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”FDP1#1 - A federated learning approach for rolling bearing fault diagnosis on data sources with imbalanced class distribution”

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Rotating machinery fault diagnosis is a field of intensive research, attracting the last years a particular interest for data-driven methodologies such as Machine Learning and Deep Learning. In order to build such models, the general assumption is that a sufficient number of healthy and fault samples, collected under various working conditions, are available for model training. This assumption is often not realistic in real industry. This limitation could be avoided by exploiting data sets collected at multiple industrial partners, but this is in practice not easily feasible since companies prefer not to share their data for privacy reasons. Federated Learning (FL) is an emerging machine learning approach proposed to train a global model without sharing data among users. In this context an FL methodology for fault classification based on Convolutional Neural Networks (CNN) is proposed in this paper. Local models are trained on local data sets, each one owned by a single client, i.e. an industrial participant, and are then aggregated at a server level. In the baseline Federated Learning approach, local models optimization fails to increase global accuracy with model aggregation in case there is significant statistical heterogeneity in the data distributions among clients. Thus the aim of this paper is the proposal of an enhanced strategy that accounts for adaptive local updates and the comparison of its performance with state-ofthe-art techniques. Each participant computes the local stochastic gradients within an adaptive interval, set by the server at the aggregation step, when the models are loaded by the participants at the end of each communication round. The improved method is applied for bearing fault diagnosis and its effectiveness and accuracy are evaluated in the case of imbalanced class distribution in rolling bearing fault local data sets, i.e. considering a scenario where fault types are non-independent and identically distributed (non-i.i.d.) among clients. This case is addressed in literature to be one of the main challenges in FL and is of practical interest since skewed data sets are common in real-world factories.

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