Inventory Monitoring at Distribution Centers

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Proposal Overview

Distribution centers often use robots to move objects as a part of their operations. Objects are carried in bins which can contain multiple objects. Have a way to check the count of those items and avoid losing them to ensure quality of service is good practice for any distribution center.

In this project proposal, I will build a model that can count the number of objects in each bin. A system like this can be used to track inventory and make sure that delivery consignments have the correct number of items.

To build this project, I will use AWS SageMaker and its services with good machine learning engineering practices to fetch data from a database, preprocess it, then proceed to train, refine, evaluate and validate a machine learning model.

Problem Statement

Inability of robots to keep count of the objects inside the bins without continuous human monitoring.

Datasets and Inputs

- **Name:** Amazon Bin Image Dataset
- **Description:** 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.
- **Documentation:** https://github.com/awslabs/open-data-docs/tree/main/docs/aft-vbi-pds
- **Contact**: amazon-bin-images@amazon.com
- **Managed By:** Amazon (https://www.amazon.com/)
- **Update Frequency:** Not updated
- **License:** Creative Commons Attribution-Non-Commercial-ShareAlike 3.0 United States (CC BY-NC-SA 3.0 US) https://creativecommons.org/licenses/by-nc-sa/3.0/us/
- **Resources:**
    - **ARN** : arn:aws:s3:::aft-vbi-pds
    - **Region** : us-east-1

  - **Type** : S3 Bucket
  - **AWS CLI** : aws s3 ls --no-sign-request s3://aft-vbi-pds/

- **Explore:** https://aft-vbi-pds.s3.amazonaws.com/index.html
- **Classes:** The number of classes used for this project will be directly related to the number of objects which should be identified in every picture. In this case, we will use 5 classes:
  - Class 1 for pictures with 1 object
  - Class 2 for pictures with 2 objects
  - Class 3 for pictures with 3 objects
  - Class 4 for pictures with 4 objects
  - Class 5 for pictures with 5 objects

Solution Statement

Proposed solution is creating object count tracking machine learning model using AWS Sagemaker as solution for counting number of objects in each bin based on a photo of its content.

I will be using 10,441 labeled images from Amazon Bin Image Dataset. Dataset will be pre-processed and split into train, test and valid with ratios 60, 20 and 20% respectively.
In the selected (based on provided Json file) number of images per class will be balanced, meaning each class (objects count in bin) there will be similar number of train, test and validation images.

Benchmark Model

In the same domain, I found 2 contributions:

- Title: Amazon Bin Image Dataset Challenge:
  - URL: https://github.com/silverbottlep/abid_challenge
  - AuthorName: silverbottlep
  - AuthorURL: https://github.com/silverbottlep
- Title: Amazon Inventory Reconciliation using AI:
  - URL: https://github.com/OneNow/AI-Inventory-Reconciliation
  - AuthorName: Pablo Rodriguez Bertorello, Sravan Sripada, Nutchapol Dendumrongsup
  - AuthorURL: https://github.com/pablo-tech

The resulted accuracy of both contributions is 55% approximately with a RMSE of 0.94. I will be trying to challenge or provide similar accuracy.

Evaluation Metrics

Training process will be evaluated using standard metrics:

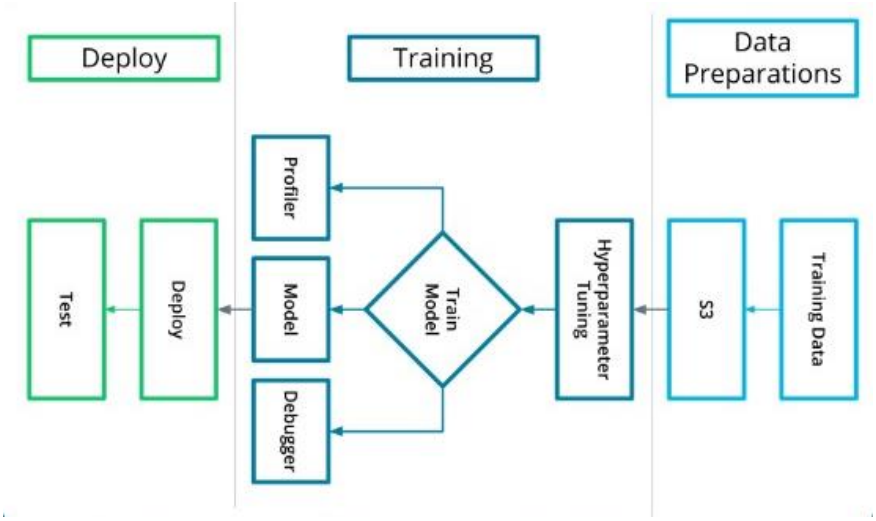
- Cross Entropy Loss function
- Precision(accuracy).

These metrics will evaluate the solution and ensure future improvements.

As the training process hyperparameter optimization will be used to ensure optimal result without overfitting.

Project Design

The project will be designed with AWS Sagemaker notebook with best machine learning engineering practices to limit the cost and provide future development with network training.



Design Process:

1. Data preparation:
    a. Train data (Fetch, Preprocessing data and Split data into train, test & valid).
    b. Upload the data to S3 container
2. Training:
    a. Hyperparameters tuning.
    b. Train model.
    c. Profile, Debug and model (if there any anomalies and Improve with KPI metrics).
3. Deploy:
    a. Deploy the model.
    b. Test and valid the outcomes.