Grading Apples With Transfer Learning.

Problem Statement

Grading the apple decides which apple would be sold at what price point. Usually, in order to do this, people would need to hire a person who has a lot of experience in the field and that would add excess cost to a farmer or a marketer of the fruit. If this grading is automated, it would save a lot of money and time for all the parties involved. Starting from the very first farmer of the fruit to the end consumer.

The data used here is publicly available on Kaggle and can be downloaded from here. The dataset has about 44406 images of labeled pictures of apples from Grade A to Grade F.

What is Transfer Learning?

Transfer Learning is a technique in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. For example, knowledge gained while learning to recognize cars could be applied when learning to recognize trucks.

Tensorflow Hub

Tensorflow Hub is a library of publication, discovery and consumption of reusable parts of machine learning models. A module is a self-contained piece of Tensorflow graph, along with its weights and assets, that can be reused across different tasks in a process known as transfer learning. Transfer learning can:

1. Train the model with a small dataset,
2. Improve generalisation,
3. Speed up training.

MobileNet

MobileNet is a light-weight model that was built by Google back in 2017. As the name suggests, this model was built so that the models would be so light weight, they could work on mobiles.

The input shape of a MobileNet V2 in 224x224 in size.

The research paper for MobileNets is available here.

MobileNet Architecture

Table 1. MobileNet Body Architecture

Type / Stride	Filter Shape	Input Size
Conv / s2	$3 \times 3 \times 3 \times 32$	$224 \times 224 \times 3$
Conv dw / s1	$3 \times 3 \times 32$ dw	$112 \times 112 \times 32$
Conv / s1	$1 \times 1 \times 32 \times 64$	$112 \times 112 \times 32$
Conv dw / s2	$3 \times 3 \times 64$ dw	$112 \times 112 \times 64$
Conv / s1	$1 \times 1 \times 64 \times 128$	$56 \times 56 \times 64$
Conv dw / s1	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 128$	$56 \times 56 \times 128$
Conv dw / s2	$3 \times 3 \times 128$ dw	$56 \times 56 \times 128$
Conv / s1	$1 \times 1 \times 128 \times 256$	$28 \times 28 \times 128$
Conv dw / s1	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 256$	$28 \times 28 \times 256$
Conv dw / s2	$3 \times 3 \times 256$ dw	$28 \times 28 \times 256$
Conv / s1	$1 \times 1 \times 256 \times 512$	$14 \times 14 \times 256$
$5\times$ Conv dw / s1	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
$5\times$ Conv / s1	$1 \times 1 \times 512 \times 512$	$14 \times 14 \times 512$
Conv dw / s2	$3 \times 3 \times 512$ dw	$14 \times 14 \times 512$
Conv / s1	$1 \times 1 \times 512 \times 1024$	$7 \times 7 \times 512$
Conv dw / s2	$3 \times 3 \times 1024$ dw	$7 \times 7 \times 1024$
Conv / s1	$1 \times 1 \times 1024 \times 1024$	$7 \times 7 \times 1024$
Avg Pool / s1	Pool 7×7	$7 \times 7 \times 1024$
FC / s1	1024×1000	$1 \times 1 \times 1024$
Softmax / s1	Classifier	$1 \times 1 \times 1000$

Training the model

The model after downloading was broken into 2 parts. Training and Validation. The model was trained using Google Colab on a Tesla K80 GPU and Intel Xeon processor. The training time took somewhere between 10 mins to 12 mins. Since we had only 6 classes, we attached a Dense layer with “softmax” activation to get the output in one of those 6 classes.

Talking Metrics

Initial training got us an accuracy of 99% and validation accuracy of 92%. Using checkpoint and learning rate scheduler, we were able to get the model in a specific epoch where the accuracy was 99% and validation accuracy was 98%.

The learning rate used is 0.001.

Batch size is 35.

Talking about Impact

The model performs pretty well and can serve as a handy tool for rookies in the business to classify or grade apples in various classes. This would not necessarily eliminate the need for an expert but would definitely reduce the dependence and make the process smooth and faster.

Thank You

Question?