# Fluorescence Imaging and Machine Learning

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This work contributes to the recycling of technical black plastic particles, for example from the automotive or electronics industries. These plastics cannot yet be sorted with sufficient purity (up to 99.9%), which often makes economical recycling impossible. As a solution to this problem, imaging fluorescence spectroscopy with additional illumination in the near infrared spectral range in combination with classification by machine learning or deep learning classification algorithms is here investigated. The algorithms used are linear discriminant analysis (LDA), k-nearest neighbour classification (kNN), support vector machines (SVM), ensemble models with decision trees (ENSEMBLE), and convolutional neural networks (CNNs). The CNNs in particular attempt to increase overall classification accuracy by taking into account the shape of the plastic particles. In addition, the automatic optimization of the hyperparameters of the classification algorithms by the random search algorithm was investigated. The aim was to increase the accuracy of the classification models. About 400 particles each of 14 plastics from 12 plastic classes were examined. An attempt was made to train an overall model for the classification of all 12 plastics. The CNNs achieved the highest overall classification accuracy with 93.5%. Another attempt was made to classify 41 mixtures of industrially relevant plastics with a maximum of three plastic classes per mixture. The same average classification accuracy of 99.0% was achieved for the ENSEMBLE, SVM, and CNN algorithms. The target overall classification accuracy of 99.9% was achieved for 18 of the 41 compounds. The results show that the method presented is a promising approach for sorting black technical plastic waste.