Capstone project proposal
Inventory Monitoring at Distribution Centers

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1 Domain Background

Delivery and logistics systems are essential to many sectors of the economy today. The COVID-19 outbreak demonstrated the serious effects of even minor disruptions in the logistical system. As a result, large warehouses need automated systems that can sort and distribute goods based on a variety of factors, including delivery address and material type. In these warehouses, shipments and other products are typically transported in boxes, each of which can accommodate many items. The automated delivery system's job would be to categorize the package and choose where to deliver it. The system first has to know how many items are in each delivery box, and the proposed Capstone project will focus on that.

To count the number of objects in a box, I'd like to use the Amazon Bin Image Dataset, which contains a photo of the box's contents as well as other object features such as the number of objects. The implemented solution will estimate the number of objects based on this image.

2 Problem Statement

Develop a model for counting the number of objects in each bin using a photo of the contents of the bin. In order to predict future false detection rates, the delivered model should have known accuracy.

3 The datasets and inputs

I'll be using the Amazon Bin Image Dataset to finish this project. Only 10,000 images labeled with the number of items inside a bin will be used from this dataset. After post-processing, the dataset will be divided into training, validation, and testing.

The dataset is described by Amazon as having nearly 500,000 photos and metadata from bins of a pod in an active Amazon Fulfillment Center. The bin photos in this dataset were taken when robot units moved pods as part of regular operations at an Amazon Fulfillment Center.

A 10,000 object subset will be split into three subsets, each with a ratio of 60/20/20, for training, testing, and validation.

The number of photos per class in the chosen dataset will be balanced, i.e., there will be an equal number of testing, training, and validation images for each class (number of objects in the bin).

4 Solution statement

An ML model that can count the number of objects in a box based on a photo of the box's contents will be the project's solution. To evaluate the model's quality, the accuracy of the given model will be computed.

5 Benchmark model

As a starting point, I'd like to use the ResNet-50 image classification network. ResNet-50 is a 50-layer deep convolutional neural network. A pretrained model of the network, trained on more than a million photos from the ImageNet database, is available in the AWS cloud. The pretrained network can classify images into 1000 different object categories, including keys, animals, and notebooks. As a result, the network has learned detailed feature representations for a diverse set of images. The network accepts 224-by-224 image input.

6 Evaluation Metrics

The training process's quality will be assessed using standard metrics such as the cross-entropy loss function and precision (accuracy). These metrics will be used to measure and quantify the solution, as well as to ensure its repeatability for future improvements. A hyperparameter optimization may be required for the training procedure to ensure that the training process converges to the expected result and does not overfit to the dataset.

7 An outline of the project design

The project will be developed in the AWS domain using Sagemaker notebooks, with some options to reduce future development and network training costs. The following are the main steps to be taken in the project:

1. Data preparation
    - obtaining information from a database,
    - pre-process the data and divide it into testing, training, and validation subsets.
    - Upload the data to the S3 container.
2. Model tuning
    - Tune the hyperparameters of the selected model.
    - Train a machine learning model and observe if there are no anomalies in
    - Measure KPI metrics; are their values acceptable for deployment?
3. Model deployment
    - Verify that the model is working as expected.
    - Examine the outcome's quality. Determine whether the quality is acceptable or whether the training should be repeated.

This project will demonstrate the end-to-end machine learning engineering skills taught in this nanodegree.