User Manual

Project Name

TrashClassifier

Product Owner

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Version 1.0 – May 12th, 2023

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Introduction

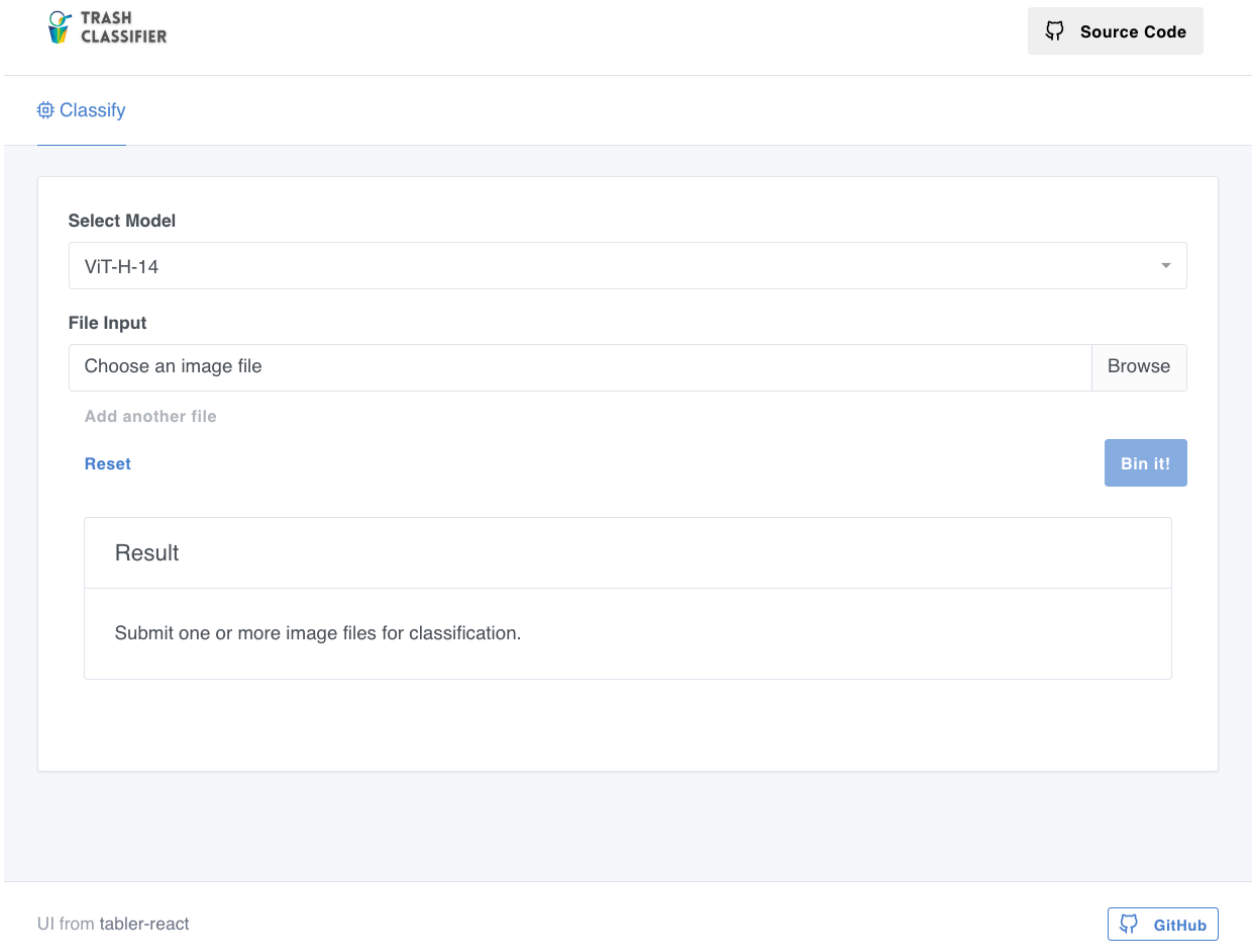
The TrashClassifier is a deep neural network-based program leveraging foundational models to assist users in the proper disposal of waste by accurately identifying and classifying various types of trash. The TrashClassifier aims to improve waste management practices and minimize the environmental impact of improper waste disposal by promoting source separation of recyclables and organic materials. Leveraging multiple, cutting-edge deep learning techniques, the TrashClassifier processes images captured by smartphone cameras or other imaging devices and classifies the waste items according to established waste disposal guidelines. This manual provides a detailed breakdown of how to use all the TrashClassifier application features.

Website

The website provides desktop and mobile users the ability to classify one or more images. Here is a video demonstrating our website's interface
https://drive.google.com/file/d/15lftOvtnm4X1BAwrecRve3CTbKNO90eL/view?usp=sharing

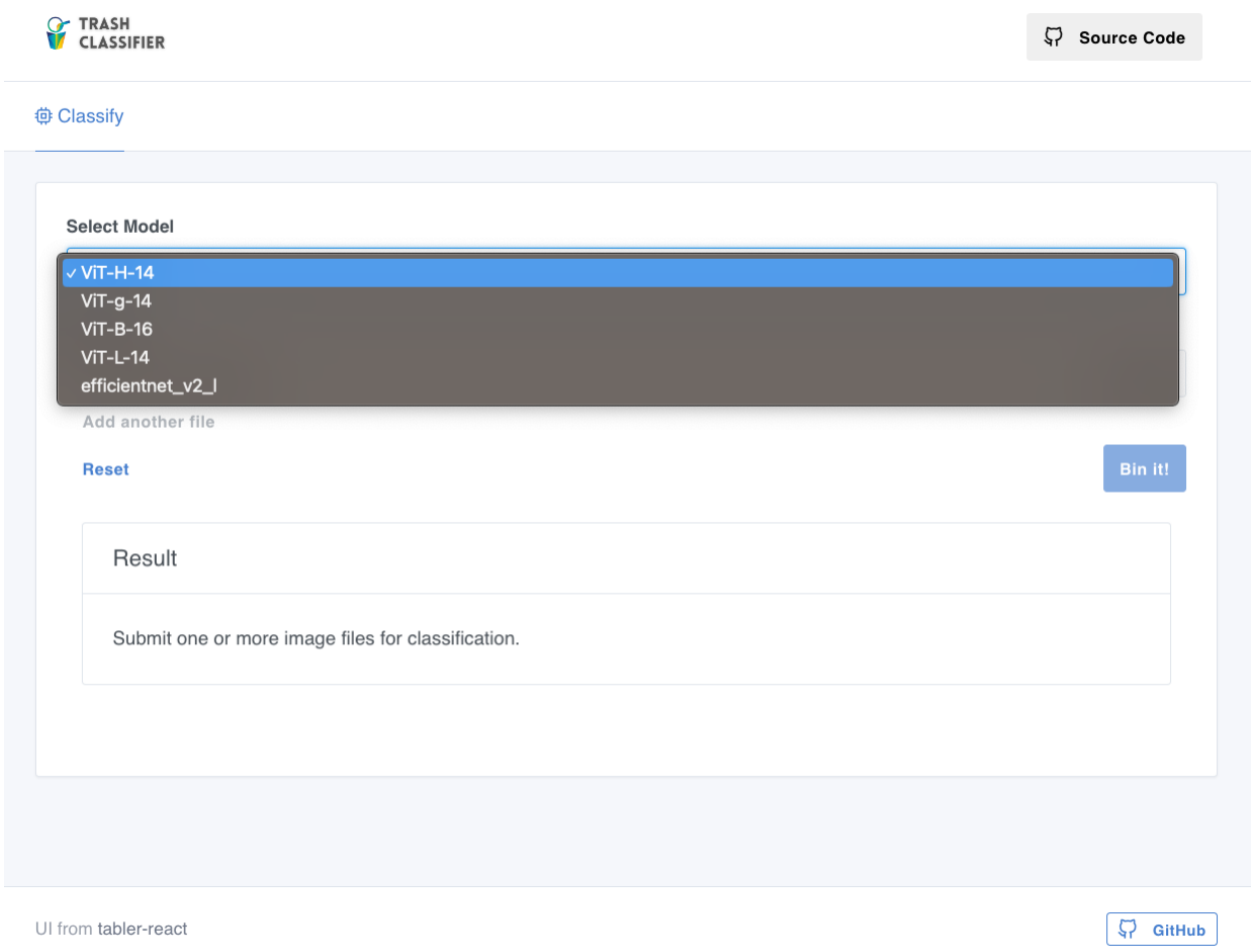
Landing Page

The following figure depicts the state of the website upon initial load.



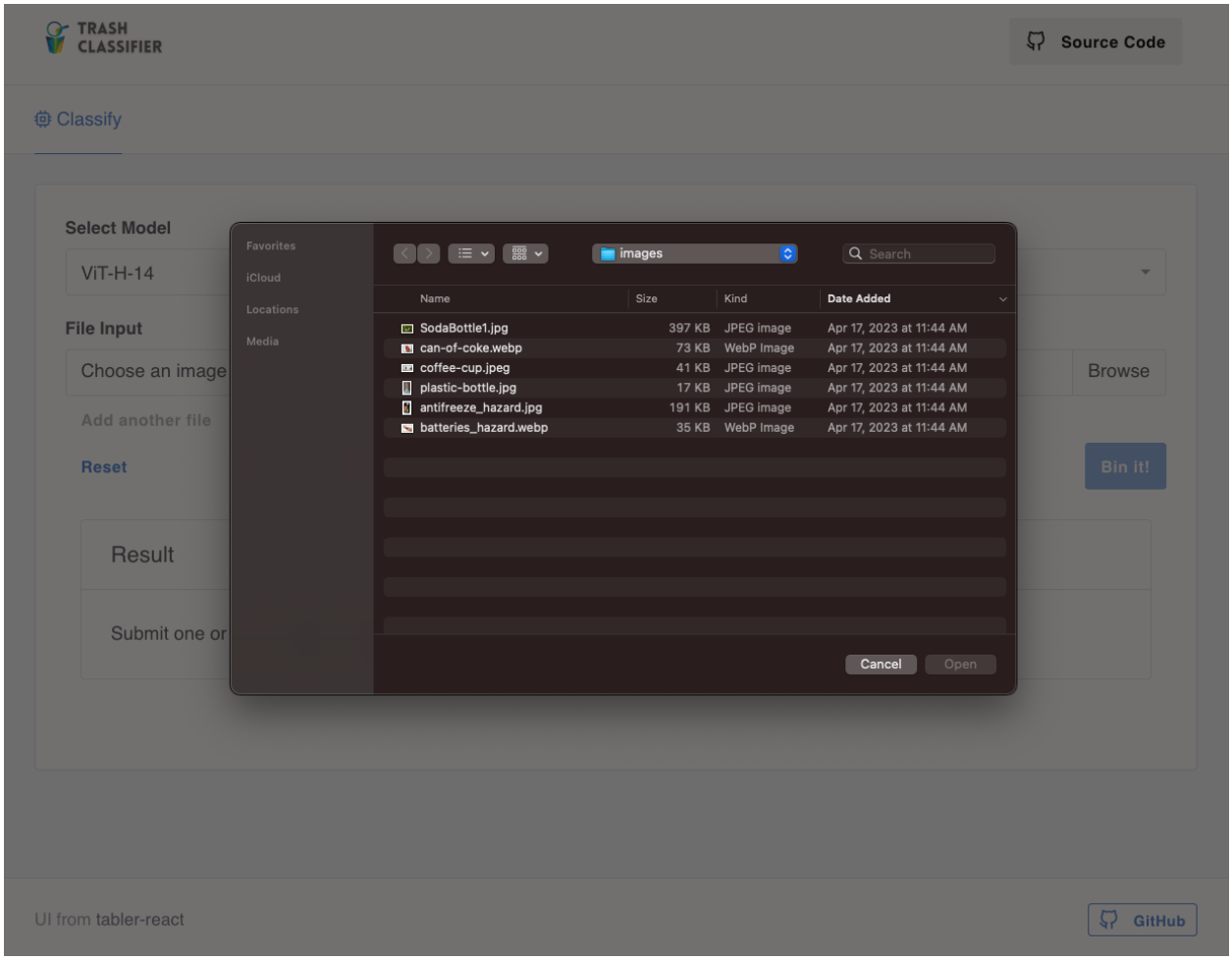
Selecting a Model

Click on the “Select Model” dropdown box to view available models. By default, the first model in the list is selected.



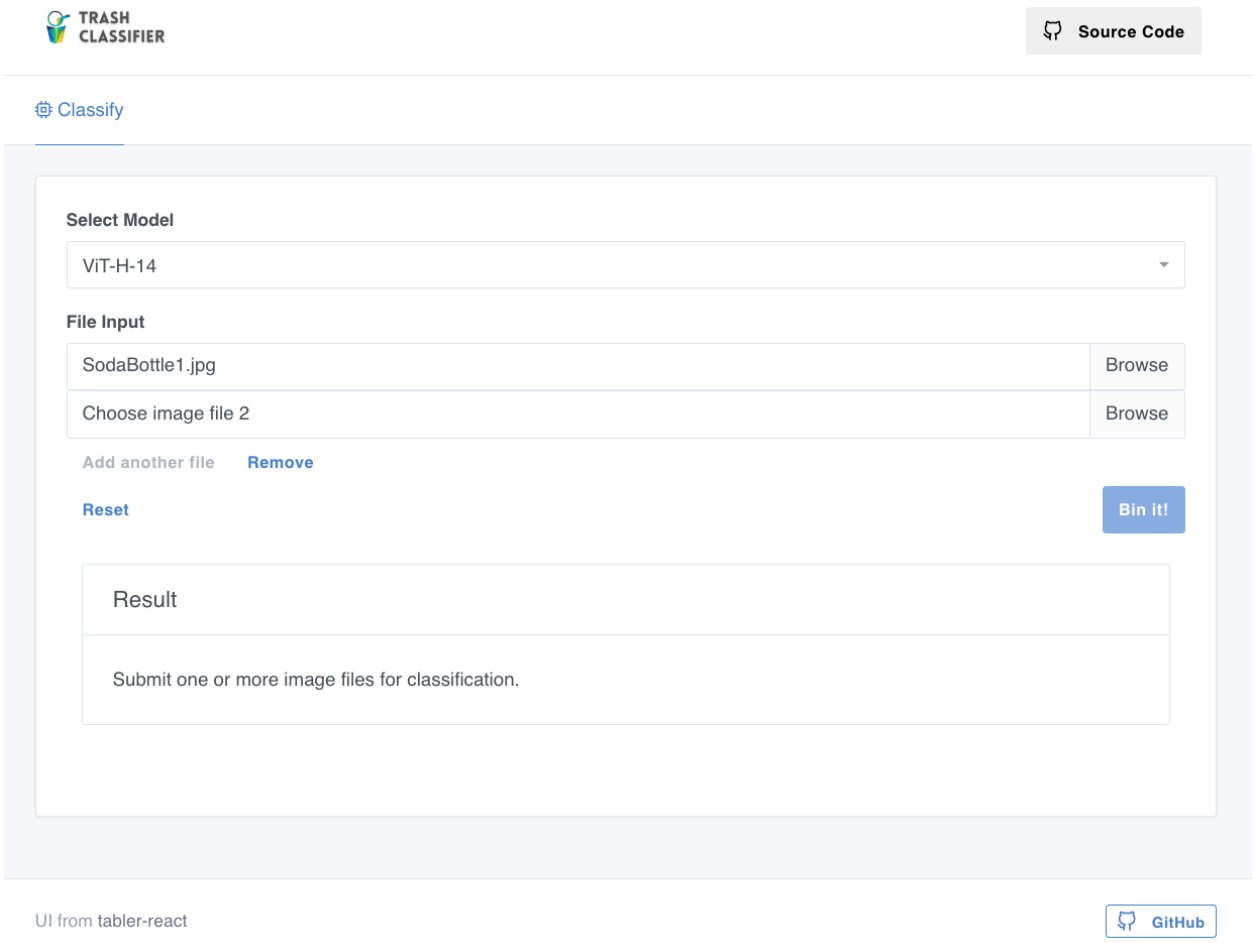
Adding Images For Classification

Click on “Choose an image” or the “Browse” button to bring up a window to add an image file. The below image is from a Mac computer and so the UI will vary depending on the operating system.



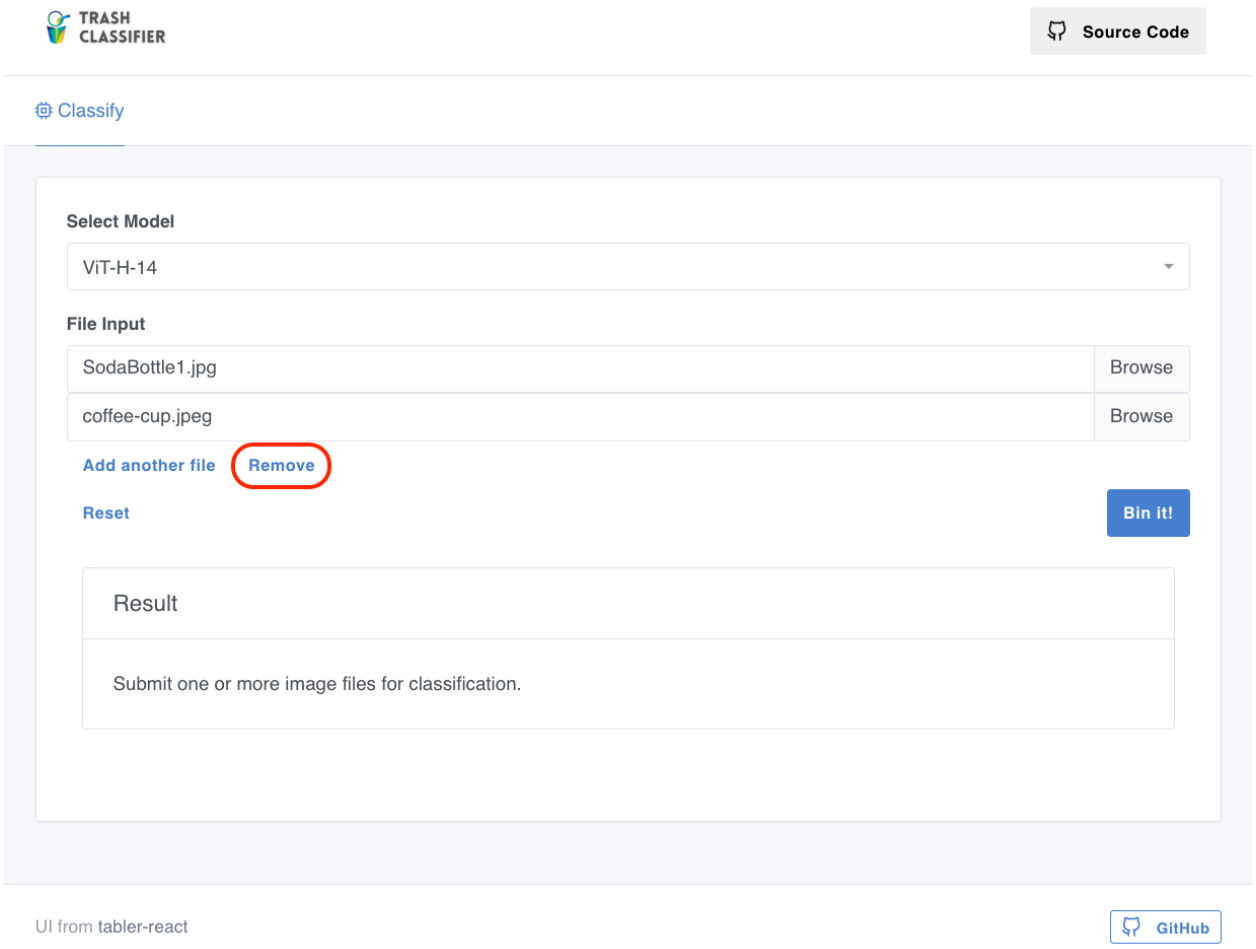
Adding More Images

Clicking on “Add another file” will add another file input. If there’s already an empty file input element, you won’t be able to add another. The limit is 10 images.



Removing Images

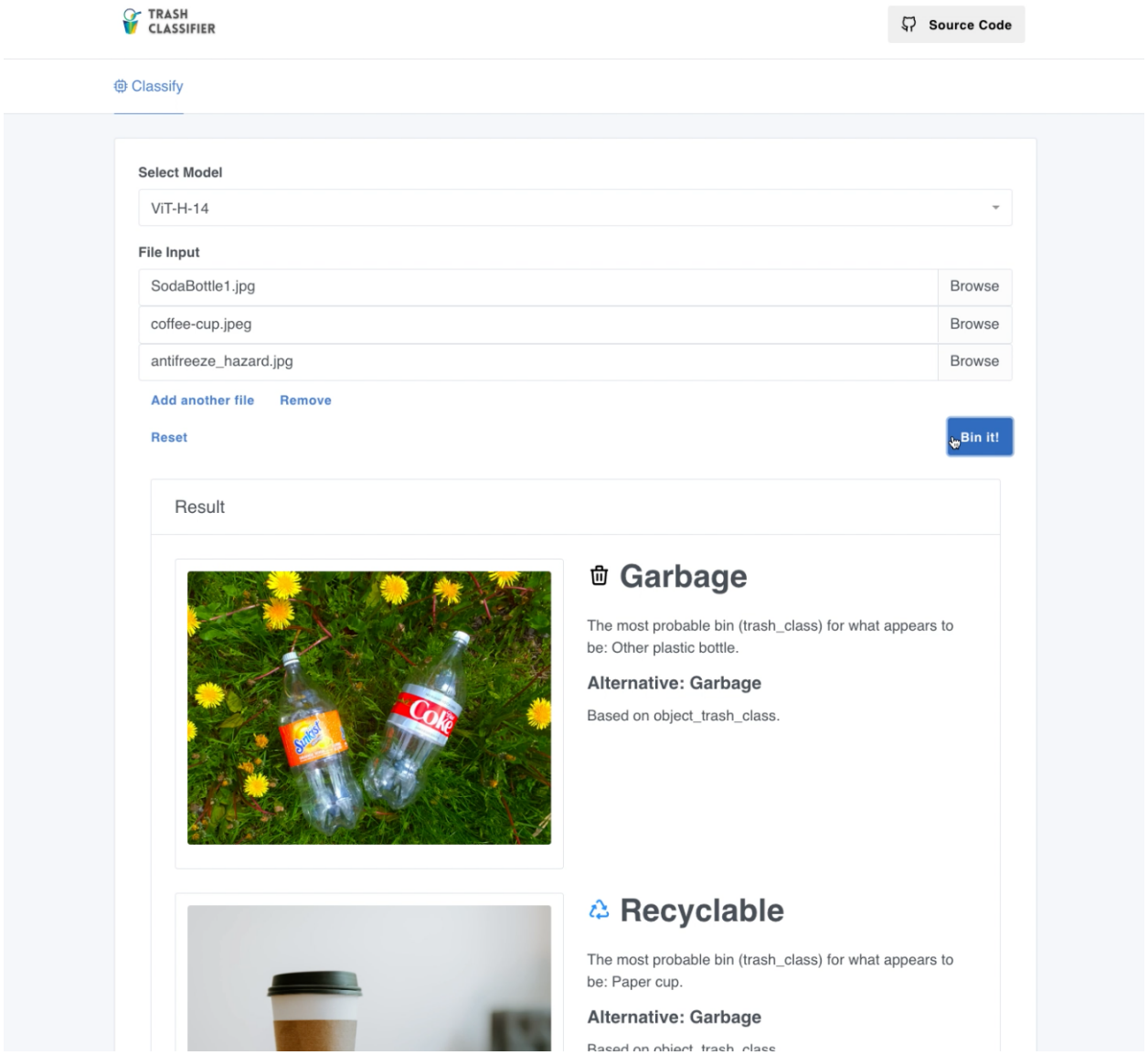
Click “Remove” to delete the last added image. The first one can’t be deleted.



Submitting for Classification

After having added the desired images, click the blue “Bin it!” button to classify them. Depending on the machine the server/model is running on, this may take about 20 seconds.

Afterwards, the originally submitted images and their classification (Garbage, Recyclable, Household hazardous waste, or Organic Waste) will be shown below in the “Result” box.



Reset

Clicking the “Reset” button below the file input area at any time will restore the page to its initial state (note: selected model will be reset to the first in the list as well).

Terminal Application

The terminal application provides desktop users the ability to annotate and classify images, get information on trash types, learn more about the project and change its settings, and download models to their local machine.

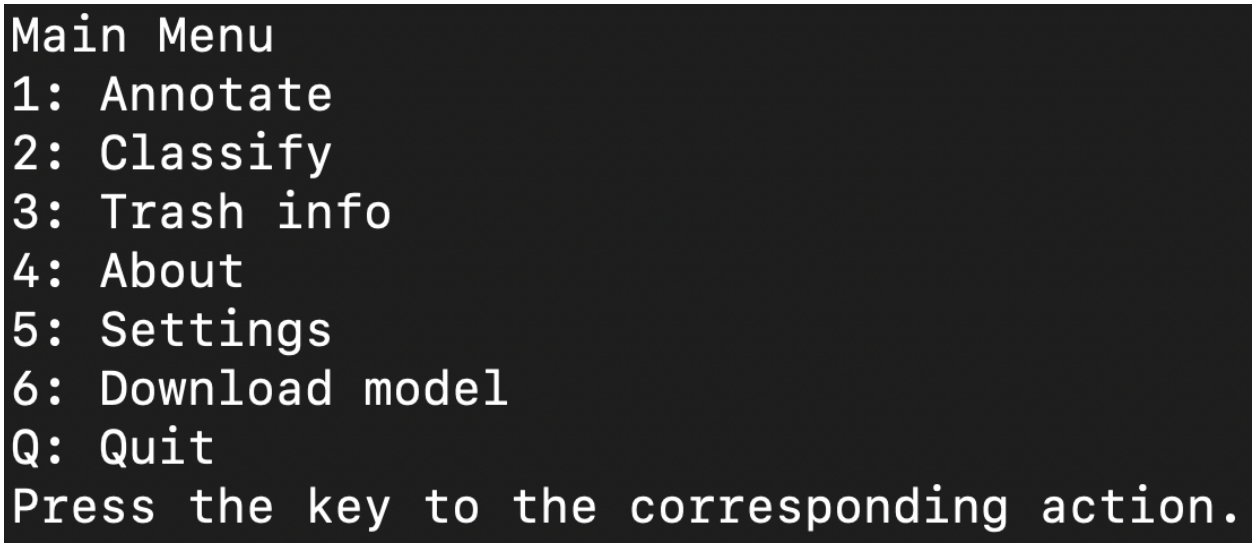
Starting the Terminal Application

Navigate to the *project* folder once the project has been downloaded and all dependencies and libraries have been installed. In the project folder, enter the following command to open the application: python project/front-end_apps/main.py

Main Menu

The following figure depicts the main menu of the application, the user is prompted with seven options to open different features of the application.

Pressing 1, 2, 3, 4, 5 or 6 followed by the ‘Enter’ key will open the corresponding option. Pressing ‘Q’ followed by the ‘Enter’ key will close the application.



Annotate

The following figure depicts the menu of the Annotate feature.

```
1: Opens GUI to capture a photo and annotate
2: Opens GUI and loads image from path to annotate
M: Exit Annotation
```

Option 1 selected:

```
1
Annotating from camera
Starting up camera...

Press SPACE to capture, Press ESCAPE to exit (on the camera feed)

Captured

 Draw: Left click drag
 Reset: Double Right Click
 Done: Ctrl + Right Click
 Exit: Esc
```

Once Option 1 is selected, the program opens the device camera if one exists, pressing the spacebar will capture an image and prompt the user to make annotations to the captured image.

Option 2 selected:

```
2
Type in the path
```

User will be prompted to enter a valid path to an image on their device, once the image is loaded the user will be prompted with the same options as in Option 1.

Classify

The following figure depicts the menu of the Classify feature.

```
Classify trash
1: Open Camera and capture
2: Upload picture
3: Capture real time
M: Exit Classify
```

Option 1 selected:

```
1
classifying from camera
Starting up camera...

Press SPACE to capture, Press ESCAPE to exit
```

The application will open the users camera if one is available and allow the user to capture a single image. The predictions of the object type and trash type will be outputted to the console in JSON format as shown in option 3.

Pressing the spacebar while in the camera window will capture a single image and return the user to the main menu of Classify. Pressing ‘ESC’ while in the camera window will close the camera and return the user to the main menu of Classify.

Option 2 selected:

```
2
Classifying from file
Enter image file path to be classifyed:
```

The application will prompt the user to enter a valid image file path to process and classify the image. The application will output a JSON object similar to the one shown in option 3. Once the file path is entered, press ‘Enter’ to classify the image.

Option 3 selected:

The application will open the users camera if one is available and begin live capture at the framerate set in settings. The predictions of the object type and trash type will be outputted to the console in JSON format. Pressing ‘Q’ while in the camera window will close the camera and return the user to the main menu of Classify.

```
{'object_class': 'Normal paper',
 'object_class_probs': [0.3199687898159027,
                        0.24947917461395264,
                        0.1643214225769043,
                        0.15953700244426727,
                        0.026748456060886383,
                        0.02599303051829338,
                        0.022551927715539932,
                        0.010632984340190887,
                        0.01059332862496376,
                        0.010173873044550419],
 'object_classes': ['Normal paper',
                    'Styrofoam piece',
                    'Rope & strings',
                    'Other carton',
                    'Glass bottle',
                    'Squeezable tube',
                    'Pop tab',
                    'Six pack rings',
                    'Plastic glooves',
                    'Shoe'],
 'object_trash_class': 'Garbage',
 'object_trash_class_probs': [0.25, 0.25, 0.25, 0.25],
 'trash_class': 'Recyclable',
 'trash_class_probs': [0.4340512454509735,
                       0.4494665265083313,
                       0.05077383294701576,
                       0.06570828706026077],
 'trash_classes': ['Garbage',
                   'Recyclable',
                   'Organic Waste',
                   'Household hazardous waste']}
```

The figure above shows an example output of the model predictions.

Option M selected:

Application will return to the main menu of the application.

Trash Information

The following figure depicts the menu of the Trash Information feature.

```
Select which type of trash you want information on.
1: Trash
2: Recycle
3: Compost
M: Exit Trash Info
```

Options 1, 2 or 3 selected:

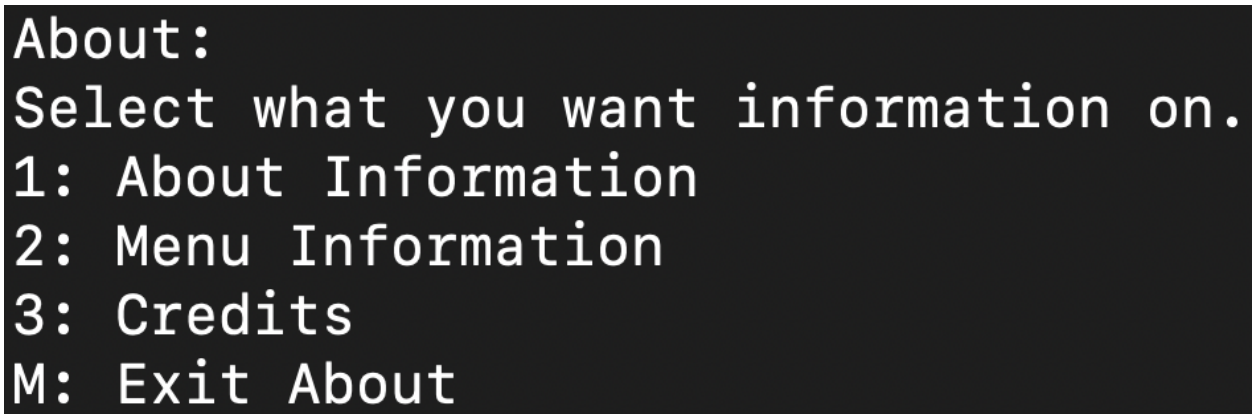
User will be provided with a short description of each trash type corresponding to the option entered in this menu.

Option M selected:

Application will return to the main menu of the application

About

The following figure depicts the menu of the About feature.



Options 1 or 2 selected:

User will be provided with general information about the application if option 1 is selected and explanations for each of the six main menu options if option 2 is selected.

Option 3 selected:

User will be provided a list of developers that contributed to the applications development as well as the name of the client of the application.

Option M selected:

Application will return to the main menu of the application.

Settings

The following figure depicts the menu of the Settings feature.

Option 1 selected:

```
1
Do you want online or offline computation?
1: online
2: offline
```

Selecting option 1 will allow the user to switch to online computation, option 2 will enable offline computation.

Option 2 selected:

```
2
Enter a number for the framerate for live capture
Min framerate:  5
Max framerate:  30
10
FPS is set to 10
```

The user will be prompted to enter a framerate value for the live capture feature in Classify. The framerate should be adjusted based on the model being used as well as the user's device specifications. To set a framerate, enter a value between 5 and 30 and press ‘Enter’.

Option M selected:

Application will return to the main menu of the application.

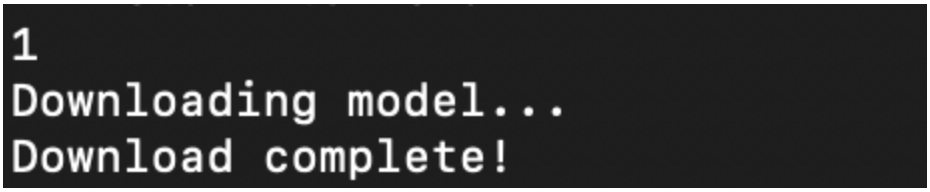
Download Models

The following figure depicts the menu of the Download Models feature.

```
1. GPU model: ViT-g-14 (5.47 GB)
2. GPU model: ViT-H-14 (3.94 GB)
3. CPU model: ViT-L-14 (1.71 GB)
4. CPU model: ViT-B-16 (599 MB)
M. Return to Menu
```

Option 1, 2, 3 or 4 selected:

The application will begin downloading the selected model to the users device, a progress bar will appear with an estimated time before model download is complete being shown as well. If the model is successfully downloaded, the ‘Download complete!’ message will appear.



Option M selected:

Application will return to the main menu of the application.

Command Line Menu

The command line menu is a more simplified way of accessing the project. It allows you to use the project by just using command line arguments.

Starting the Command Line Menu

Navigate to the front-end_apps folder. Should look similar to the picture below.

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps
```

Help

Type in “python trashsorting.py” then type “-h” (or “--help”). Just like the picture below.

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py --help
usage: Trash Sorting Application [-h] (-i INPUT | -c) [-l LOCAL] [-o ONLINE] [-j JSON]

This application classifies trash in images.

optional arguments:
  -h, --help            show this help message and exit
  -i INPUT, --input INPUT
                        filename to an input image
  -c, --camera          Opens camera and takes a picture
  -l LOCAL, --local LOCAL
                        The name of the model to use for local inference (Possible values: ViT-g-14, ViT-L-14,
                        ViT-B-16)
  -o ONLINE, --online ONLINE
                        A url to the REST API that hosts the inference model
  -j JSON, --json JSON  Saves a prediction output as json instead of going to console
```

Camera

To access the camera type in “python trashsorting.py”, followed by “-c” (or “--camera”).

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py -c
Active. Press SPACE to capture.
```

Input with Local or Online

To input an image type “-i” (or “--input”). Then input the location of the image file you want to use, just like the picture below.

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py -i "C:\Users\chris\PycharmProjects\T
odel\pytorch-ssd\TACO\data\batch_6\000010.JPG"
```

Local

Next if you want to select local you would type in “-l” (or “--local”), and put in the model you want to use, just like in the picture below. The models that you can use for local are ViT-g-14, ViT-L-14, or ViT-B-16.

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py -i "C:\Users\chris\PycharmProjects\Trash-Sorting\project\m
odel\pytorch-ssd\TACO\data\batch_6\000010.JPG" -l ViT-L-14
{'object_class': 'Clear plastic bottle',
 'object_class_probs': [0.4844551086425781,
                        0.344755619764328,
                        0.1087178885936737,
                        0.021851714700460434
```

Online

If you want to use a model from an online source you would type in “-o” (or “--online”), followed by the url for the model. It should look like the picture below (omit the parentheses).

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py -i "C:\Users\chris\PycharmProjects\Trash-Sorting\project\m
odel\pytorch-ssd\TACO\data\batch_6\000010.JPG" -o ("Enter Url that hosts infererence model here")
```

Json output

If you want to make a json output instead of seeing the prediction output on the console window, type in “-j” (or “--json”), followed by the location of where you want the file to be. It should look like the picture below.

```
C:\Users\chris\PycharmProjects\Trash-Sorting\project\front-end_apps>python trashsorting.py -i "C:\Users\chris\PycharmPro
jects\Trash-Sorting\project\model\pytorch-ssd\TACO\data\batch_6\000010.JPG" -l ViT-L-14 -j "C:\Users\chris\output"
```

Your file should look like this in its destination folder.