

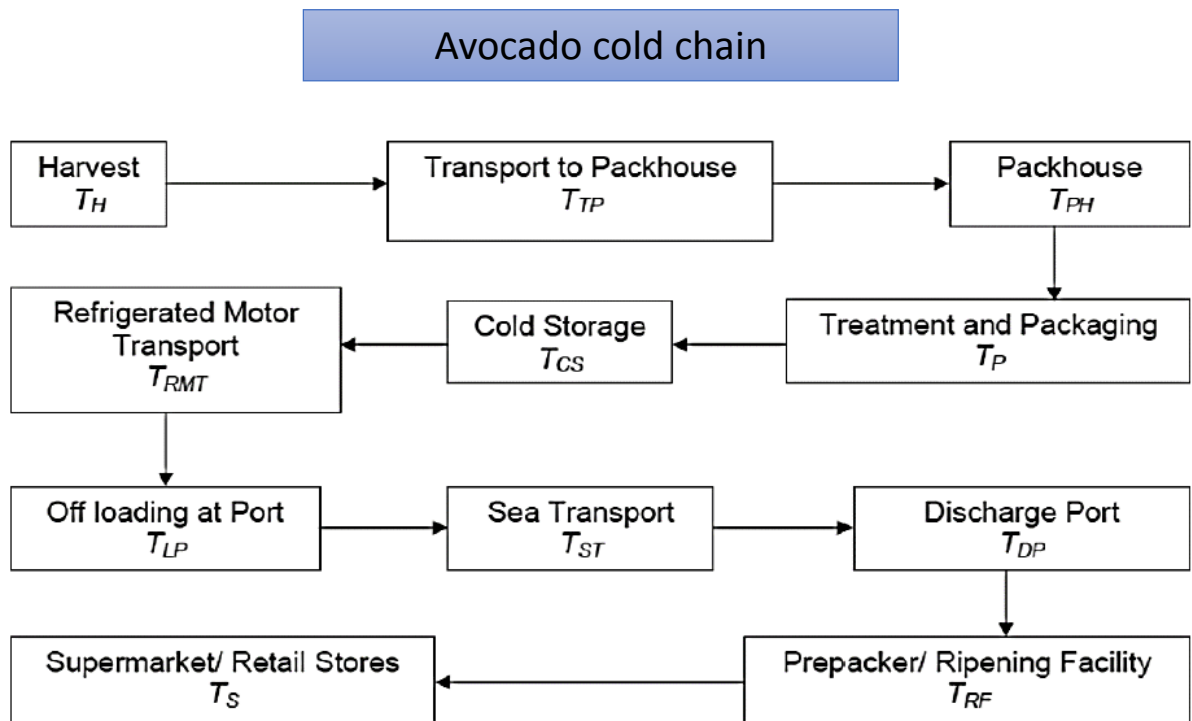
Avocado counting using Machine Vision and Machine Learning



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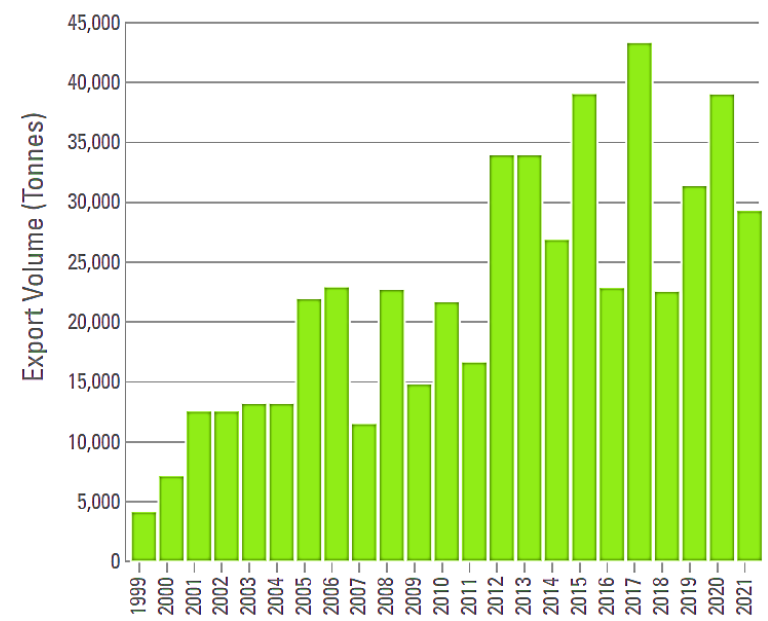
April 2022

Importance of correct fruit counting



NEED FOR ACCURATE YIELD PREDICTION

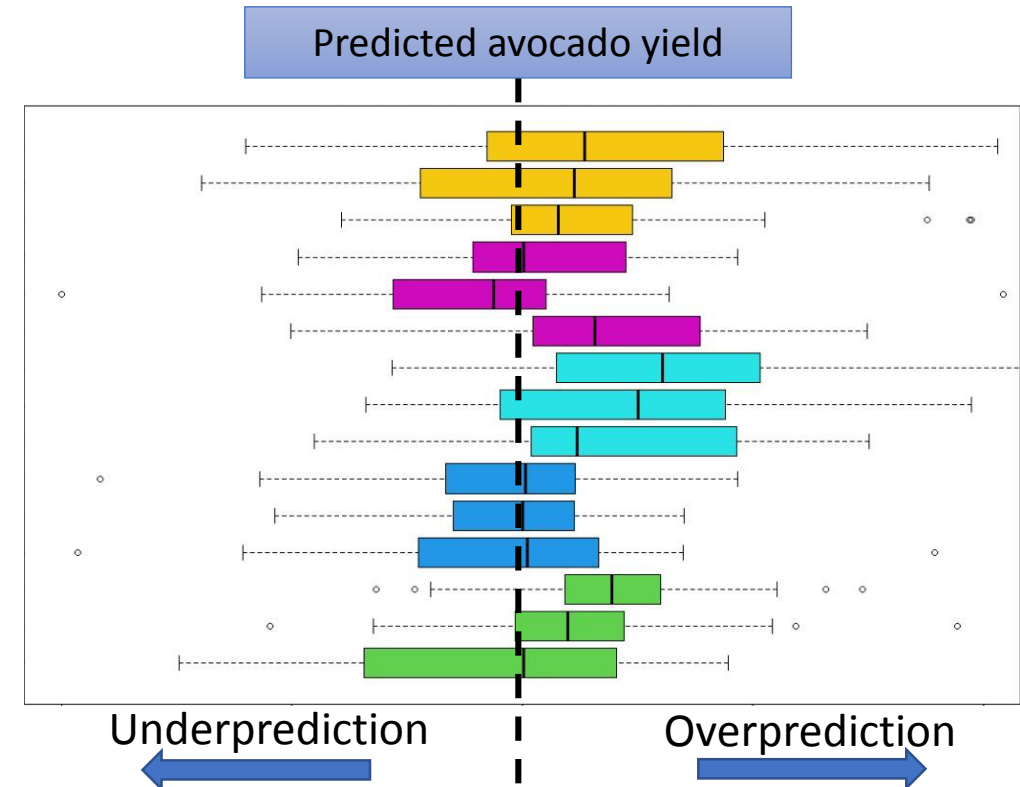
Avocado export volume (ton) as a function of time (h) (Source: FreshFacts NZ)



Methods of fruit counting methods

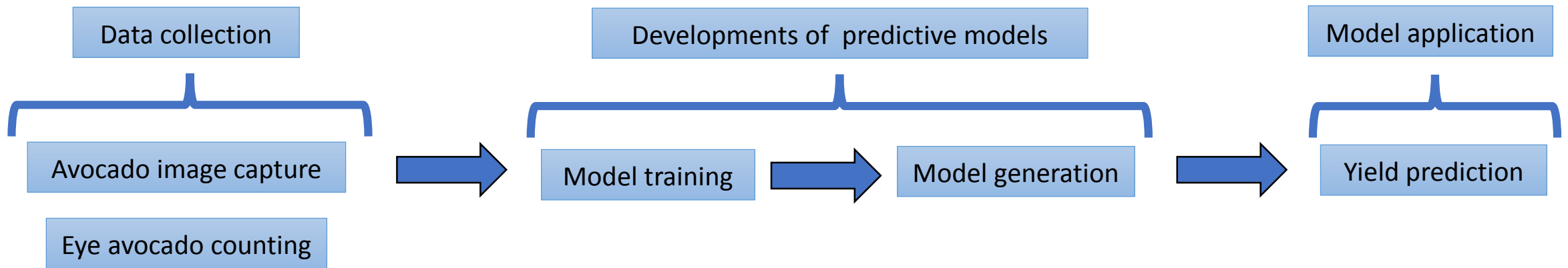
Crop estimation is performed based on the following:

- Historical data
- Weather conditions
- Experiments/tests
- Experiences
- Manual counting of avocados



This work aims to develop a prototype computer-vision-based system to enable crop estimation for blocks of avocado production.

Proposed methodology



Development of models: YOLOv5 (You Only Look Once)

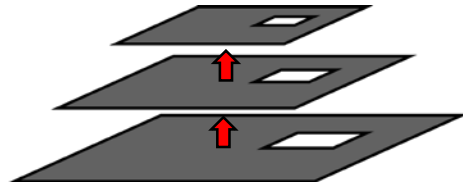
Backbone

Extracts features from the input image



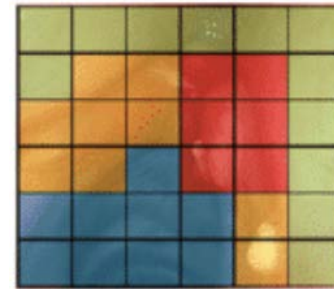
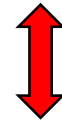
Neck

Connects the backbone to the head and helps to further refine the features extracted by the backbone

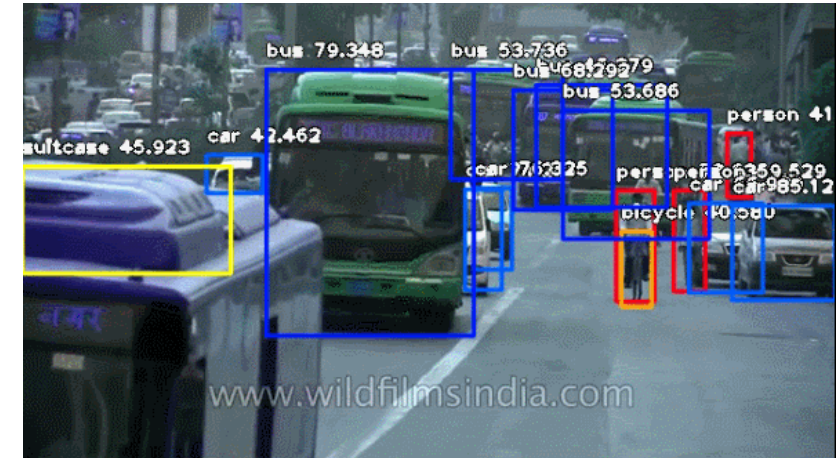


Head

Predicts the location and class of objects in the input image



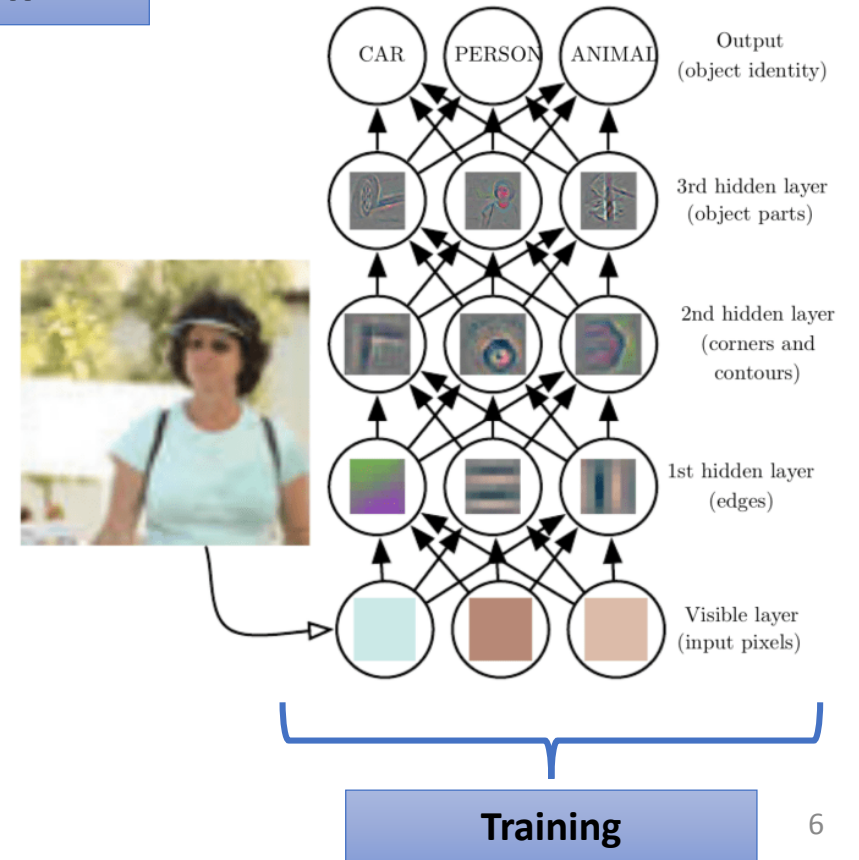
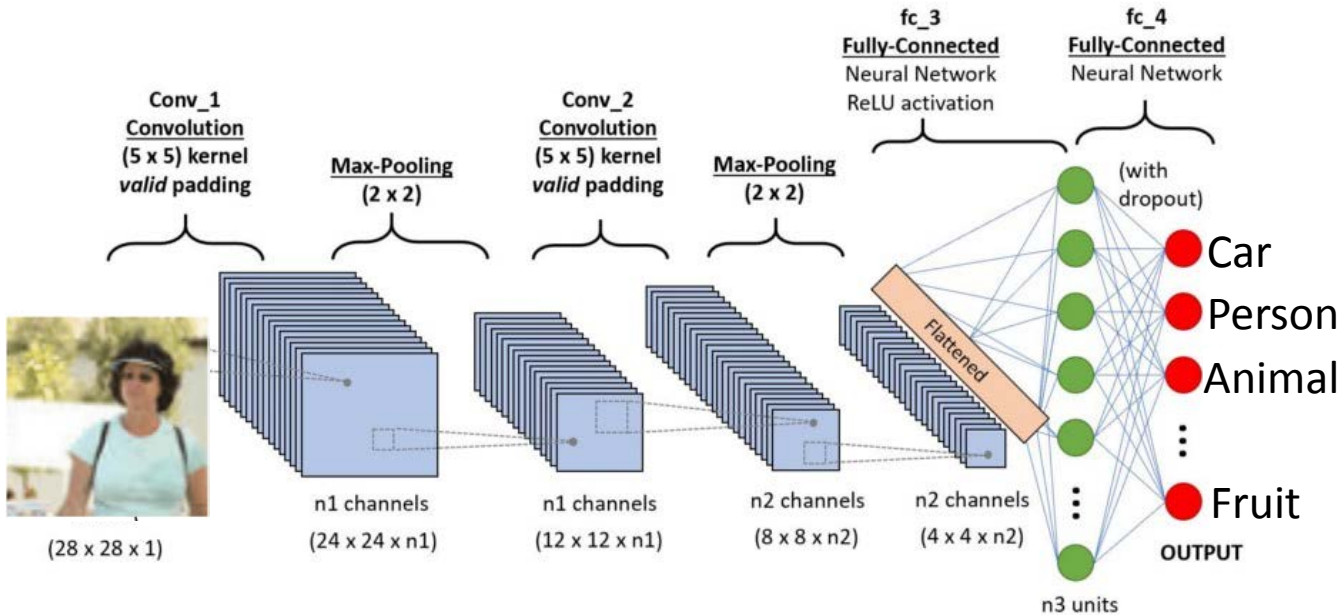
Results



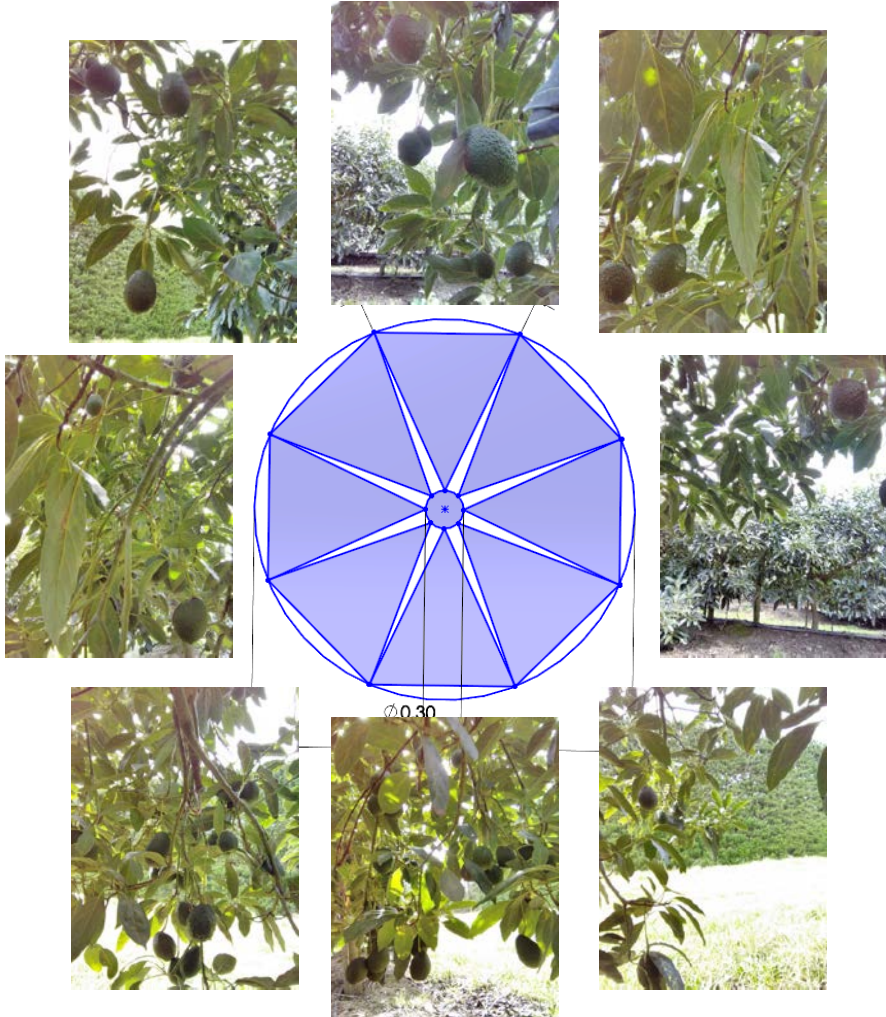
<https://imageai.readthedocs.io/en/latest/video/index.html>

Development of models: YOLOv5 (You Only Look Once)

Convolutional neural network



Data collection: Image capture for model training



- Images captured from the trunk underneath canopy from about 40 cm to 60 cm of the ground (minimise image overlapping)
- Two smartphones were used to capture images (Vodafone P11 and Alcatel 1B)
- Images every 45°- 50° (8 images per tree)
- Over 2,000 images were taken to ensure an adequate number of images

Data augmentation

Take existing images to generated an extended image library

Parameters to be modified:

- Cropping
- Rotation
- Gray scale
- Hue
- Noise
- Saturation
- Brightness
- Blur
- Others

Library from 2,000 to 4,200 images

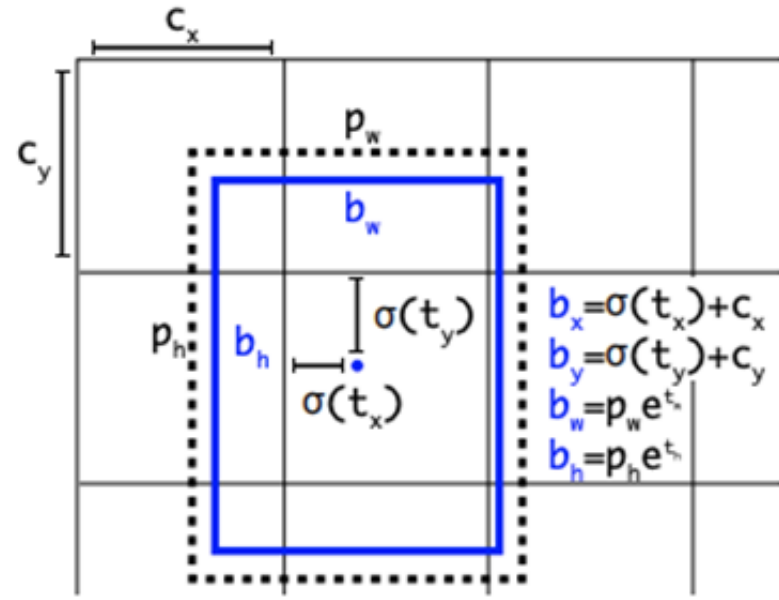


Development of predictive models: Model training

Image with bounding boxes



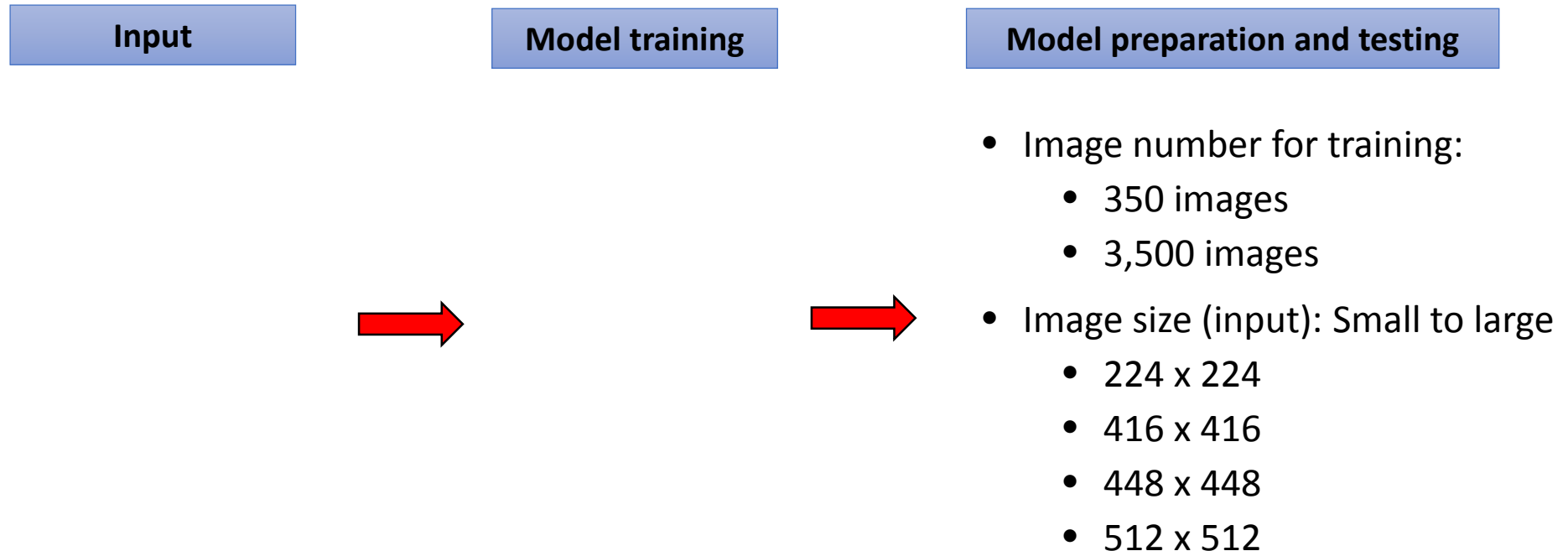
Bounding box*



Potential detected features

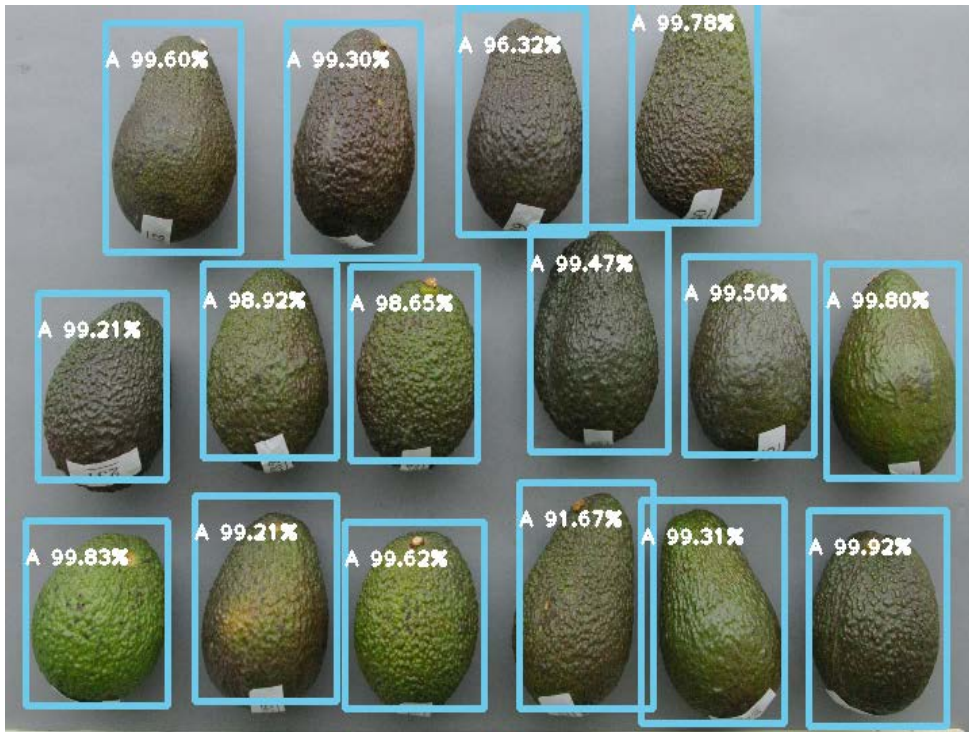
- Object part
- Corners
- Walls
- Edges
- Colors
- Others

Development of predictive models: Model preparation



Avocado counting from photography: Ideal scenario

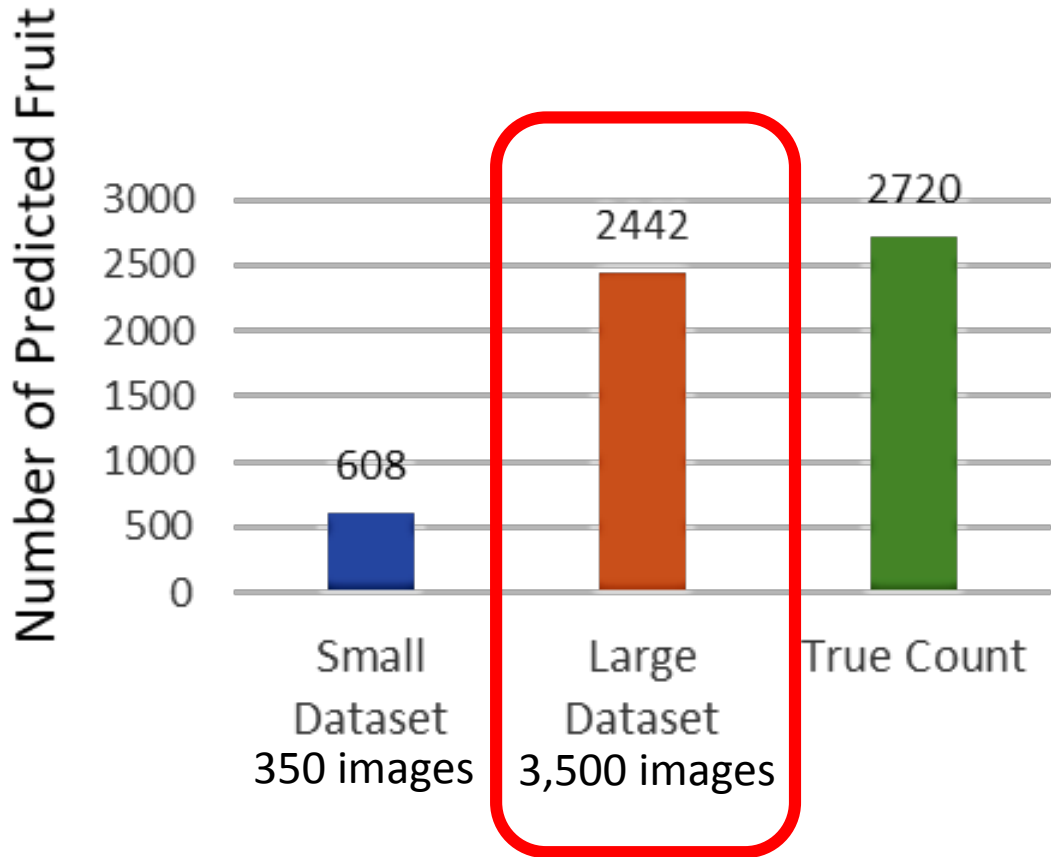
Ideal detecting conditions



- 16 avocados were detected
- Ideal conditions for detection (uniform camera distance, background colour, lighting, and no overlapping)
- Confidence levels were between 91% and 100%

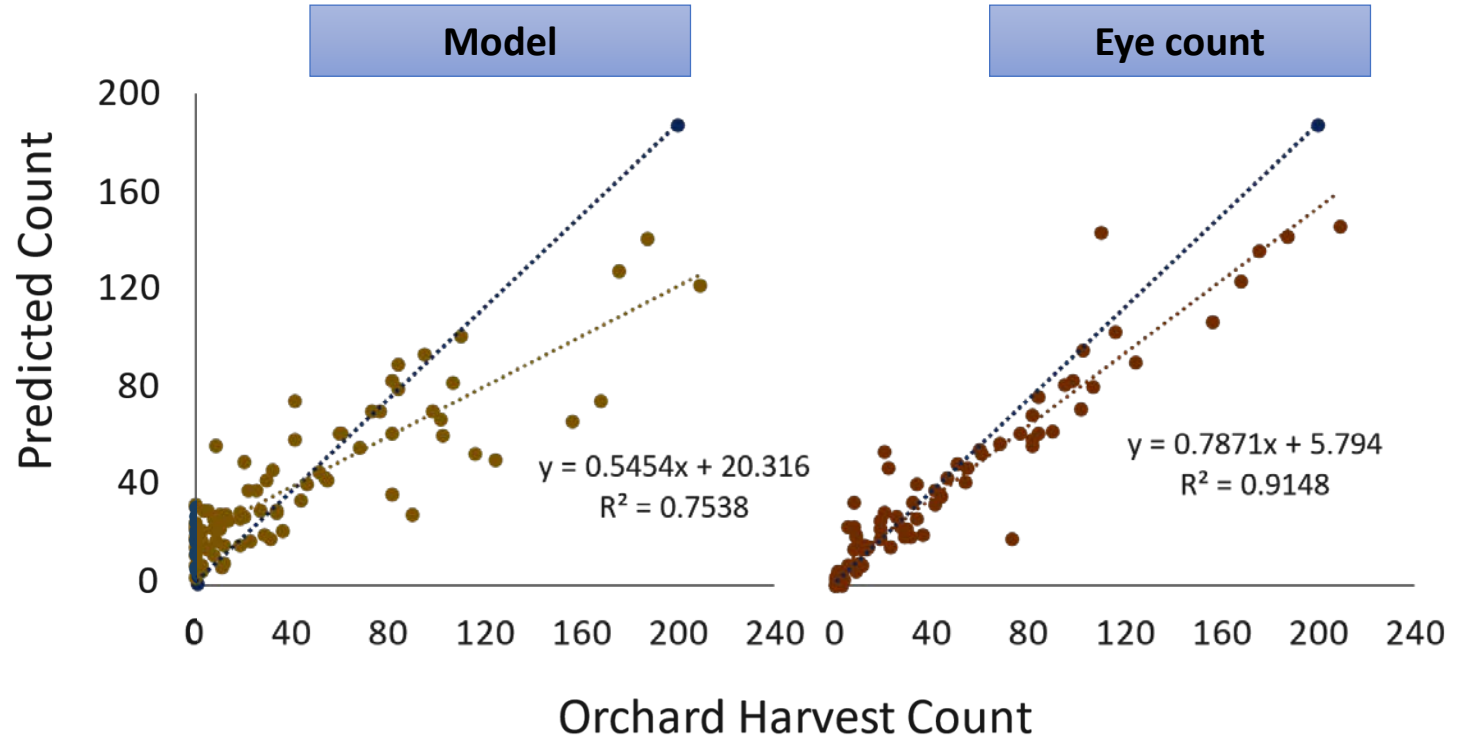
**High accuracy in avocado detection
under ideal scenarios**

Avocado counting from photography: Orchard



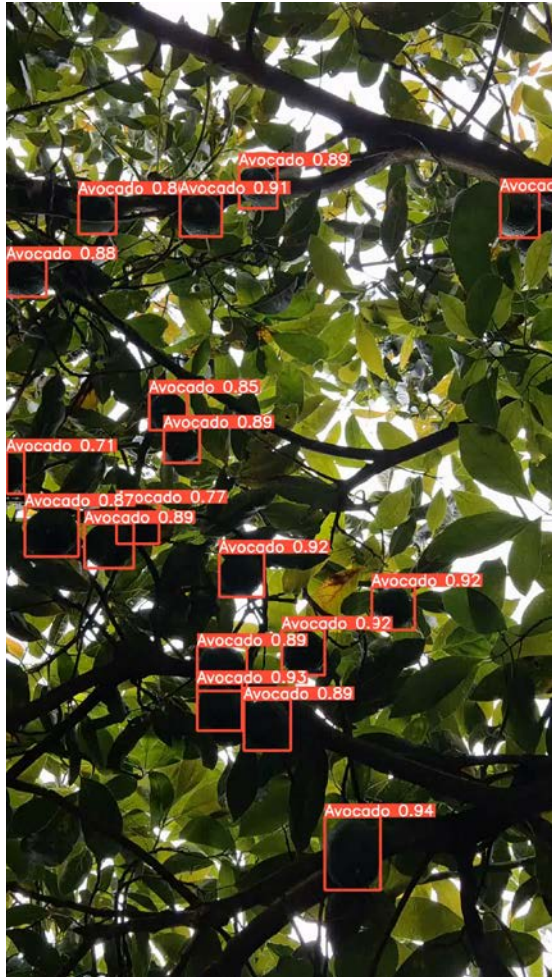
SIZE (PIXELS)	MD	STD	RMSE	MAE
416 X 416	-3.706	5.603	6.709	3.873
512 X 512	-1.103	3.583	3.917	2.671
640 X 640	0.067	3.102	3.097	1.917
832 X 832	1.393	2.827	3.147	2.187
960 X 960	2.265	3.201	3.743	2.079
1280 X 1280	3.448	4.297	5.504	3.861
2048 X 2048	4.424	5.660	7.176	5.385

Avocado counting from photography: Orchard



METHOD	MD	STD	RMSE	MAE
640 x 640	-2.99	28.87	28.85	19.20
Eye Count	-3.05	14.36	14.59	9.28

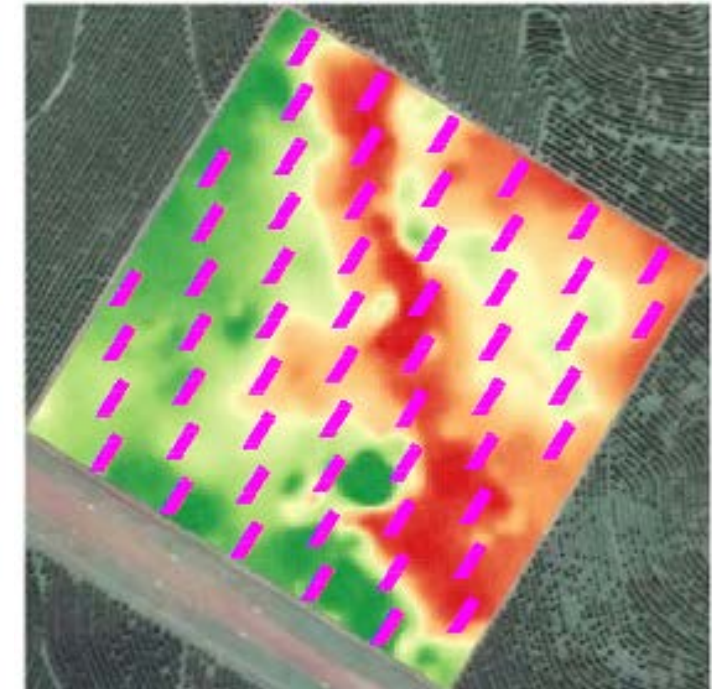
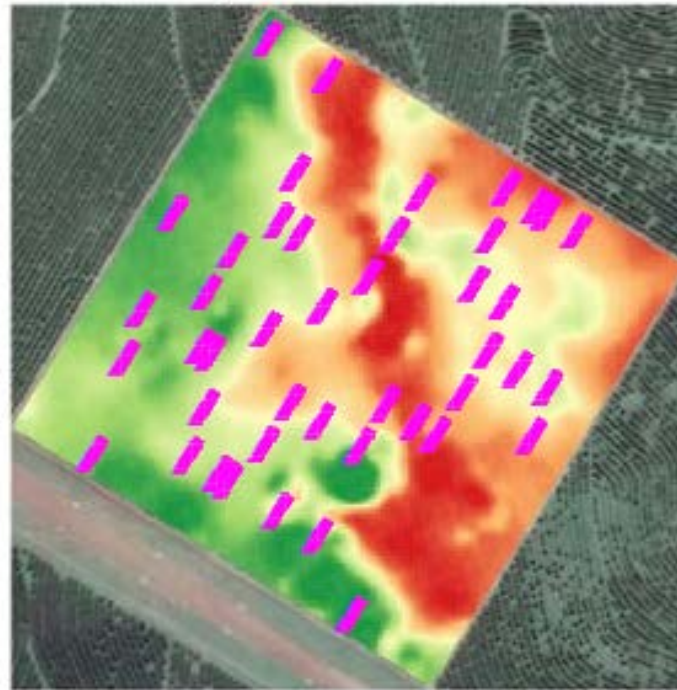
Avocado counting from smartphone video



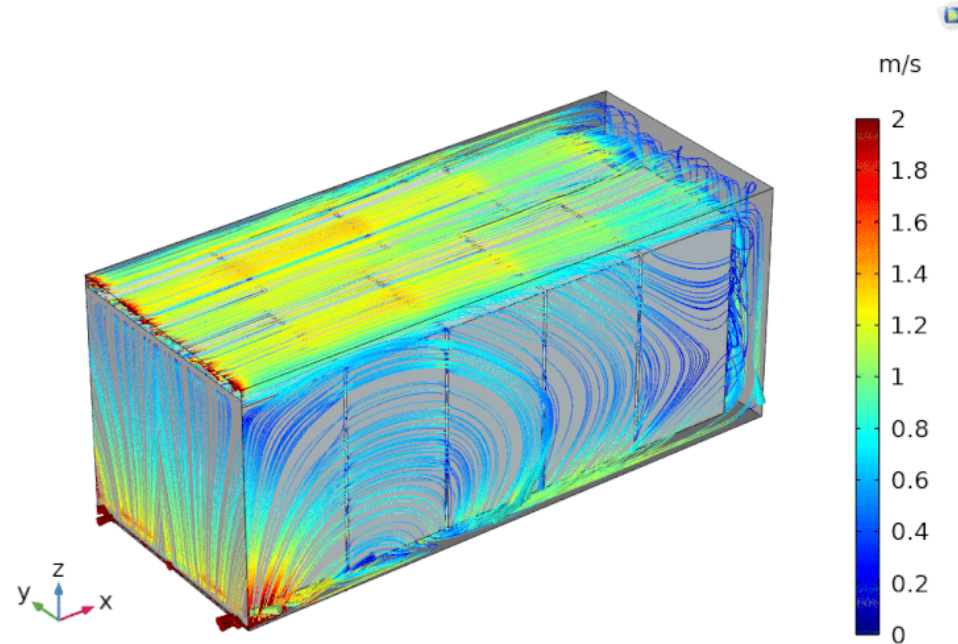
	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5	Total
Time Stamp	0:32	0:50	1:08	1:24	1:25	
Avocados Eye Counted	48	37	57	55	74	271
Predicted Avocados Counted	43	36	55	39	66	239
Accuracy	90%	97%	96%	71%	89%	88%

Ongoing work on yield prediction: Representative sampling

- Statistical analysis to recognise patterns on the blocks
- It is based on the number of fruit as a function of the position
- The block is divided in an arbitrary number of elements
- Cumulative distribution of mass of fruit per area is estimated.



Thank you very much for your attention
Muchas gracias por su atención



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