

# Waste: Biodegradable or Non-Biodegradeable?

Image Classification

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# Goal of Analysis and Project

I've been hired by ABC Waste Corp. to look into how operations, global impact, and revenue could be improved.

I will build an image classifier in an effort to classify waste types. With waste types classified, ABC Waste Corp. can dispose of each waste class differently to achieve these goals.

# Waste Industry Facts



- Only 1% of all plastic products in the United States are recycled every year, as are only 1% of all aluminum products.
- Americans throw away 25 million plastic bottles per hour.
- The largest component of industrial waste is actually paper products.
- As of 2021, the world generated over 2.01 billion tons of municipal solid waste annually. At least 33% of that waste was not managed in an environmentally safe manner.

# Landfills Decreasing and Waste Generation Increasing

## US Landfills

1990 - over 6,000

2018 - under 1,300

## Waste generation

1960 - 88 million tonnes

1990 - 208 million tonnes

2018 - 292 million tonnes

Waste generation has increased partly due to increased consumerism and "throwaway culture".

\*Landfills have grown and waste incineration plants have increased

# Alternative Disposal Options

Aside from environmental reasons to consider waste sorting, there are potential monetary incentives as well.

The average cost to landfill municipal solid waste in the US was \$53.72 per ton in 2020. This is over a \$20 increase from 2005 which was about \$30 at that time.

Tax breaks to recycle through many state and federal programs.

Waste items such as aluminum, plastic, metal cans, glass, cardboard, and more can all be sold to create new items.

Aluminum - cans, car parts, construction material

Plastic - bottles, carpet, used in certain clothing

Metal - bike parts, rebar, steel beams, appliances

Glass - bottles, fiberglass

Cardboard - new cardboard, paper bags

# Image Classification Model

Used a Binary CNN model to classify images either 'biodegradable' or 'non - biodegradable'

Using over 75,000 images with a test/train split of about 78% train and 22% test.

Zero classifier baseline of about 50%

Biodegradable



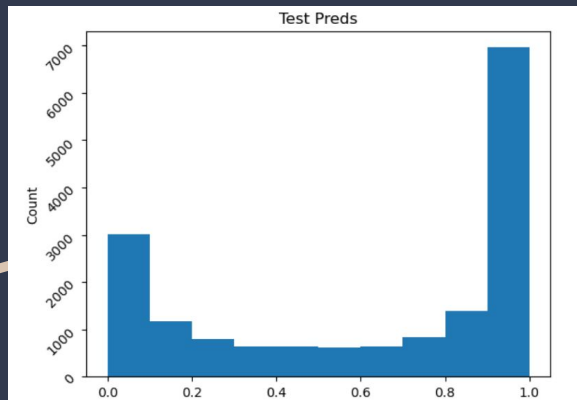
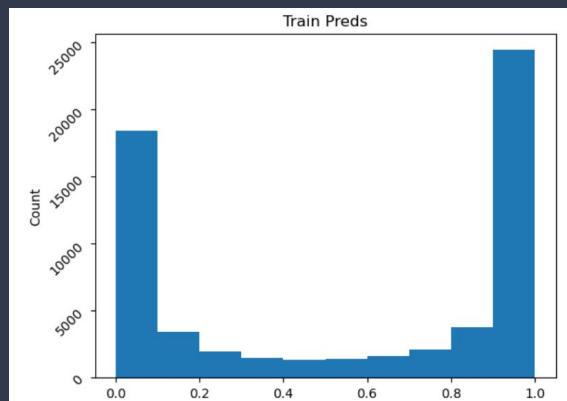
Non-Biodegradable



# CNN Modeling

- Train and Test folders
  - Each folder has a folder for each classification
- Rescaled images to be between 0 and 1
- First Layer of model was resizing images to have the model run faster. Didn't effect scoring much.
- Remaining layers were as follows:
  - Conv2D
  - MaxPool2D
  - Conv2D
  - MaxPool2D
  - Dropout
  - Flatten
  - Output layer - 'sigmoid' activation

# CNN Modeling



Baseline of about 50% for train and test images

Final model has an accuracy of 86.61% and validation accuracy of 81.87%. Losses were 0.32 and 0.40, respectively.

Rescaled data to be between 0 and 1

First layer resized images to 50 x 50

- Caused only small effect on accuracy

Model has 8 layers total



# Efficient Net

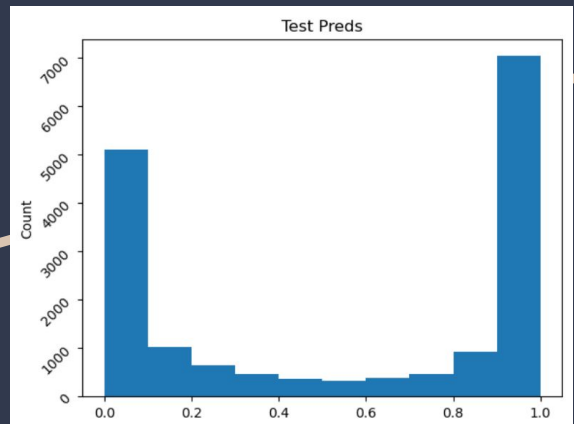
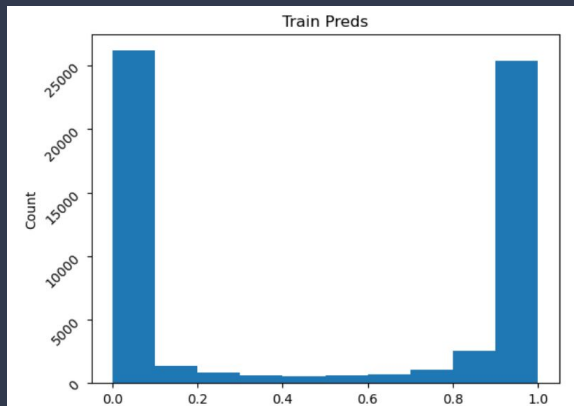
Resized images to 224 pixels X 224 pixels

- EfficientNetB0 calls for this size

5 layer construction:

- Effnet
- GlobalAveragePooling2D
- Dropout
- Dense
- Output layer - 'sigmoid' activation

# Adding Efficient Net to CNN



I added an Efficient Net to the CNN model, with 5 layers and had even better results.

Accuracy - 90.99%

Loss - 0.22

Validation Accuracy - 92.8%

Validation Loss - 0.19

# Streamlit App

Streamlit App was built on CNN Model

Image Classifier could be implemented to help ABC Waste Corp. sort waste items

# Conclusions and Recommendations

Streamlit App could be implemented by ABC Waste Corp. classify waste items to help sort items for different disposal methods.

The CNN Model and EFFNet performed well and very well compared to the baseline. This would be a good model to use for the Streamlit App.

If ABC Waste Corp. decides to use the app, I would fine tune the model further and experiment with other models for more accurate results.

# What's Next?

Build a Support Vector Machine Model to compare performance against the CNN Model.

Slight overfitting on CNN Model, will fine tune model to correct overfit.

Continue to work on the Streamlit App to make it more user friendly and visually appealing.

Experiment with advanced feature extractors such as SIFT and SURF.