A Machine Learning Tool for Automatic Classification of Pollen Grains from Apple Orchards

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1 Pollinators in apple orchids

Understanding the structure and complexity of pollination networks in agricultural landscapes (e.g. apple orchids) is critical for determining the stability of pollination services in the face of environmental change.

Methods to rapidly and accurately identify pollen types found on pollinator species (e.g. bees) are essential for studies aiming to classify pollination network structure.

2 Current problem

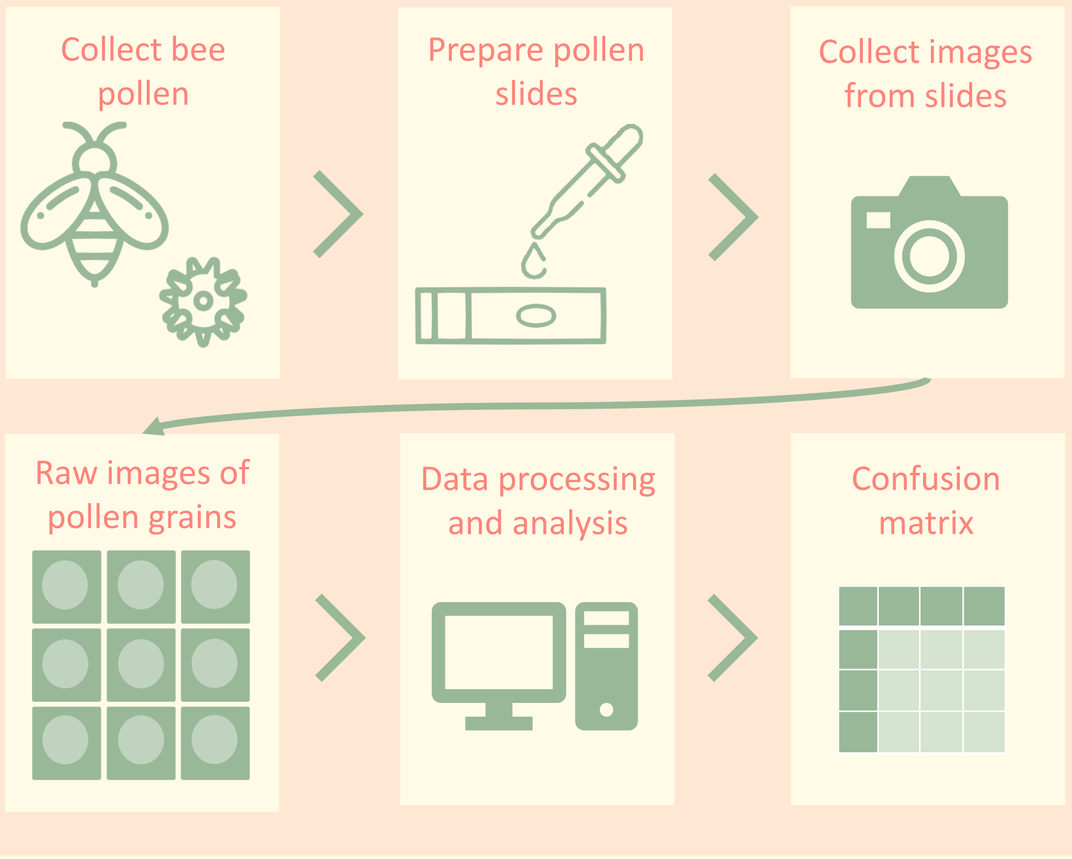
Current methods, which are based on manual identification under a light microscope, are both time consuming and expensive.
Can the development of automated image recognition system help improve this process?

3 Our suggestion

We investigated whether a machine learning based approach (based on an artificial neural network) can be the solution to an improved method for counting and classifying pollen sampled from bees in apple orchids.

4 What we did

Pollen was extracted from bees collected from two Norwegian orchids. Slides from UiB's pollen reference collection were also obtained. Pollen grains were transferred to microscope slides and imaged using a slide scanner. These images were used to generate a neural network image classifier in python using tensorflow.
Images were split into training set and validation sets. We assessed model performance of the validation set using a confusion matrix (figure 1) and tested it on the bee pollen samples (figure 2).



5 Our neural network performance

Figure 1: A confusion matrix showing how often the trained AI managed to correctly classify pollen grains in the validation set.

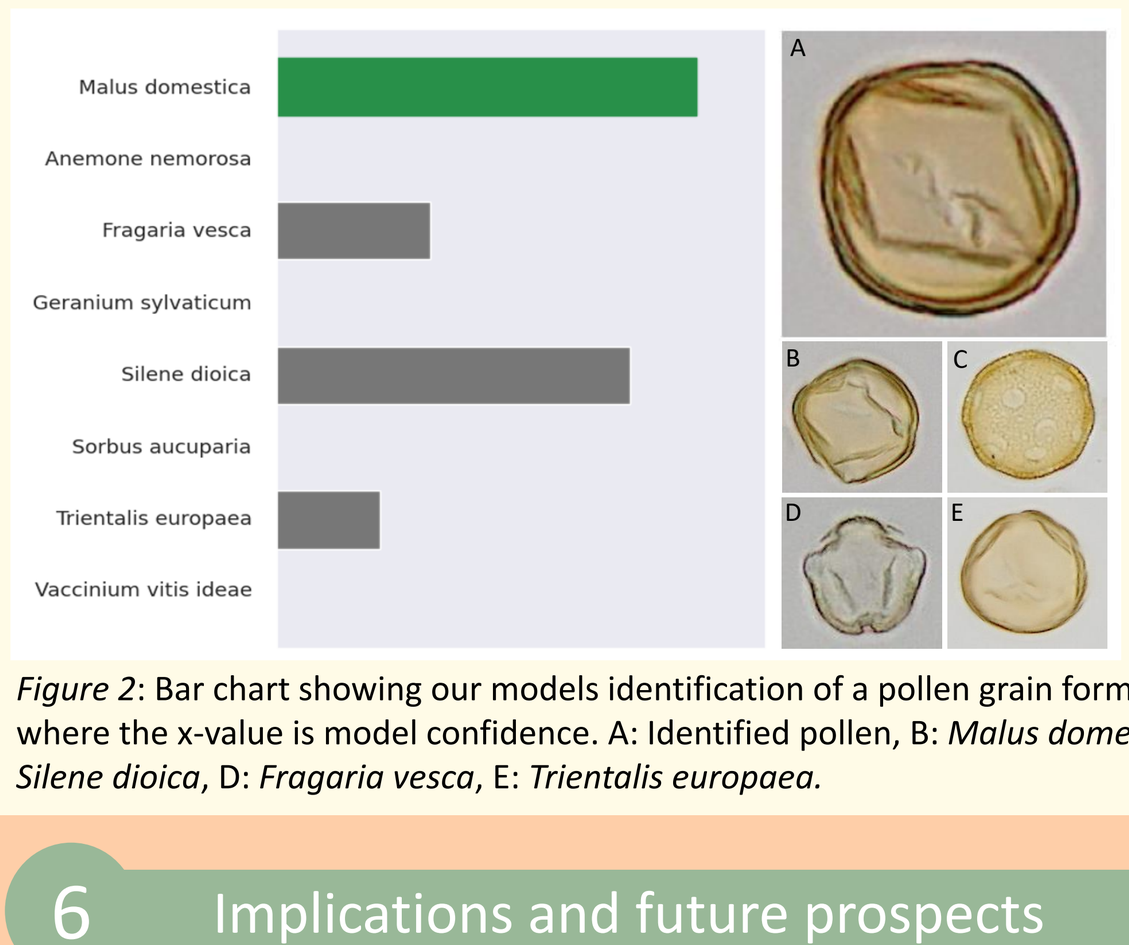


Figure 2: Bar chart showing our models identification of a pollen grain form a bee where the x-value is model confidence. A: Identified pollen, B: *Malus domestica*, C: *Silene dioica*, D: *Fragaria vesca*, E: *Trientalis europaea.*

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6 Implications and future prospects

Our classification tool performed very well on the validation set, with only a few false prediction (figure 1). It also did well when predicting unidentified bee pollen (figure 2), as pollen A and B shows similar appearance. Future studies should expand beyond the 8 species used here to test the performance of the model under higher samples of species richness.
Our approach can also be useful in many other areas within biology where counting and/or identifying based on visual characteristics are used.