

# A bioinspired mechanism for learning-free general fruit detection

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# Initial Aims

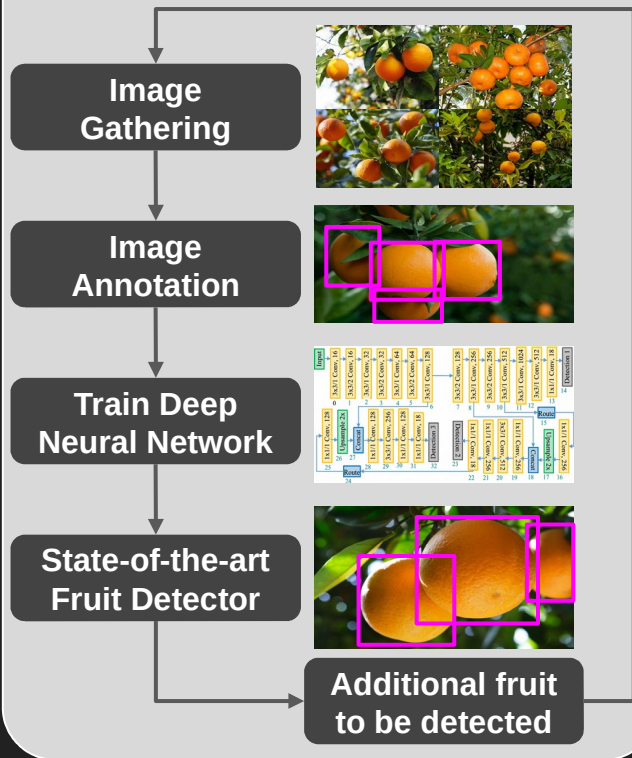
1. Implement a soft fruit detector.
2. Gain an understanding of how *Drosophila Suzukii* achieve this.
3. *Drosophila Suzukii* are attracted to *Strawberries* and other red fruits.

# Drosophila are Generalists not specialists

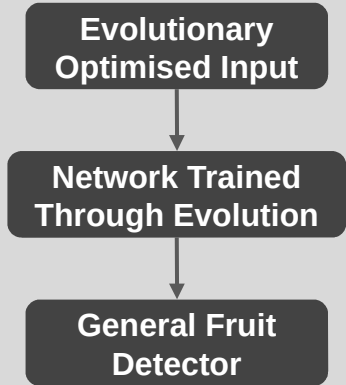
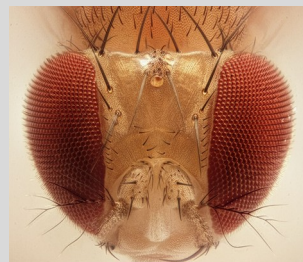
- Drosophila *Suzukii* are generalist seeking fruit many different fruits such as cherries, blueberries, raspberries, blackberries, peaches, nectarines, apricots, grapes and more.
- Trapping studies show that *colour is sufficient* to attract Drosophila *Suzukii* being attracted to Red, Green, Orange, Yellow, Blue, Purple and Black
- Other factors that plays a role are:
  - *shape*
  - *Size*
  - Angle of approach - Drosophila either approach from above or below the fruit

# Drosophila Inspired Fruit Detection

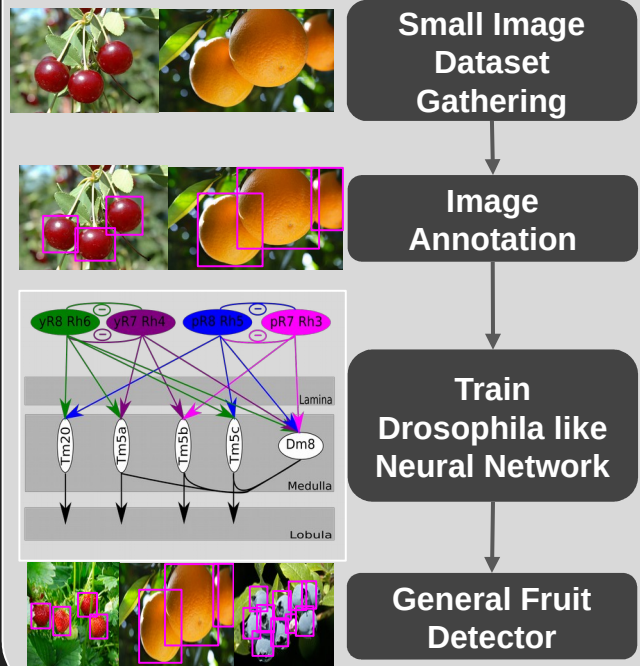
## Deep Learning Life Cycle



## Drosophila Melanogaster



## Bioinspired Learning life cycle



# Hypothesis

Drosophila are general fruit detectors trained by evolution, modeling the eye and brain will lead to computer vision models that are general fruit detectors.

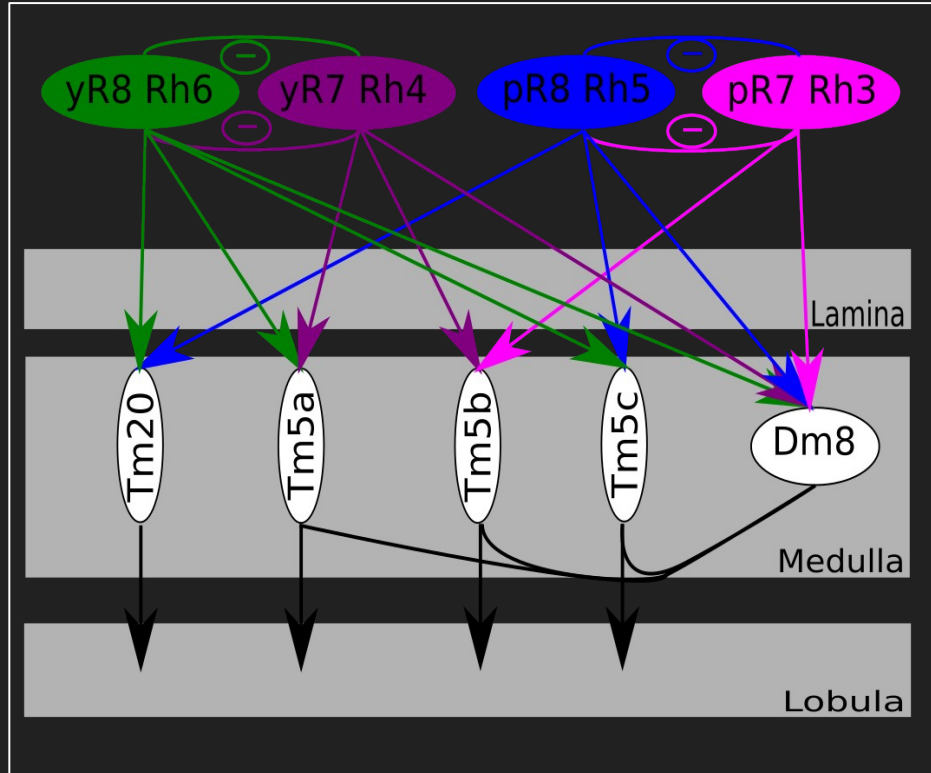
Trained On



Detect



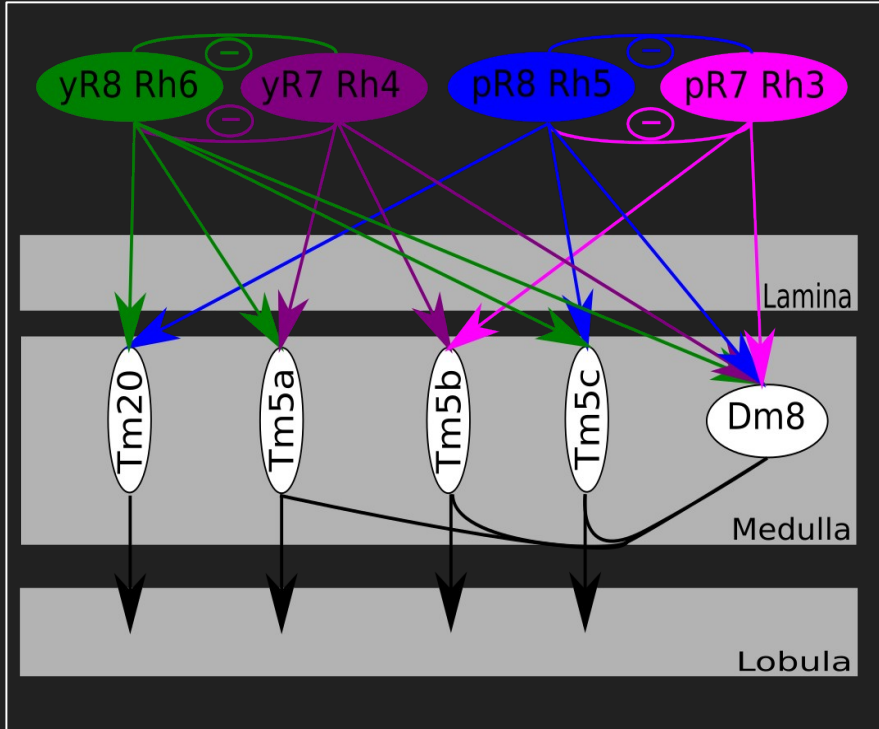
# The derived model



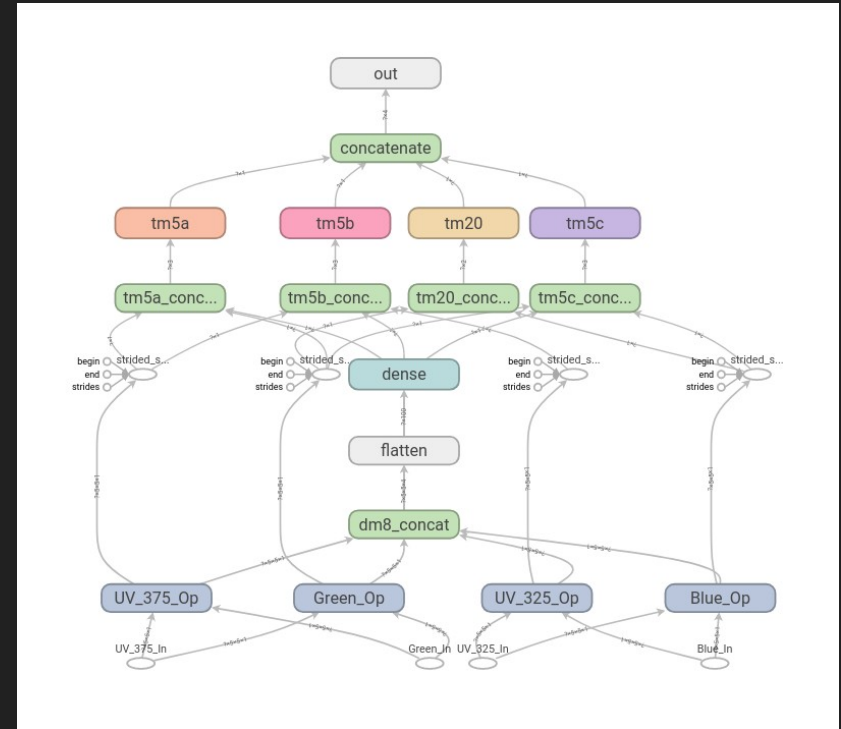
- Photoreceptors wavelength sensitivity (**Drosophila Melanogaster**) -
  - UV (335nm and 355nm),
  - Blue (460nm)
  - Green (530nm).
- Colour Opposition - Found in Photoreceptor neurons passing through the lamina.
- Five Key Neurons for colour learning. Four projecting deeper into the optical lobe. One Projecting to Neurons in the Medulla.

# Model Comparison

Drosophila Melanogaster Neuron Connection



Vision Model

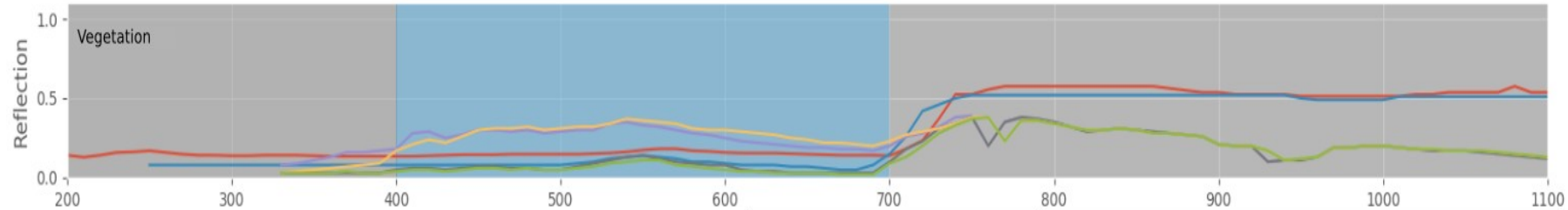
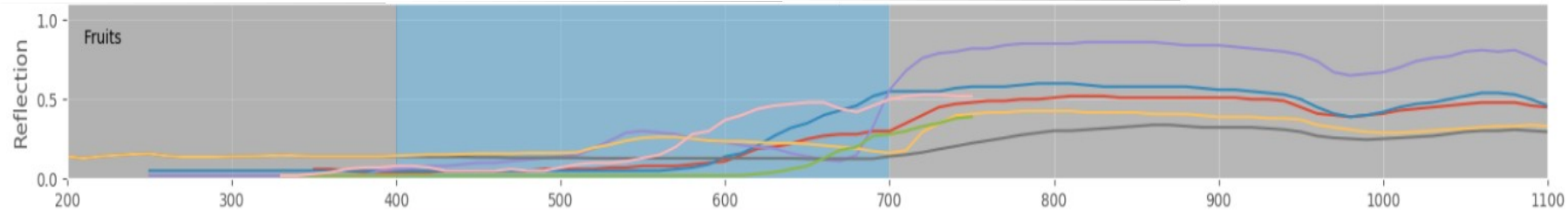
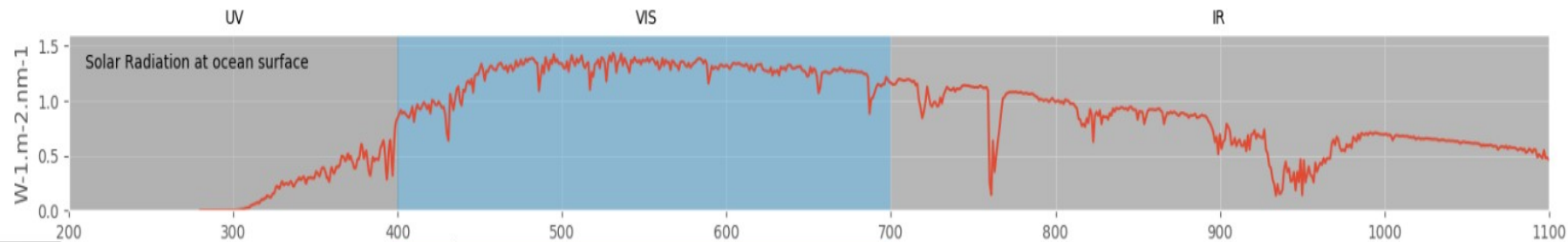


# Simulation Study

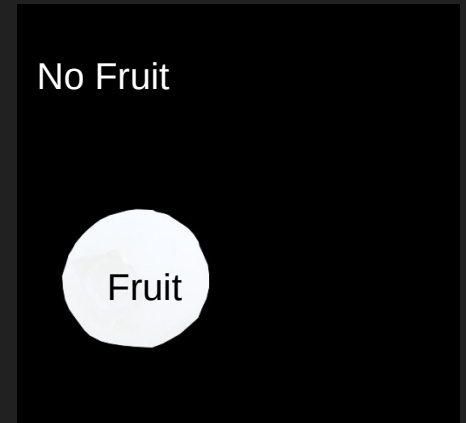
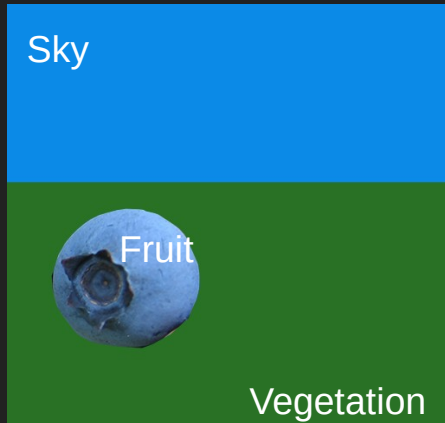
- Proof of concept simulation study undertaken.
- Found full spectrum data from studies analysing fruits reflective properties.
- With the simple simulated data the model is very promising.
- The Question was asked is this ready to publish?



# Reflective Data



# Simulated Images



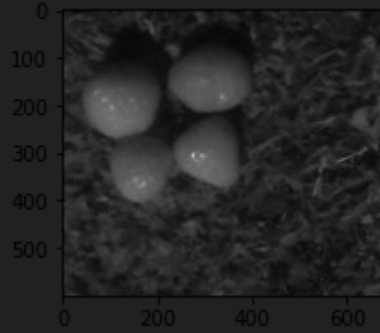
# Real World Study - Camera

- Consists of Four modified webcams.
- Mimicking Photoreceptors wavelength sensitivity Found in *Drosophila Melanogaster* -
  - UV (325nm and 375nm),
  - Blue (450nm)
  - Green (550nm).
- Images stitched together in post processing.

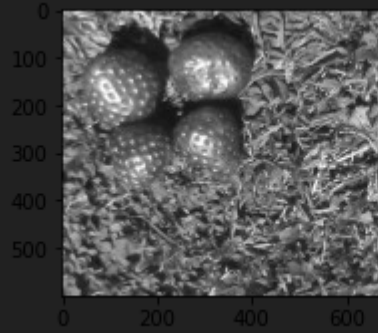


# Images from camera

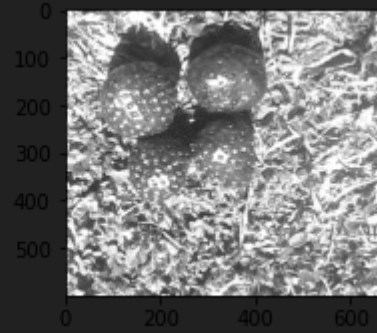
UV1 325nm



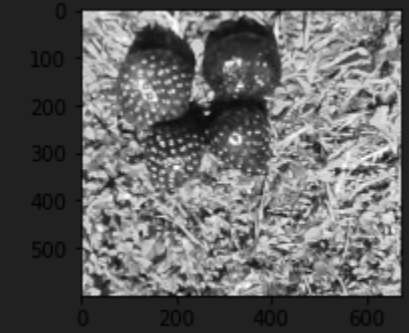
UV2 375nm



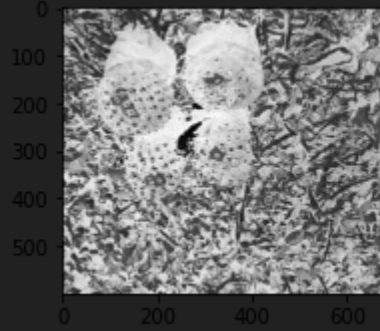
Blue 450nm



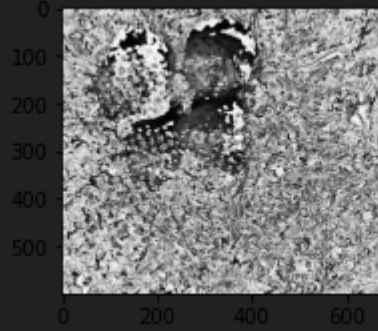
Green 550nm



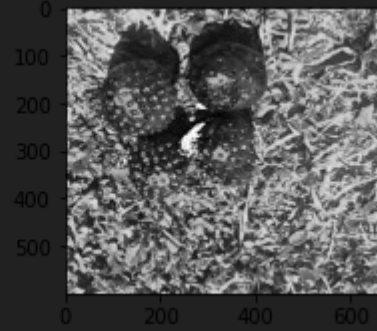
Op (UV1 - Blue)



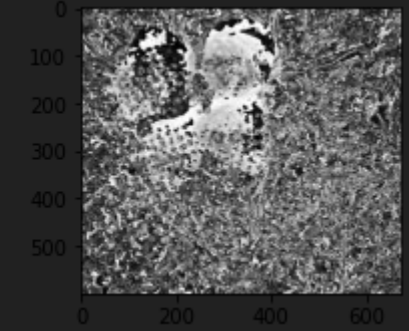
Op (UV2 - Green)



Op (Blue - UV1)



Op (Green - UV2)



# Real world data only Trained on Strawberries

Trained



Tested

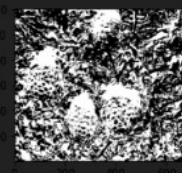
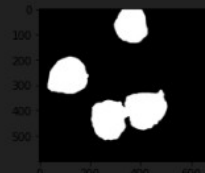
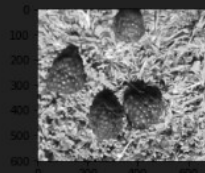


Input image

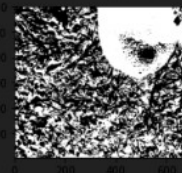
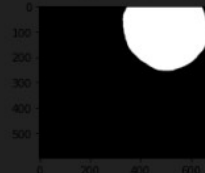
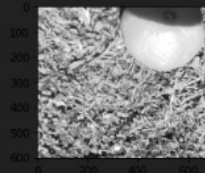
Ground Truth

Model Output

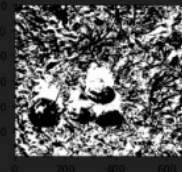
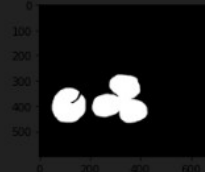
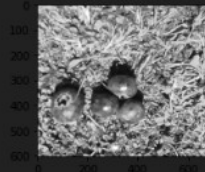
Raspberry



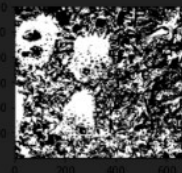
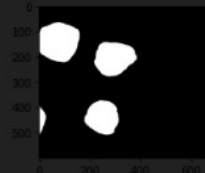
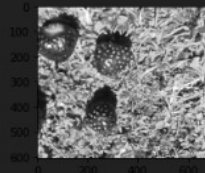
Orange



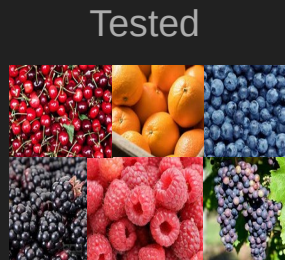
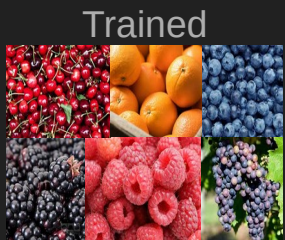
Blueberry



Strawberry

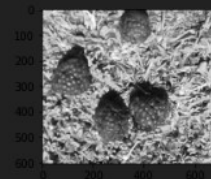


# Real world data, Trained on all Fruit types

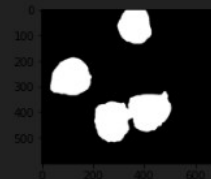


Raspberry

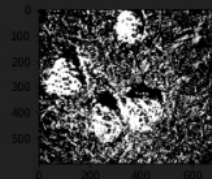
Input image



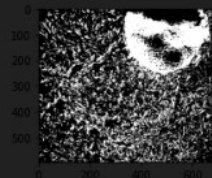
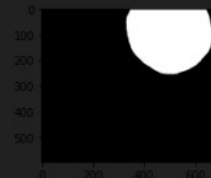
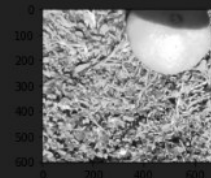
Ground Truth



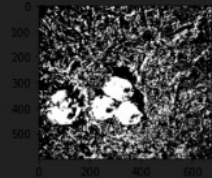
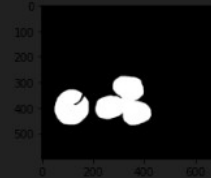
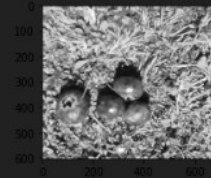
Model Output



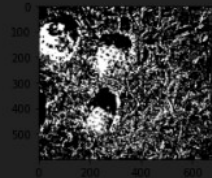
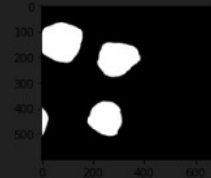
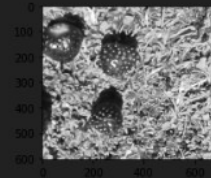
Orange



Blueberry



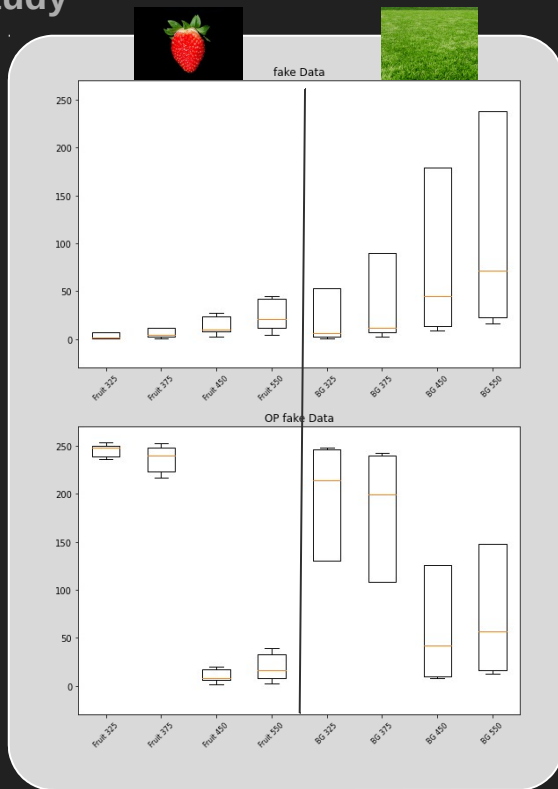
Strawberry



# Looking at the data

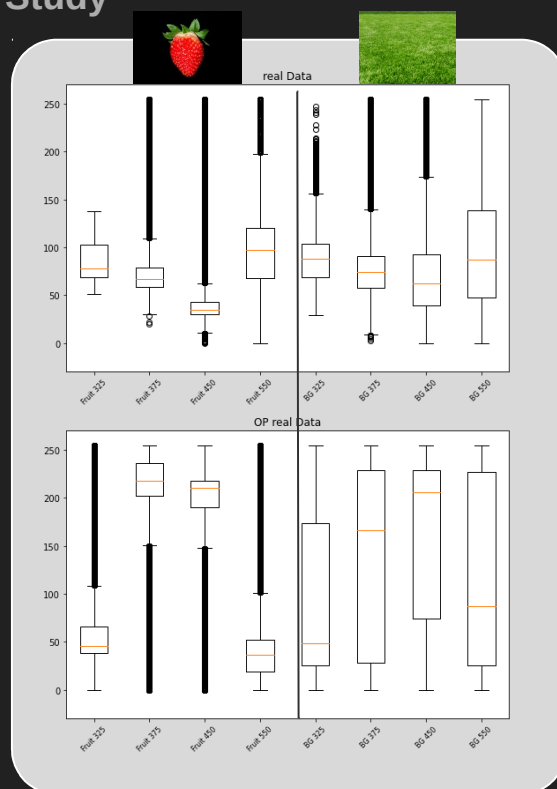
## Simulation Study

Visual Input



Col-op layer

## Camera Study



# Summary of work done so far

1. Generalists not specialists
2. Abstracted biological model allowing generalised fruit detection at the pixel level
3. Tested in simulation with good results
4. Investigating translation to real world
  - a. TBC



# Next Steps

Trapping studies show that *colour is sufficient* to attract *Drosophila Suzukii* being attracted to Red, Green, Orange, Yellow, Blue, Purple and Black

- Low resolution vision - edges etc
- Other factors that plays a role are:
  - *shape*
  - *Size*
  - Angle of approach - *Drosophila* either approach from above or below the fruit

Thanks for listening.

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