INTRODUCTION

Our project attempted to solve the problem of waste sorting to aid in discarding personal trash.

Our team implemented a CNN classifier for sorting images into seven categories, spanning recycling, trash and non-waste.

Our model used transfer learning from the VGG-19 network trained on ImageNet. We trained a small dense neural network with a Softmax classifier.

The Facts

$30.83 99.8% 1
spent training on Amazon final training accuracy hidden layer

Overview

We had 2415 total examples, spanning seven classes: paper, plastic, glass, cardboard, metal, trash, non-waste.

We chose to use 93.5% of our data for training, and 6.5% for validation.

Sources

We used data from 3 sources, all of close up images of objects, mainly taken with Apple iPhone 6/7 cameras.

Images of waste from CS229 project by Gary Thung and Minyi Yang [2]
Objects dataset from PASCAL VOC 2012 [3]
Flowers dataset by Visual Geometry Group at the University of Oxford

PRE-TRAINING

Augmentation

Due to the small size of our dataset, we implemented preprocessing and augmentation through the Keras ImageDataGenerator. We applied shear, rotation, zoom, and shifts to the original dataset (Figure 4).

Hyperparameter Search

We tested:
- Batch size
- NN architecture
- Dropout rate
- Learning rate (Adam)
- Epsilon (Adam)

NETWORK OVERVIEW

VGG19 [minus FC Layers]

The VGG-19 architecture is an extra-deep network with thirteen convolutional layers, divided into convolution blocks each with max-pooling layers (Figure 6). We use all layers up to the last max-pooling layer, and use the features produced from the last convolution as input to our transfer network. We retained the last two convolutional blocks in order to optimize the convolved features in our dataset.

Transfer Network

Our network is comprised of four layers: a dense layer with ReLU activation, a dropout layer, a BatchNorm layer, and a dense output layer with a dense activation (Figure 7).

Loss

Categorical Cross-entropy

Optimization

Adam

RESULTS

Short Train (10 Epochs)

<table>
<thead>
<tr>
<th>Training Loss</th>
<th>Validation Loss</th>
<th>Training Accuracy</th>
<th>Validation Accuracy</th>
<th>AUC</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5469</td>
<td>6.947</td>
<td>50.68%</td>
<td>49.68%</td>
<td>14</td>
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<tr>
<td>60 Epochs</td>
<td>1.1399</td>
<td>50.68%</td>
<td>10.03%</td>
<td>10.3</td>
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<td>180 Epochs</td>
<td>0.6310</td>
<td>50.68%</td>
<td>88.28%</td>
<td>39</td>
</tr>
</tbody>
</table>

Medium Train (50 Epochs)

Long Train (100 Epochs)

FUTURE

We have four areas to explore with future work:

Reduce variance by further regularization techniques
Aquire more data by embedding network in mobile app
Tighten focus to separation of recycling materials
Create “ensemble” network using multiple CNN models feeding into a single transfer network

REFERENCES