THE BIN CONUNDRUM

Image-Based Waste Sorting

Data Knyts

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MOTIVATION

Have you ever been confused where to throw trash?

PROBLEM STATEMENT

The Garbage Problem

Waste sorting is critical for increasing the amount of waste that can be recycled.

However, it is often impractical to sort large quantities of waste by hand.

GOALS & AIM

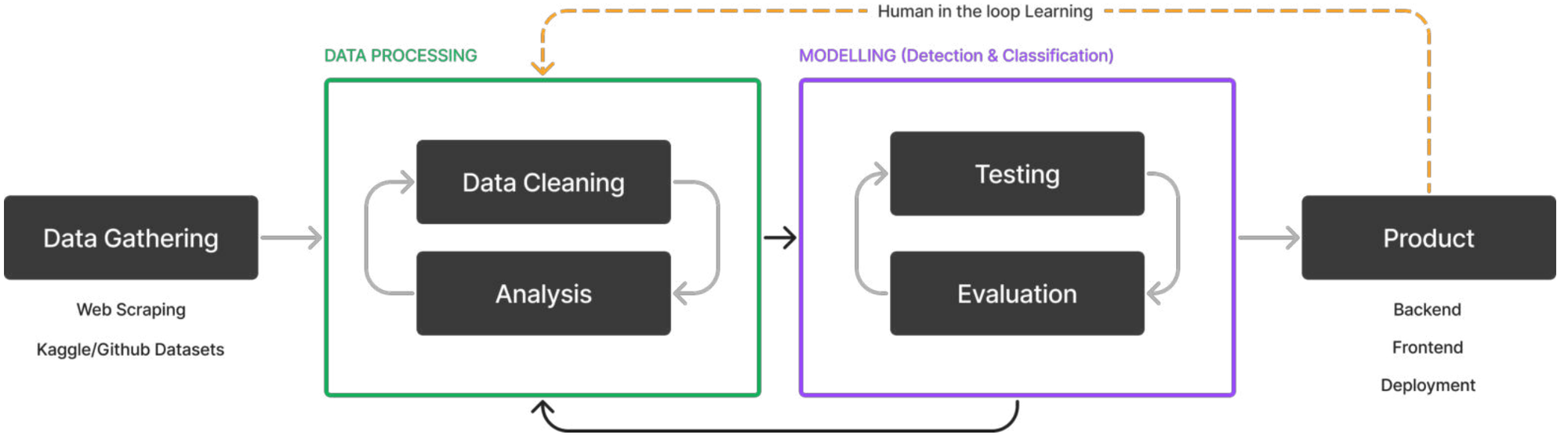
Our Intention

- Can we improve waste sorting by using a neural network to identify which waste products are compostable and/or recyclable?

- Via comparative analysis, which neural network provides the best results for identifying waste? Are some better than others in certain scenarios?

- Can we improve this process by utilizing active learning procedures?

METHODOLOGY & TOOLS



Selenium 4

scikit learn

PyTorch

Flask

GitHub

OpenCV

TensorFlow

DigitalOcean

kaggle

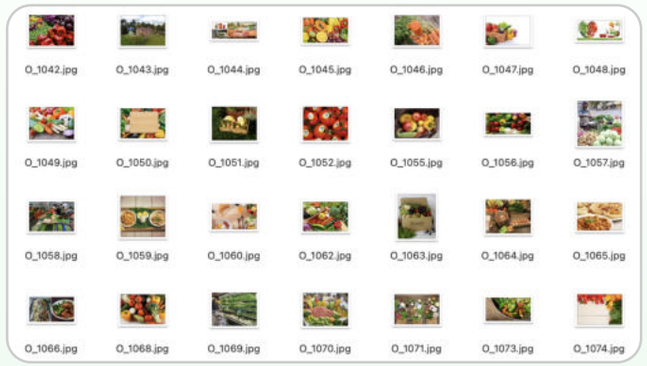
docker

DATA

Annotated Data

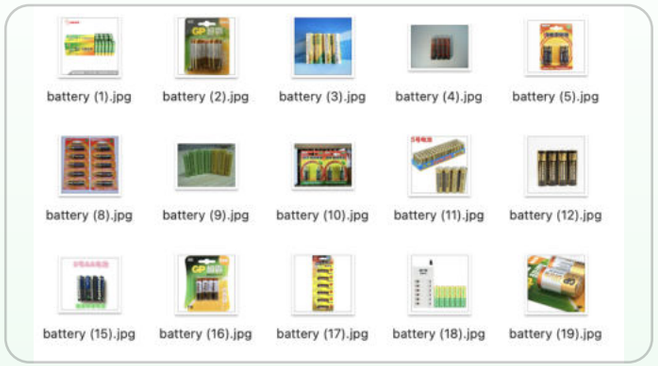
Taco Dataset

Non-Annotated Data



4+ Sets Kaggle/GitHub

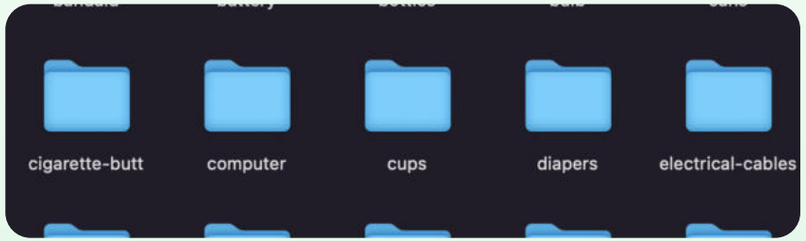
Scraped Data



20K+ images scraped

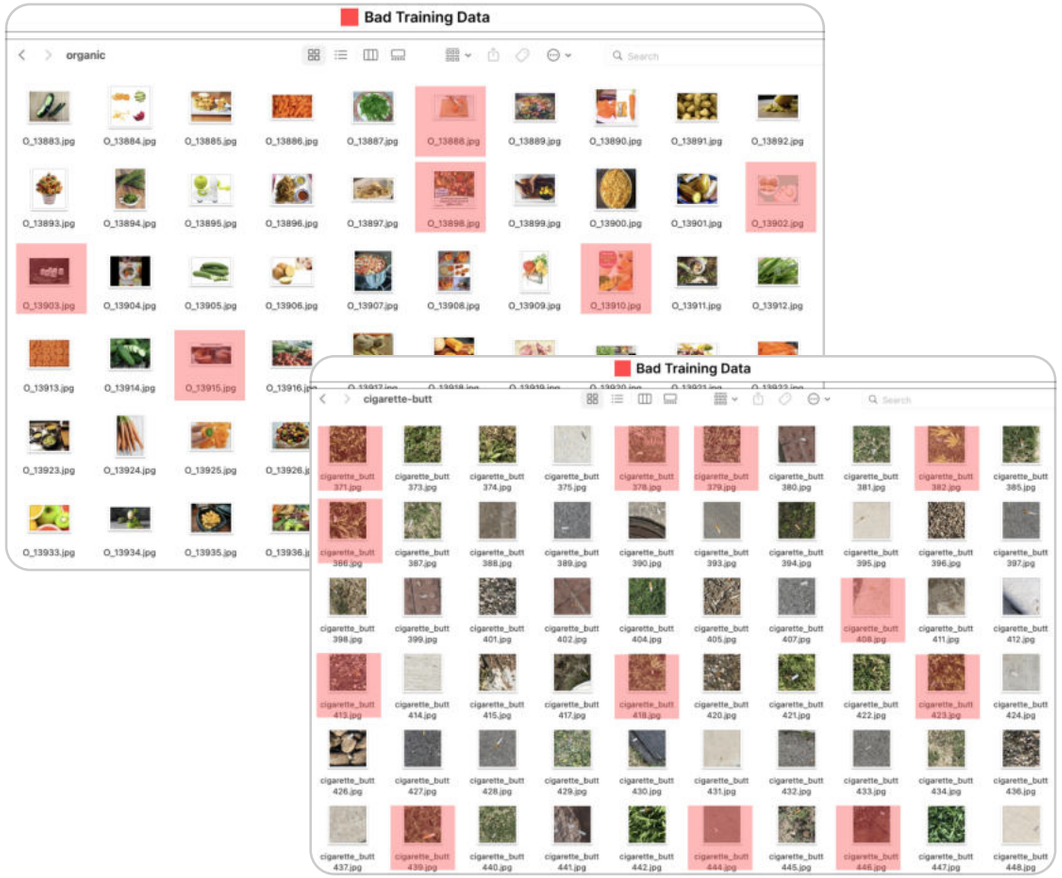
```
Dataset: 44,200 items
Size: 3.91 GB
```

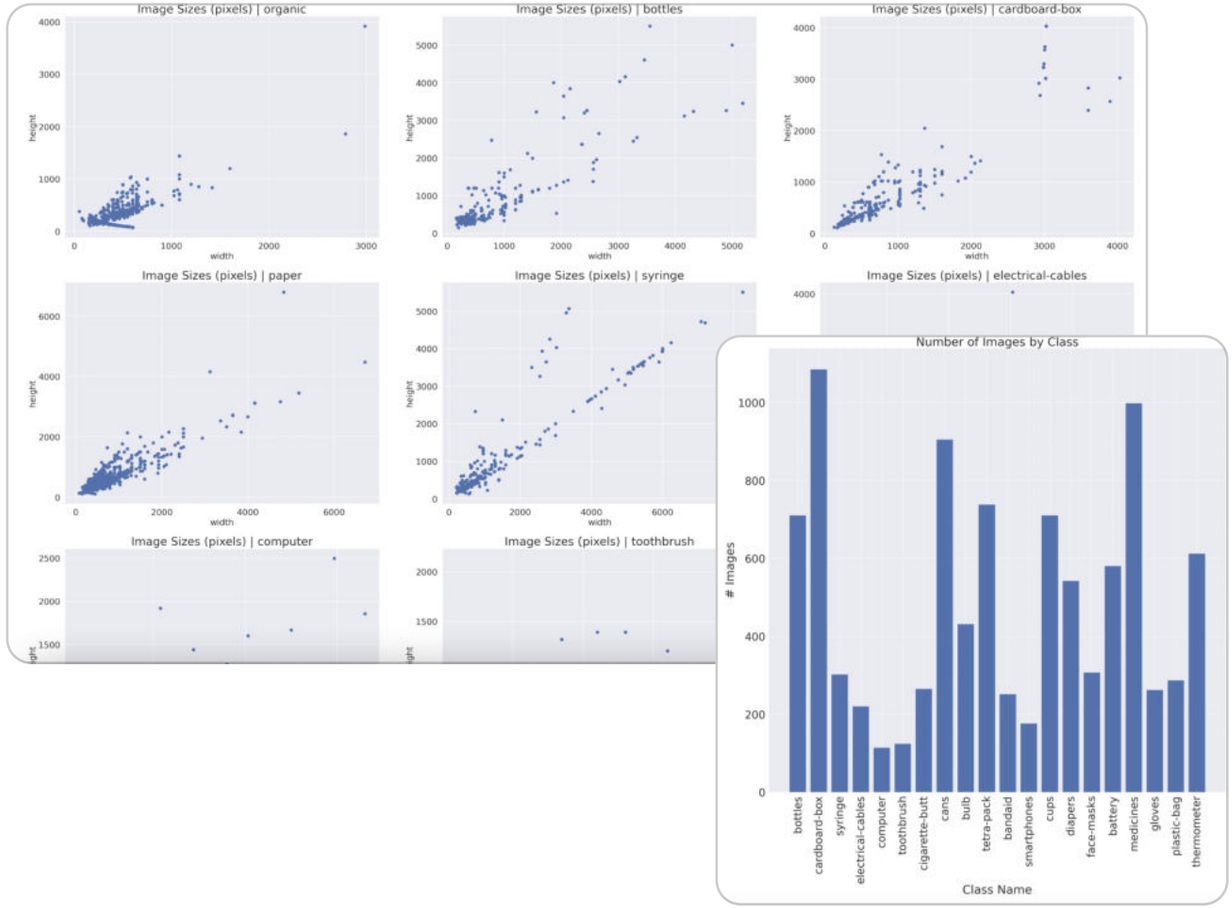
Total Size



22 Classes

CLEANING & PROCESSING





MODELS

CLASSIFICATION

- Vgg16
- Resnet18
- Inception-v3
- SqueezeNet

DETECTION

- Mask R-CNN with Resnet50

```
model_vgg.classifier = nn.Sequential(*list(model_vgg.classifier.children())[:-1] + [nn.Linear(num_ftrs,len(all.clas

model_vgg = model_vgg.to(device)

criterion = nn.CrossEntropyLoss()

# Observe that only parameters of final layer are being optimized as
# opposed to before.
optimizer_vgg = optim.SGD(model_vgg.classifier.parameters(), lr=0.001, momentum=0.9)

# Decay LR by a factor of 0.1 every 7 epochs
exp_lr_scheduler = optim.lr_scheduler.StepLR(optimizer_vgg , step_size=7, gamma=0.1)

checkpoint_path = "./checkpoints/vgg16_all_simply/"

model_vgg = train_model(all_dataSets, all_dataLoader, model_vgg, criterion, optimizer_vgg,
                        exp_lr_scheduler, checkpoint_path, num_epochs=25, device=device)
```

```
ncy expressed in bytes should be converted to RGBA images
  warnings.warn(
/home/tanmay/miniconda3/lib/python3.9/site-packages/PIL/Image.py:945: UserWarning: Palette images with Transpare
ncy expressed in bytes should be converted to RGBA images
  warnings.warn(

train Loss: 0.2312 Acc: 0.9318

/home/tanmay/miniconda3/lib/python3.9/site-packages/PIL/Image.py:945: UserWarning: Palette images with Transpare
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ncy expressed in bytes should be converted to RGBA images
  warnings.warn(

val Loss: 0.3085 Acc: 0.9196
```
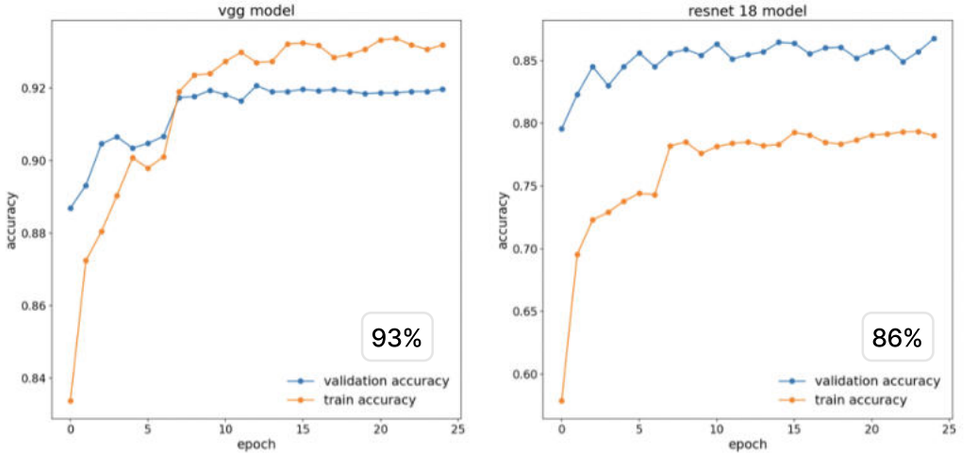
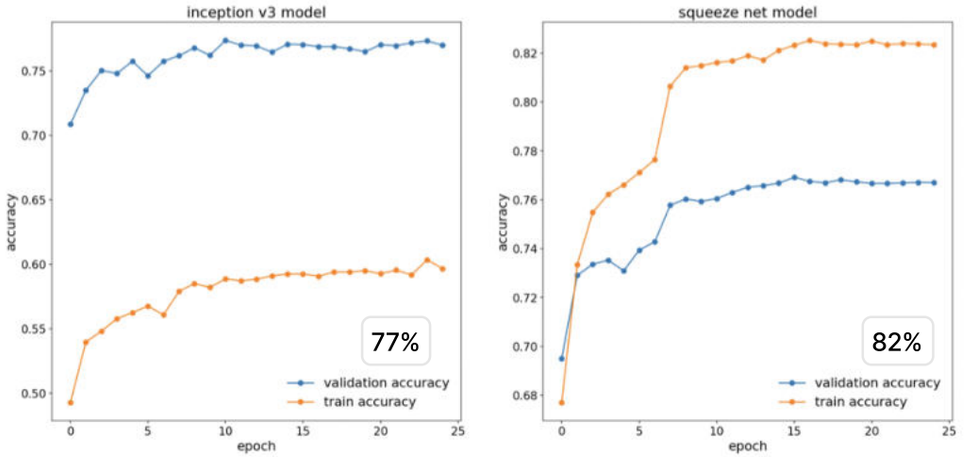
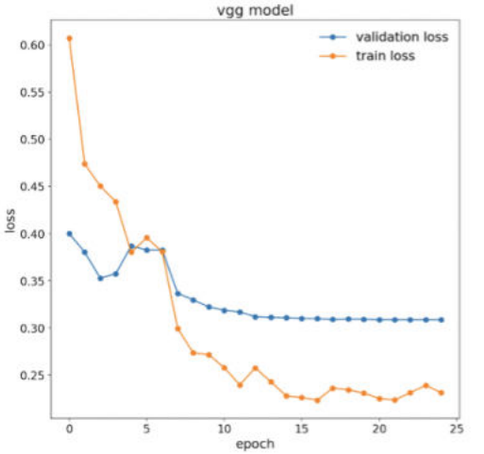
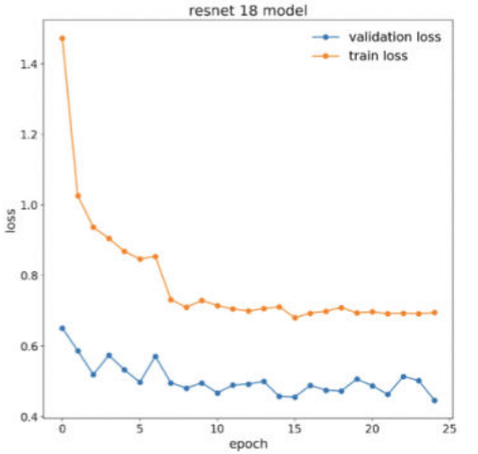

EVALUATION

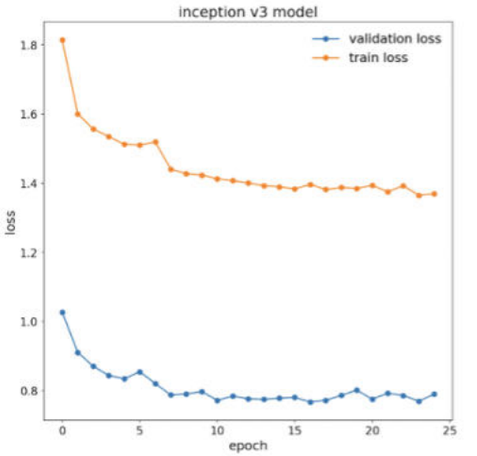


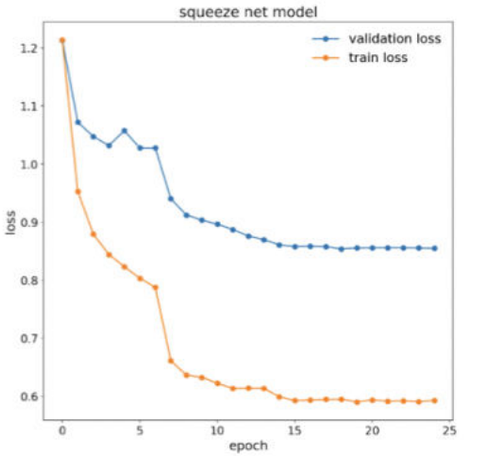


Accuracy









Losses

RESULTS

What works well?

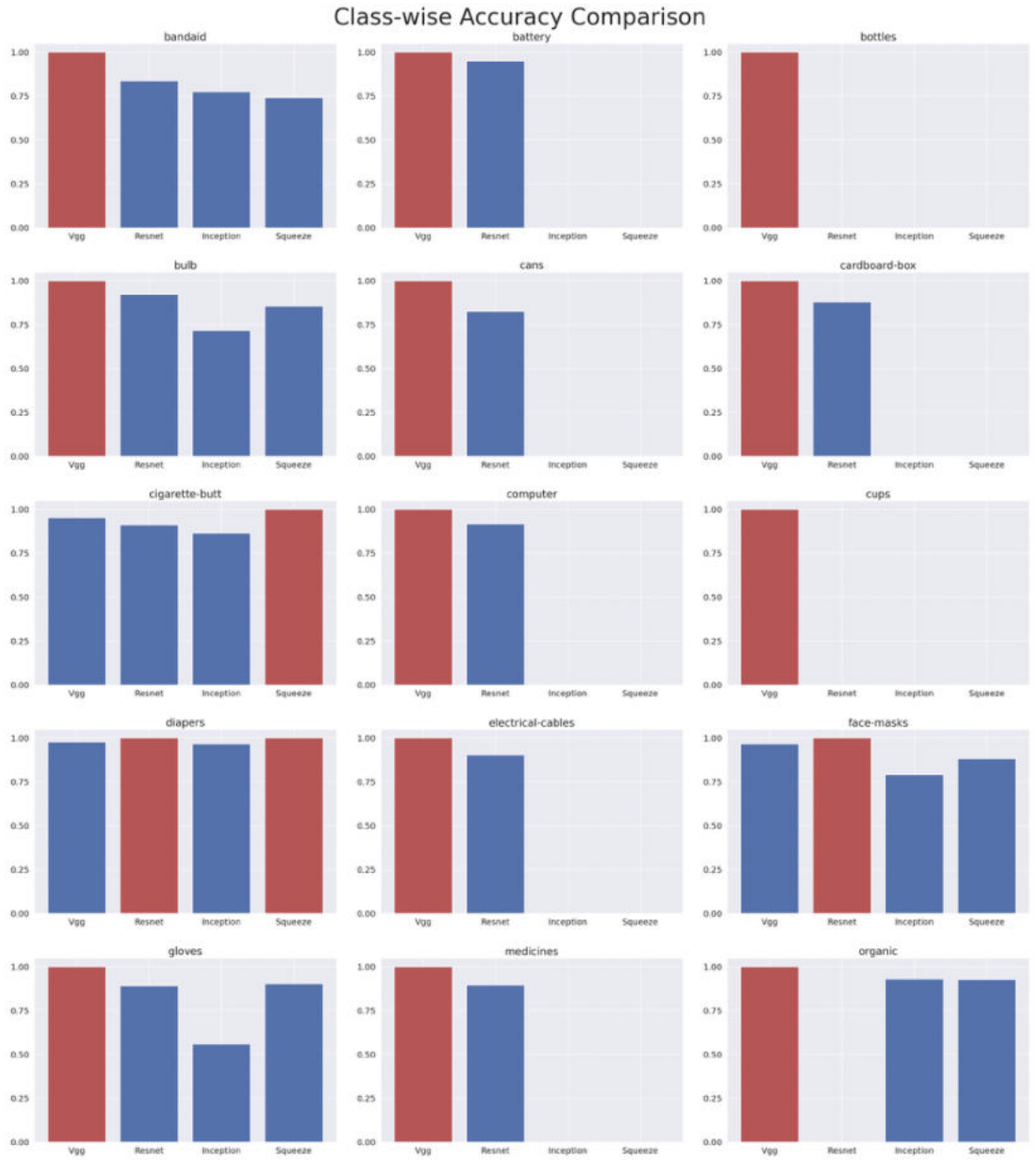
- Classification of items: bandaid, electronics, face masks, cups, organic, etc.
- Detection of items: cigarettes, bottles, cups.
- Detection on bounding boxes.

What doesn’t?

- Limited training for detection: items detected but unable to classify.
- Bias for classification label - organic

BEST MODEL

VGG16 with **93%** Overall accuracy



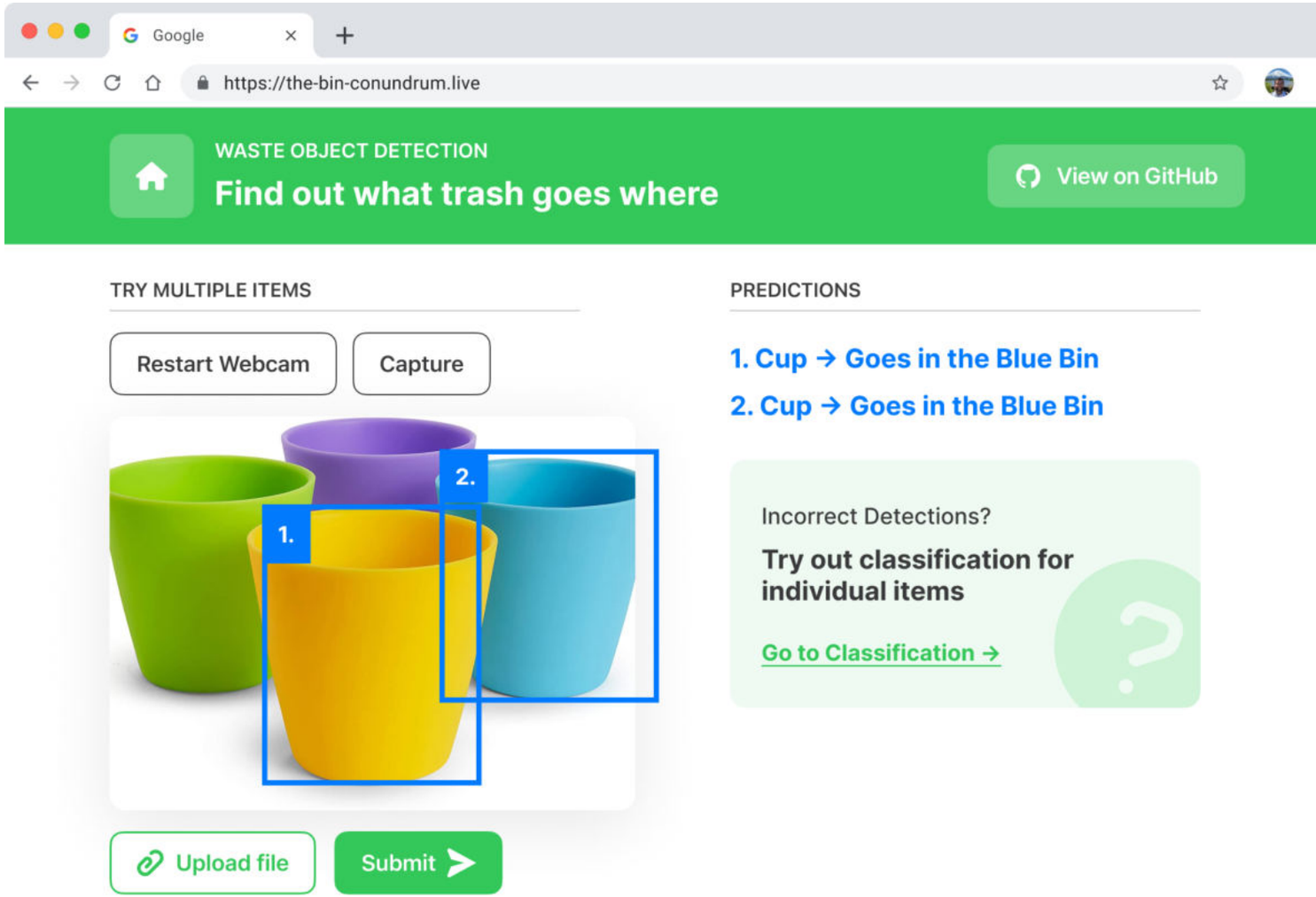
Class-wise accuracy

DATA PRODUCT

Our data product is a web app that integrates the classification and detection models into a single comprehensive system.

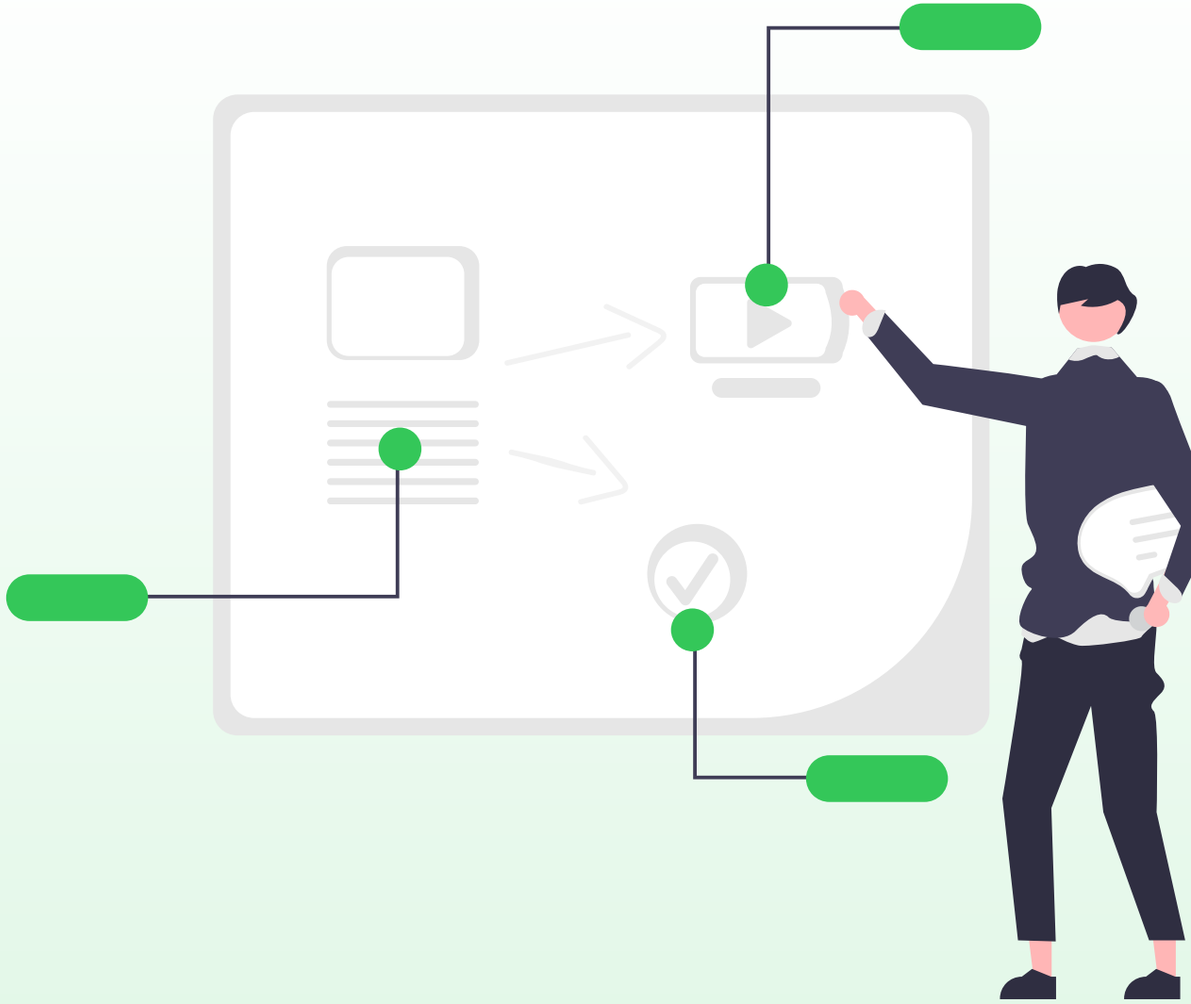
TRY IT OUT! 🎉

https://the-bin-conundrum.live



LEARNINGS

- Data Cleaning is not for the faint hearted. Even when working with pre-existing datasets, outliers and faulty data can still be present.
- Reinforce faith on: *Garbage In → Garbage Out*
- Checkpointing is of critical value when models have long training times.
- Model pros and cons in real-life usage: size, load Times, Accuracy trade-offs.
- ML Deployment with Containerization.



FUTURE WORK

What we have incorporated:

Dataset Creation

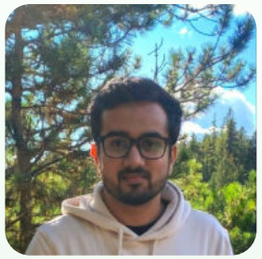
- Keeping a track of every image sent on the web-app and storing those predictions.
- Make Data lake through S3

What we plan to:

Active Learning

- Apply active (human-in-the-loop) learning for the dataset created and retrain our models.

Thank you



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