

## **Team Copy-Waste - Project Bazaar 1**

### **Team Member (Re)introductions**

- Nolan - Machine Learning Lead
- Will - Back-End Services Lead
- Rishabh - Front-End Services Lead

### **Vision:**

Our project has two objectives; reduce risks to the public, waste management employees and facilities and reduce the cost to municipalities and waste management companies caused by rare and severe contaminants in recycling waste collection.

### **Mission**

We strive to achieve our vision by automating the detection of severe and rare contaminants in the recycling stream

### **Business Need**

Our business need, to reiterate, is to reduce risk and cost to municipalities and waste management employees. As recycling rates increase, contamination and risk becomes a growing concern.

### **Current: Status Green**

### **Individual Contributions (Dec 6 - Jan 25):**

#### **Will:**

- Collecting and annotated True Negative image datasets
- Separated and categorized images for testing and training using python scripts
- Created, trained, and generated results for initial YOLO detection model
- Creating python scripts to import an audited annotation dataset for Copy Paste

#### **Rishabh:**

- Collecting annotated images of Prairie Robotics audited hopper images
- Research implementations of Copy Paste data augmentation
- Begin prototype version copy paste augmentation on a subset of images

#### **Nolan:**

- Trained Bin Detector in YOLOv5
- Evaluated Model Performance
- Collected additional training images and retrained detection model
- Created simulation videos to evaluate model performance with business logic.

- Working with our Industry Partner to deploy our model in their production environment and edge computers (recycling trucks).

### **Project issues / changes**

- Limited resources on implementing copy paste augmentation leading us to rely heavily on personal research and experimentation as this methodology was published June of 2021.
- TPU stick for processing tensors is no longer necessary as our Industry Partner has upgraded their edge devices to a more powerful model.
- First prototype for Copy-Paste will use yard waste images as we have a readily available source of validation images, whereas validation data for propane tanks and batteries requires cooperation of a third party.

### **Bin Tip Detector**

This is a demonstration and comparison of our Bin detector between our first model and our most recent model. On the left you can see the original model struggled with classification and would frequently get confused. On the right, the re-trained model using more cycles, additional images and fewer classes, performs significantly better.

Here is the confusion matrix produced after training our most recent model, it has high precision and recall. We compiled a number of tables to evaluate model performance on validation and training dataset where we can see the number of false positives and false negatives. Our most recent model has an accuracy of 94.8% for detecting blue recycling bins.

The model is ready for real world deployment, we will be working closely with our industry partner to deploy it to multiple municipalities

### **Simple Copy-Paste**

This flow chart describes our intended plan for the data augmentation pipeline. It begins by a Waste Management worker identifying a contaminant for detection, then using the copy-paste data augmentation methodology, we can produce an artificial dataset composed of real world images from our industry partner and samples of the requested contaminant. The final product will be a trained object classification model.

Our current data augmentation prototype utilizes a background image and the image where objects will be extracted from. In this case the left image will be the background image and the right image consists of contaminants which will be extracted. **The** following image is produced as a result of applying this method which performs basic image transformations and applies the annotations.

## **Waste Management Dashboard**

This is our dashboard for municipal decision makers with easily accessible information on how various regions around the city are performing. Through coloured signifiers it provides information regarding performance such as number of offenders, contaminants detected and contamination rate.

### **Next up**

#### **Team**

- Meetings planned with our Advisors and with Prairie Robotics
- Deploying our bin detector to a truck's edge computer

#### **Nolan**

- Test bin detector by deploying model to PR test truck
- Measure bin detector real-time performance on edge computer
- Measure bin detector performance against existing model
- Move onto Phase 2, begin implementation of the Simple Copy-Paste algorithm.

#### **Rishabh**

- Creating scripts for pasted object placement and transformations

#### **Will**

- Working towards running copy-paste on the audited dataset
- Working on exporting pasted images from the Copy Paste algorithm with combined annotations files

### **Team Reflection**

- **Does the team feel "on track"? (reiterate the above colour status)**
  - We believe we are still on track, time management has been a challenge. However, with the bin tip detector being deployed soon, all three of us will be working on the copy-paste pipeline which will increase productivity.
- **What progress does the team particularly feel good (great) about?**
  - We feel really great about the progress of the Bin Tip detector, we made significant improvements to the model's performance and our industry partner has enough confidence in our detector to deploy it to their production environment.
  - Our initial progress on Copy Paste has been extremely encouraging and we are excited about the next stages of our project.
- **What barriers (if any) does the team feel is a current impediment to success?**
  - Limited documentation has required us to allocate time for experimentation.
- **What help (if any) does the team require to move positively forward?**
  - Moving forward we need to keep having regular meetings with our industry partner to guide us.

- **What questions or concerns does the team have (if any)?**
  - No concerns at this time