Enhancing Plastic Recycling through Machine Learning and Computer Vision: A Case Study on Plastic Bottles

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Abstract
Enhancing recycling efficiency remains a challenge due to many contemporary innovations' cost and organizational constraints. Conventional methods of plastic categorization are not scalable for plastic recycling due to extreme costs for multiple sets of hardware, such as different types of sensors. However, in this project, I propose a new method of classifying plastic based on computer vision. As a case study, I decided to focus on creating a model for identifying different kinds of plastic in plastic bottles. I used this model to increase accuracy of identifying and classifying different kinds of bottles, such as clear and blue plastic bottles, and was able to find that with a neural network, the model could classify the bottle at a high rate compared to the baseline. The results of my study show the potential of this technology in context of economically sustainable recycling. My model displays an ability to distinguish between different types of bottles, surpassing my baseline by a significant margin of 58.83%. This improvement in accuracy has large implications for improving recycling efficiency and plastic waste management. These findings highlight the potential of integrating machine learning with computer vision for cost-effective and efficient recycling methods.

1 Introduction

As the accumulation of plastic in our ecosystem persists, efforts have increasingly shifted towards recycling rather than producing new plastic. However, this approach is fraught with challenges. One major issue is the sheer variety of plastics, making categorization and sorting a complex task (Sullivan, 2022). This complexity, coupled with the enormous volume of plastic produced, makes the recycling process highly problematic and difficult to manage effectively. Consequently, a significant portion of plastic intended for recycling ends up in landfills, as illustrated by Figure 1.

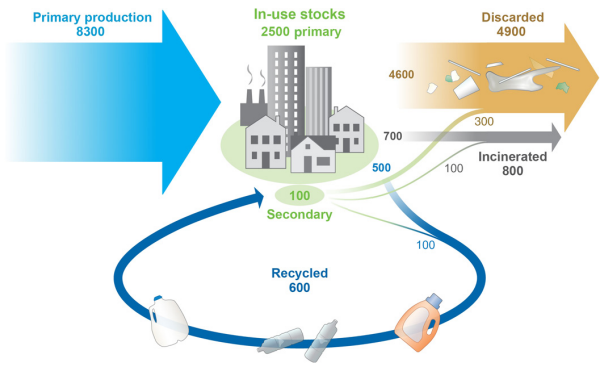

Figure 1: Global production, use, and fate of polymer resins, synthetic fibers, and additives (1950 to 2015; in million metric tons). (Geyer et al.)

In this project, I propose an alternate method of classifying plastics by using machine learning algorithms and computer vision. I am motivated by the fact that even though I believe that recycling helps the environment, the rates of recycling still fall short compared to what I need to make a difference. My hypothesis is that using a neural network for a machine learning algorithm would result in an algorithm that would be able to classify plastics based on how they look. To test this hypothesis, I applied the example first to plastic bottles, one of the most used forms of plastic (Olson-Sawyer & Madel, 2020). By using computer vision, I was able