

Lygus Bug Detection Using Machine Learning for Pest Management

NASGA 2023 Meeting and Conference

A background image featuring a large, ripe strawberry in the center, surrounded by several smaller strawberries and green leaves. Water droplets and a prominent water splash are visible on the left side, suggesting a fresh or aquatic theme.

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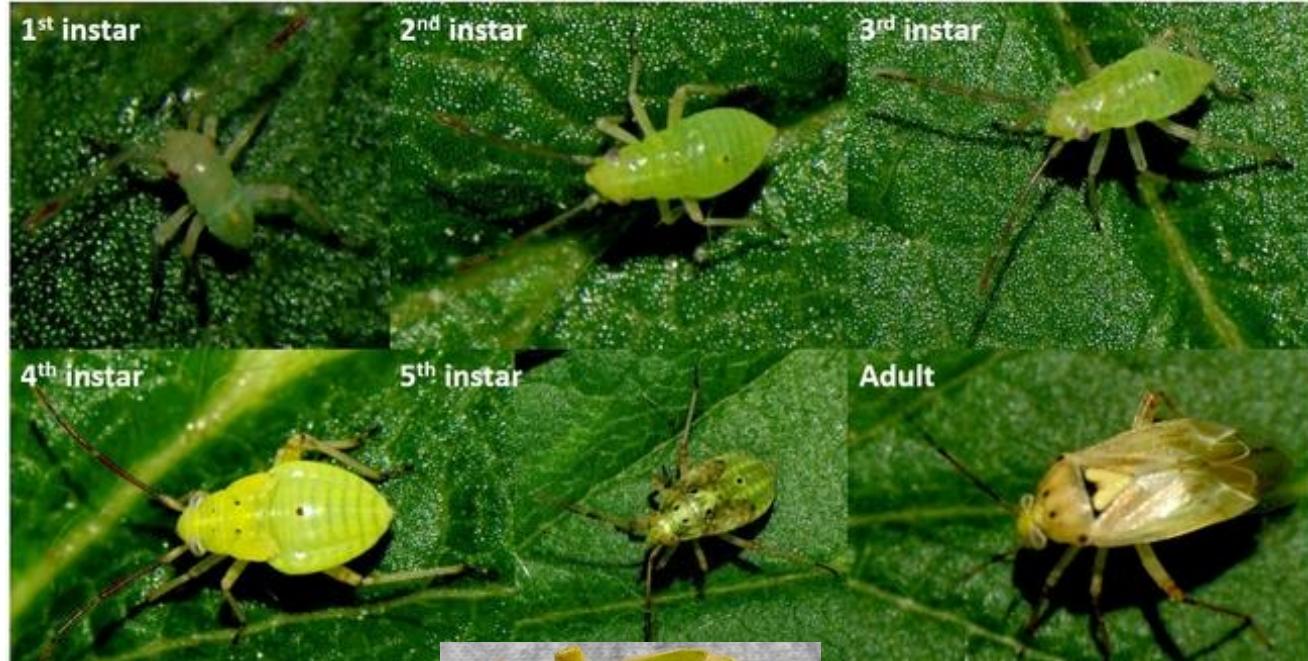
San Luis Obispo, CA, March 2023



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STRAWBERRY
COMMISSION

- Lygus bug is major pest of strawberries
- Cat-faced strawberries
- Annual damage around \$100-200 million USD



<https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=19630>



Bug Vacuum



<https://organicgrower.info/article/california-betters-its-bug-vacuums-for-lygus/>

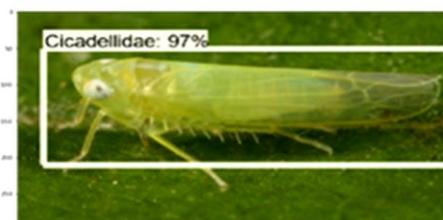
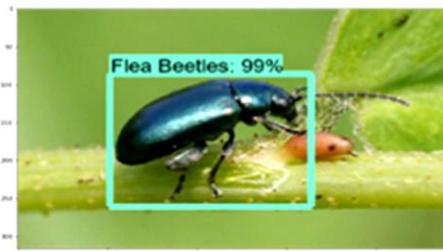
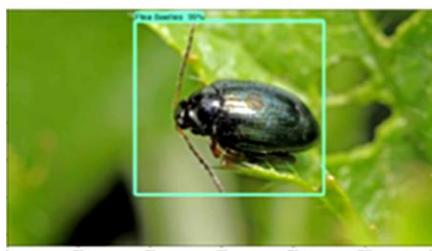
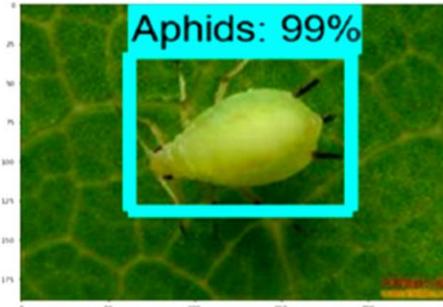
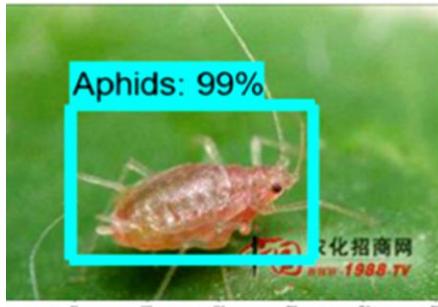


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Introduction



Insect detection using deep learning techniques



Karar, M.E., F. Alsunaydi, S. Albusaymi and S. Alotaibi. 2021. A new mobile application of agricultural pests recognition using deep learning in cloud computing system. Alexandria Eng. J. 60:4423–4432.

Li, R., R. Wang, C. Xie, H. Chen, Q. Long, L. Liu, J. Zhang, T. Chen, H. Hu and L. Jiao. 2022. A multi-branch convolutional neural network with density map for aphid counting. Biosyst. Eng. 213:148–161.

The objective of this research was to detect adult and nymph Lygus using deep learning in lab settings.



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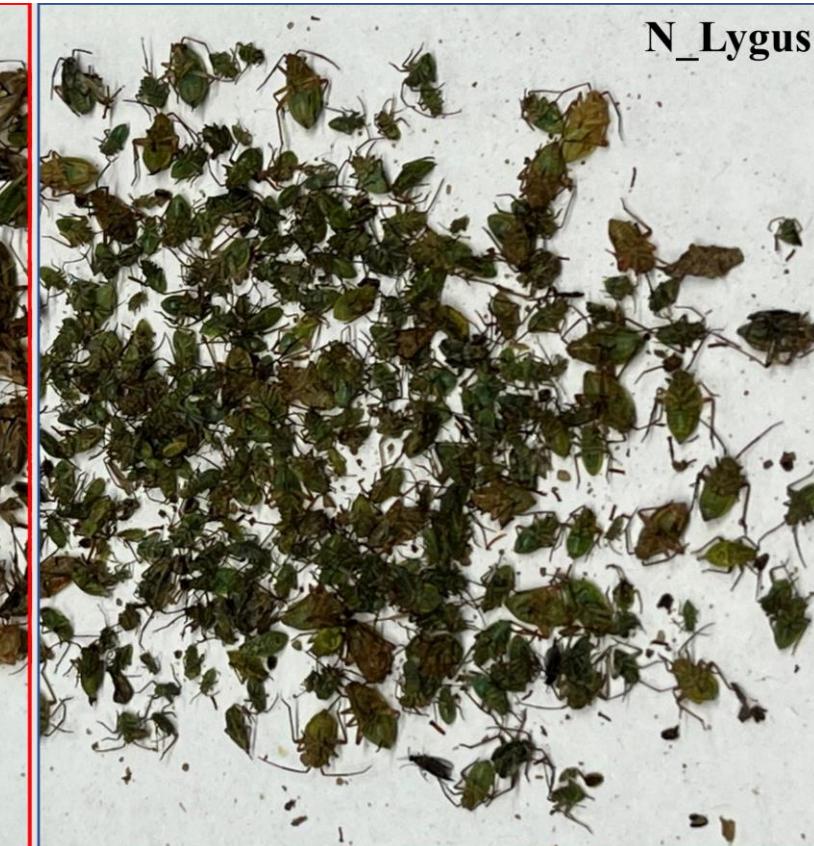
Introduction



Field sample



Adult and Nymph Lygus

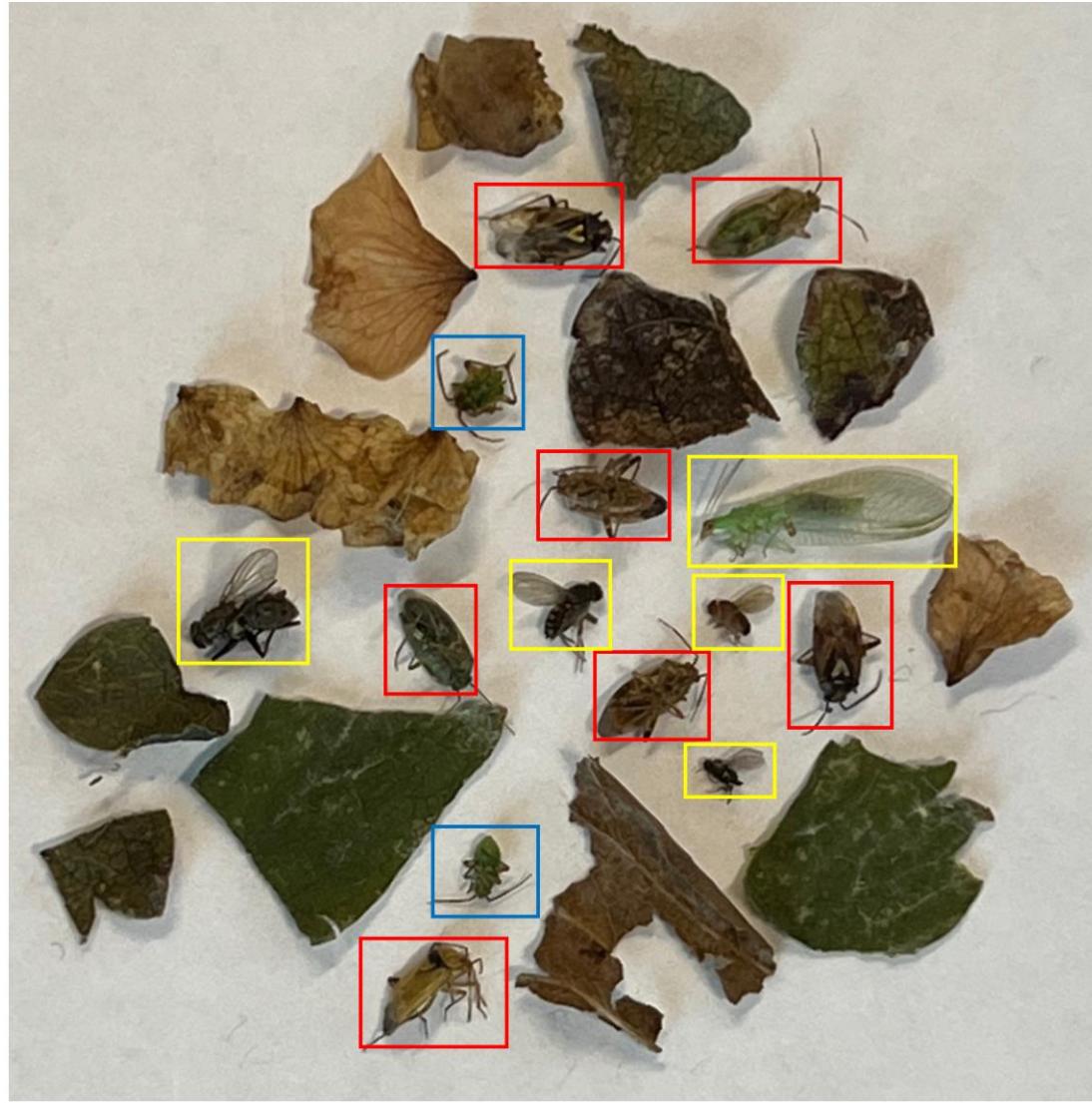


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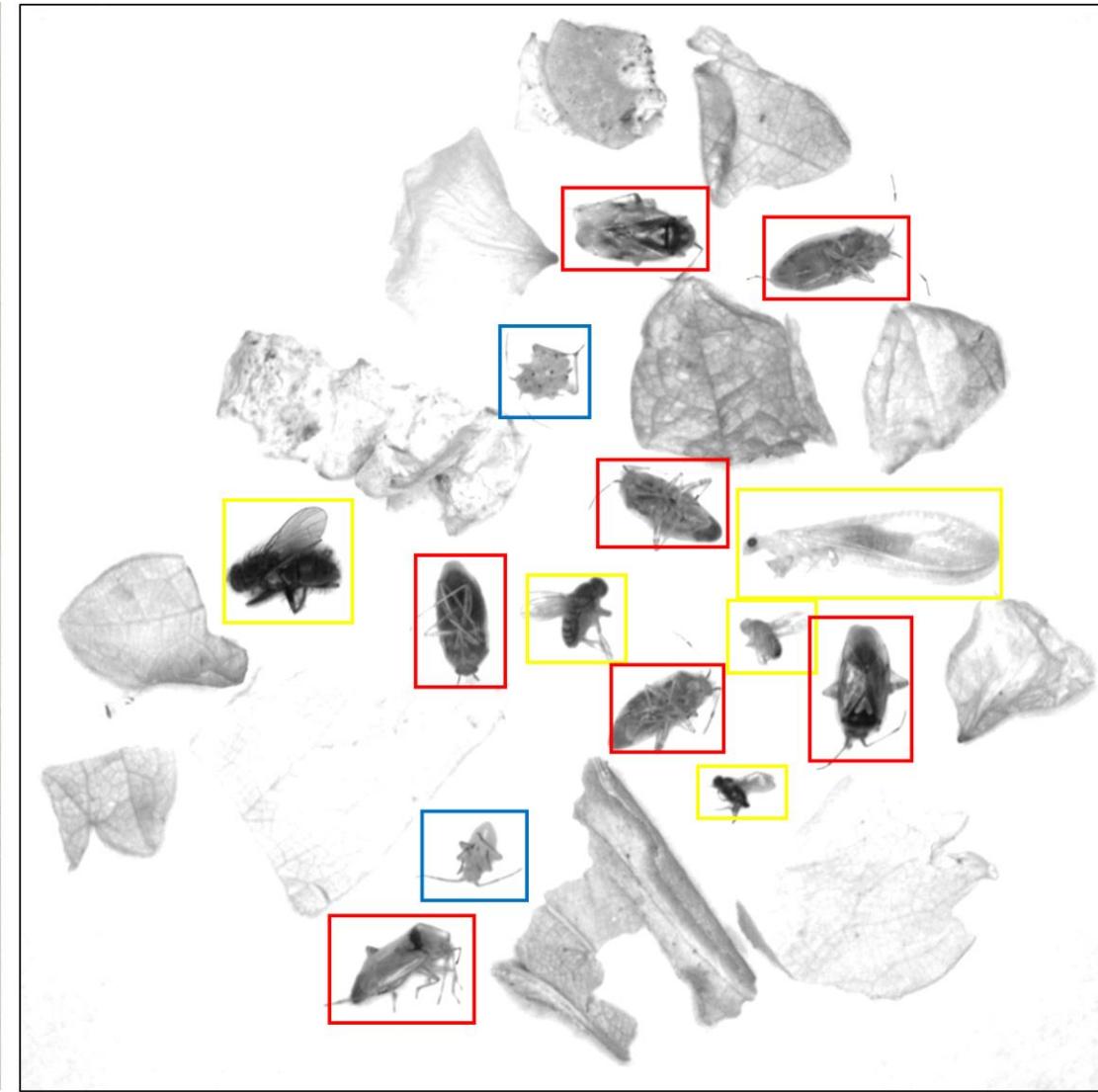
Materials and Methods



RGB image

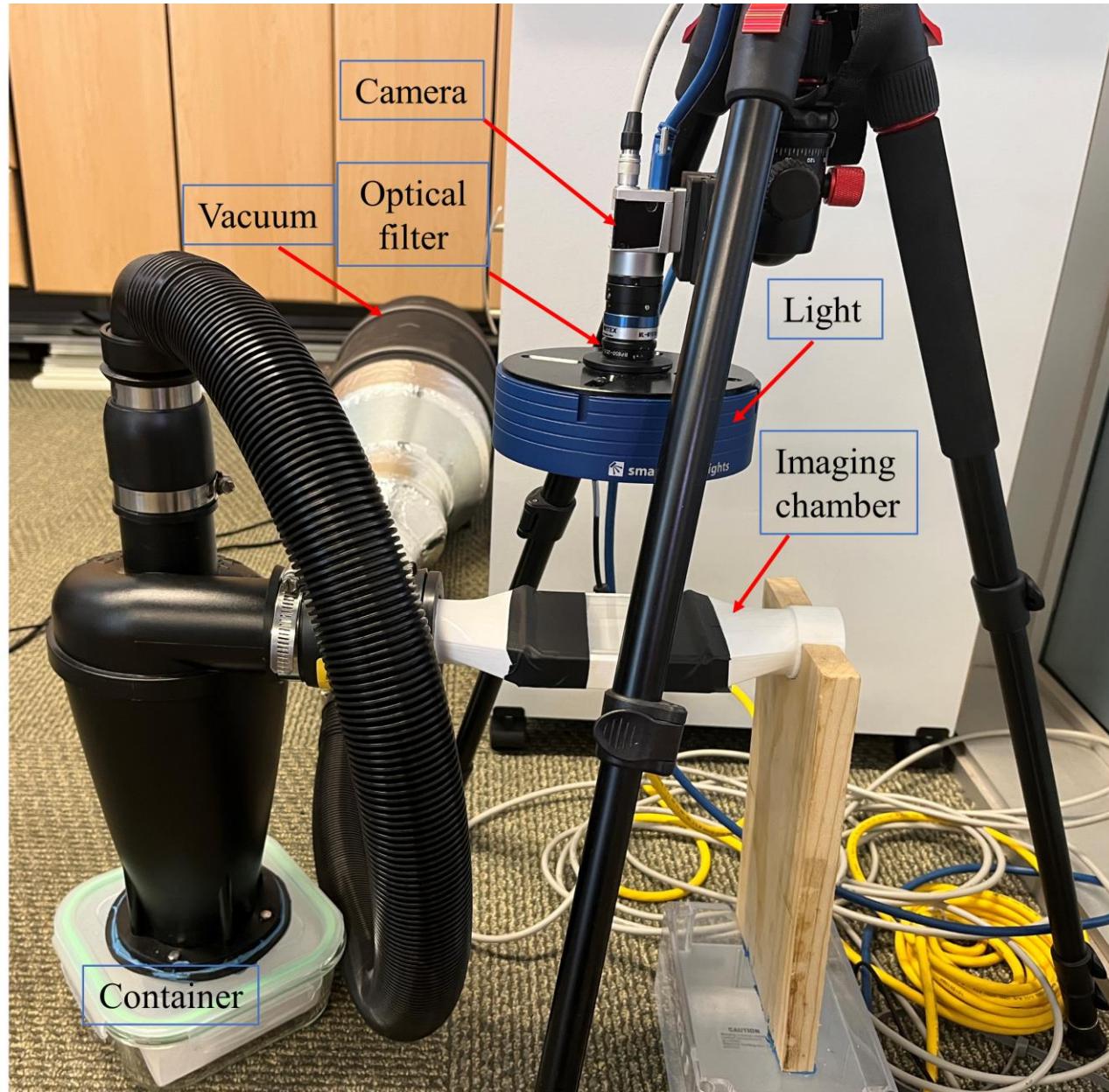


NIR image (850 nm)

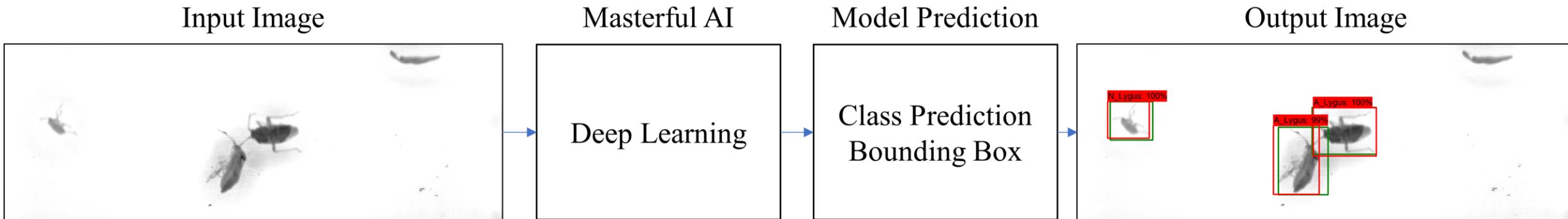


Experimental settings in the lab

- Adult and Nymph Lygus, other insects, plant debris
- Sample moves ~40 mph



Deep learning pipeline for Adult and Nymph Lygus detection



- Total number of 1800 images
- Training, validation, testing datasets (90%, 10%, 10%)
- Training models: **faster_rcnn** and **ssd_mobilenet**
- Evaluation metrics: **Precision**, **Recall**, and **F1-score**



A_Lygus and N_Lygus detection using two training models on test dataset (IoU=0.5)

Object Name	ssd_mobilenet_v2			faster_rcnn_resnet50_v1		
	P	R	F1-score	P	R	F1-score
A_Lygus	0.75	0.84	0.80	0.89	0.84	0.87
N_Lygus	0.82	0.80	0.81	0.77	0.91	0.83

- Both models could accurately identify the Lygus bugs ($\text{F1-score} \geq 0.8$)
- The accuracy of faster_rcnn is higher than ssd_mobilenet
- faster_rcnn is a two-stage object detection model, while ssd_mobilnet is one-stage detector



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- Nymphs have a substantial variation in size and shape
- Nymphs show more green color objects
- Nymphs have more physical and intensity similarities to plant debris/small flies in gray-scale images



**Background
predicted as
Lygus and vice
versa**

Confusion matrix for Lygus detection using ssd_mobilenet_v2

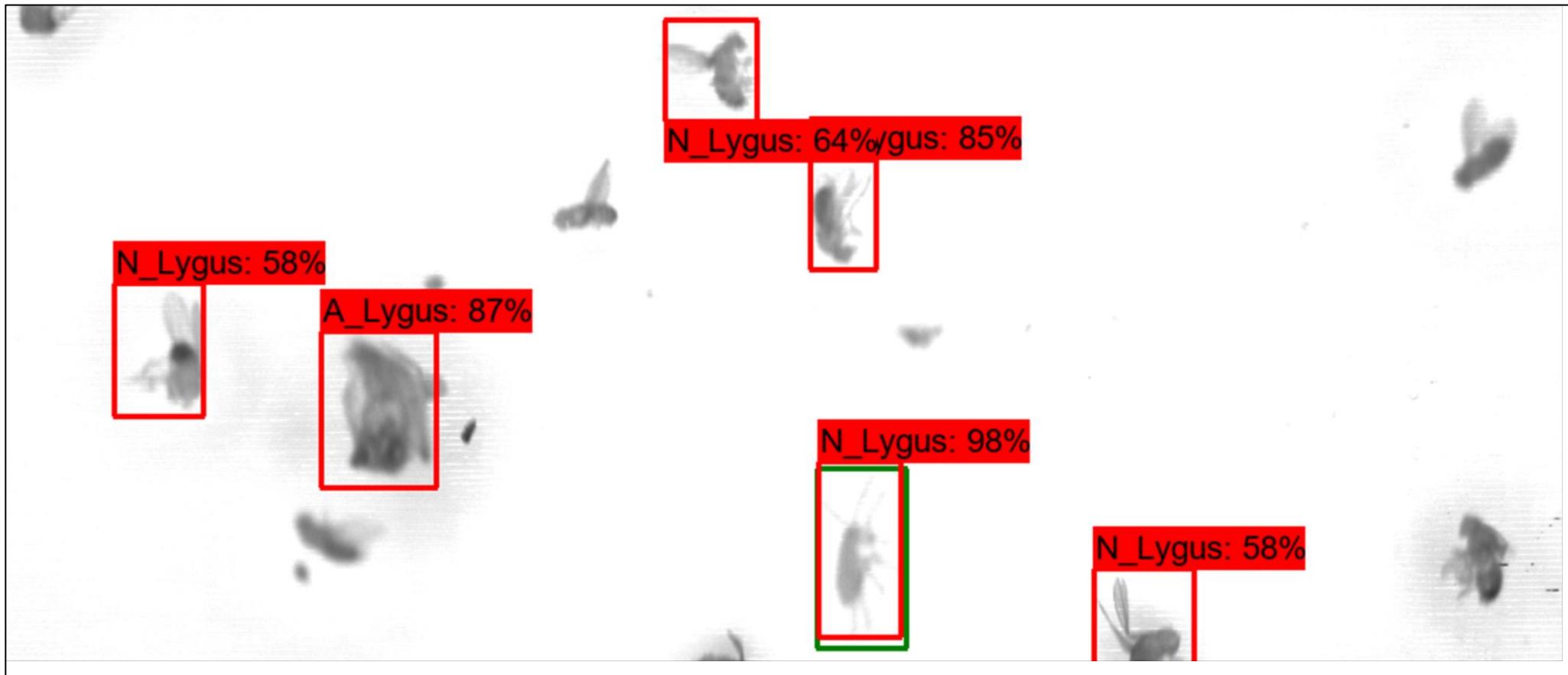
Object Name		Predictions		
		A_Lygus	N_Lygus	Background
Actual	A_Lygus	119	8	14
	N_Lygus	8	125	24
	Background	31	20	0

Confusion matrix for Lygus detection using faster_rcnn_resnet50_v1

Object Name		Predictions		
		A_Lygus	N_Lygus	Background
Actual	A_Lygus	119	15	7
	N_Lygus	3	143	11
	Background	12	28	0



Background was predicted as Lygus bugs or vice versa



More incorrect predictions than missing ones

Confusion matrix for Lygus detection using ssd_mobilenet_v2

Object Name	Predictions			
	A_Lygus	N_Lygus	Background	
A_Lygus	119	8	14	
Actual	N_Lygus	8	125	24
Background	31	20	0	

Confusion matrix for Lygus detection using faster_rcnn_resnet50_v1

Object Name	Predictions			
	A_Lygus	N_Lygus	Background	
A_Lygus	119	15	7	
Actual	N_Lygus	3	143	11
Background	12	28	0	





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A large, vibrant red strawberry with green leaves is positioned in the background, partially overlapping the text.

Thank you!

- Field team (Andrew Molinar, Miriam Mendez, James Reid, Jasmine Rodriguez, Carolina Lobo)
- Entomology team (Dr. Sarah Zukoff, Jose Alvarado Rojas)



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