Investigating generative neural-network models for building pest insect detectors in sticky trap images for the Peruvian horticulture

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Pest insects in Peruvian horticulture

Visual inspection of pest insects (Source: Agraria.pe)

The inspection of pest insects is done manually in the field, which implies costs, time and staff exhaustion.

Chemical control (Source: Agraria.pe)

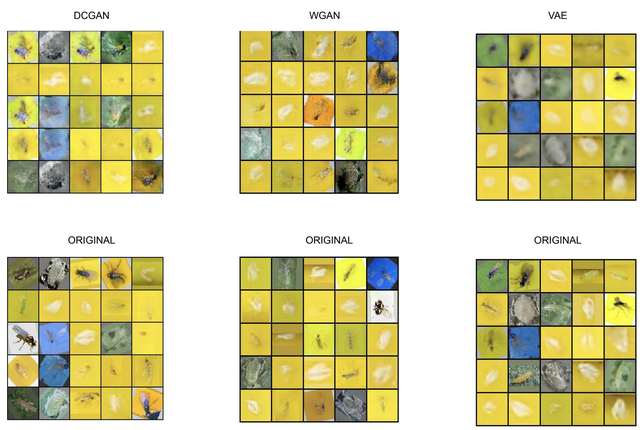
The most used pest control strategy is indiscriminate chemical control, which implies possible damage to the environment and people.

Effect of pest insects on tomato crops (Source: Agraria.pe)

Low productivity due to late detection of pests

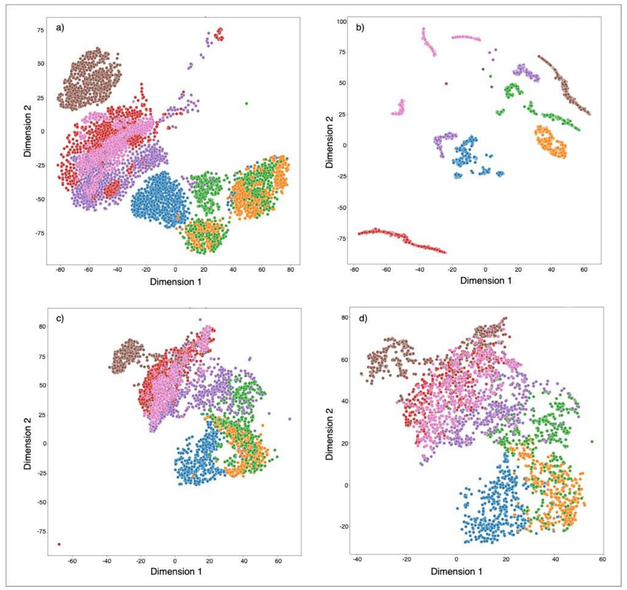
Synthesized images and original images

We adjusted three generative models (DCGAN, WGAN and VAE) to acquire the capacity to synthesize pest insect images to be used as data augmentation procedures for subsequent classifier induction.



Synthesized images by the models DCGAN, WGAN, and VAE. (Source: Own elaboration)

Two-dimensional t-SNE representations of the original and synthesized images



Two-dimensional t-SNE representations of 3500 pest insects images each one. a)Real images, the rest are from generated images as follow: b)DCGAN, c)WGAN and d)VAE. Colors identify the insect species (Blue: Bemisia tabaci, Orange: Macrolophus pygmaeus, Green: Nesidiocoris tenuis, Red: Brevicoryne brassicae, Purple: Liriomyza huidobrensis, Brown: Prodiplosis longifila and Pink: Trips tabaci).

Divergence between real images and generated images per model and species.

Universal divergence (Q. Wang, 2009) between generated and real images (Source: Own elaboration)

	Generative Models		
Species	**DCGAN**	**WGAN**	**VAE**
Bemisia tabaci	7,207	7,431	**7,058**
Macrolophus pygmaeus	6,953	**7,227**	7,264
Nesidiocoris tenuis	7,247	**6,604**	6,878
brevicoryne brassicae	6,759	6,022	**6,070**
liriomyza huidobrensis	**5,721**	5,880	5,742
prodiplosis longifila	7,707	6,278	**5,997**
trips tabaci	7,475	6,507	**6,494**
Average	**7,010**	**6,564**	**6,500**

Sticky trap image recreated with synthesized pest insects images

Images of a sticky trap recreated with images of interesting pest insects (Source: Own elaboration)

Detection with YOLOv5

To further assess the utility of the synthetic data, we induced YOLOv5m models with such data and evaluated their performance in identifying and classifying insect species in test sticky trap images. To evaluate the detection performance of the YOLOv5m models we use the area under the curve precision-recall (AUC) in testing data.

		AUC Precision-Recall						
		Use of generated images						
Species	**# Imgs.**	**0%**	**20%**	**40%**	**60%**	**80%**	**100%**	**Max. Diff**
Bemisia tabaci	5807	0,91	0,91	0,92	0,87	**0,93**	0,90	2,10%
Macrolophus pygmaeus	1619	0,70	0,68	0,72	0,72	0,75	**0,81**	10,60%
Nesidiocoris tenuis	688	0,61	0,52	**0,65**	0,36	0,44	0,49	4,00%
Brevicoryne brassicae	58	0,47	**0,51**	0,37	0,26	0,40	0,47	4,50%
Liriomyza huidobrensis	112	0,81	0,81	0,87	0,86	0,89	**0,95**	14,60%
Prodiplosis longifila	35	**0,77**	0,75	0,61	0,44	0,44	0,51	0,00%
Trips tabaci	53	**0,52**	0,49	0,45	0,44	0,42	0,42	0,00%

References

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