Project Proposal - Inventory Monitoring at Distribution Centers

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Project write-up covers following sections related to Inventory Monitoring at Distribution Centers

- **Domain**
- **Problem Statement**
- **Solution Statement**
- **Overview of Dataset and Inputs used**
- **Benchmark Model**
- **Evaluation Metrics used**

Domain Overview

Distribution centers form the critical part of a supply chain. Goods are transported in and out of these distribution centers to the destination such as wholesale, retail stores, customer warehouse etc. Goods transported need to be efficiently handled and this applies for almost all industries irrespective of products manufactured. In order to streamline the process, company employ inventory monitoring steps to make sure right goods are moved to the right place.

- Improving inventory monitoring will result in streamlining entire supply chain and also improves customer and vendor management and relationship for an organization

- In this context, this project focus on how to implement Machine Learning +Computer vision to modernize and improve the inventory monitoring process

Problem Statement

Current setup in the company is based on manual process where the goods loading and movement and done by employees manually checking the assortment requirements and loading the cart. However, this process may lead to employee fatigue and low efficiency. In addition, there is possibility of error in loading goods based on correct quantity and type.

- This problem can be mitigated by using computer vision and Machine learning. Computer vision embedded in camera input can identify the objects / goods and can be integrated with Machine Learning based algorithm to identify various parameters such as count, type etc. This solution can be implemented as a solution framework which can be replicated.

- The efficiency of this solution can be tracked and measured using metrics such as accuracy, F1 score etc. Which is explored further in Evaluation Metrics section. Thus, the solution is measurable. The efficiency can also be measure by tracking the quantity of the good handled per day or per measuring time scale

Solution Statement

In this section we will deep dive into the solution approach

Solution requires following components

- Image Source (Camera)
- Algorithm to process the image – Convolutional Neural Network model
- Platform – Cloud

Image Source

- Image source is from a high-resolution camera and images of the goods, bundle and other components which forms part of inventory that are moved in the distribution centers.
- The technical details on high-end image capture are outside the scope of this project.
- As part of the solution, we will be used the pre-built data which is available in
- Amazon Bin Image Dataset - Registry of Open Data on AWS
- The data will be loaded into the S3 bucket of AWS cloud for consumption in the model training

Algorithm

- Algorithm that will be used as part of the solution is based on Convolution Neural Network architecture where the images are feed into the network to train the model and will be used for final classification based on the quantity of the goods in the image.
- PyTorch Deep Learning Framework will be used
- AWS Sagemaker instance will be initiated and image that is stored in S3 bucket will be used as part of data pipeline.
- Model will be tuned and model with best hyper parameter will be identified and deployed

Platform

- In this project AWS cloud platform will be used for model training and deployment
- AWS Sagemaker is a dedicated services for machine learning model training purpose and this will be used to train the deep learning model
- S3 will be used for data storage and training model storage
- Model will be deployed using Endpoint services in AWS

Optimal Sagemaker instance will be selected based on resource requirement and cost factor into consideration

Overview of Dataset and Inputs used

- Data can be downloaded from Amazon Open Data website https://registry.opendata.aws/amazon-bin-imagery/
- Data is captured by Amazon in their Fulfilment centre and has around 500000 images
- License

Creative Commons Attribution-NonCommercial-ShareAlike 3.0 United States (CC BY-NC-SA 3.0 US) https://creativecommons.org/licenses/by-nc-sa/3.0/us/

- Images are located in the bin-images directory, and metadata for each image is located in the metadata directory. Images and their associated metadata share simple numerical unique identifiers.

Inputs

There are two set of inputs for the model training

1. Images for the model, which is available in the source as JPEG file

Example

https://aft-vbi-pds.s3.amazonaws.com/bin-images/523.jpg

2. JSON format with meta data for the image

Example

https://aft-vbi-pds.s3.amazonaws.com/metadata/523.json.

From the JSON file, we can filter the target label which the quantity of the objects in the image

Benchmark Model

- **Following result from silverbottlep** is taken as benchmark result for model training **https://github.com/silverbottlep/abid_challenge**

- **The author has achieved an overall accuracy score of 56 % (Approx.) which will be considered as benchmark and this experiment will focus to achieve this**

Evaluation Metrics used

Evaluation metrics used – Overall Classification accuracy, F1 score for the classes

Reference

https://registry.opendata.aws/amazon-bin-imagery/

https://aft-vbi-pds.s3.amazonaws.com/metadata/523.json.

https://www.mckinsey.com/industries/metals-and-mining/our-insights/succeeding-in-the-ai-supply-chain-revolution

Amazon Bin Image Dataset - Registry of Open Data on AWS