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Blueberry Drone AI: Estimating Crop Yield using Deep Learning & Smart Drones

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BLUEBERRY DRONE AI

Estimating Crop Yield using Deep Learning & Smart Drones

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ABSTRACT: This project seeks to assist blueberry growers in New Jersey estimate crop yield by developing software that allows autonomous drones to capture aerial images of blueberry bushes in the field, perform berry count, and identify blueberry conditions using deep learning models & computer vision.

How the Berry Model was Trained

- Using YOLOv5 model via Ultralytics
- Trained on 2208 images created from splitting 80 images into 640x640 tiles
- Default YOLOv5s hyperparameters
- 300 epochs

Our Current Datasets (annotated):

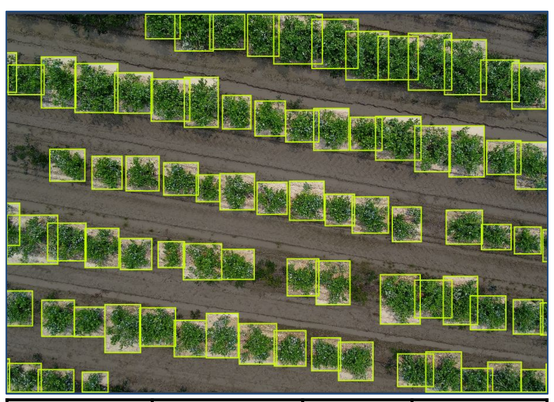
- Berry model: 100 images
- Bush model: 487 images
- Birdseye model: 36 images
- Data augmentation

Bush Analysis Deep Learning Models

Estimate Crop Yield
Berry Count
(Early Fruit Stage)

Crop Yield Pipeline

Birdseye Bush Detection



	Precision	Recall	mAP
Birdseye	0.865	0.840	0.873

First, we **estimate the number of bushes** in the field.

We then plan out our flight path, **fly to individual bushes**, and **take pictures**.

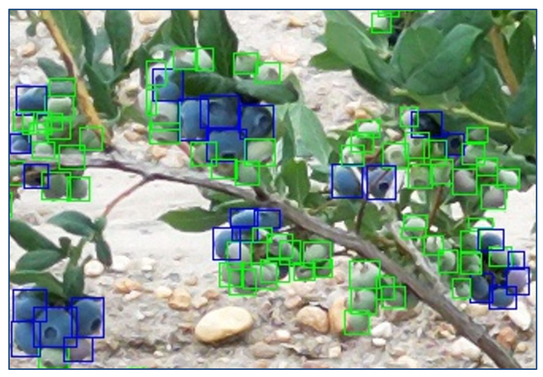
Bush Detection

	Precision	Recall	mAP
Bush	0.854	0.842	0.881

Later, we use our berry model to **detect berries** on the bushes.

Then, **apply the average # of berries to all bushes in the field**, to get crop yield**.**

Berry Detection



	Precision	Recall	mAP
Berry	0.832	0.723	0.792

Example of optimizing berry model through revising one of our worst performing images

Berry Model Optimizing

Initial Annotations

Compare to the model's detections

Model Detections

Try to reannotate all the berries we missed

Revised Annotations

Performance on the image before and after revisions

	Precision	Recall
Before	0.582	**0.969**
After	**0.969**	0.454

The model's *precision* looked worse than it truly was due to human errors in our annotations that it detected.

Recall fell post-revision as our annotation approach became more thorough than the model's initial training data.

Revised Annotations

Retrain new model on revised data

"Moving Target" Validation

Compare old model to new model when validated on revised data

	Precision	Recall
Old	**0.961**	0.675
New	0.912	**0.853**

Analyze new model's misses and false positives

We find that the new model, which should be smarter than old model, is finding even *more* berries we missed.

Thus, our validation data must get revised again to get closer to the model's true potential.

The optimizing cycle repeats as we target the "moving" validation.

Collaborators:

- Influential Drones (Lumberton, NJ)
- Peter Oudemans, Director, Rutgers Marucci Center for Blueberry and Cranberry Research
- South Jersey Farms: DiMatteo, Haines, Macrie, Moore, Piney Hollow, Vaccarella, Matro

Next Steps:

- Field test our AI models
- Continue revising our berry model data to improve crop yield prediction accuracy

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