ECE1504 Project Presentation

Trash Classification Using Convolutional Network Upon Colored Image

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Agenda

- Introduction
- Background
- Design & Rationale
- Test Results & Discussion
- Conclusion and Questions

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Introduction

Project Description

- Segregation and recycling of trash have been necessary for a sustainable society. The current segregation and recycling process require facilities to sort garbage manually and use a series of large filters to separate out more defined objects.
- The motivation is to find an automatic method for trash classification.

Introduction

Project Objectives

- Using Machine Learning algorithm of Convolutional Neural Networks (CNN) to classify the input images into six categories: metal, plastic, paper, cardboard, glass and trash.
- Dataset enlargement will be used for training
- ResNet will be used to do the classification

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Background

5 convolutional neural network cases

Classic networks:

- LeNet-5 (1980)
- AlexNet
- VGG

Modern network:

- **ResNet**
- Inception NN

Background

LeNet-5

- Goal was to recognize handwritten digits
- The raw grey scaled image of 32*32*1 pixels as input.
- Layers:
  - 2 convolutional layers :reduce the dimension of image
  - 2 subsampling (pooling) layers : reduce dimension of both height and width
  - 2 fully connected layers: fully connected nodes to each of neurons

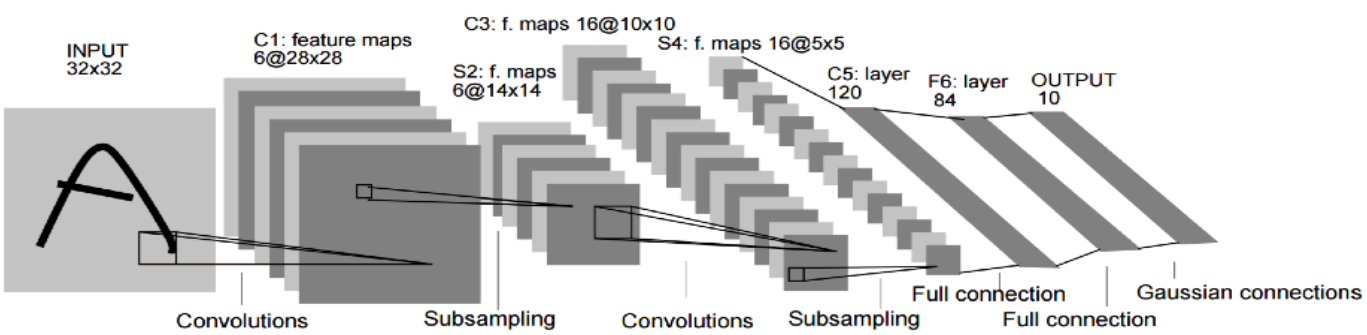

Figure 1. Y. LeCun, L. Bottou, Y. Bengio, and P. Haffner, Gradient-based learning applied to document recognition, Proc. IEEE 86(11): 2278–2324, 1998.

Background

AlexNet

- Similar to LeNet but much larger with 60 million parameters.
- The raw image would be a 227*227* color image
- The architecture including 5 convolutional layers, 3 max pooling layers and 3 fully connected layers.
- Use ReLU activation function.

Background

VGG

- Smaller filters (3*3 convolutional layers) and deeper networks

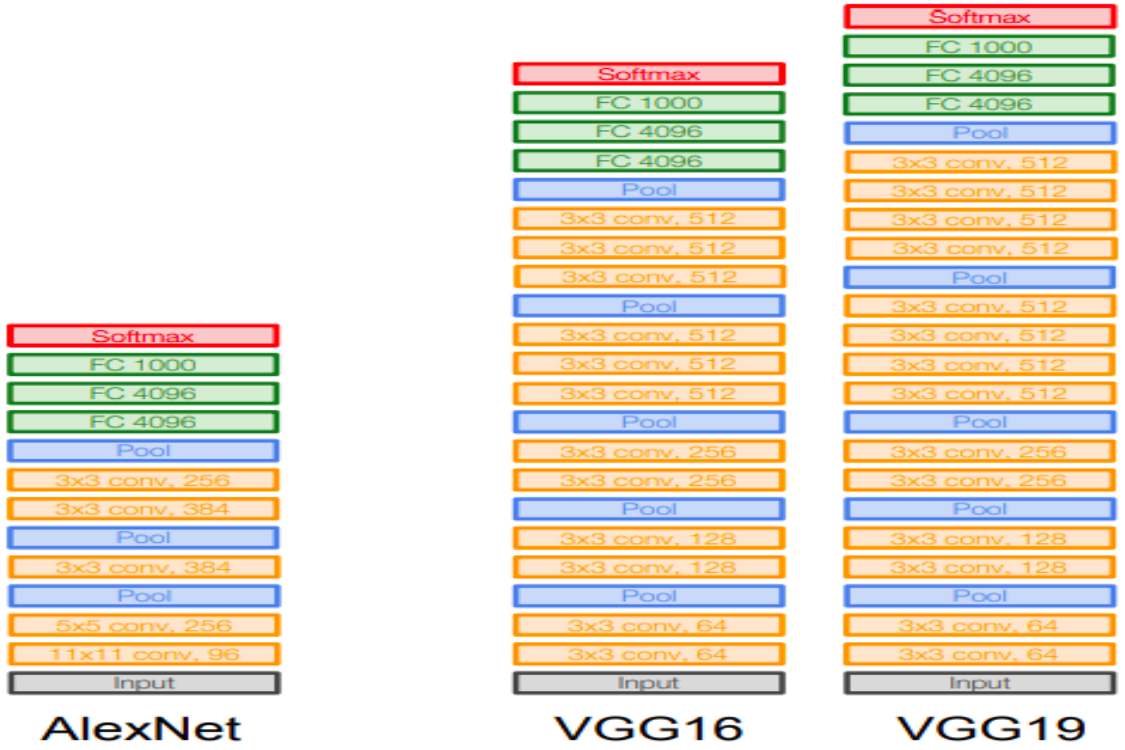

Figure: Comparison among the architectures of AlexNet, VGG16 and VGG19

Background

ResNet

- In theory, very deep networks can represent very complex functions.
- However, they are hard to train because of vanishing and exploding gradient types of problems.
- Skip connections can take the activation from one layer and suddenly feed it to another layer even much deeper in the neural network.
- Build ResNet enables you to train very, very deep networks, even over 100 layers.

Background

ResNet50

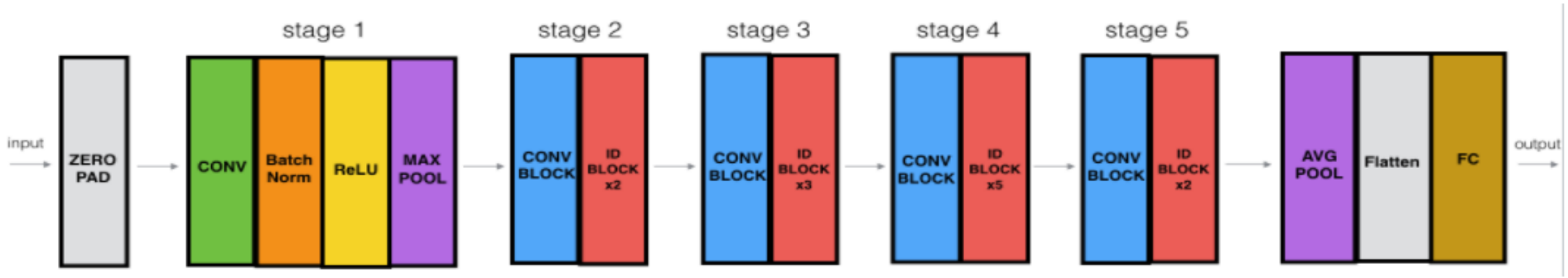

Figure : Resnet50 (Got from Coursera)

Background

Inception NN

- Inception NN is a deeper network with computational efficiency.
- The process of modeling:
  - a good local network topology (network within a network)
  - and then stack these modules on top of each other.
- Apply parallel filter operations on the input from previous layer:
  - Multiple receptive field sizes for convolution (1x1, 3x3, 5x5)
  - Pooling operation (3x3)
  - Concatenate all filter outputs together depth-wise
  - To avoid expensive computation: adding “bottleneck” layers that use 1x1 convolutions to reduce feature depth

Background

Inception NN

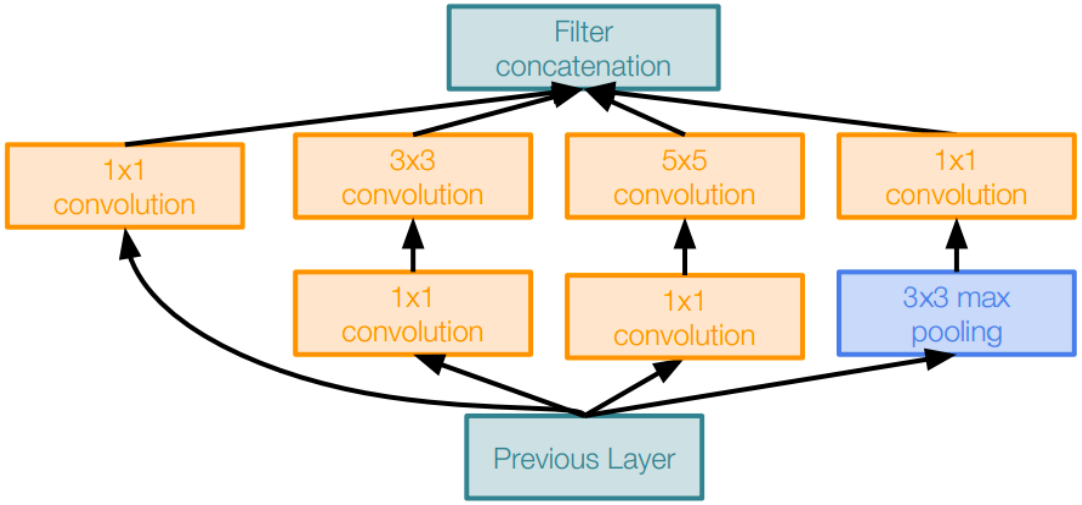

Figure . Inception module with dimension reduction [Szegedy et al., 2014]

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Design & Rationale

- **Source of data:**
  - Original dataset: trashnet.zip
    - spans six classes: glass, paper, cardboard, plastic, metal, and trash
    - consists of 2527 images of different sizes
  - New dataset
    - Data augmentation by cropping 9 tim es and flipping 1 time per image
    - Consists of 2527*18 = 45486 images of same size

Design & Rationale

Dataset enlargment

Design & Rationale

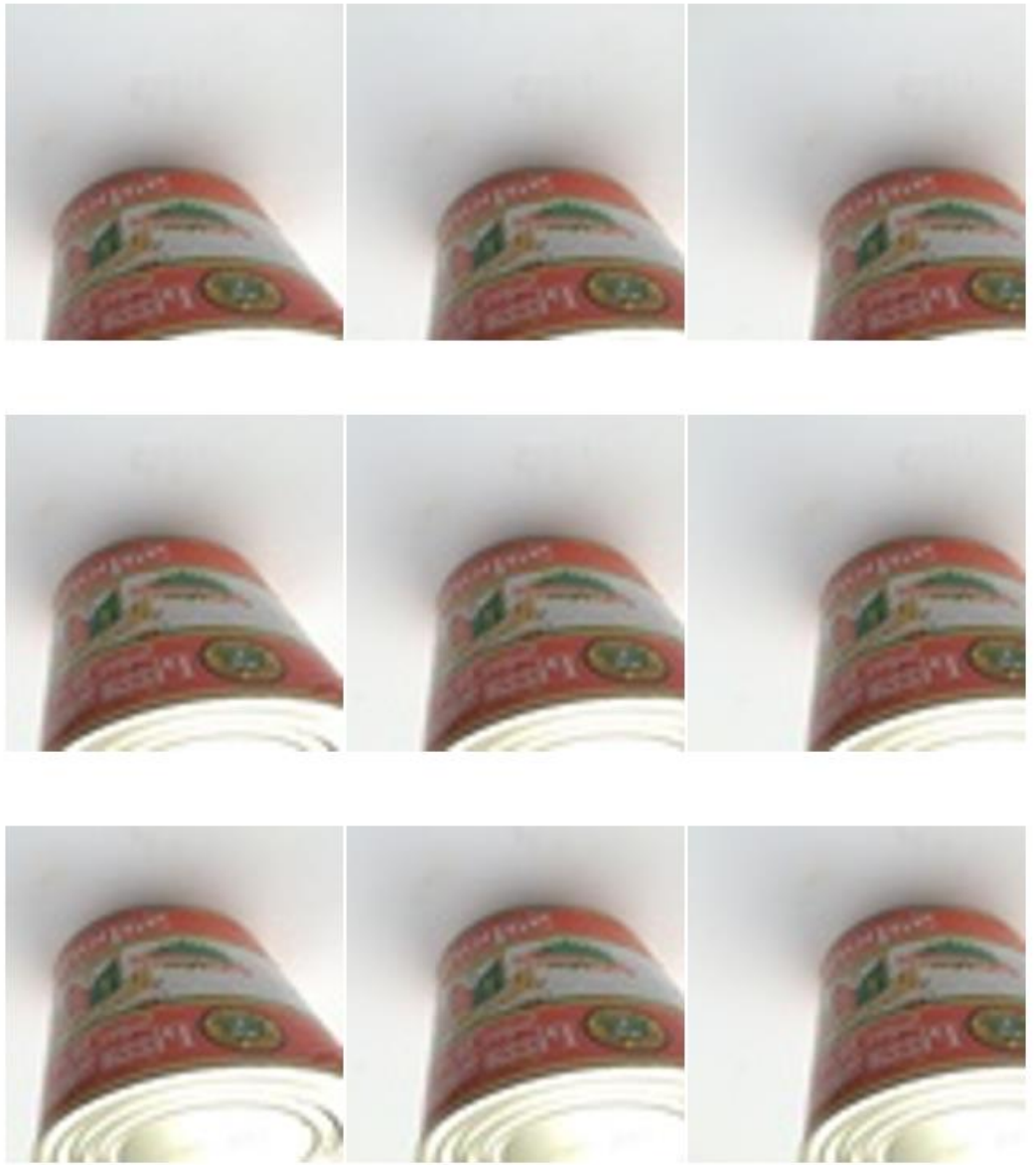
Orginal photo

Design & Rationale

- After enlargement

Design & Rationale

- After enlargement



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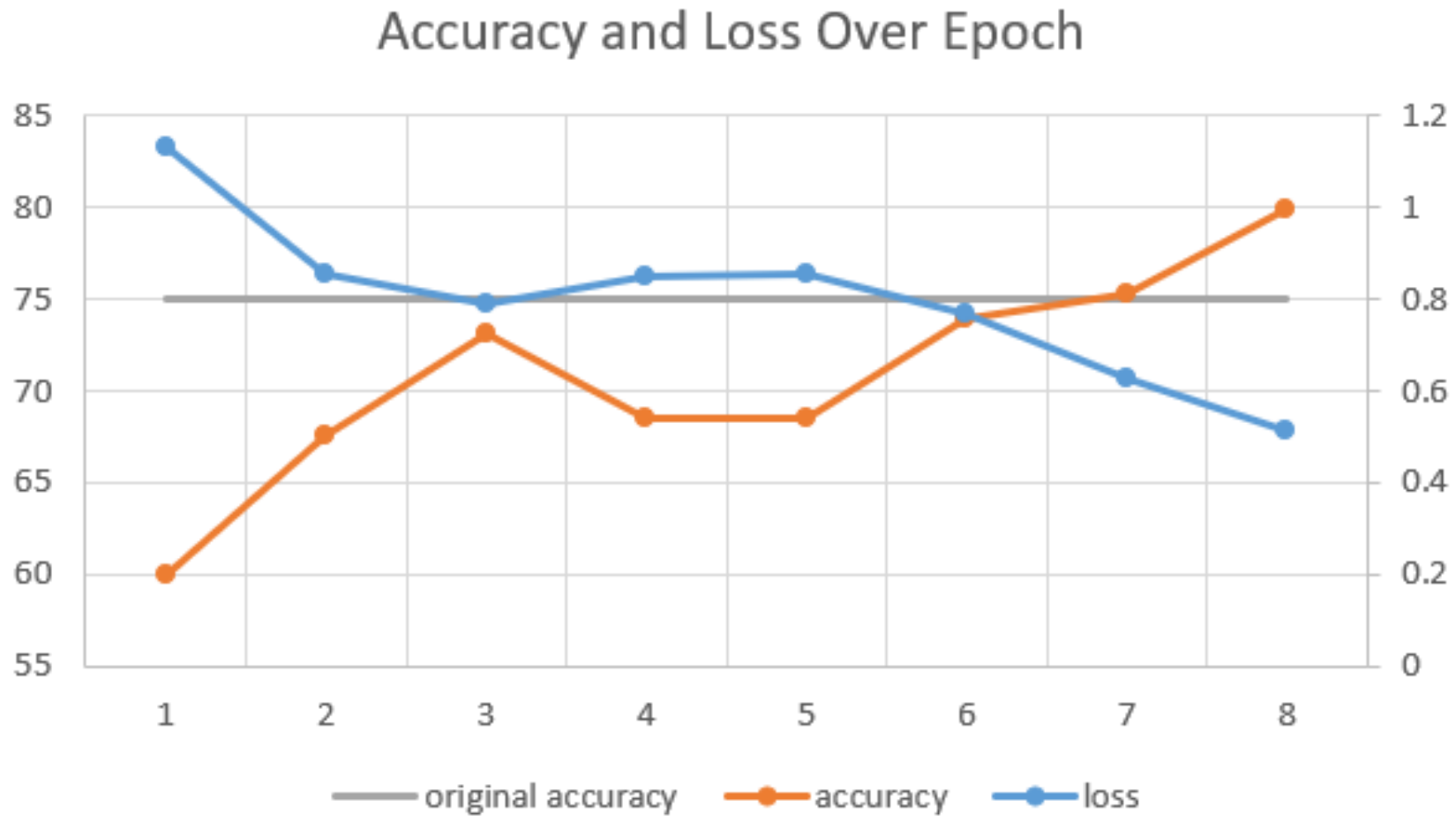
Test Result & Discussion

Table of loss, accuracy for each epochs

epoch	loss	accuracy
1	1.132	59.92
2	0.855	67.57
3	0.789	73.11
4	0.849	68.45
5	0.853	68.46
6	0.77	73.88
7	0.626	75.27
8	0.5148	79.96

Test Result & Discussion



Test Result & Discussion

- With 8 epochs, the training accuracy is 79.96% and the test accuracy is 79.51%.
- More time are needed for getting better results for more epoches.

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Conclusion

- Supported by our enlarged data, the training set we used, known as Resnet50, is better than the orginal model given by the dataset provider.

Thank You For Listening!

Any Questions?