Machine Learning Engineer Nanodegree

Capstone Proposal

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Proposal

Domain Background

We have many e-commerce businesses around us and the main component of any e-commerce or retail business is the inventory. Many businesses own distribution centres and one of the main concerns is the monitoring the stocks. For example, Amazon has their own warehouses and logistics services known as Amazon Fulfillment centre. Among many concerns, inventory monitoring is a significant one.

Problem Statement

Inventory monitoring is a crucial job at any distribution centers. Many distribution centre are utilising robots to move objects as a part of their operations. Objects are carried in bins which can contain multiple objects. In this project, 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.

Datasets and Inputs

To complete this project I will be using the Amazon Bin Image Dataset. The dataset contains 500,000 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, I will try to classify the number of objects in each bin. The images are available here: s3://aft-vbi-pds/bin-images/. 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. For example, the metadata for the image at https://aft-vbi-pds.s3.amazonaws.com/bin-images/523.jpg is found at https://aft-vbi-pds.s3.amazonaws.com/metadata/523.json.

Following is an example image:

Following is the corresponding metadata file:

```json
{
  "BIN_FCSKU_DATA": {
    "B000A8C5QE": {
      "asin": "B000A8C5QE",
      "height": {
        "unit": "IN",
        "value": 4.200000000000001
      },
      "length": {
        "unit": "IN",
        "value": 4.7
      },
      "name": "MSR PocketRocket Stove",
      "quantity": 1,
      "weight": {
        "unit": "pounds",
        "value": 0.45
      },
      "width": {
        "unit": "IN",
        "value": 4.4
      }
    },
    "B0064LIWVS": {
      "asin": "B0064LIWVS",
      "height": {
        "unit": "IN",
        "value": 1.2
      },
      "length": {
        "unit": "IN",
        "value": 5.799999999999999
      },
      "name": "Applied Nutrition Liquid Collagen Skin Revitalization, 10 Count 3.35 Fl Ounce",
      "quantity": 1,
      "weight": {
        "unit": "pounds",
        "value": 0.3499999999999999
      },
      "width": {
        "unit": "IN",
        "value": 4.7
      }
    }
  },
  "EXPECTED_QUANTITY": 2,
  "image_fname": "523.jpg"
}
```

The metadata file contains the expected quantity.

Solution Statement

My capstone project is going to be about inevntory monitoring. In this project I will create an Image classification system, which will be able to determine how many objects are present in a certain space at one time.

Benchmark Model

For benchmarking, I will create a simple Convolutional Neural Network model. Using this model, I will calculate the accuracy. Following on from here I will fine tune a pretrained model and compare the result. I am planning on using PyTorch library for creating the CNN model.

Evaluation Metrics

Evaluation metrics for this project will be two standrad metrics, accuracy(precision) and root mean square error(RMSE).

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}}$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}\left(Predicted_i - Actual_i\right)^2}{N}}$$

Project Design

I will first download the subset of the bin image data ([Amazon Bin Image Dataset (https://registry.opendata.aws/amazon-bin-imagery/)](https://registry.opendata.aws/amazon-bin-imagery/)). as suggested. Then I will create train, validation and test split. I plan to make 80% train, 10% validation and 10% test dataset split.

I will apply some data augmentation (RandomRotation, Resize) on the images while generating the data loaders. I will then train my initial benchmark model. I will calculated accuracy and RMSE of the model.

Following on I will finetune a pretrained model using PyTorch library and I will calculated accuracy and RMSE of the model.

I will then compare the performance of these two models.

References:
Amazon Bin Image Dataset was accessed on 10th March 2023 from https://registry.opendata.aws/amazon-bin-imagery.