An Explainable AI based Decision Support System for Waste Sorting Systems

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Abstract

The fast growth of municipal solid waste (MSW) has been the main reason of creating automated, and accurate waste sorting methods. Even though convolutional neural networks (CNNs) are very good at classifying trash based on images, their black-box nature makes it hard to trust and use them in places where policies and industry standards are important. This study presents an explainable decision support system (X-DSS) that amalgamates Deep Learning (DL)-based waste classification with advanced explainable artificial intelligence (XAI) techniques. We used picture data from the open-access TrashNet dataset (2,527 images) in six categories: cardboard, glass, metal, paper, plastic, and trash. We evaluated four CNN architectures namely, DenseNet121, MobileNetV2, ResNet50, and EfficientNetV2B0. In order to fix the class mismatch, we applied balanced weighting schemes. DenseNet121 had the best test accuracy reaching 90.41% and a weighted F1-score of 0.895, which shows its general use given the size and the variety of the dataset. In increase interpretability, different XAI methods, such as Grad-CAM, occlusion sensitivity, integrated gradients, and LIME, were used to look and measure the image subregions that affected the outcomes of the categorization. These explanations increased the X-DSS predictive performance, creating a scalable framework for waste management decision making.

Keywords: *Sustainable waste management, Deep learning, Explainable Artificial Intelligence (XAI), Waste classification, Decision Support System (DSS), Transfer learning*