

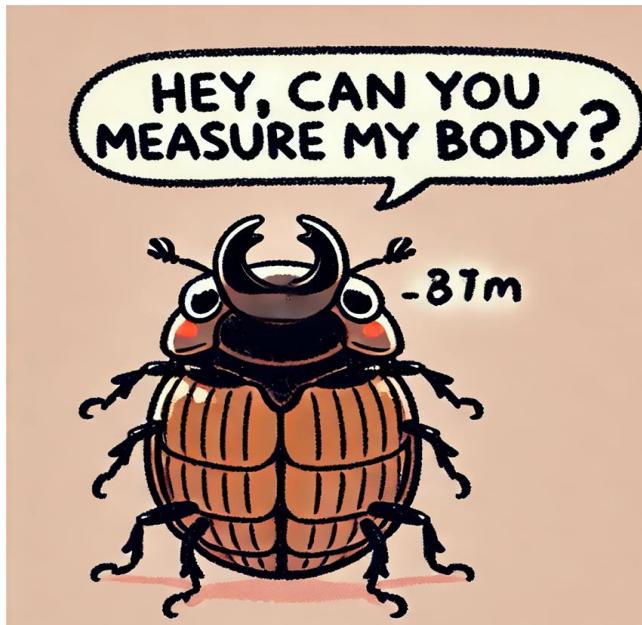


Zero-Shot Coordinate Prediction for Beetle Elytra Length and Width Measurement

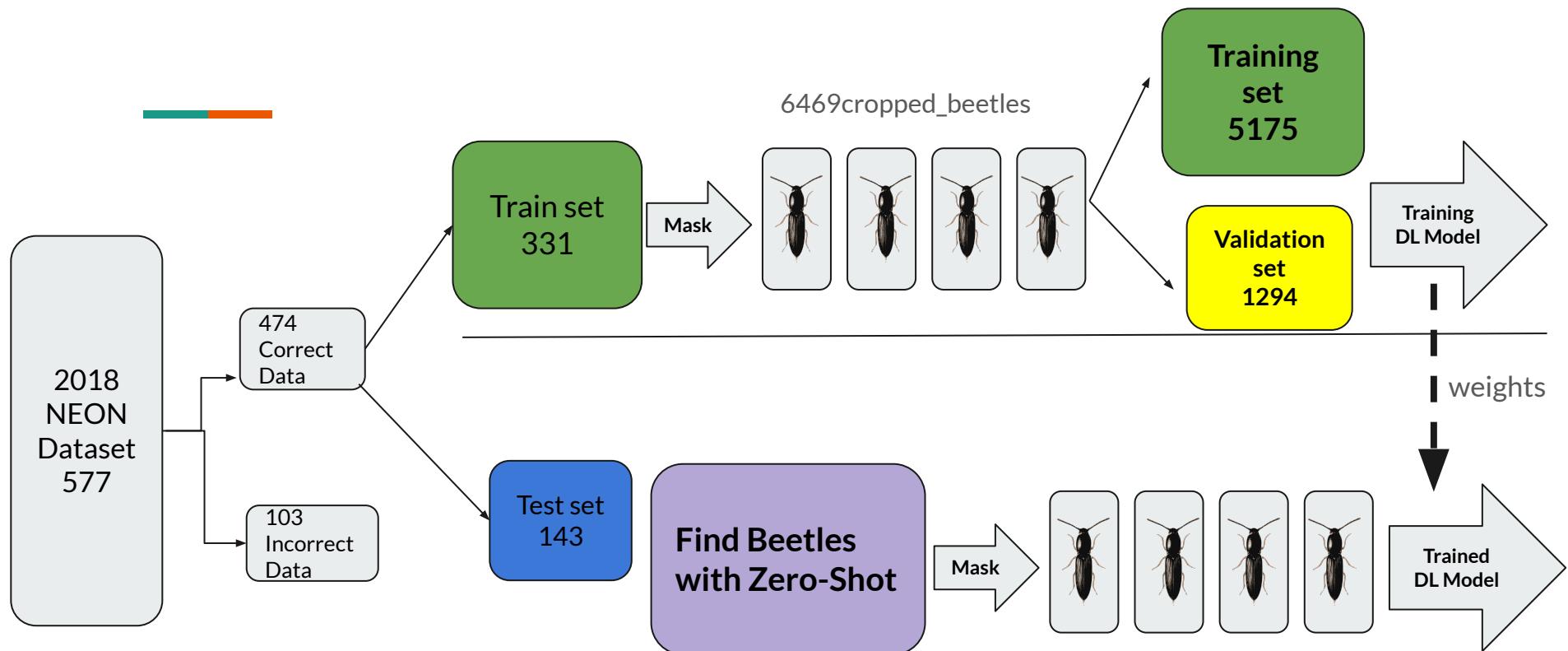
Hojin Yoo
Dhanyapriya Somasundaram

Goal:

- Automate beetle elytra coordinate generation without relying on Zooniverse.
- Emphasize the significance of this automation for large-scale entomological studies.



PROJECT WORKFLOW

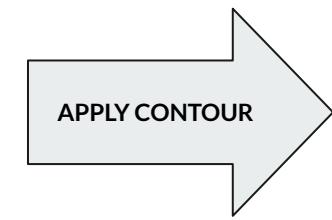
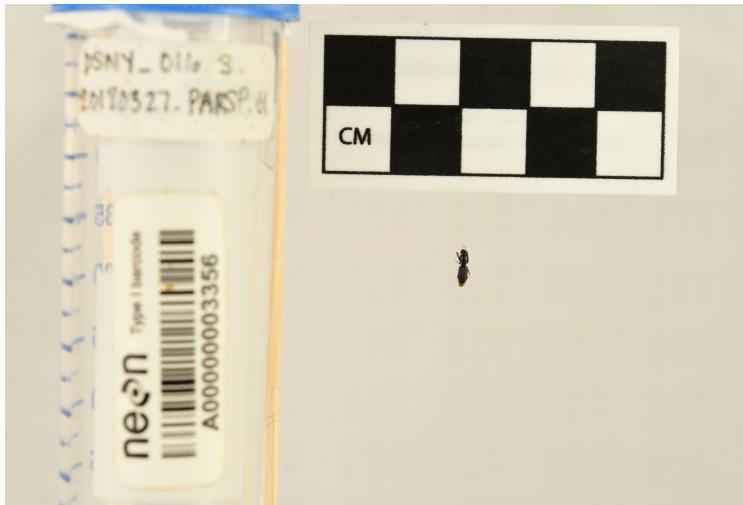


Methodology:

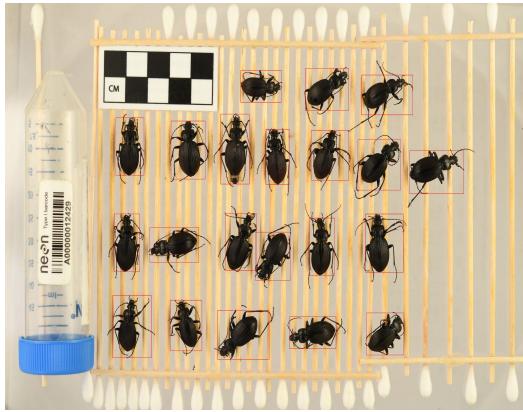
Dataset Acquisition and Preprocessing:

- **Download Dataset:** Obtain [2018-NEON](#) from Hugging Face.
- **Select Original Images:** Focus on 577 original high-resolution `group_images` for detailed analysis.
- **Mask Processing:**
 - Use `masked_images` to identify beetles using bounding boxes.
 - Removed 102 incorrect masks, leaving 474 valid ones.
- **Handle Overlapping Beetles:** Retain merged bounding boxes for overlapping beetles to avoid data loss.

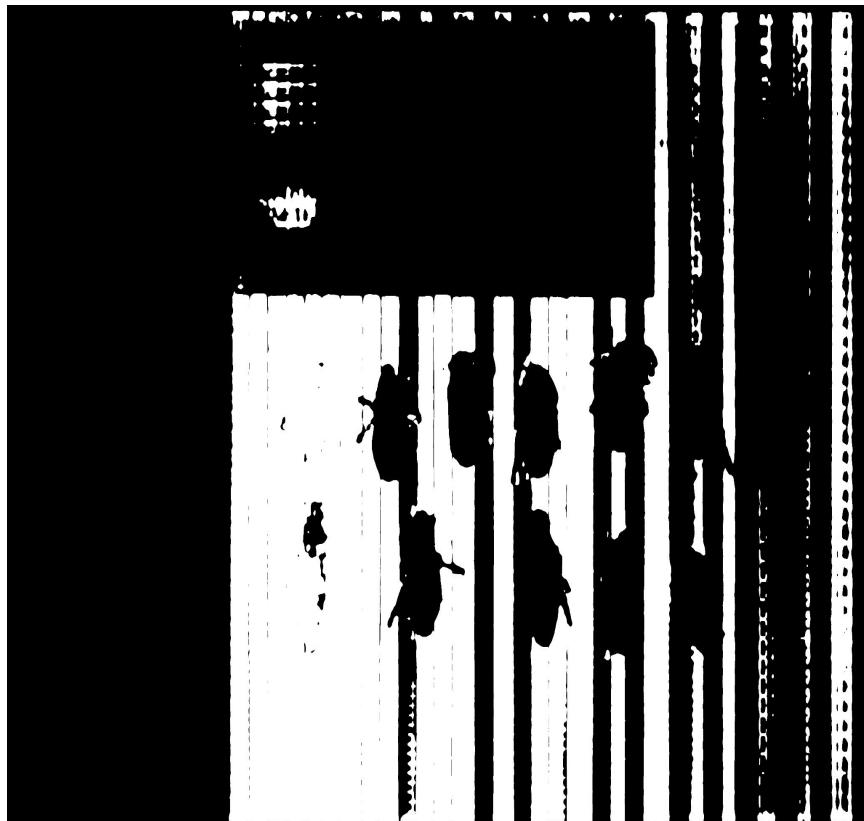
Mask Processing:



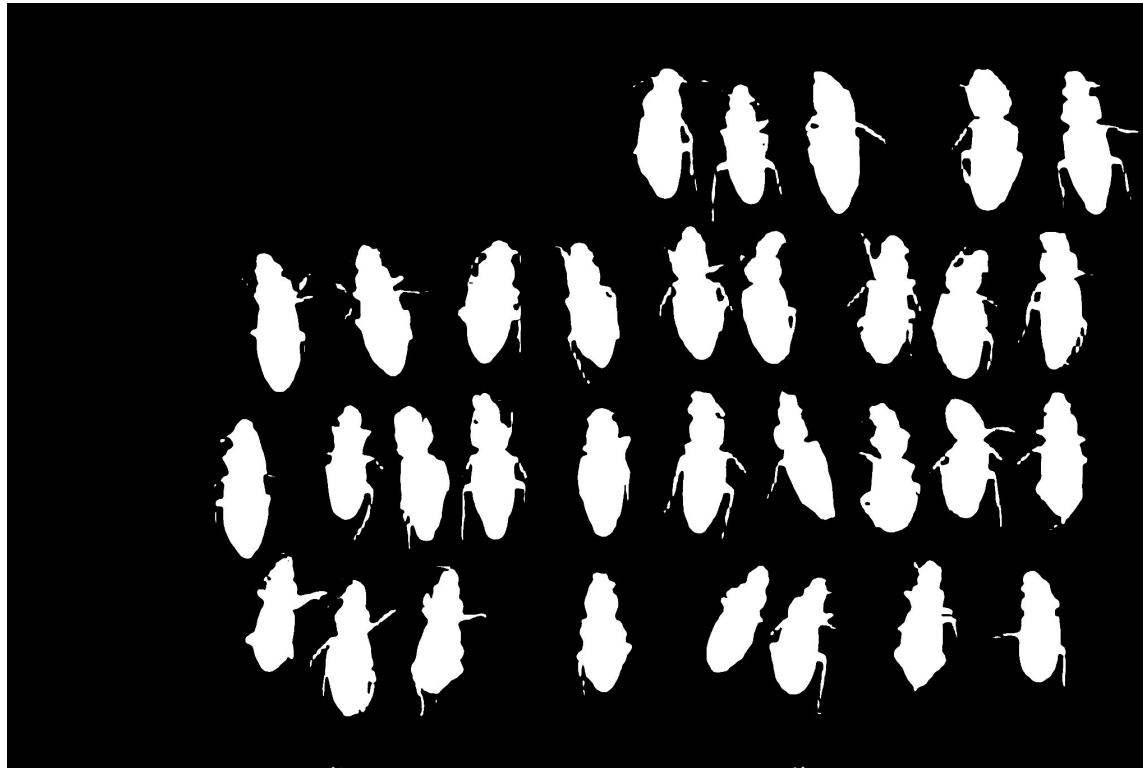
Identify the beetle using bbox



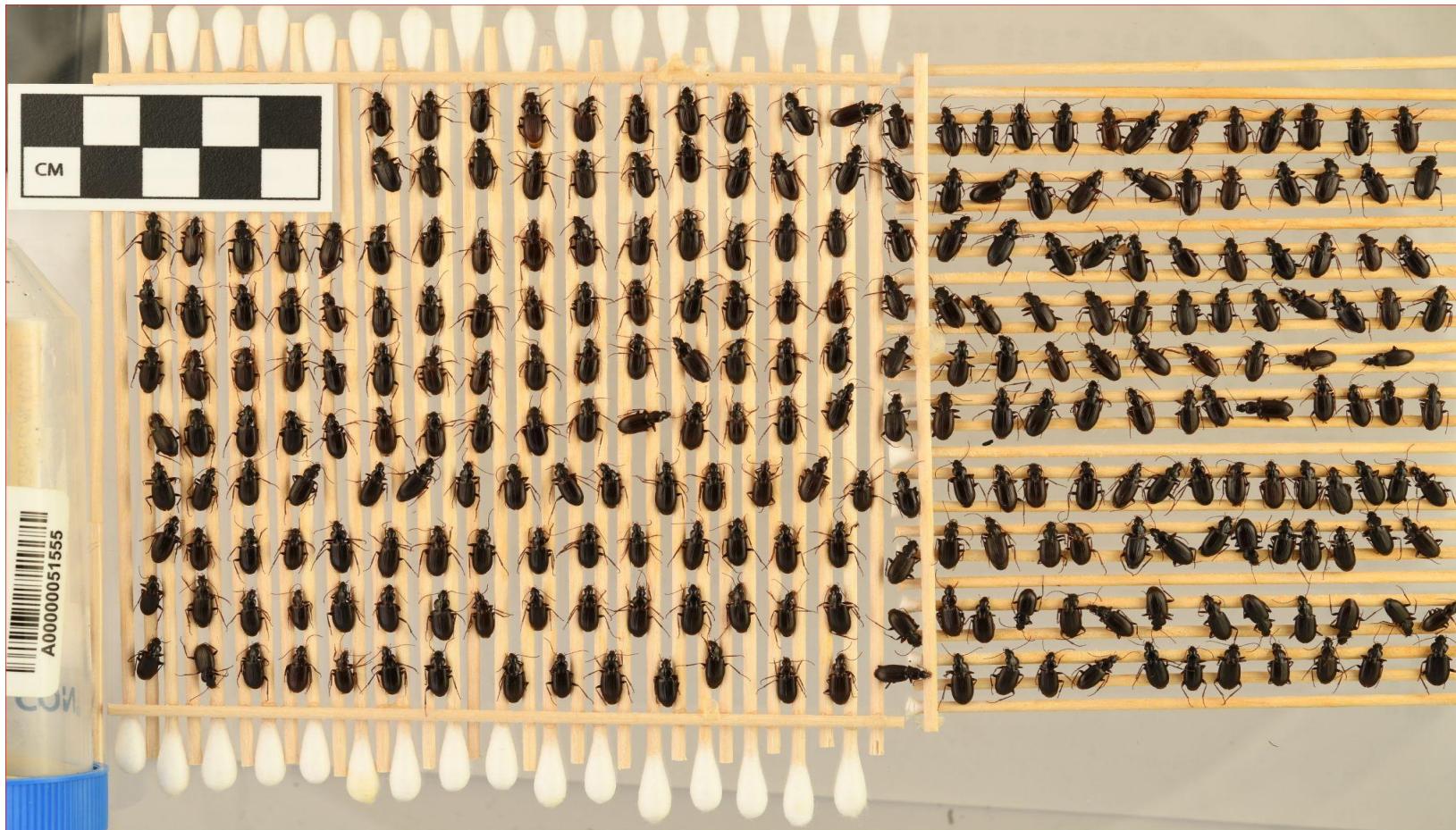
Remove 102 incorrect group_image_masks

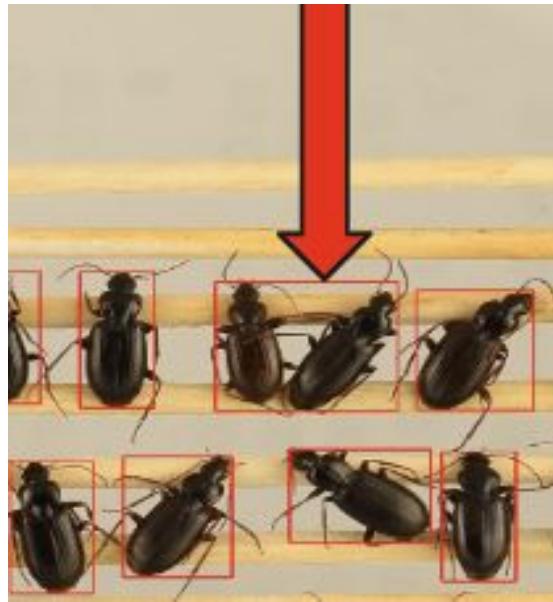
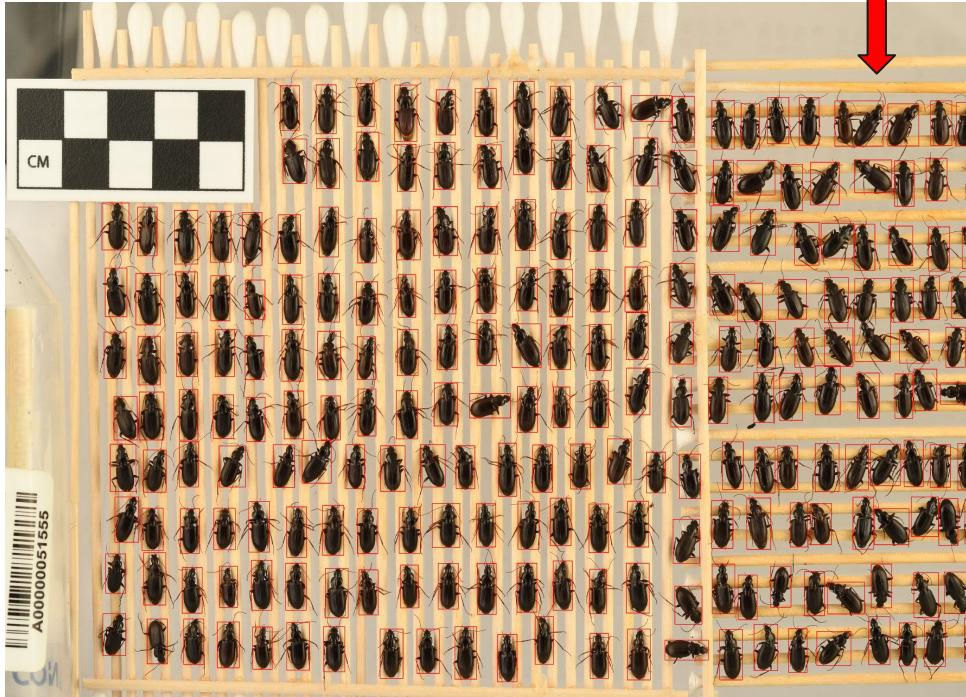


Retaining 474 valid group_image_masks



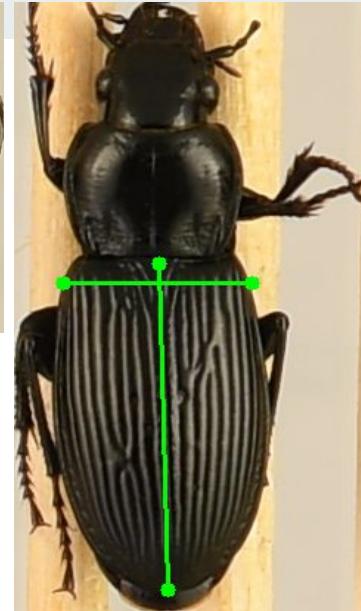
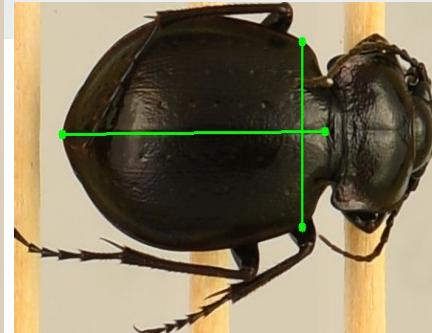
Handle Overlapping Beetles:





Ground Truth Creation:

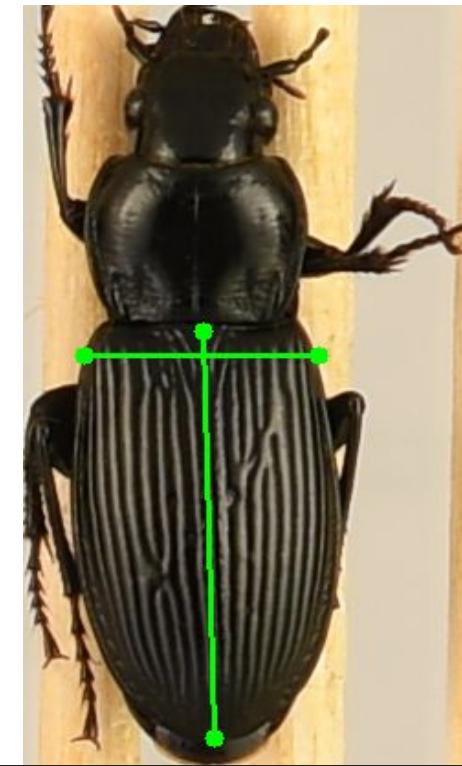
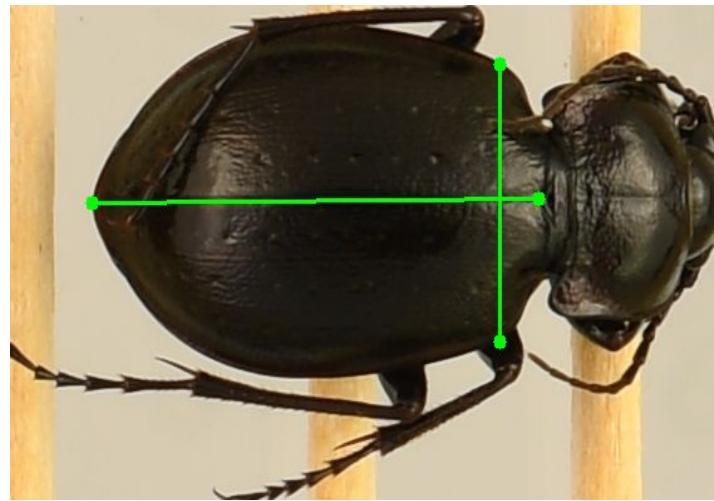
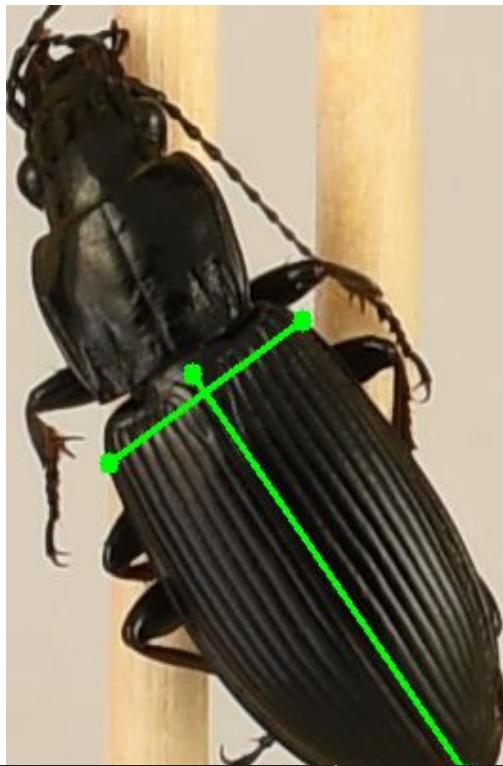
- Generate **GT.csv** from **BeetleMeasurement.csv**
- Columns:
 - **ImageID_BeetleID.png**: Unique identifier for each segmented beetle.
 - **Original Image Dimensions**: Key for coordinate scaling.
 - **Bounding Box Coordinates**: (x1, y1, x2, y2) defining each beetle's region.
 - **Elytra Coordinates**: Specific points marking elytra length and width.



STEPS:

1. Make a list of coords length, width
2. Find bbox of the beetle
3. Match the original coords with coordsBeetle_box
4. If len of matched coords==1, then save it to csv, else save the upper coords

Ground Truth Creation:



```
1 BeetleID,dim_ori_img,coords_beetle_box,coords_len,coords_width
```

```
2 A00000049798_000.png,"(3712, 5568, 3)","(3054, 2943, 3241, 3208)","(3125, 2997, 3146, 3205)","(3067, 2999, 3185, 2991)"
```

```
3 A00000049798_001.png,"(3712, 5568, 3)","(1902, 2816, 2328, 3157)","(2107, 2989, 1917, 3131)","(2065, 2936, 2141, 3052)"
```

Model Architecture:

Model Training:

- **Model Choice:** ResNet as the backbone for feature extraction, combined with a regression head for coordinate prediction.
- **Train-Test Split:**
 - 70% Training (331 group_images)-6500 cropped_beetle_images
 - 30% Testing (143 group_images)
- **Training-Validation Split:**
 - 80% (5000 cropped_beetle_images)for training
 - 20%(1500 cropped_beetle_images) for validation.
 - Used Mean Squared Error (MSE) as the validation metric.
 - Trained a deep learning model.
 - Recorded train accuracy.
 - Validation accuracy

Training and Validation Results:

Training Overview:

- Utilized ResNet as the backbone model.
- Dataset split: 70% training (further divided into 80% training and 20% validation) and 30% testing.
- Focused on baseline performance; advanced data augmentation (rotation, scaling, brightness adjustments) and transfer learning techniques planned for future iterations.

Validation Metrics:

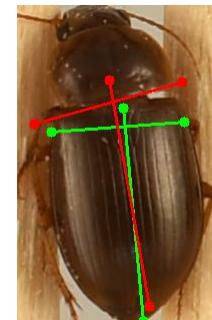
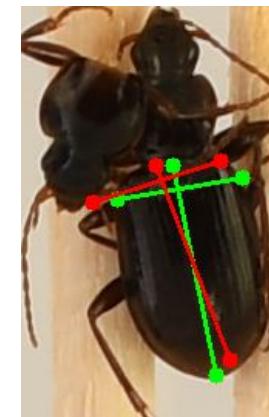
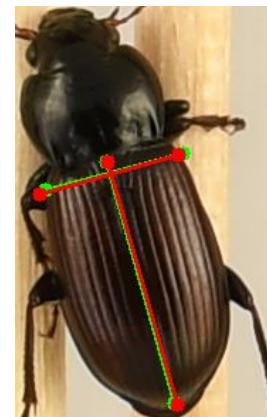
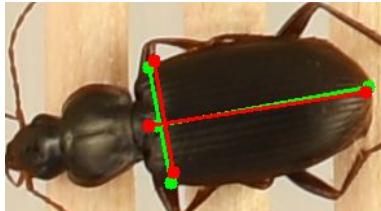
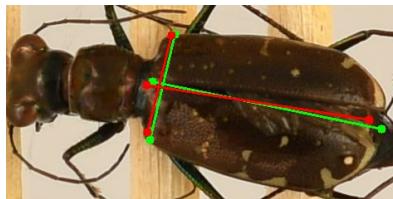
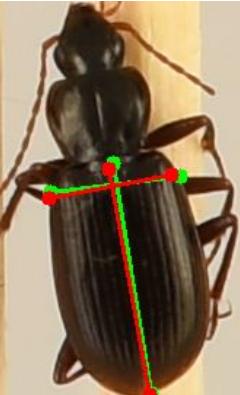
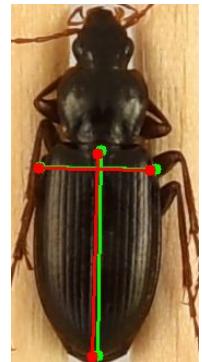
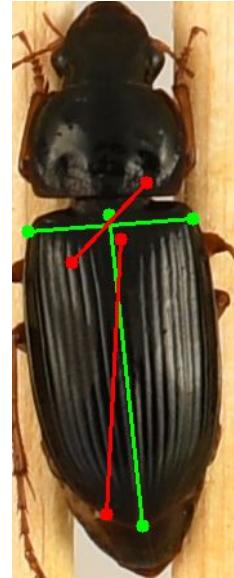
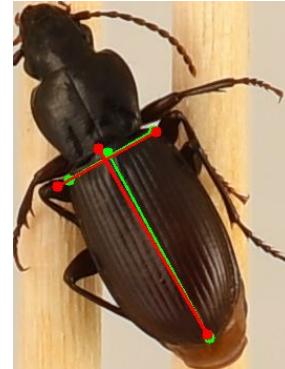
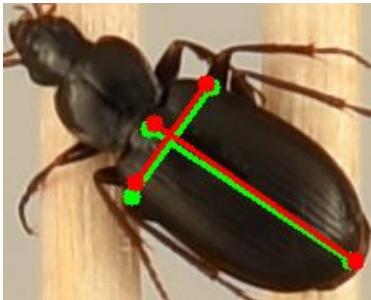
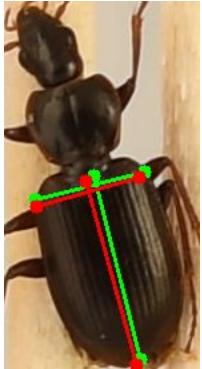
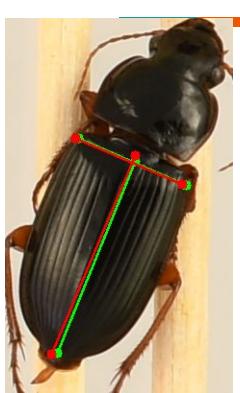
- Primary metric: Mean Squared Error (MSE) for coordinate prediction accuracy.
- Achieved high training and validation accuracy, indicating strong model performance.

Challenges:

- **Issue:** Overlapping beetles caused merged bounding boxes.
- **Solution:** Retained these cases, accepting the trade-off between precision and data retention of the upper coordinates.

— Ground Truth
— Prediction

Validation Results:



Validation Results:



MSE: 1.529E-03

Next Steps of this model:

Testing: Plan to apply SAM + Zero-Shot Object Detection for testing.

- a. To Predict elytra length and width.
- b. To Compare predicted values with actual values in a comparison table.

Plan for Multi-Class Species/Genus Classification

Objective: Leverage the length and width of beetle elytra to classify species/genus.

Approach:

1. **Feature Extraction:** Calculate elytra length, width, and area.
2. **Data Tabulation:** Generate a machine learning dataset with these features.
3. **Classification:** Develop a multi-class classification model for species/genus prediction.

Validation:

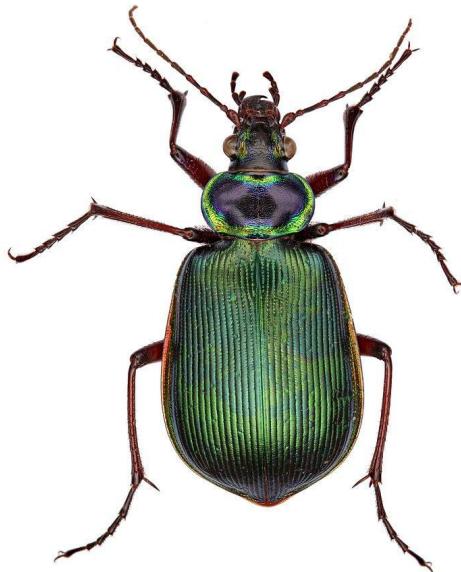
- Compare model predictions against human-labeled data from Zooniverse.
- Focus on improving model accuracy.

Future Goal:

- Automate the classification process: given a new beetle image, automatically detect coordinates, calculate length, width, area, and classify the beetle under the correct species/genus.

Plan for BeetleGPT 1.0:

- **Objective:** To Develop a foundational Visual Language Model (VLM) tailored for beetle elytra analysis





THANK YOU!

