

# VespAlert

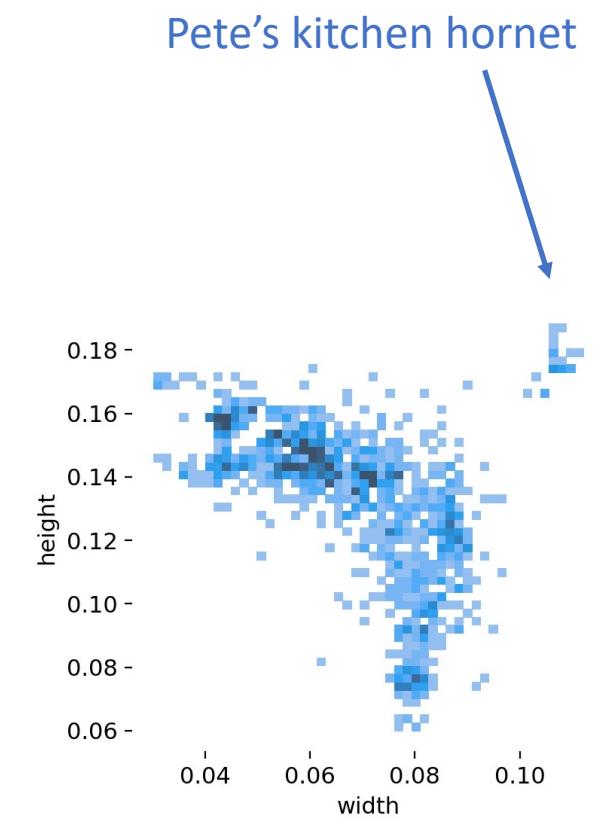
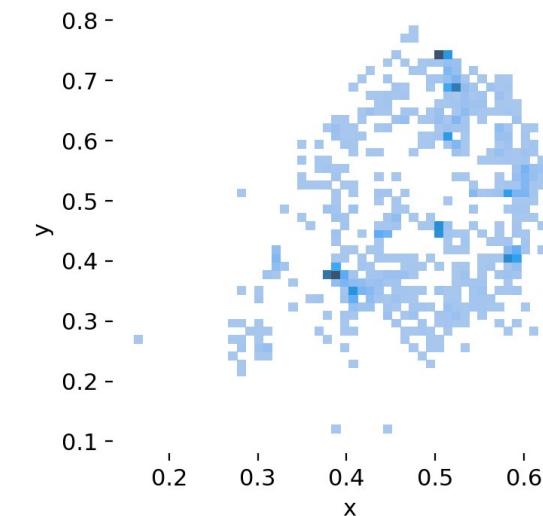
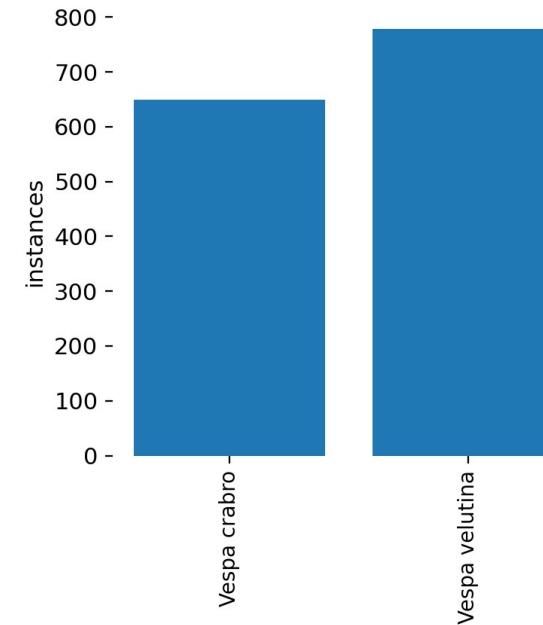
Institute for Data Science and Artificial Intelligence

# Hornet Dataset

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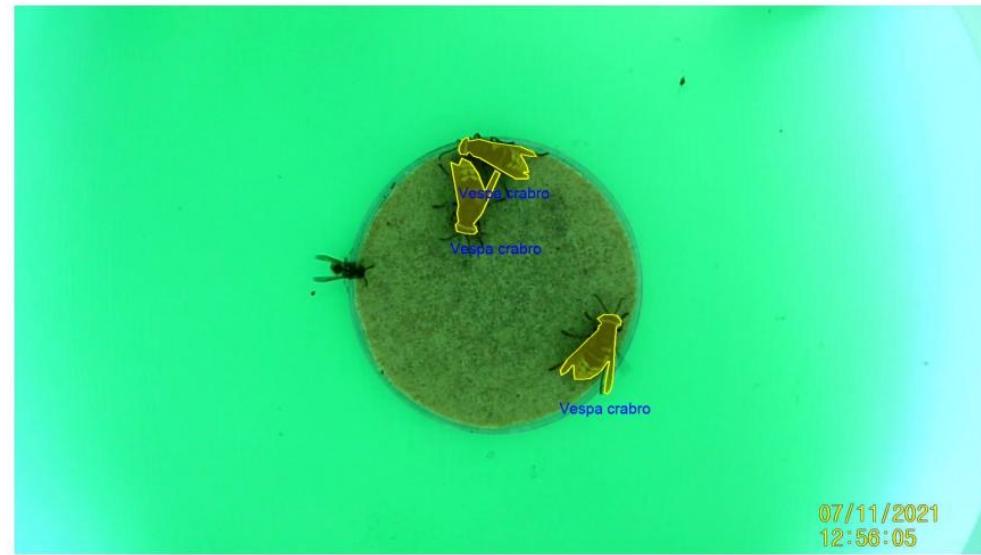
- 1811 images
- 0-3 labels per image
- 2 classes:

Vespa velutina // Vespa crabro



# Hornet Dataset

- Polygonal labels
- Overlapping
- Different backgrounds
- Timestamps
- Other insects



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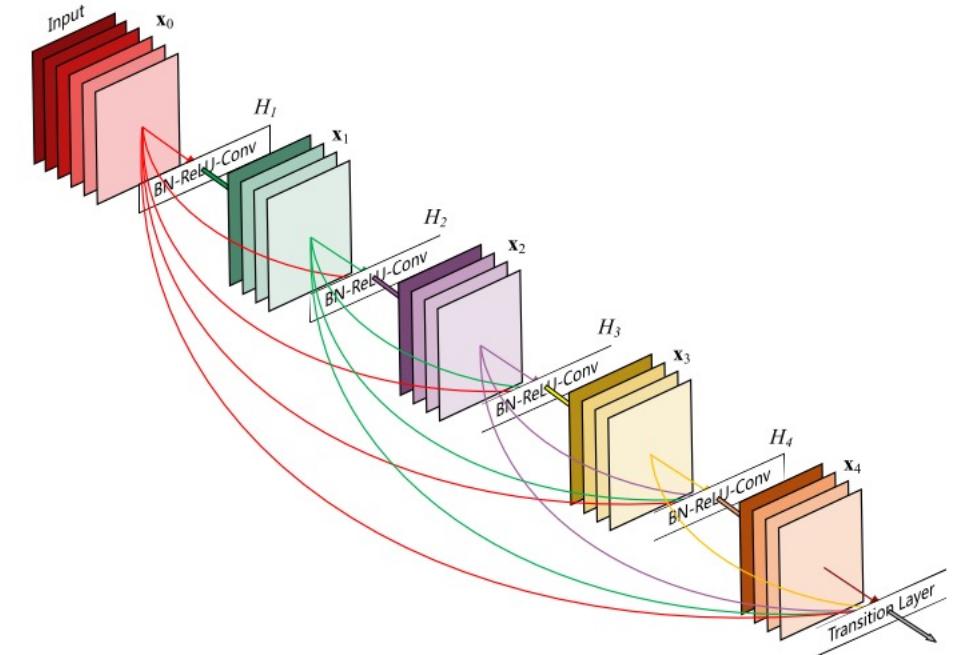
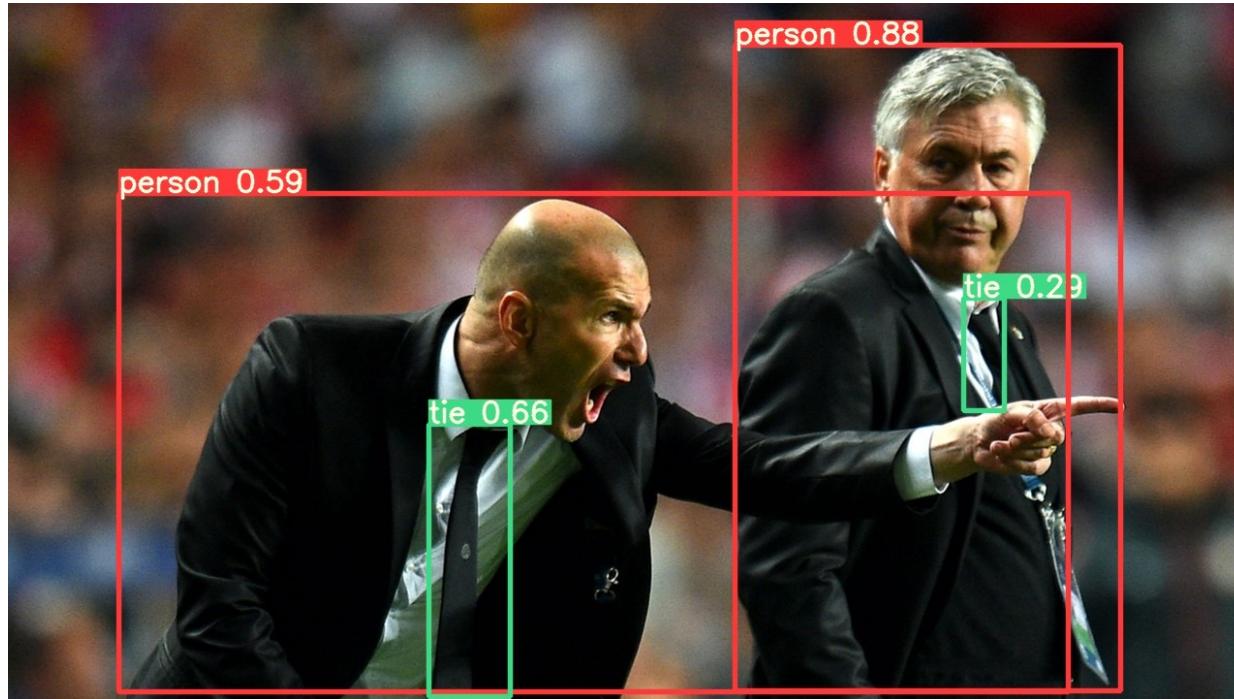
- Polygonal labels
- Overlapping
- Different backgrounds
- Timestamps
- Other insects

Pete's kitchen hornet



# Object detection and classification

# YOLOv5



- State of the art object detection
- Transfer learning from trained models
- Lightweight and heavy architectures

# Training a robust network: *Image Augmentation*

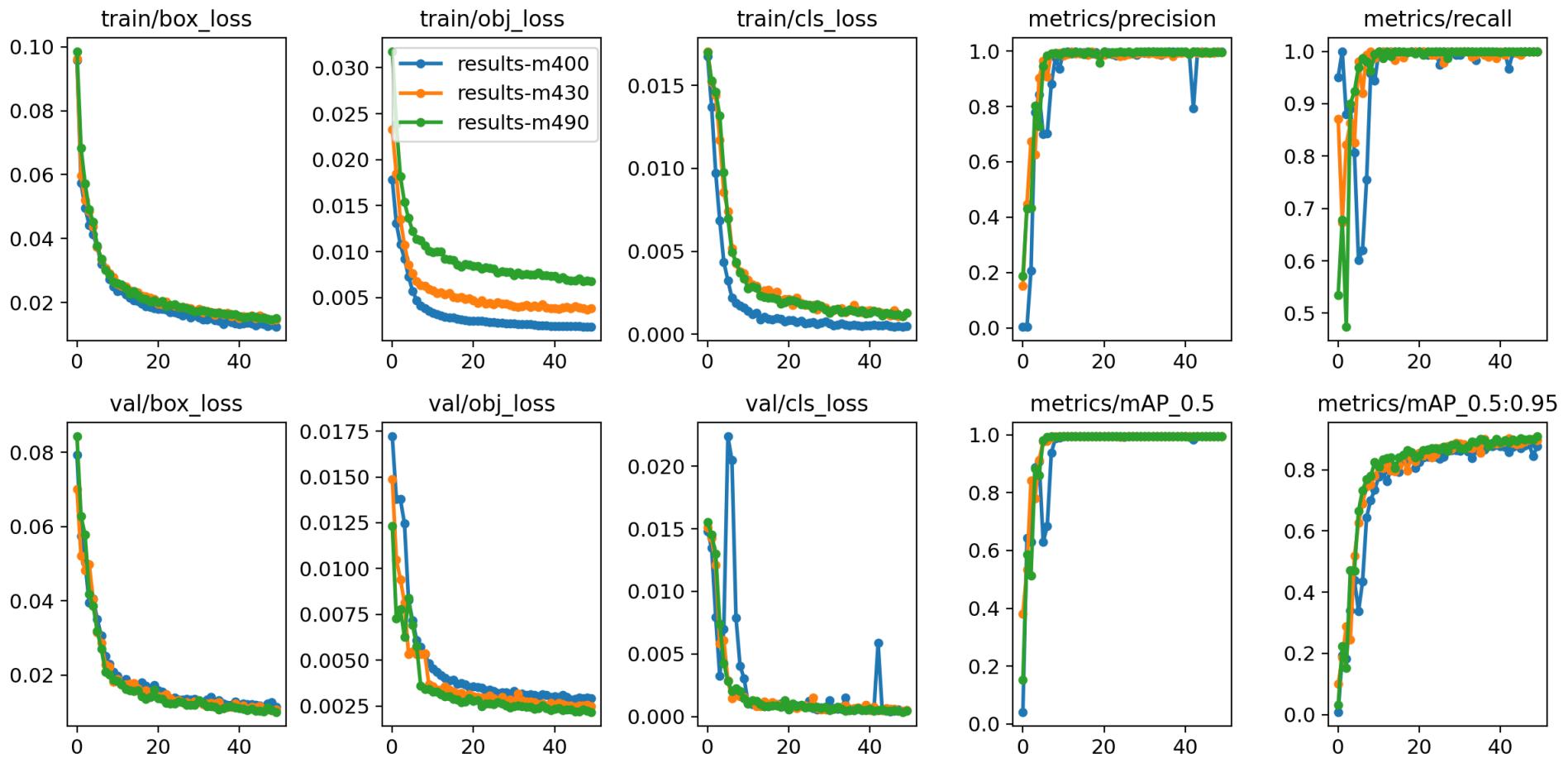
# Mosaic tiles

- Combine backgrounds onto single image
- Randomly crop, shuffle and displace artifacts (e.g. date stamp)

# Mosaic tiles

Proportion of training data using mosaics:

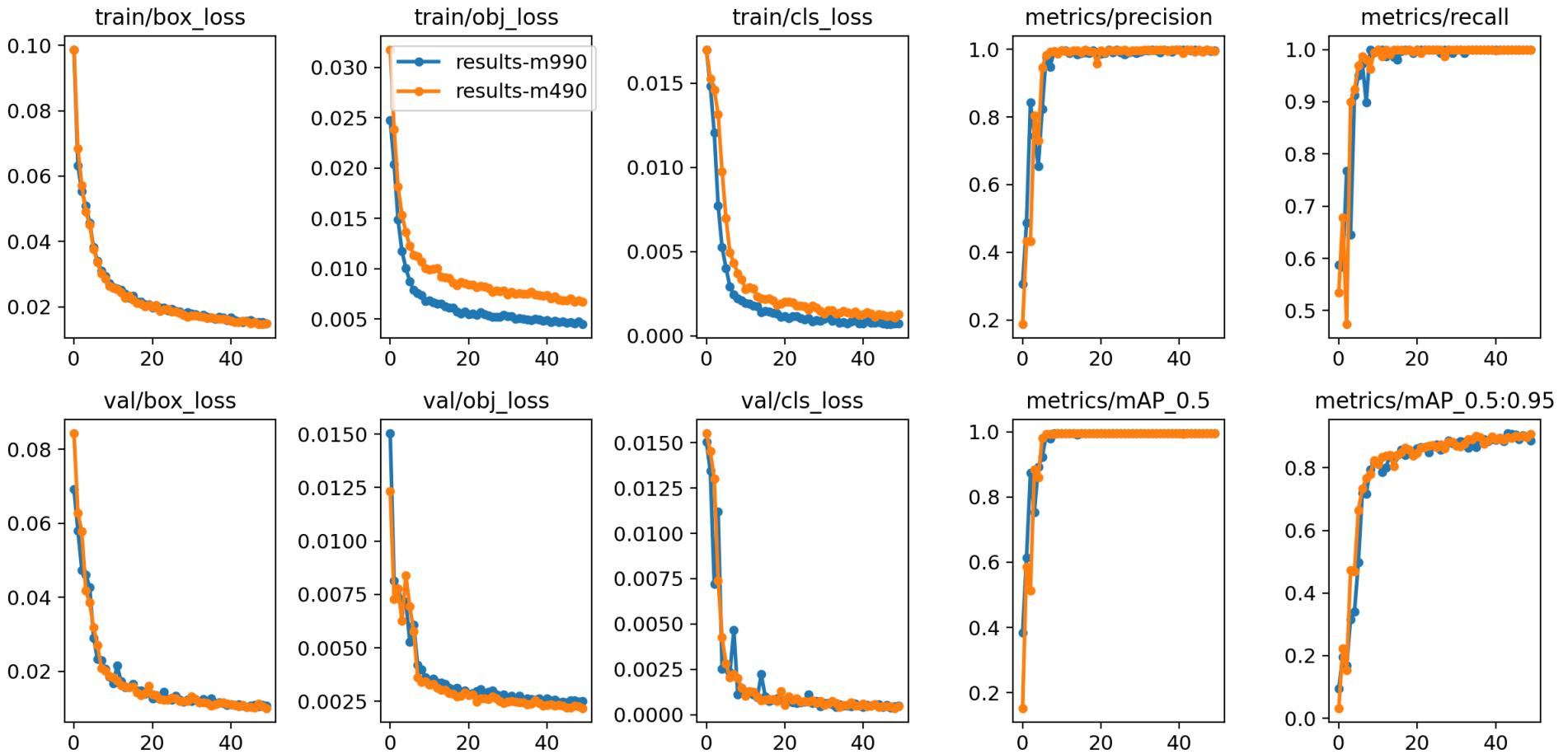
- 0% (best in training)
- 30%
- 90% (best in validation)



# Mosaic tiles

Proportion of training data using mosaics:

- 9 tiles (best in training)
- 4 tiles (best in validation)



# Augmented colouration

1. RGB channel swap (30%)
2. Image blur (20%)
3. HSV shift (40%)
4. Brightness/Contrast (50%)
5. RGB shift\* (30%)

To account for variation in camera and environment set-up.

\*Small deviations in each RGB channel to account for partially bleached backboards.

# Copy-paste augmentation

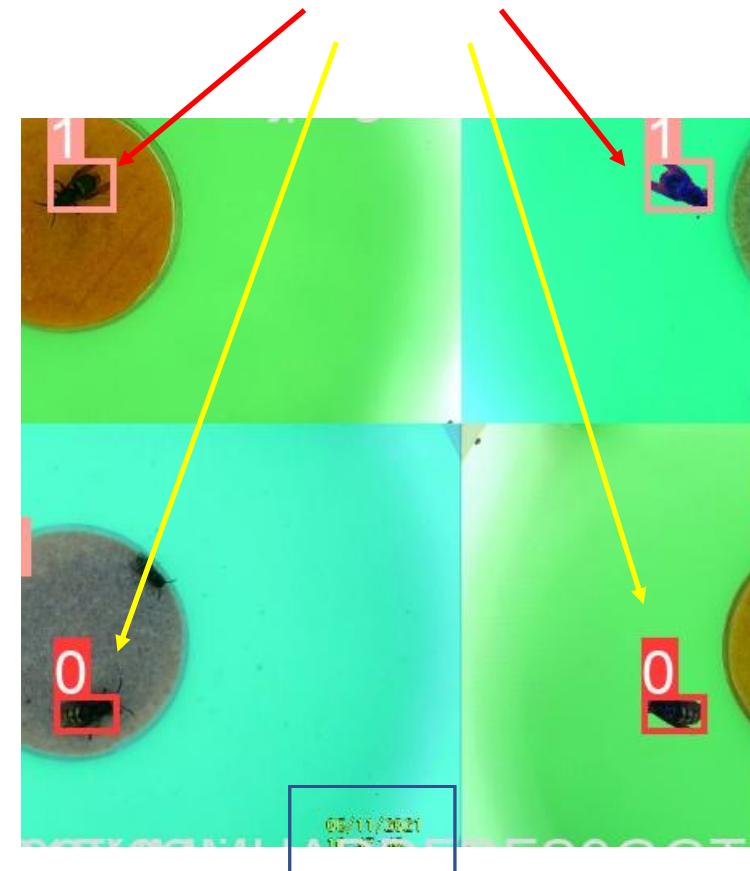
- Utilise polygon labelling  
(thanks Pete & Thomas!)
- Put hornets onto different backgrounds during training



# Copy-paste augmentation

- Utilise polygon labelling  
(thanks Pete & Thomas!)
- Put hornets onto different backgrounds during training

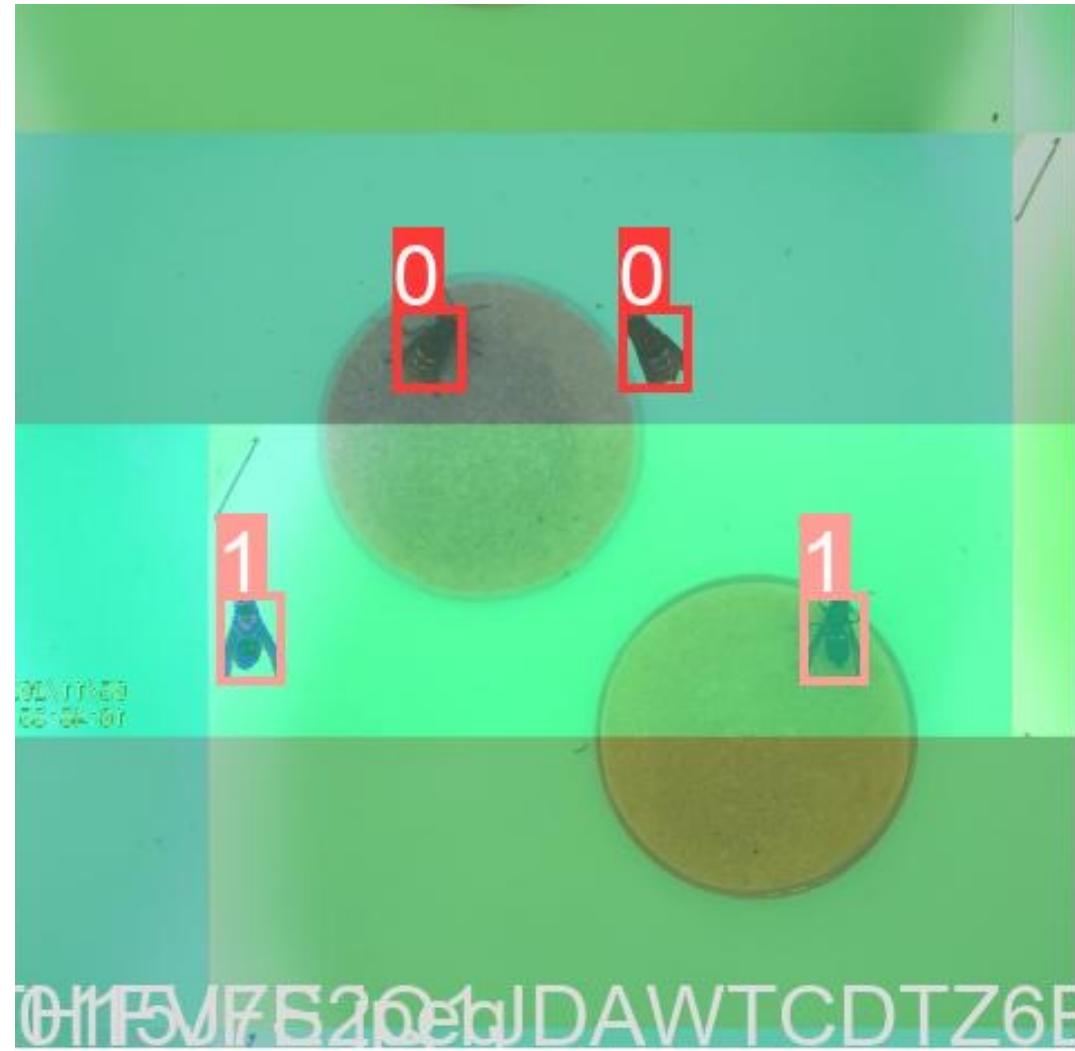
Same hornets, different bait station.



Robust to time-stamped images

# Mix-up augmentation

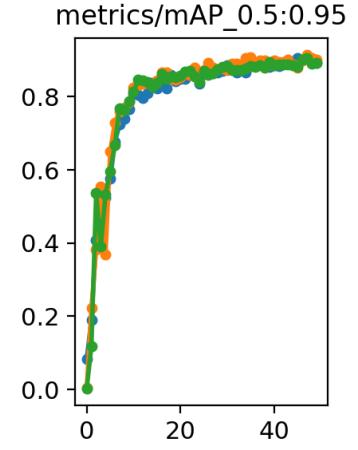
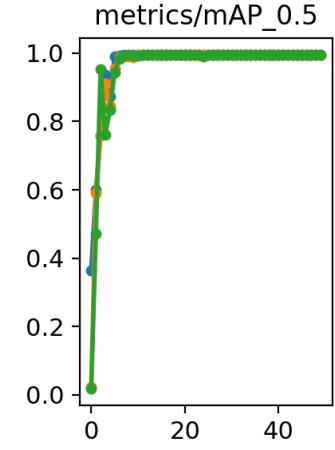
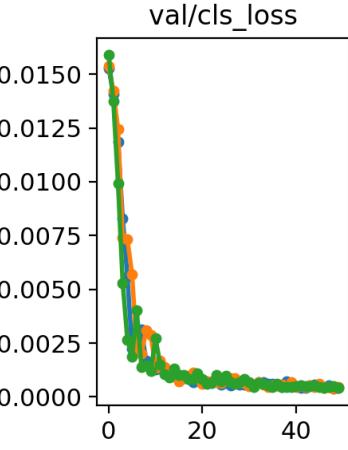
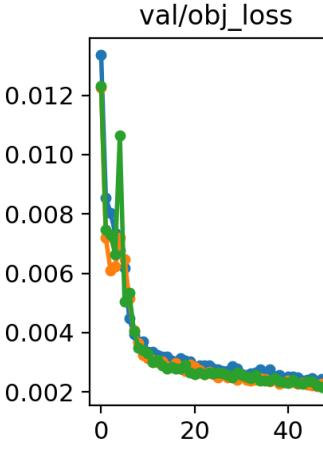
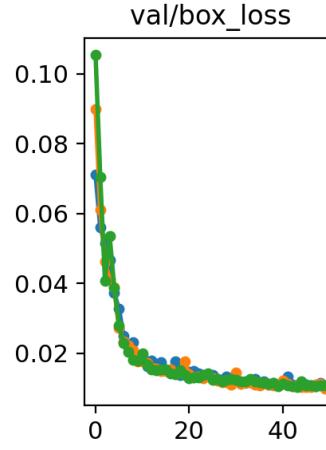
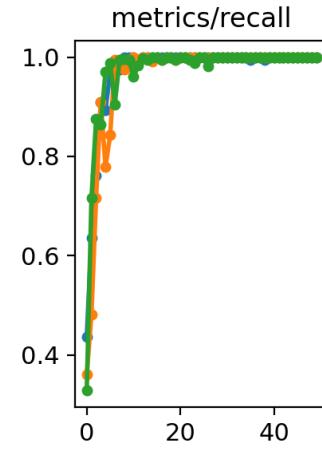
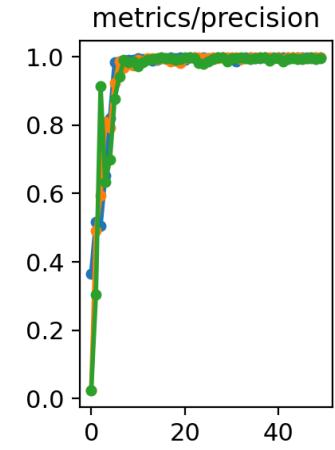
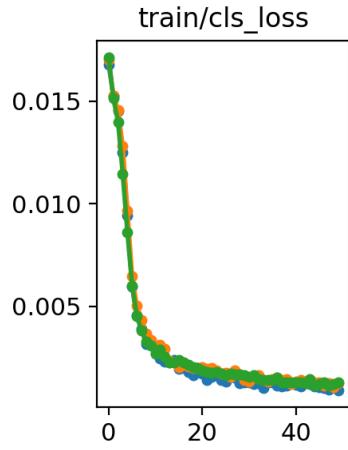
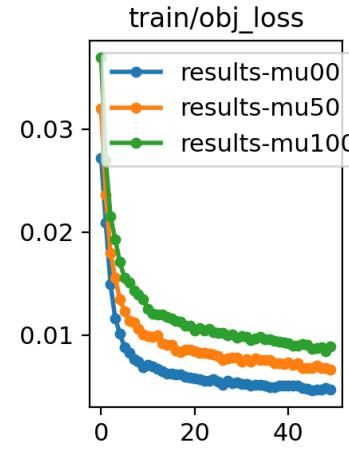
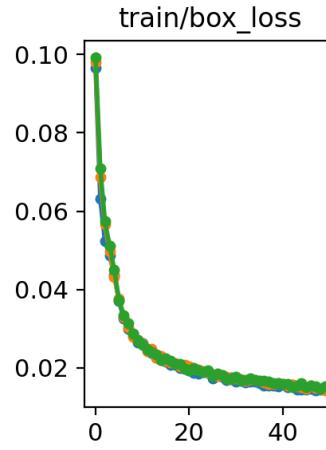
- Overlay images proportionally
- Place different hornets on different backgrounds
- Generate realistic background augmentations



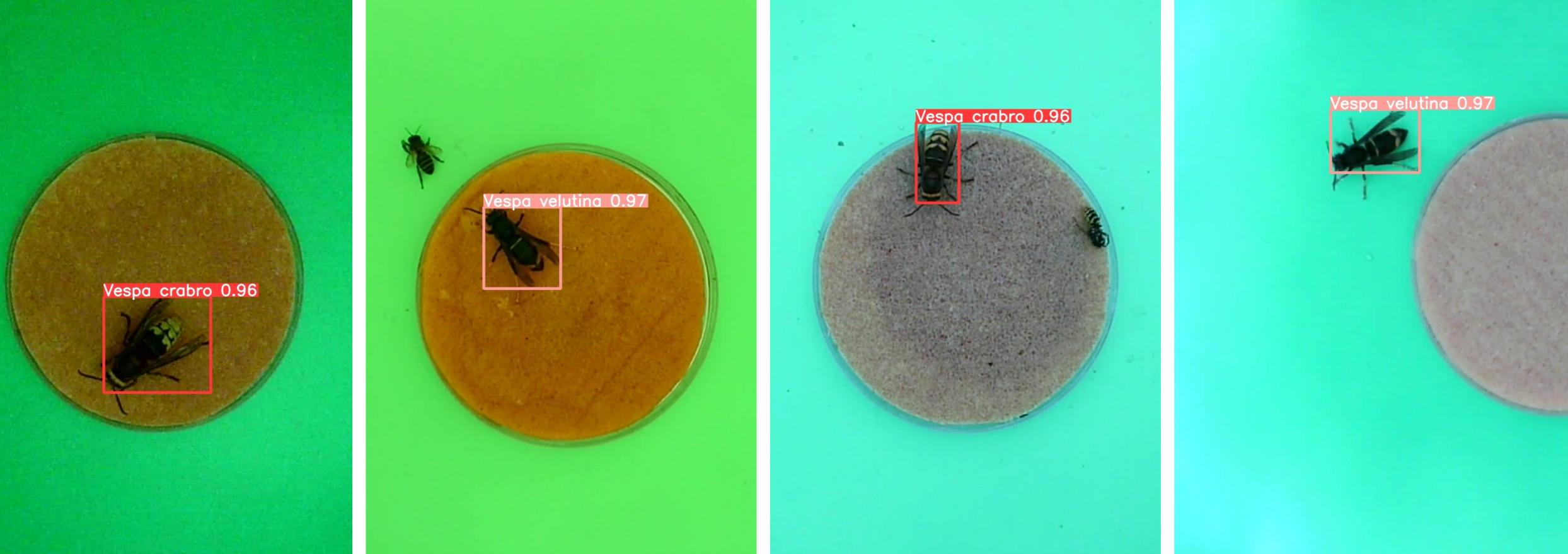
# Mix-up augmentation

Proportion of training data using mix-up:

- 0% (best in training)
- 50% (well performing)
- 100% (well performing)

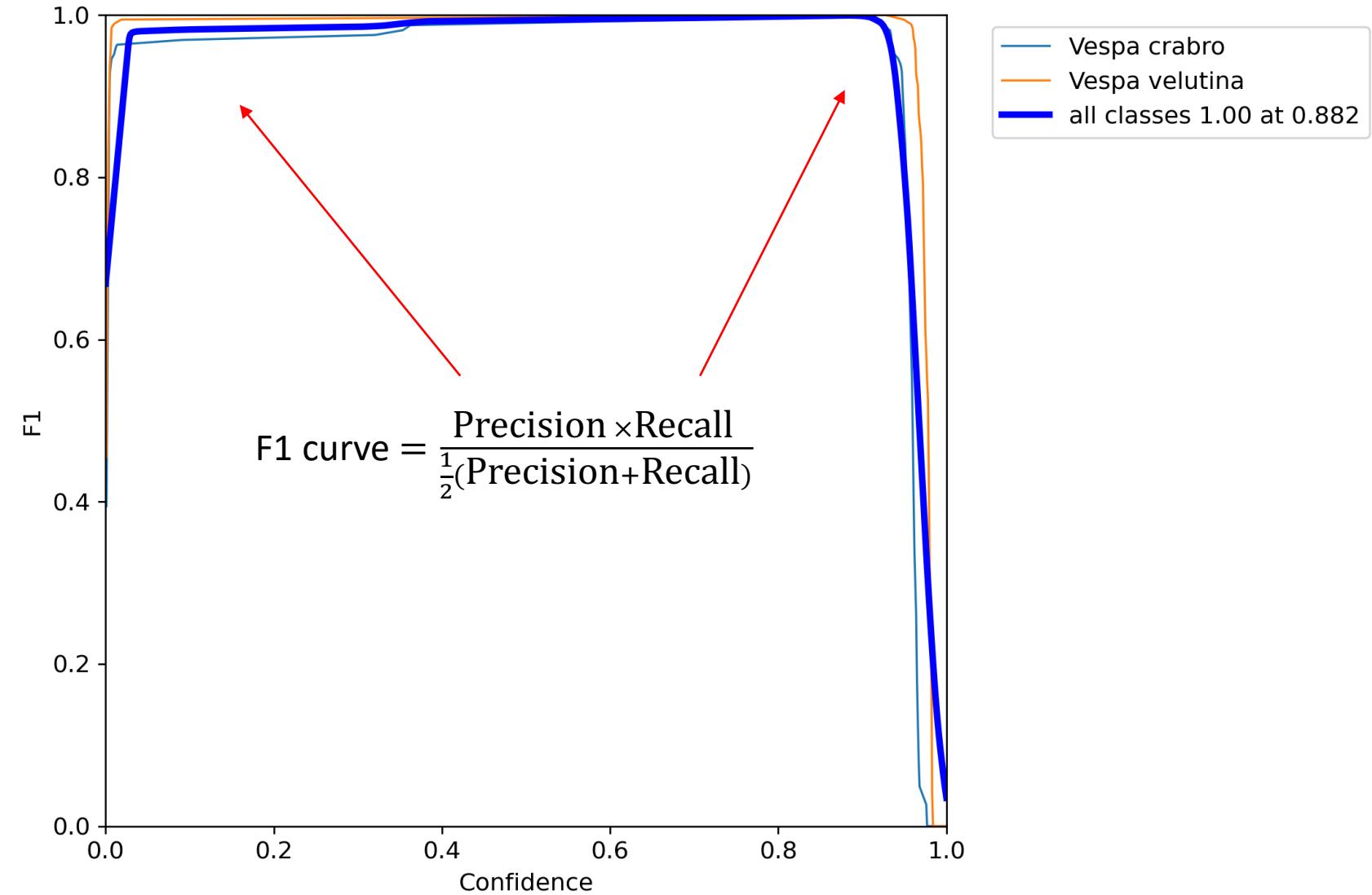


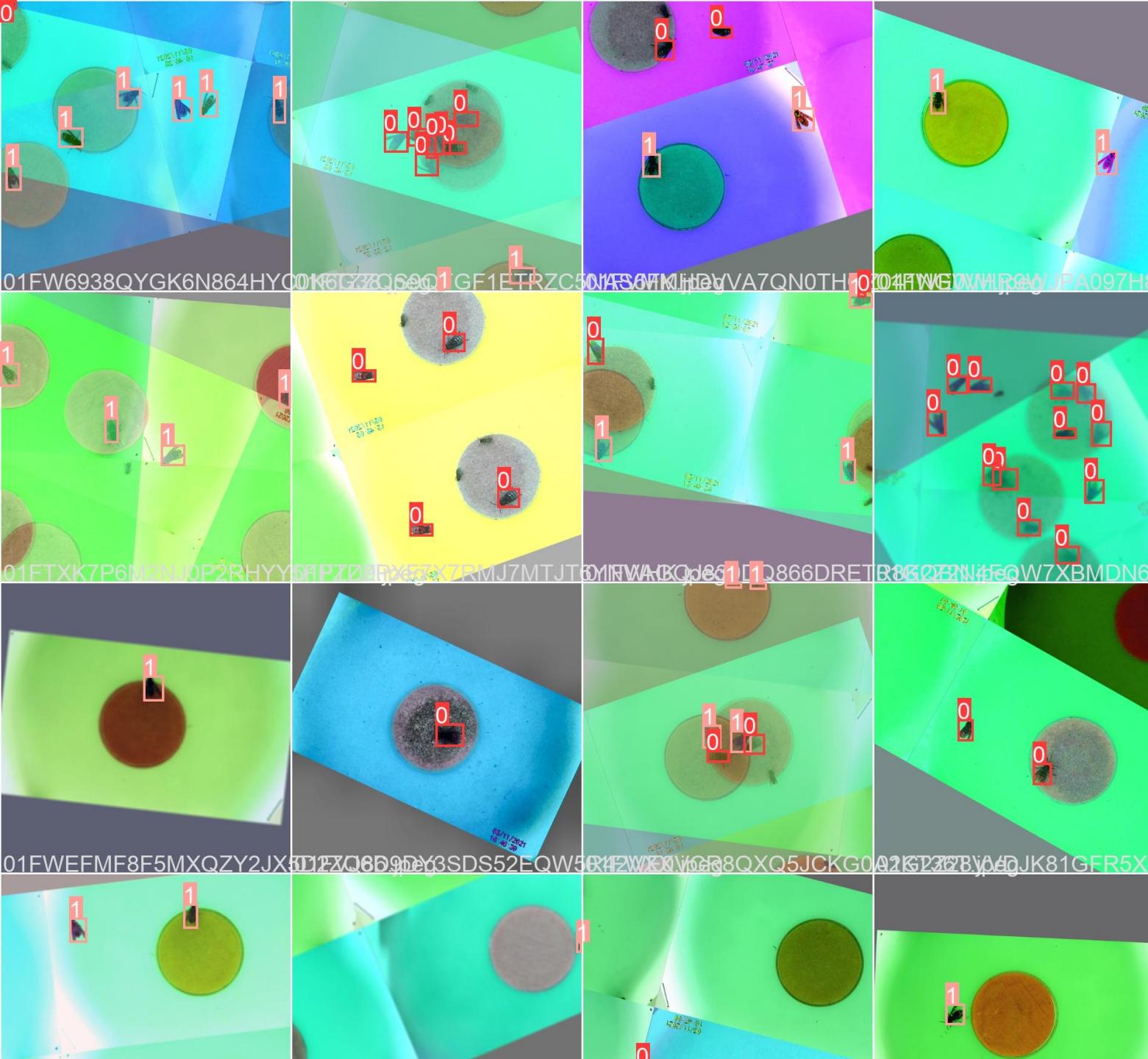
# Output: detections with confidence



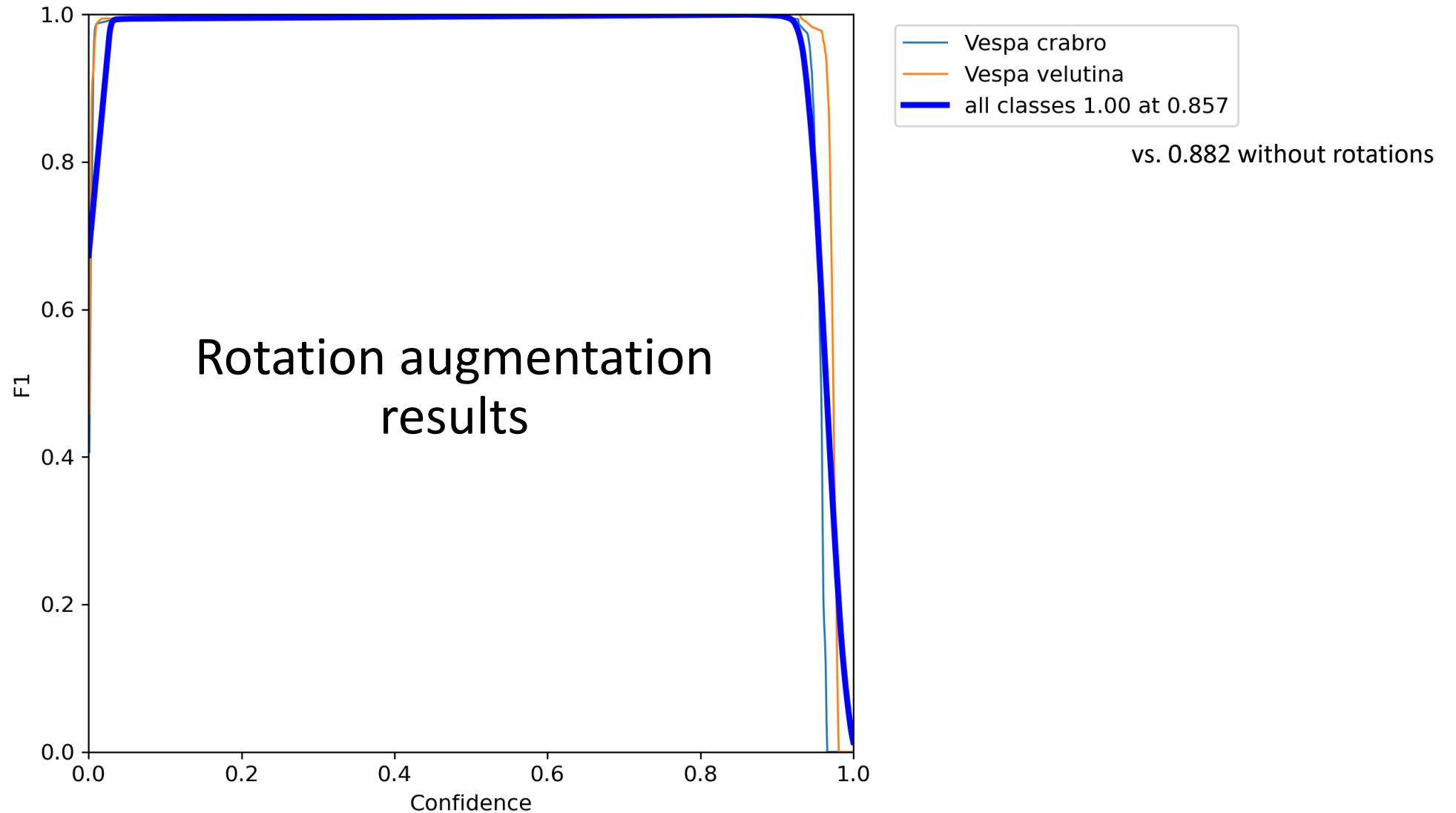
Model outputs candidate detections to be sent to bait station attendant.

# Still overfitting?



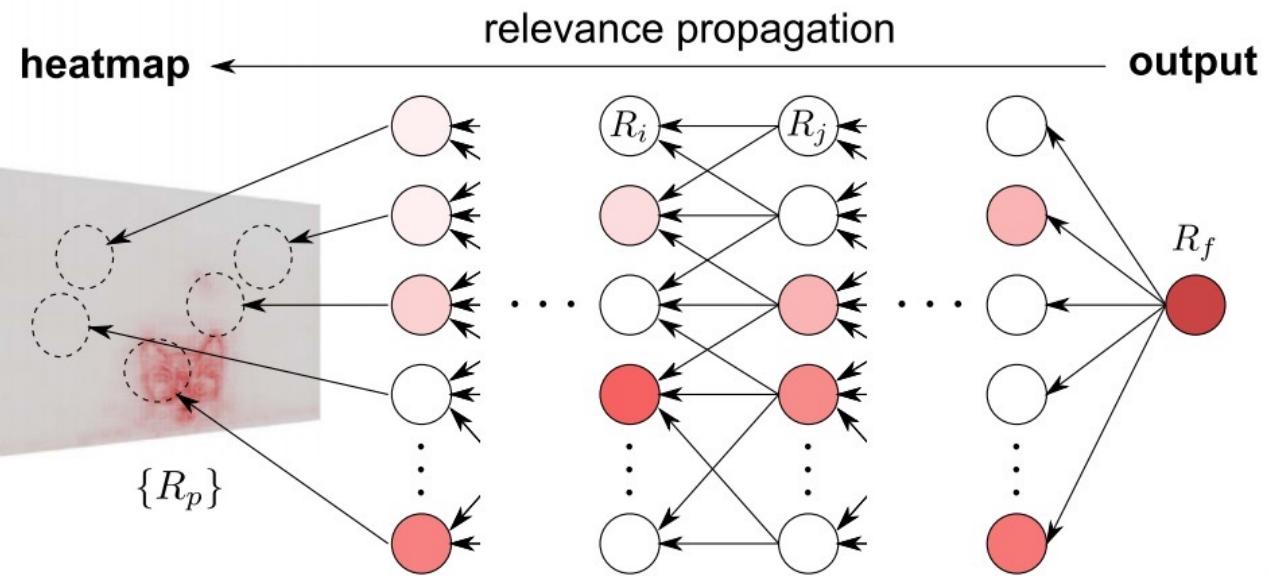
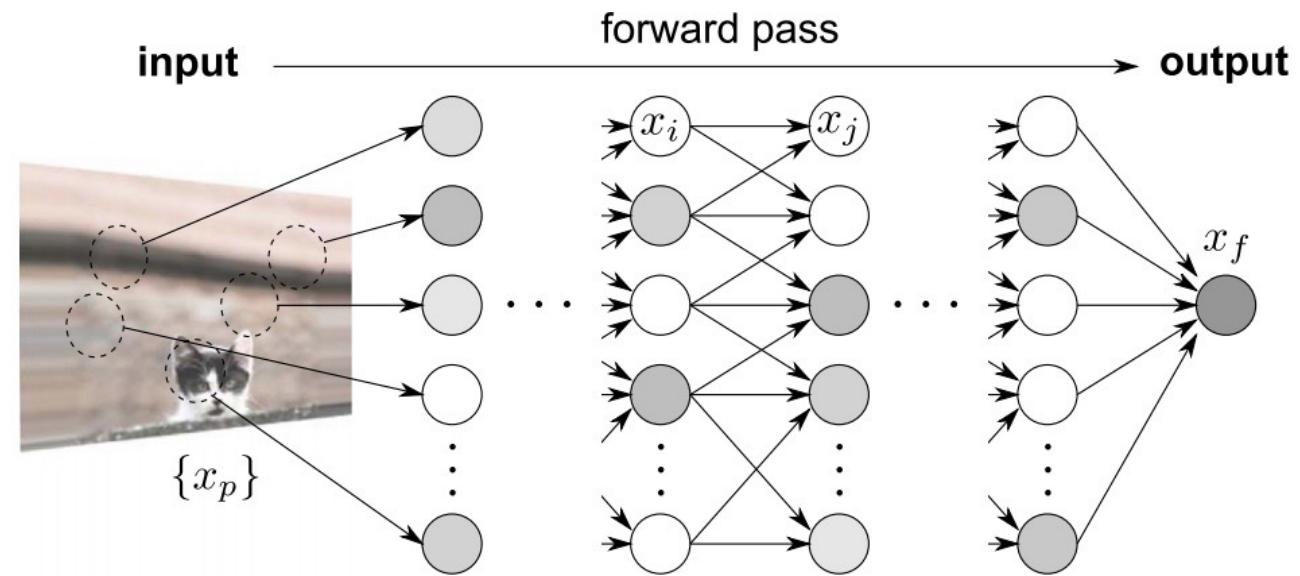


# Moment of madness



# Explaining the machine's thinking

## Layer-wise Relevance Propagation (LRP)



Vespa velutina 0.97



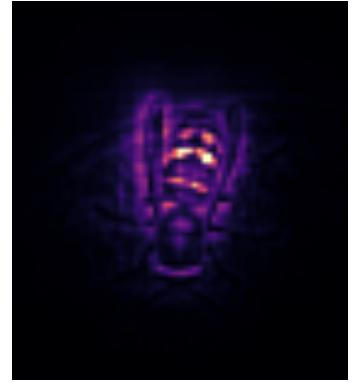




05/11/2021  
15:47:50

1500

*Vespa crabro*



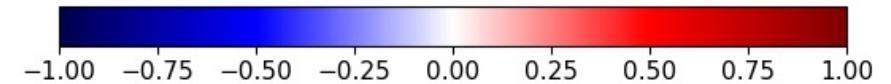
*Vespa velutina*



# Contrastive LRP

- Relevance computed by subtracting a weighted proportion of other class
- *Vespa velutina*:

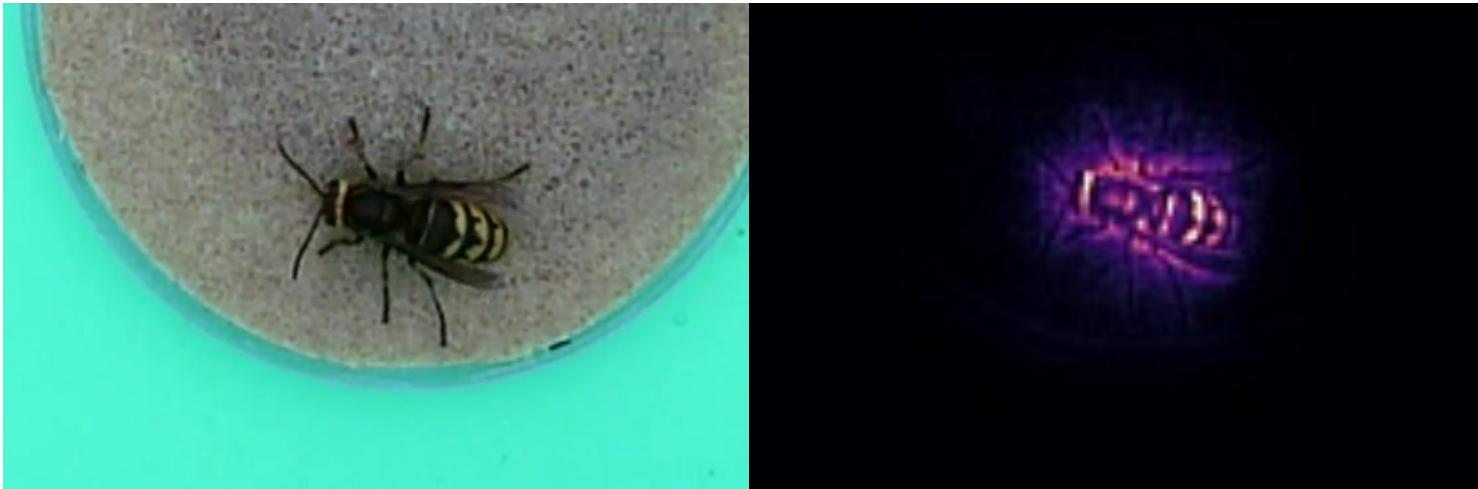
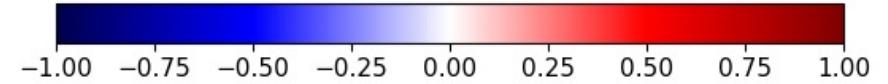
$$\tilde{R}_{velutina} = \alpha R_{velutina} - \beta R_{crabro}$$



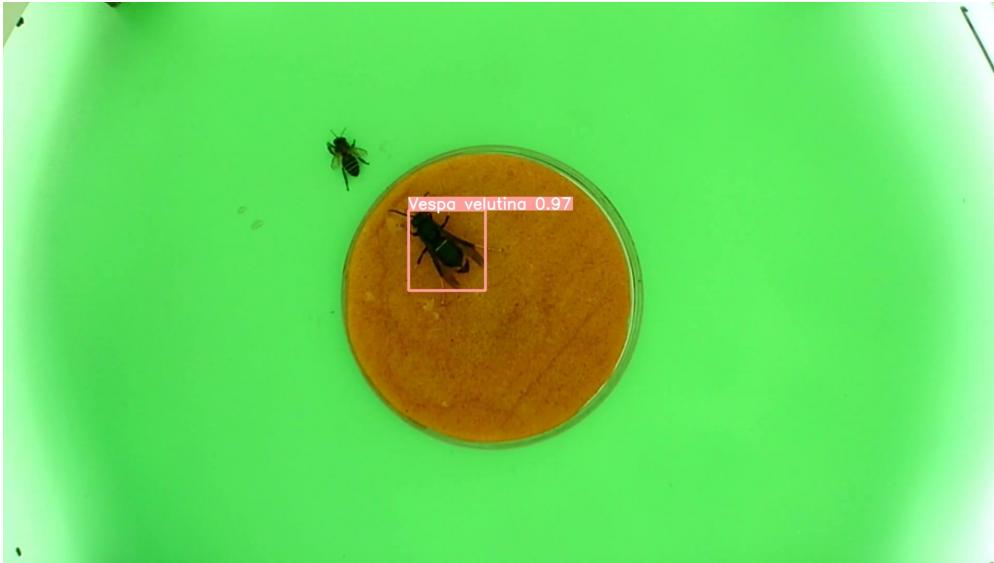
# Contrastive LRP

- Relevance computed by subtracting a weighted proportion of other class.
- *Vespa crabro*:

$$\tilde{R}_{velutina} = \alpha R_{velutina} - \beta R_{crabro}$$



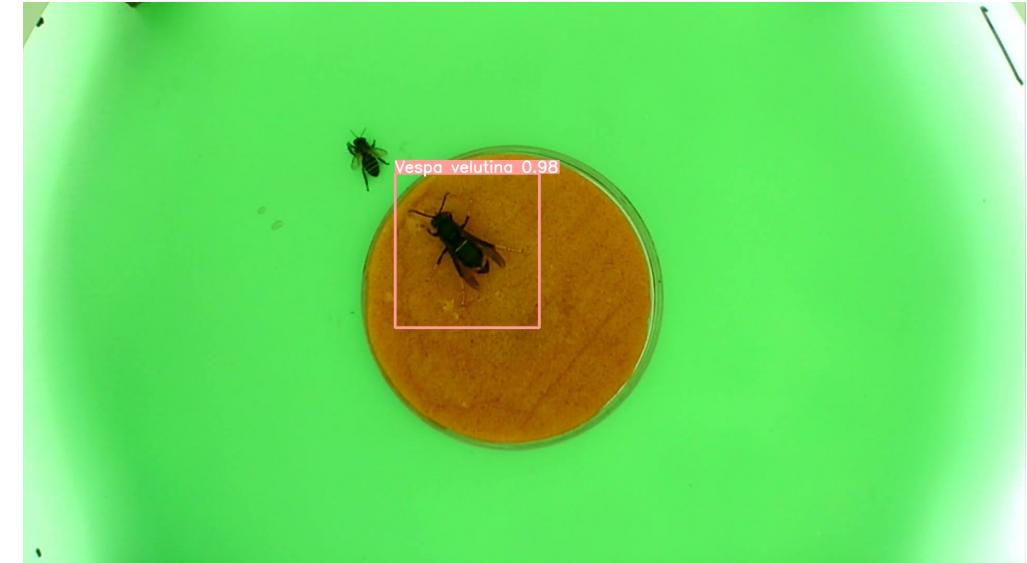
# Training against larger box annotations



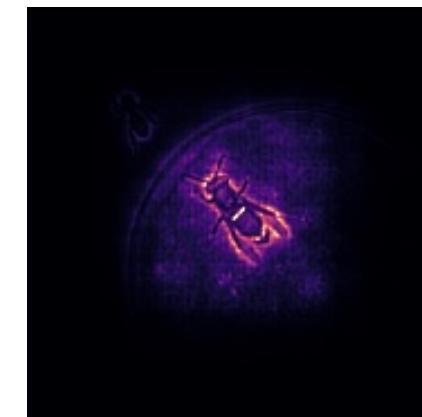
LRP



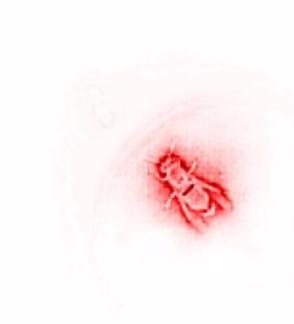
Contrastive LRP



LRP

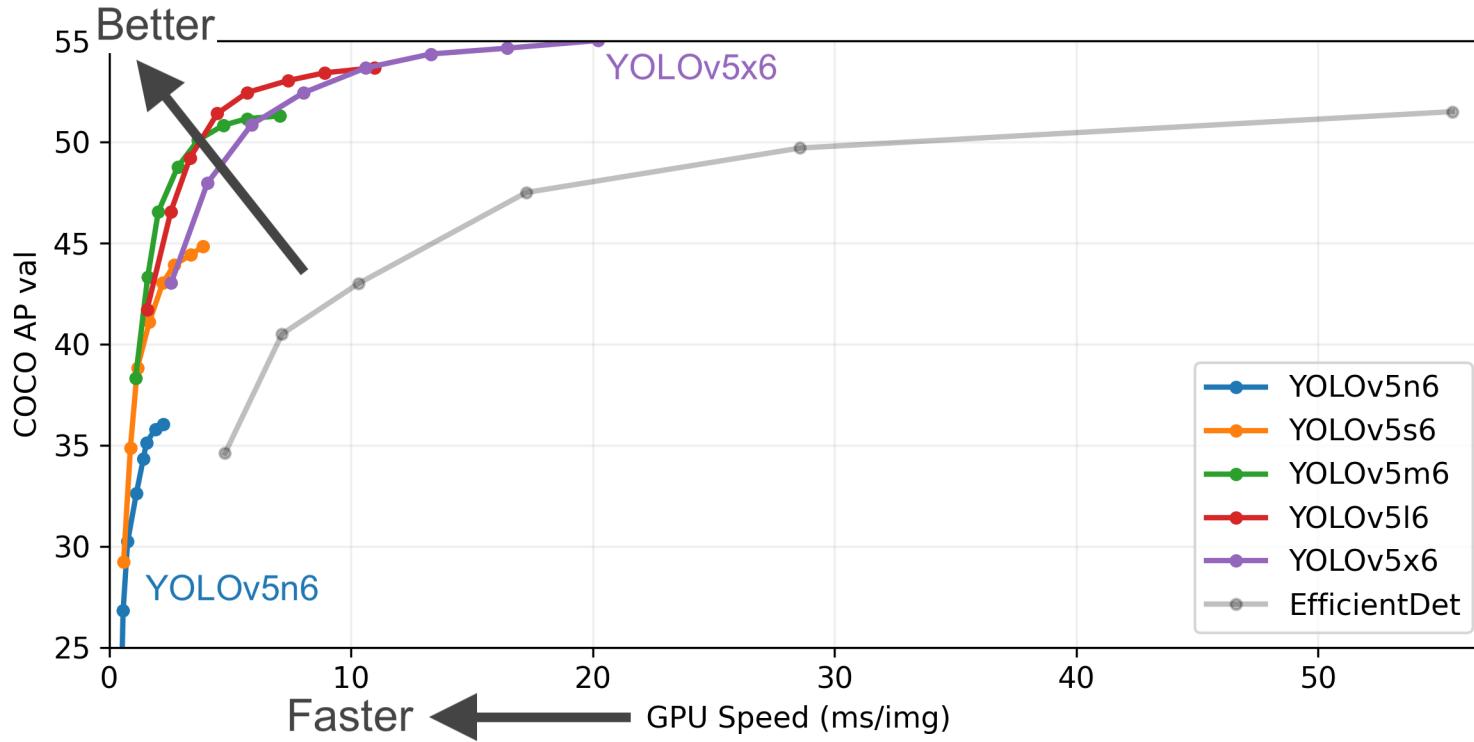


Contrastive LRP

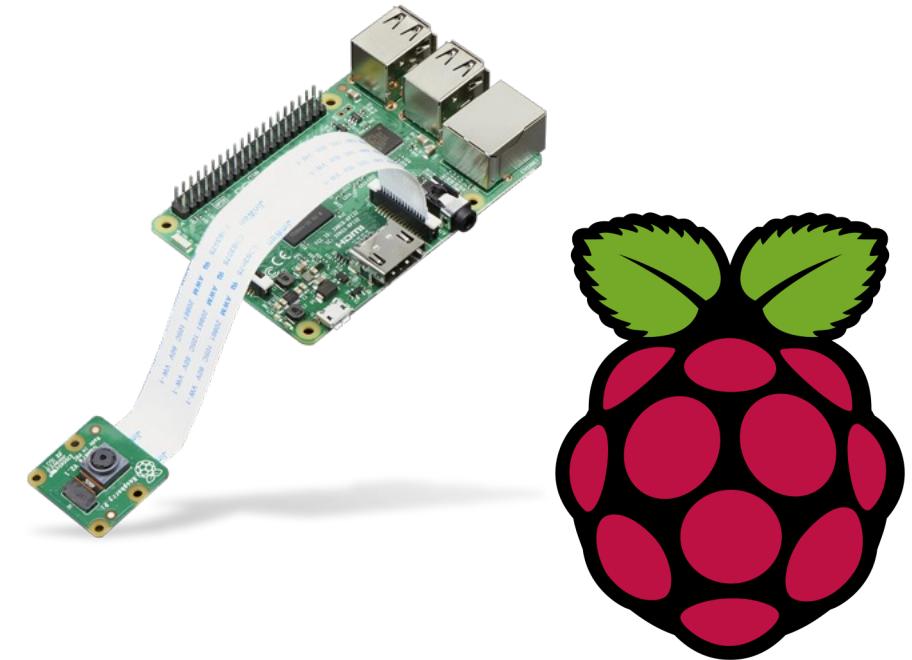


# Implementation

## Lightweight model architecture



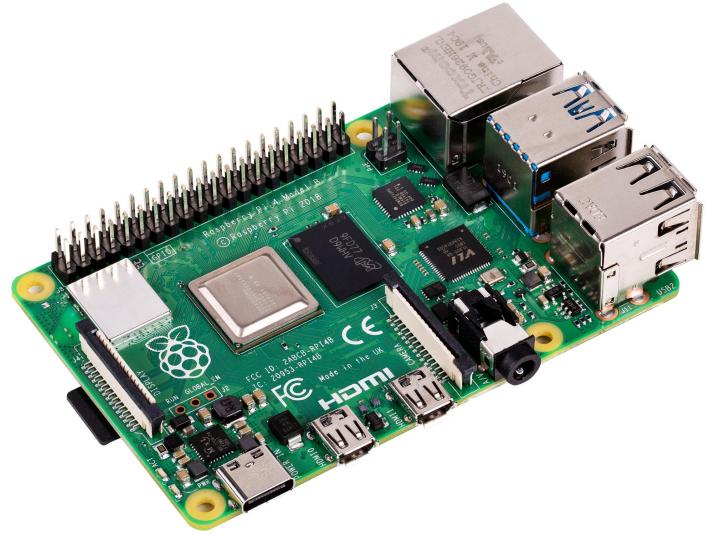
## Prototype detector using Raspberry Pi



# Shopping list

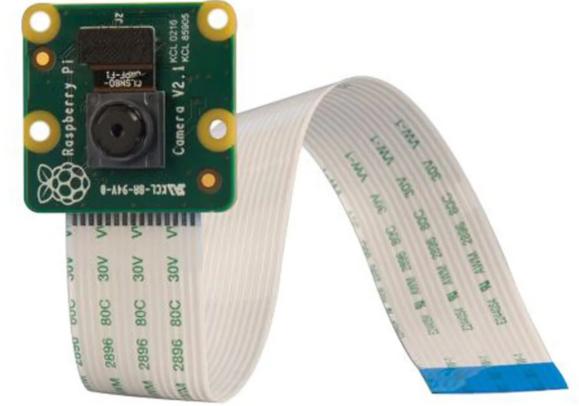
- Raspberry Pi 4 Model B

£35-55; 1-4GB RAM



- Camera module V2.1

£24.90



- Connectivity: 4G HAT

£64.50



- Power: PiJuice Solar kit (Solar panel + battery + HAT)

£89.99-187.49; 6-40 Watt panel

£214.39-331.89





The End

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