Predictive Maintenance of Technical Faults in Aircrafts

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A key issue for handlers in the air cargo industry is arrival delays due to aircraft maintenance [1]. This maintenance can be planned or unplanned depending on the underlying cause : it can either be a routine check, which usually causes very little delay due to its periodicity and predictable nature, or it can also be an undetected technical failure which manifests itself during the pre-flight check. The latter is formally known as *technical delays*. With the recent resurgence of artificial intelligence techniques in decision making, especially in cases such as predictive maintenance [2], the approach followed in this work is to gather delay and maintenance data from a cargo handler in order to train a machine learning classifier that can predict if a flight will suffer from an unexpected technical delay or not. In this study, a few typical machine learning techniques are explored and a novel one is also proposed. A new version of the proposed decision tree extension by Hoffait & Schyns [3], which will be referred to as *confidence trees*, is presented.

Provided datasets by the handler are pre-processed for missing data; a subset of the available variables for each flight is selected and another subset of variables is generated based on the information available in the other datasets, such as the number of maintenances performed on the plane before the given flight. Selected machine learning models are then compared on this final dataset comprised of 41,415 samples using a 75/25 holdout method. Each model's hyper-parameters are fine-tuned using a 5-fold cross-validation technique first. A comparison of the regular decision trees and the proposed confidence trees highlights the advantages of the latter over the former. More specifically, it is shown that using confidence trees significantly improves the interpretation of the results and thus the decision making process.

The final results of the study show that it is possible to predict aircraft technical delays with a recall of 69.9% using the aforementioned confidence trees model which is the model showing the best results in this context. Although the trained

machine learning models are not accurate enough to be deployed in a true industrial setting, they are still a step towards informed predictive maintenance. Further developments should focus on extending the confidence trees model to its random forest counter part; they could also focus on adopting the approach used by Altay et al. [4] which is to transform the classification problem of delay prediction into the regression problem of predicting the number of days between unscheduled maintenance operations.

References

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