Udacity AWS Machine Learning Engineer Capstone Proposal

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1. Domain Background

A Distribution Centre is a large warehouse where products/Goods are often stocked to be redistributed to wholesalers or retailers. Distribution centres are integral to the smooth running of a supply chain network between a company, it's vendors and ultimately the buyer of the goods.

The Distribution center is a large space housing so many goods stored in storage containers known as bins. These centers are usually busy with constant movement of goods in and out. It is therefore essential that the movement of this goods are done in a timely, efficient, and prompt manner. The efficient processing of a distribution center has a direct impact on the final price of the product delivered to the end user and an indirect impact on the cost of goods through reduced inventory.

2. Problem Statement

The act of Tracking the records of sales and inventories in a Distribution Centre manually can be very cumbersome, prone to errors and inefficient most especially for companies operating more than one Distribution centers and stores selling thousands of products per month. It's critical to manage the process accurately, efficiently, and cost-effectively devoid of error. Else, one loses the risk of failing to meet customer demand which ultimately degenerates into increased costs and reduction in revenue.

This process can be largely augmented by the application of Computer vision and Machine learning to detect and classify various images present in a particular bin and computes its resulting count which ultimately can be useful in predicting stock level. Managing inventory strategically has never been more important, and it only gets more challenging as product development evolves.

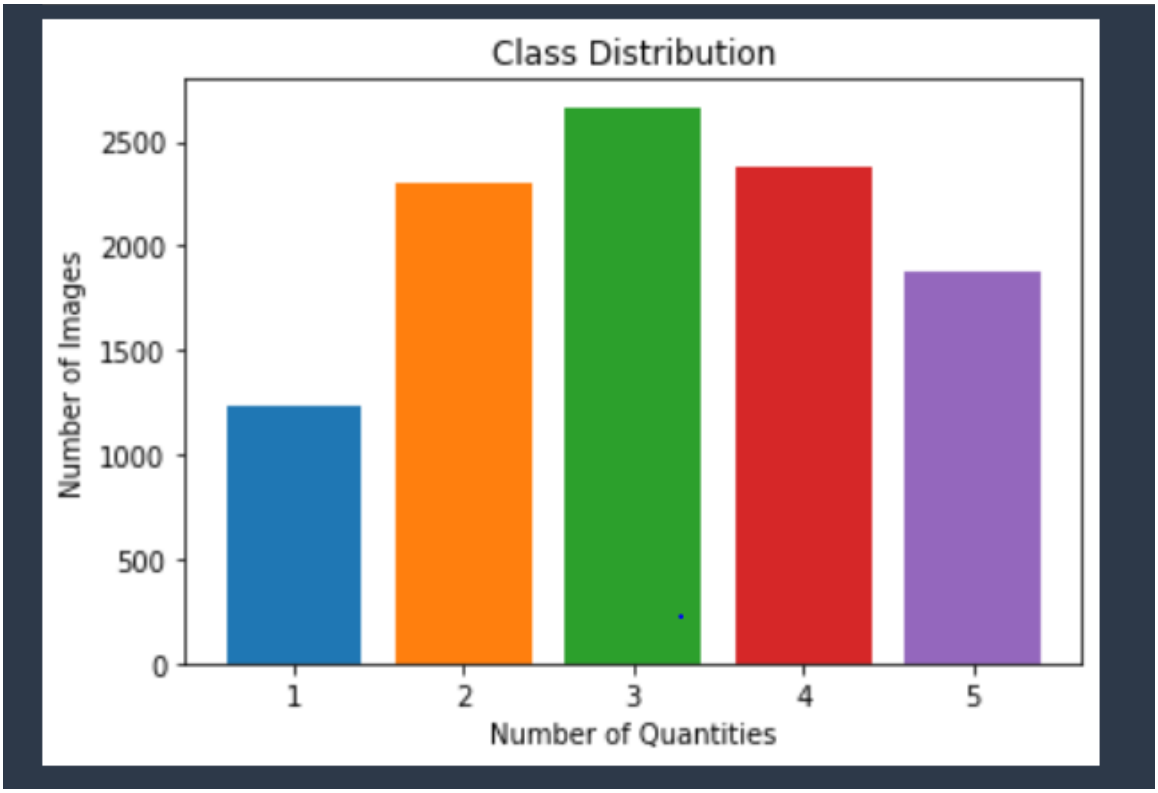
3. Datasets and Inputs

The lifeblood of any organization is Data. In other to achieve these projects below are the necessary Dataset components to be sourced/utilized from the **Amazon Bin Image Dataset, AWS and the internet.**

Dataset Information

1. This Dataset consist of about 535,000 images in jpg format of Bins alongside a corresponding metadata of the items contained in each Image in json format. This data is available in an S3 bucket named (**aft-vbi-pds**) in the US-east-1 AWS region
2. There is a unique numerical identifier of each image and the corresponding metadata pair, for example the image named 1000.jpg will have its metadata named 1000.json. See below
    - image(1000.jpg) and json file (1000.json)

3. The quantity of items contained in each bins varies across the bins. Only a subset of the data would be used for the project. And chosen in such a way that the number of objects is between I and 5. The class distribution of the subset is not balanced. Below is a screenshot of the subset of the data.



4. The metadata(json) file contains information like the associated Image name, expected quantity of items, dimensions and units of each item.

Data Inputs

1. Items information (SKUs, Dimension, Number of Items) which in this case of these project can be gotten from the metadata file
2. Images of the storage containers (BINS)
3. BIN image Information e.g Number of Objects

Algorithm

1. Convolution Neural Network
2. PyTorch Deep Learning Framework will be used
3. Model Hyperparameter Tuning

Resources

1. AWS sagemaker
2. S3

3. Endpoints
4. Other Amazon web services as needed

4. Solution

The project would be solved by leveraging on deep learning (Convolutional neural network techniques) and machine learning. The dataset contains about 535,000 images of bins containing one or more objects. For each image there is a metadata file containing information about the image like the number of objects, it's dimension and the type of object. For this task, the aim is to classify the number of objects in each bin.
To perform the classification task, the model type would be a pre-trained convolutional neural network would be further trained and fine-tuned using SageMaker.

The Major aim of the project is to provide sufficient assurance that machine learning can be employed to devise a system that can be used to track inventory and make sure that delivery consignments have the correct number of items.

5. Benchmark Model

This project I am embarking on would evaluate the model output by accuracy(precision) with an aim to attaining a score with 55.67% or more. The author of the below project had obtained a score of 55.67% and made use of the resnet 34-layer architecture and trained from the scratch. This accuracy score would serve as the threshold for the project.

Amazon Bin Image Dataset Challenge by silverbottlep

6. Evaluation Metrics

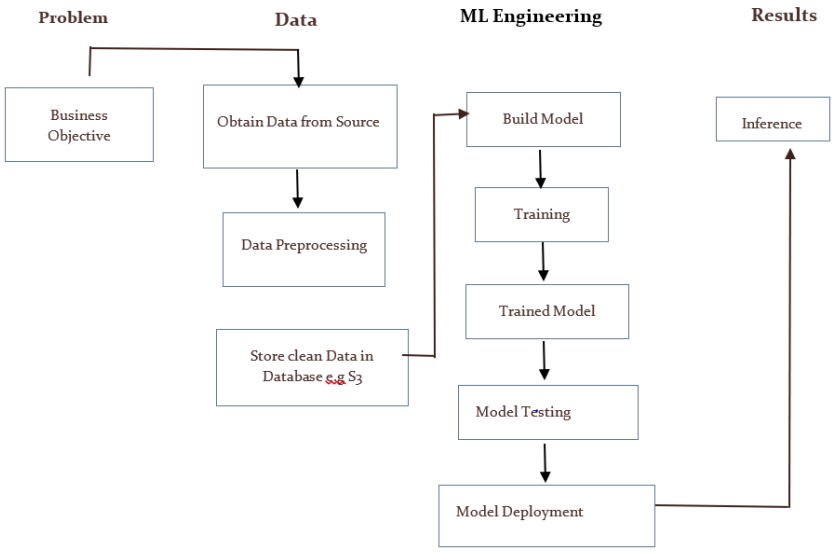
Being a classification exercise, the metrics to be used in this project is the Accuracy(precision)

$$\frac{1}{N}\sum_{i=1}^{N} 1[p_i == g_i]$$

1 being indicator function and p and g is prediction and ground truth respectively.

7. Project Design

Below is the flow diagram of the approach to solve the project and steps that would be carried out to obtain results.



1. Import necessary libraries
2. Download Images and perform Data splits into train, validation, and test data
3. Upload Data to S3
4. Perform image resizing to about 224X224, Normalize the image for zero mean and perform data augmentation using the transform library in pytorch
5. Use the Resnet34 or 50 Layer pretrained model to train model using sagemaker
6. Select learning rate, batch size and epoch as hyperparameter to tune.
7. Evaluate the trained model
8. Deploy model so it can be used for inference.

9. References

1. Inventory Management: Definition & Processes [2021] (shipbob.com)Df
2. Amazon BIN Image dataset Amazon Bin Image Dataset - Registry of Open Data on AWS
3. Documentation https://github.com/awslabs/open-data-docs/tree/main/docs/aft-vbi-pds
4. Amazon BIN Image Dataset challenge silverbottlep/abid_challenge: Amazon Bin Image Dataset Challenge (github.com)