Garbage Classifier

Multi-Class Garbage Detection For use In User Feedback

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This should have not happened...

Why have a garbage classifier???

Motivation - Nishanth

- Waste management has been a challenge for many years
- Most of the garbage in the world are mixed up and difficult to separate and recycle
- It is necessary to recycle waste in order to protect the environment
- Waste classification is the first step in effective waste management

Challenges Posed:

- Lack of awareness in people about the garbage problem
- Confusion in classifying which garbage goes where

Problem Description - Rene

- We define “Garbage” as a used item to be discarded within a trash bin
- For efficient recycling, different “classes” of garbage should remain separate from each other
- Individuals hold significant responsibility in ensuring garbage is discarded in the appropriate locations (e.g. non-recyclables shouldn't mix with recyclables)

Problem Description

- Goal: Develop a feedback mechanism to guide/motivate individuals to correctly dispose of garbage, reducing waste and improving efficiency
- Approach:
  - Develop garbage classification model using machine learning
  - Model identifies 8 garbage classes: plastic, glass, paper, metal, organic, electronic, chemical
  - Extend computer vision object detection model using our classification model so as to provide real time classification feedback

Classes


Carboard
Chemical
E-Waste
Glass
Metal
Organic
Paper
Plastic

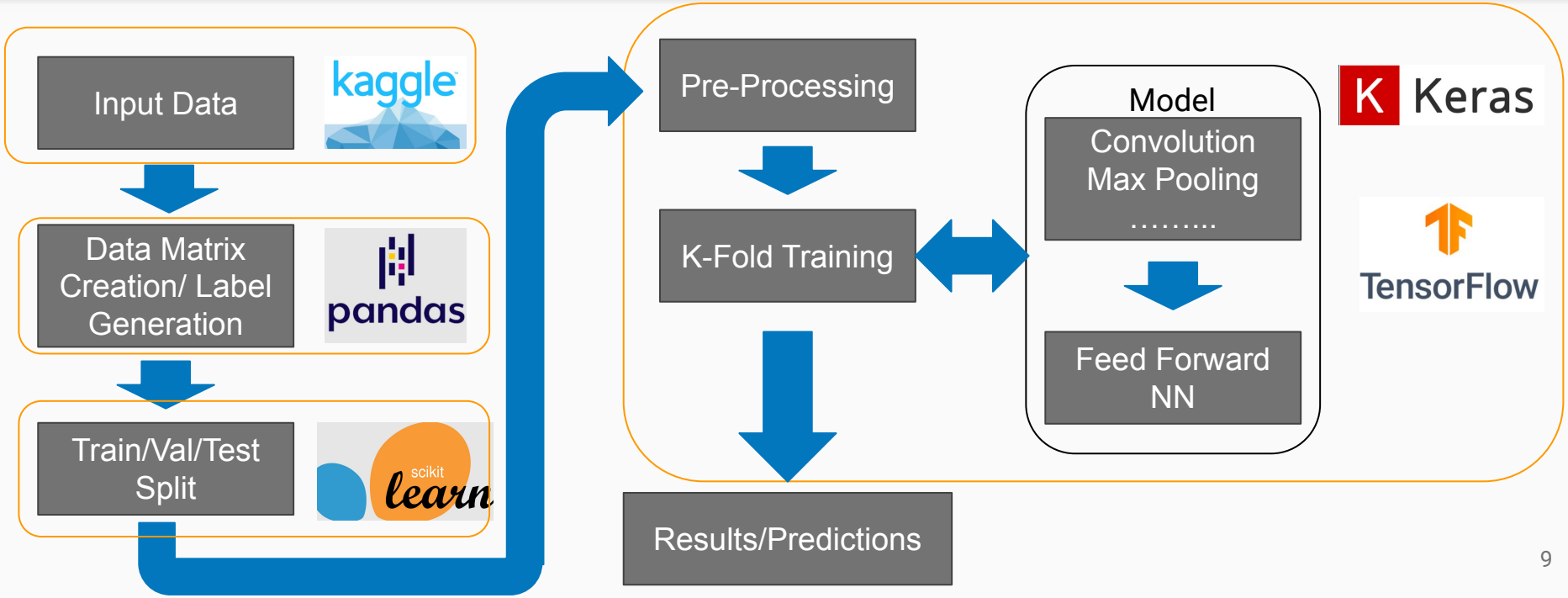
Approaches considered

- Simple Logistic Regression
  - Easy to implement
  - Good at classifying simple, linear relationships
  - Limited/Poor Accuracy for modeling more complex relationships with hidden features
- SVM
  - Good at mapping both linear and non-linear functions
  - Typically faster training time than NN
  - May not perform as well as NNs on large datasets
- CNN
  - Flexible and good with image recognition
  - Good accuracy and feature extraction
  - Performs better on large datasets
- Transfer Learning
  - Considered for applying our machine learning model to computer vision application
  - More complex

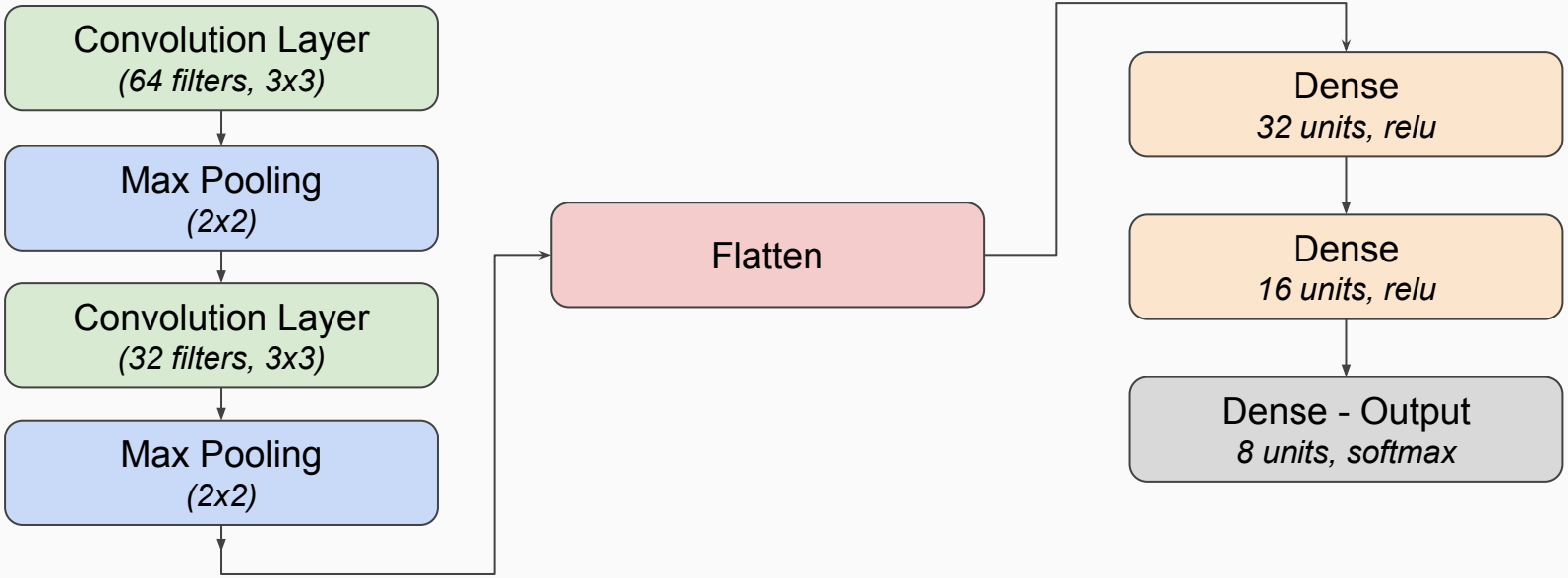
Theory behind our approach

- Use CNN to extract features from images fed to it by training data images
- Use convolution layer to extract important/identifying features of an image
- Reduce processing load of images by max pooling
- Feed processed image to neural network tuned for classification
- The convolution and max pooling steps combined allow us to feed a less computationally heavy version of the image without losing significant features

Classifier Pipeline

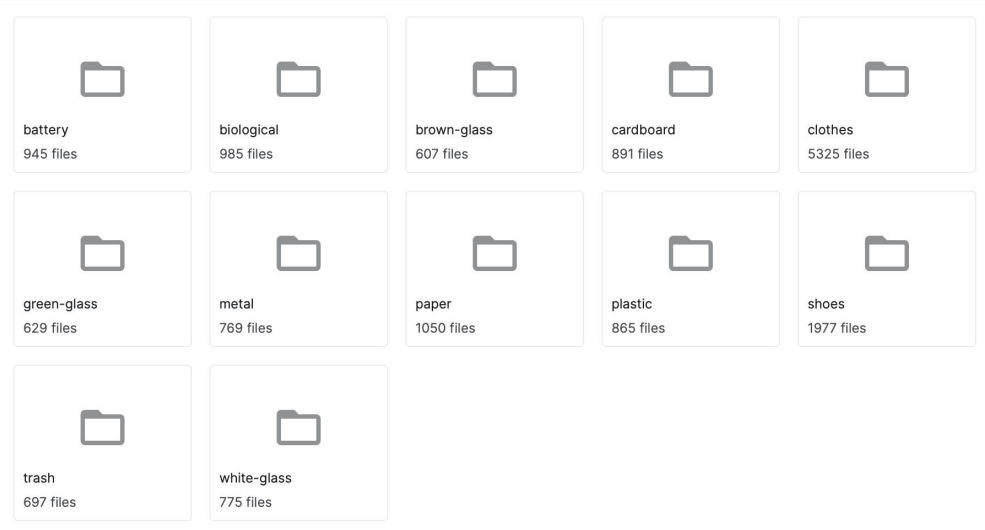


The Model we trained - JEAN



Data Gathering - Jean

https://www.kaggle.com/mostafaabla/garbage-classification

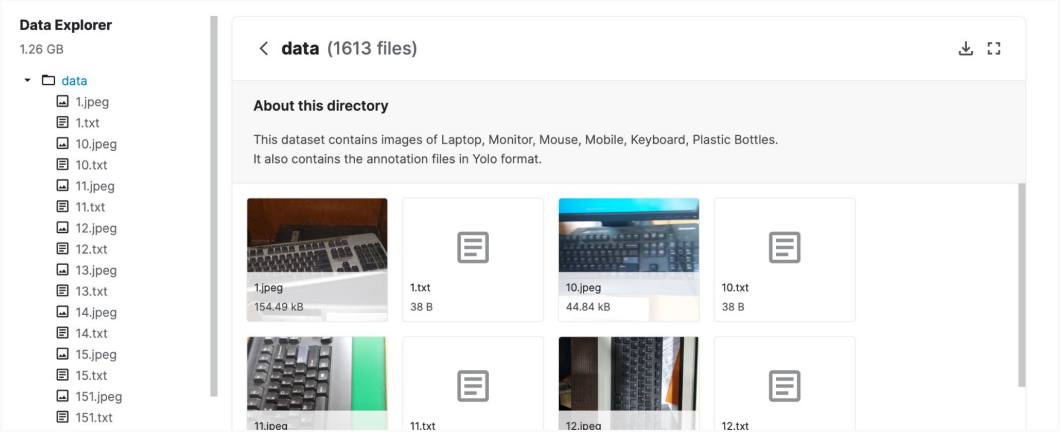


- 7 classes from this dataset

  - Cardboard
  - Chemical
  - Glass
  - Metal
  - Organic
  - Paper
  - Plastic

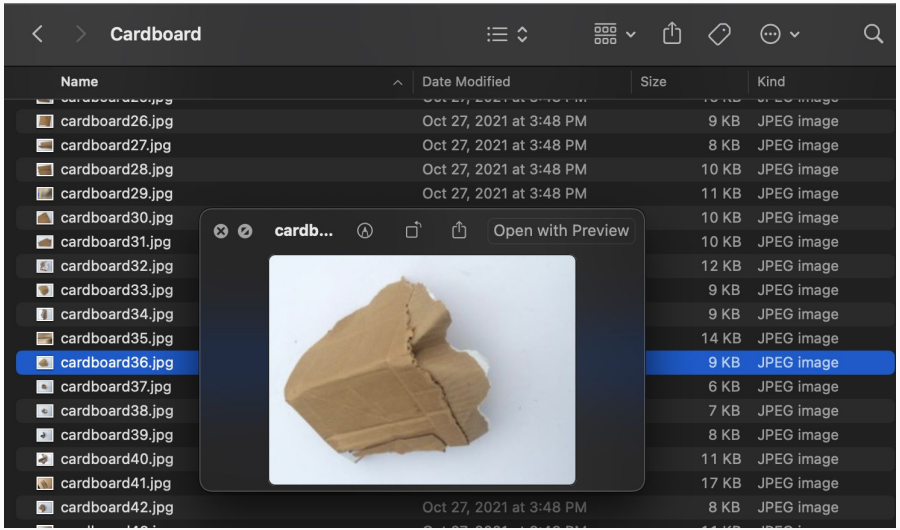
Data Gathering - Jean

https://www.kaggle.com/kaustubh2402/ewaste-dataset?select=data



- E-waste

Data Gathering



Standardize the dataset:

- Convert all images to .jpg
- Set maximum size to 256x256
- Normalize pixel values [0,1]

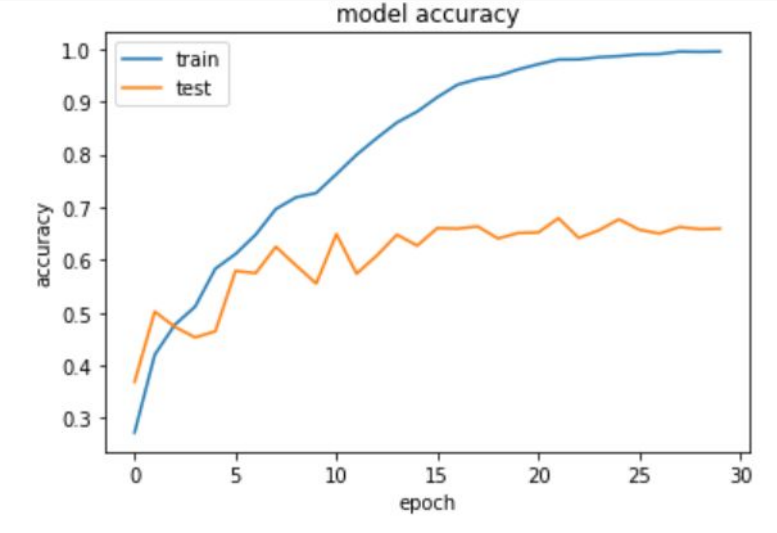
Model’s results - Nishanth

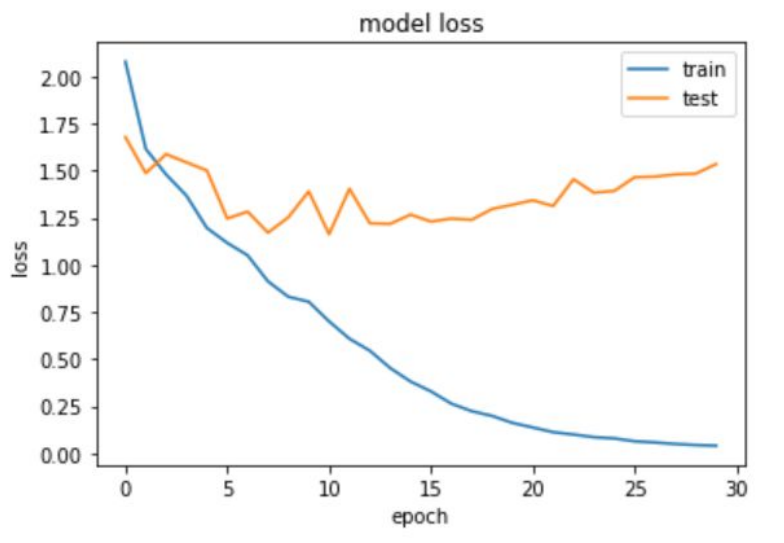
Trained Model:

- Epochs = 30
- Batch_size = 32
- Training_set_volume = 3839
- KFold n_splits = 6

-

accuracy	99.51%
loss	.041
val_accuracy	65.94%
val_loss	1.53



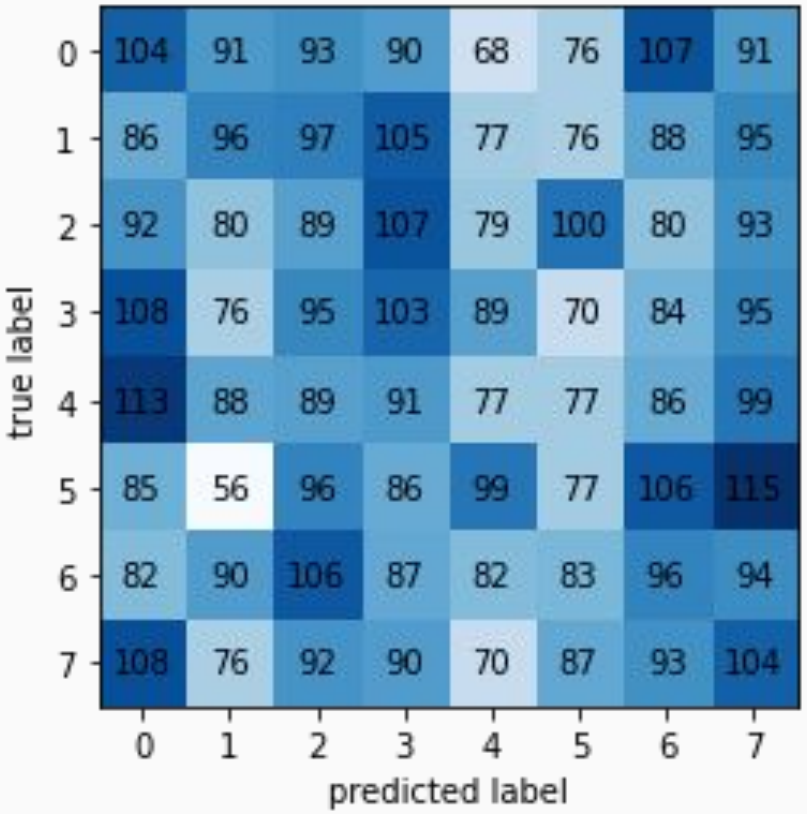


Test results on unseen data

Accuracy on unseen test data set: 69.07%

Loss on unseen dataset: 1.2409

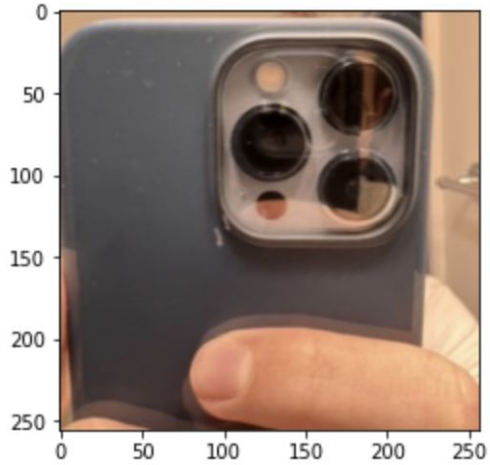
Confusion Matrix



It is not great, but...

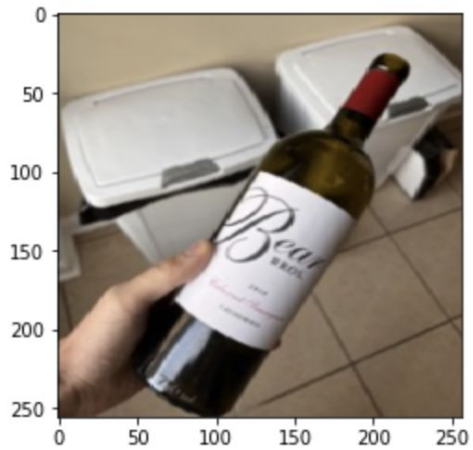
We are trying to improve the accuracy

Sample results



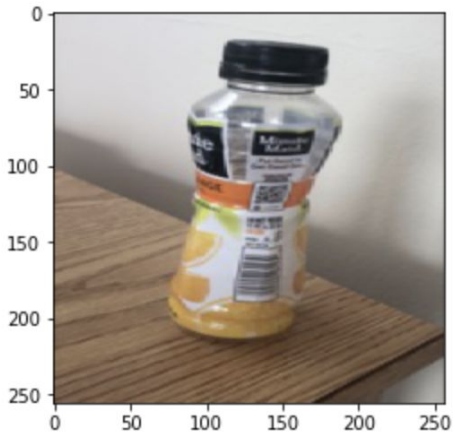
Cardboard 1%
Chemical 0%
E-Waste 91%
Glass 0%
Metal 8%
Organic 0%
Paper 0%
Plastic 0%

RESULT:
E-Waste



Cardboard 0%
Chemical 0%
E-Waste 19%
Glass 58%
Metal 1%
Organic 0%
Paper 1%
Plastic 21%

RESULT:
Glass

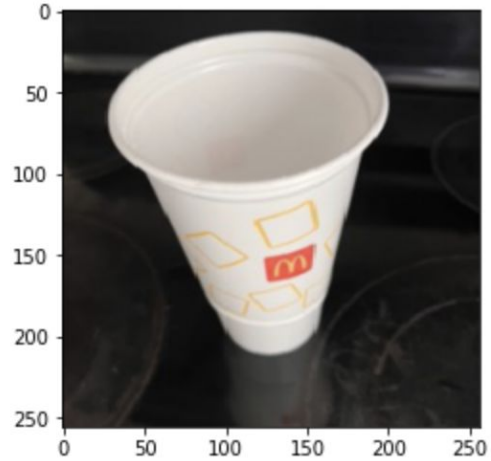


Cardboard 0%
Chemical 0%
E-Waste 0%
Glass 4%
Metal 1%
Organic 0%
Paper 1%
Plastic 93%

RESULT:
Plastic

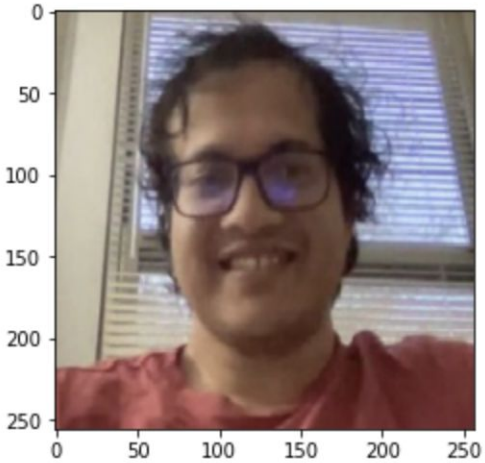
Sample results


```
Cardboard 11%
Chemical 0%
E-Waste 1%
Glass 0%
Metal 0%
Organic 84%
Paper 2%
Plastic 2%

RESULT:
Organic
```

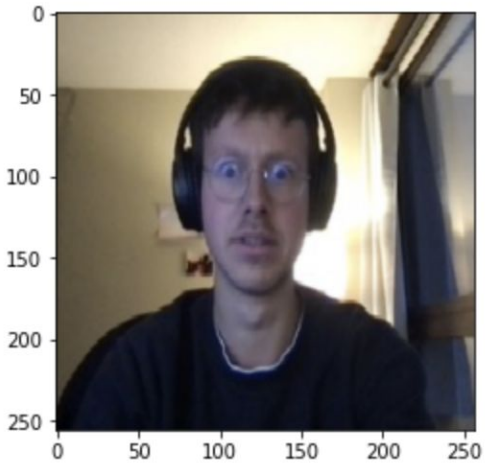


```
Cardboard 1%
Chemical 0%
E-Waste 0%
Glass 0%
Metal 0%
Organic 97%
Paper 0%
Plastic 2%

RESULT:
Organic
```

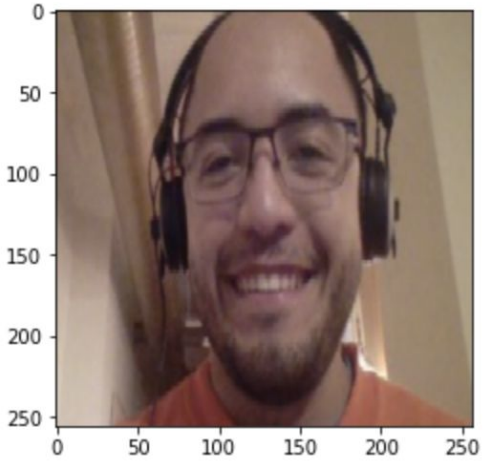
Sample results



```
Cardboard 15%
Chemical 0%
E-Waste 41%
Glass 1%
Metal 0%
Organic 0%
Paper 43%
Plastic 0%

RESULT:
Paper
```



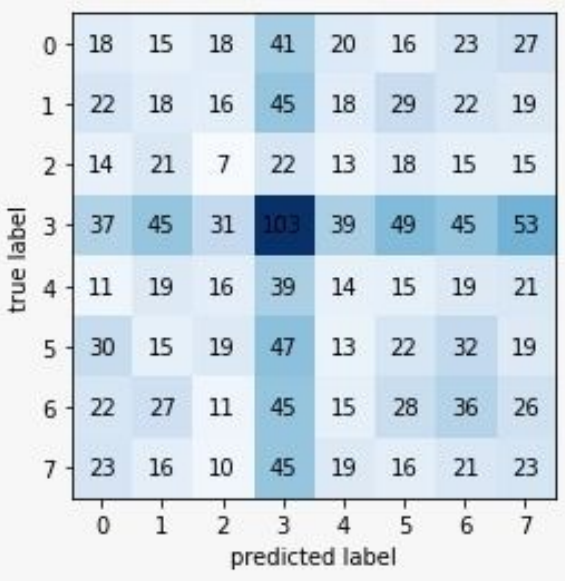
```
Cardboard 0%
Chemical 5%
E-Waste 93%
Glass 0%
Metal 1%
Organic 0%
Paper 0%
Plastic 1%

RESULT:
E-Waste
```



```
Cardboard 1%
Chemical 0%
E-Waste 94%
Glass 2%
Metal 1%
Organic 2%
Paper 0%
Plastic 0%

RESULT:
E-Waste
```

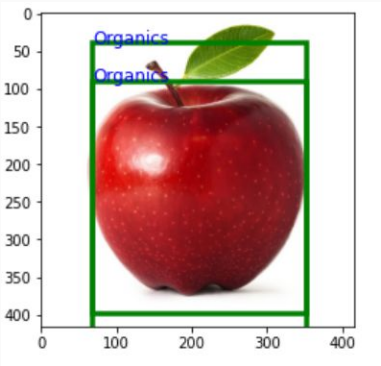
The design issues - Nishanth

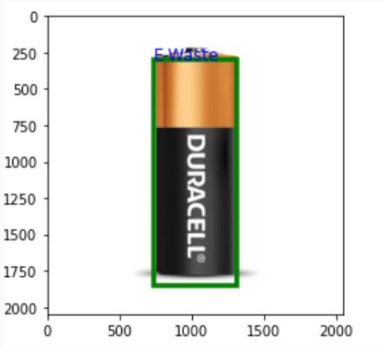
- Long Training Times
  - Required Use of GPU
- Biased Images in Dataset
  - Noticed many inaccurate representations in training set
- This confusion matrix is a result of imbalance in the number of entries for one of the classes. There were over 2000 elements classified under class-3. Hence the huge bias towards class-3 and the formation of “The Cross”!!!

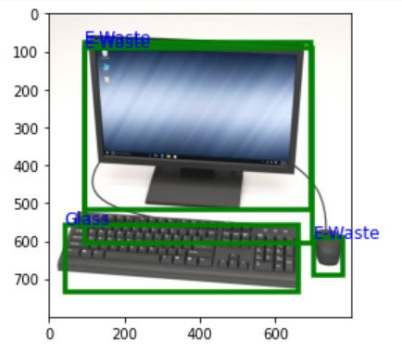


The next challenges - Rene

- Possibly use transfer learning to improve classifier accuracy
  - ResNet, MobileNet
- Extend classifier to computer vision application
  - Work in progress - see examples below







Thank you for listening!

Questions?