of our approach using real-world aircraft operation and maintenance datasets, which spans over 7 years. Our approach shows better performance compared to other similar approaches. We also validate our approach strength for handling multiclass imbalanced dataset, our results also show good performance compared to other based classifiers.

Keywords : prognostics, data-driven, imbalance classification, deep learning
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