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Trash AI: A Web GUI for Serverless Computer Vision Analysis of Images of Trash

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Software

- Review
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Summary

Although computer vision classification routines have been created for trash, they have not been accessible to most researchers due to the challenges in deploying the models. Trash AI is a web GUI (Graphical User Interface) for serverless computer vision classification of individual items of trash within images, hosted at www.trashai.org. With a single batch upload and download, a user can automatically describe the types and quantities of trash in all of their images.

Statement of need

Trash in the environment is a widespread problem that is difficult to measure. Policy makers require high quality data on trash to create effective policies. Classical measurement techniques require surveyors with pen and paper to manually quantify every piece of trash at a site. This method is time-consuming. Scientists are actively trying to address this issue by using imaging to better understand the prevalence and distribution of trash in an `efficient yet effective manner` (K. Kerge, 2020; Lieshout et al., 2020; Lynch, 2018; Majchrowska et al., 2022; Moore et al., 2020; Proença & Simões, 2020; Waterboards, 2018; Wuu, 2018). Image-based reporting of trash using cell phones, laptops, and other devices has been a `valuable solution` (Lynch, 2018). Applications for AI in detecting trash using imagery currently include: cameras mounted on `bridges` (Lieshout et al., 2020), `drone imaging` (Moore et al., 2020), cameras on `street sweepers` (Waterboards, 2018), and cell phone app based reporting of `trash` (Lynch, 2018). Although there are many artificial intelligence algorithms developed for trash classification, none are readily accessible to the average litter researcher. The primary limitation is that artificial intelligence (AI) algorithms are primarily run through programming languages (not graphic user interfaces), difficult to deploy without AI expertise, and often live on a server (which costs money to host). New developments in browser-side AI (e.g., tensorflow.js) and serverless architecture (e.g., AWS Lambda) have created the opportunity to have affordable browser-side artificial intelligence in a web GUI, alleviating both obstacles. We present Trash AI, an open source service for making computer vision available to anyone with a web browser and images of trash.

Demo

We have a full video tutorial on Youtube

Basic workflow:

1.

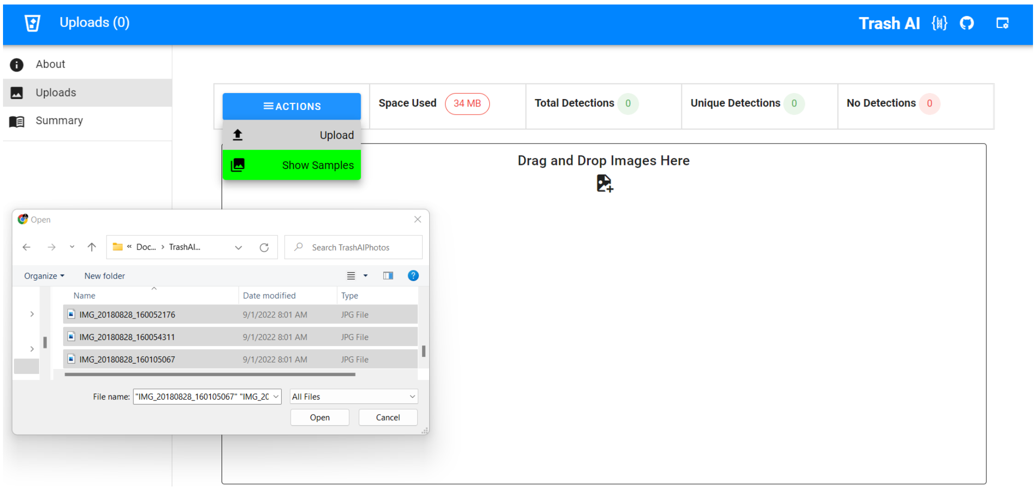

Figure 1: Upload images by dragging onto the screen.

2.

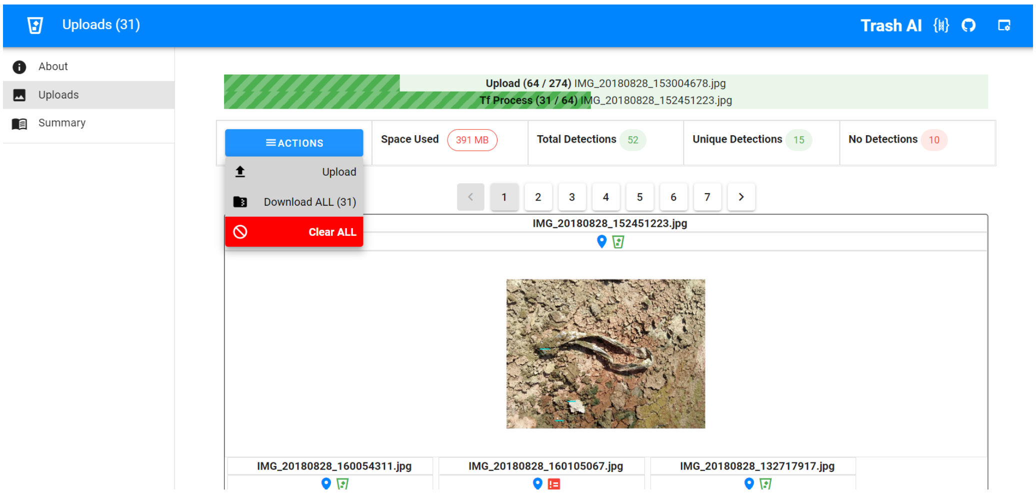

Figure 2: View results while images are processing.

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3.

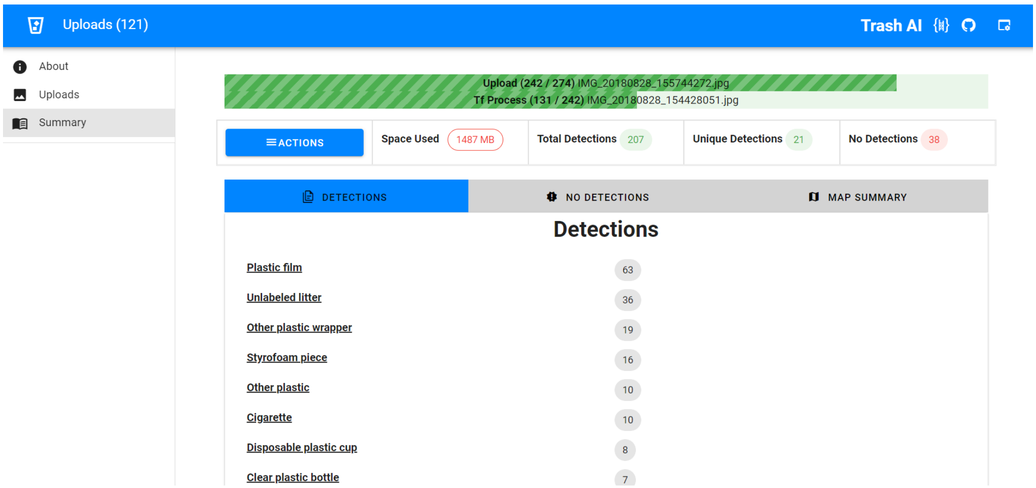

Figure 3: View summary results of detected trash.

4.

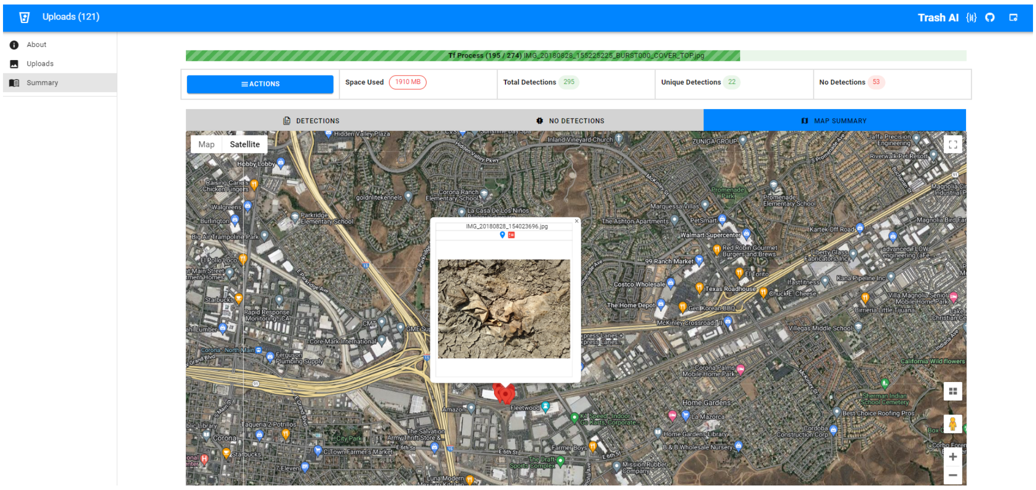

Figure 4: View results mapped if the images have location stamp.

5.

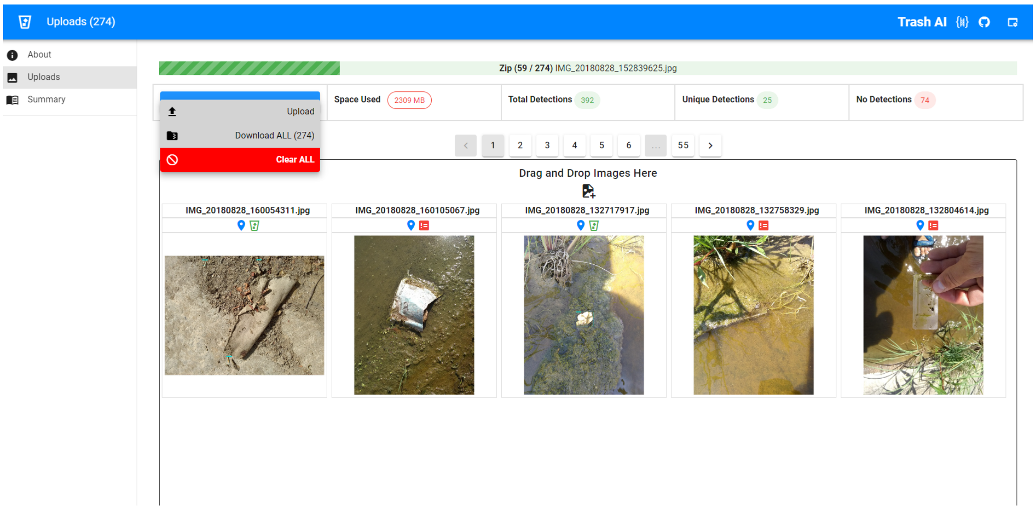

Figure 5: Click download all to extract a zip folder with labeled images and metadata.

6.

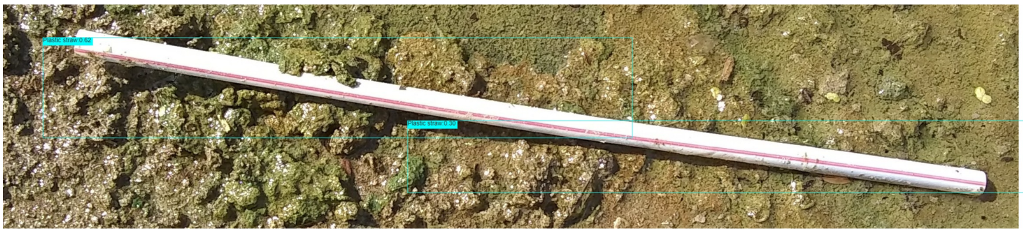

Figure 6: View labeled images from downloaded results.

7.

Figure 7: View metadata for each image using "image_hash.json" (using https://jsoneditoronline.org/).

8.

Figure 8: View metadata for all images in "summary.json" (using https://jsoneditoronline.org/).

Method

Workflow Overview

Trash AI is trained on the TACO dataset using YOLO 5. Trash AI stores images in IndexDB to keep the data primarily browser side and uses tensorflow.js to keep analysis browser side too. When images are uploaded to the browser, Trash AI provides the prediction of the model as a graphical output. The raw data from the model and labeled images can be downloaded in batch to expedite analyses.

AI Training

The AI model was developed starting with the TACO dataset, which was available with a complimentary Jupyter Notebook on Kaggle. An example notebook was referenced, which used the default `YOLO v5 model` (Jocher et al., 2020) as the basic model to begin transfer learning. Next, transfer learning was completed using the entire TACO dataset to import the image classes and annotations in the YOLO v5 model.

Limitations

From our experience, the accuracy of the model varies depending on the quality of the images and their context/background. "Trash" is a word people use for an object that lacks purpose, and the purpose of an object is often not obvious in an image. Trash is a nuanced classification because the same object in different settings will not be considered trash (e.g., a drink bottle on someone's desk vs in the forest lying on the ground). This is the main challenge with any image-based trash detection algorithm. Not everything that LOOKS like trash IS trash. This and other complexities to trash classification make a general trash AI a challenging (yet worthwhile) long-term endeavor. The algorithm is primarily trained on the TACO dataset, which is composed of images of single pieces of trash, with the trash lying on the ground ($<$ 1 m away). Thus, model class prediction of trash in these kinds of images will generally be better than trash appearing in aerial images or imaged from a vehicle, for example.

Availability

Trash AI is hosted on the web at www.trashai.org. The source code is available on github with an MIT license. The source code can be run offline on any machine that can install Docker and Docker-compose. Documentation is maintained by Code for Sacramento and Open Fresno on Github and will be updated with each release. Nonexhaustive instructions for AWS deployment is available for anyone attempting production level deployment.

Future Goals

This workflow is likely to be highly useful for a wide variety of computer vision applications and we hope that people reuse the code for applications beyond trash detection. We aim to increase the labeling of images by creating a user interface that allows users to improve the annotations that the model is currently predicting by manually restructuring the bounding boxes and relabeling the classes. We aim to work in collaboration with the TACO development team to improve our workflow integration to get additional data into the TACO training dataset by creating an option for users to share their data. Future models will expand the annotations to include the `Trash Taxonomy` (Hapich et al., 2022) classes and add an option to choose between other models besides the current model.

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