A Novel Approach to the Application of Machine Learning in the Mitigation of Waste Pollution

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This study aims to use machine learning to develop a more precise waste identification process than humans. We first observed the amount and type of contents in trash and recycling bins around a high school and noted human recycling behaviors, where students correctly recycled only 55% of possible items, indicating poor compliance. Next, we hand-annotated approximately 2,500 images including metal, glass, paper, plastic, trash, and cardboard, of a public dataset to provide our machine learning algorithm with correctly classified and identified objects during its validation stages. Using the Google Collab environment, we wrote our original code and trained our algorithm on the public YOLOv8 object detection model for 100 epochs, retraining the model 3 times.Results showed an overall classification accuracy of 67%. However, the model made the right decision 80% of the time and will correctly recycle 85% of the time. Despite inaccuracy in classifying all six types of waste, the model outperformed recorded human decision accuracy by 5%, and exceeded human recycling accuracy by 30%. Improvement for the model would include further image annotation for new training and more trials. These metrics indicate that this algorithm could be applied practically in trash bins inside homes, buildings, parks, streets, or recycling centers.Ultimately, machine learning in the recycling industry could improve accuracy and efficiency, as indicated by the theoretical results of our algorithm, and avoid the inevitability of human error surrounding the process of recycling.