Capstone proposal: Inventory Monitoring at Distribution Centers

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1. Domain Background:

Inventory monitoring is crucial for businesses as it impacts production, warehouse costs, and order fulfillment. Effective inventory management helps contain costs, ensures businesses have the correct amount of stock, and cuts down on excess inventory. By keeping track of inventory, businesses can streamline production and fulfillment processes, lower costs, minimize storage needs, and forecast sales trends. It also provides critical data to help businesses respond to trends, avoid breakdowns in supply chain management, and maintain profitability. An accurate inventory monitoring system allows businesses to understand what products need to be bought and in what quantities, helping them reduce the holding costs of inventory that does not sell. Overall, inventory monitoring plays a vital role in keeping businesses organized, optimizing operations, and satisfying customers with timely deliveries.

2. Problem Statement and Solution:

Advances in Artificial Intelligence, especially in computer vision, allowed novel approaches for monitoring inventory in real time. This project is about one of them: Imagine warehouses where robots put and pick items to be delivered in bins. These robots have cameras attached to them and take photos of these bins. The photos are then uploaded to the cloud and are the inputs to a machine-learning pipeline that classifies the number of objects in the bins. This output and other metadata, like SKU names, can be sent to the company's inventory system to update the product stock. The described situation is approximately what happens at Amazon's distribution center, and this project will use an Image dataset they provided.

The project aims to develop a machine-learning pipeline that leverages AWS services to build an Image Classifier that counts the number of objects present in the distribution center's bins. Besides that, profiling and debugging will be performed in order to evaluate how the pipeline could be improved.

3. Dataset:

The Amazon Bin Image Dataset contains over 500,000 images and metadata from bins of a pod in an operating Amazon Fulfillment Center. The bin images in this dataset are captured as robot units carry pods as part of normal Amazon Fulfillment Center operations.
We are working with a subset of this data that contains:
- 1228 images with 1 object
- 2299 images with 2 objects
- 2666 images with 3 objects
- 2373 images with 4 objects
- 1875 images with 5 objects

The dataset should be processed into train, test, and validation splits. It should also be uploaded to S3 so It can be used as input for Sagemaker training jobs.

4. Benchmark Model and Evaluation Metrics:

decided to perform transfer learning on a ResNet50 model using Pytorch. Resnet50 models were already used in other projects throughout the NanoDegree and have shown good results. The idea is to see whether this architecture will be good enough for this task once it is more complex and resembles more an Object detection task than a Classical Image Classification problem.

The primary metric used to classify the model's performance will be the average test set accuracy:

$$\text{Accuracy} = \frac{(TP + TN)}{(TP + FP + TN + FN)}$$

5. Project workflow:

The project can be broken down into the following steps:

1. Create Sagemaker Studio environment and clone starter files repository
2. Download and preprocess it
3. Upload dataset to s3
4. setup sagemaker profiler and debugging rules
5. Create and fit estimator
6. evaluate the results