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Title:

Comparing explainable machine learning methods to determine uncertainty factors of sound absorption coefficient measurements with an impedance tube

Short title: xML methods for uncertainties of impedance tube measurements

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Abstract:

A Brüel & Kjaer type 4206 impedance tube is used to create a dataset of sound absorption coefficient (SAC) measurements for porous materials, such as polyethylene terephthalate and melamine foam. The objective is to identify factors contributing to measurement uncertainty and to enhance the repeatability and reliability of impedance tube tests. A total of 864 measurements are performed, focusing on four factors: thickness, diameter, material, and rotation angle. This contribution focuses on the analysis of the factors, employing explainable machine learning techniques, comparing both univariate and multivariate methods. Predictive supervised classification algorithms, including Neural Networks, Decision Trees, k-Nearest Neighbors, Linear Discriminant Analysis, and Random Forests are employed to predict which factor classes are active, based on the SAC measurements. Accurate predictions indicate that variations in the examined factors significantly influence the SAC, particularly within specific frequency ranges. The findings reveal that variations in thickness, porous material type, and diameter introduce significant uncertainties in measurements, especially at low frequencies. In contrast, the rotation angle has minimal impact on the SAC, suggesting that the measurement procedure is robust regarding different angle positions. Notably, multivariate algorithms identified higher classification performance, implying greater measurement uncertainty probably due to the interrelationships among factors under analysis.

(200 words)