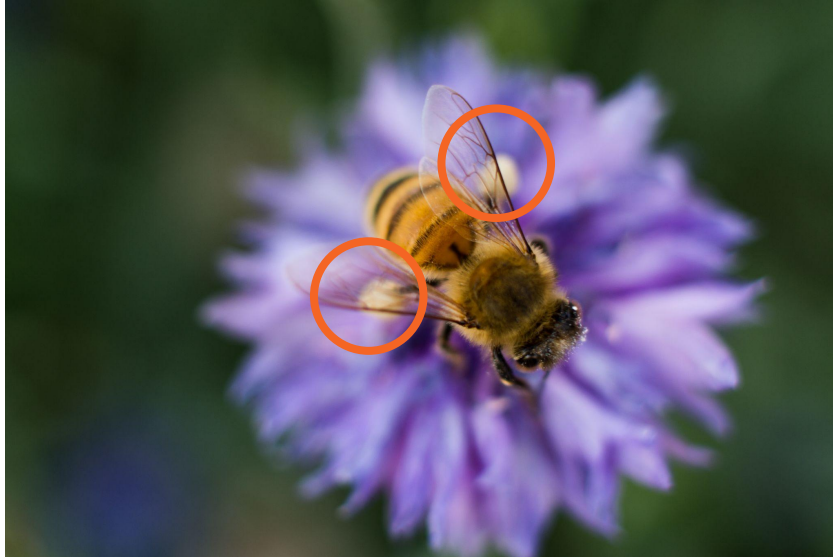

Image Classification of Pollen-Bearing Honey Bees

Natalie Larsen

Problem Statement



- Honey bees take care of 80% of all pollination, including essential crops
 - Climate change, land use change, pesticide use, parasitic mites
- ↓
- Decline in honey bee population



Rodriguez et al.

Recognition of Pollen-Bearing Bees from Video Using Convolutional Neural Network

- **Goal:** recognize pollen-bearing bees from videos of a hive entrance in order to automatically oversee honey bee activity such as foraging behavior and task specialization
- Tested multiple approaches
- **CNN outperforms other approaches**
 - Tested one and two convolutional layers



Research Question

Can we create a convolutional neural network model that can accurately classify whether a bee is carrying pollen or not?

Data Description

- image dataset from Kaggle that is based on data used in Rodriguez et al.
- **714 image files** of bees carrying/not carrying pollen
 - “P” are images of bees carrying pollen
 - “NP” are images of bees not carrying pollen
- A corresponding **.csv file**
 - 714 rows and 3 columns
- **Variables:**
 - index number
 - filename
 - pollen carrying classification: 0 or 1



Data Description



No pollen (0)



Pollen (1)





Sample Training Images

1 = Pollen carrying

0 = Not carrying pollen

Note: Labels above images

Model

- Imported and split the images into training and test sets (80/20; 571/143)
- Built a convolutional neural network model

```
model = models.Sequential()
model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(300, 180, 3)))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation='relu'))

model.add(layers.Flatten())
model.add(layers.Dense(64, activation='relu'))
model.add(layers.Dense(2))

model.compile(optimizer='adam',
              loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
              metrics=['accuracy'])

history = model.fit(train_images, train_labels, epochs=5, validation_data=(test_images, test_labels))
```



Model



```
model = models.Sequential()
model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(300, 180, 3)))
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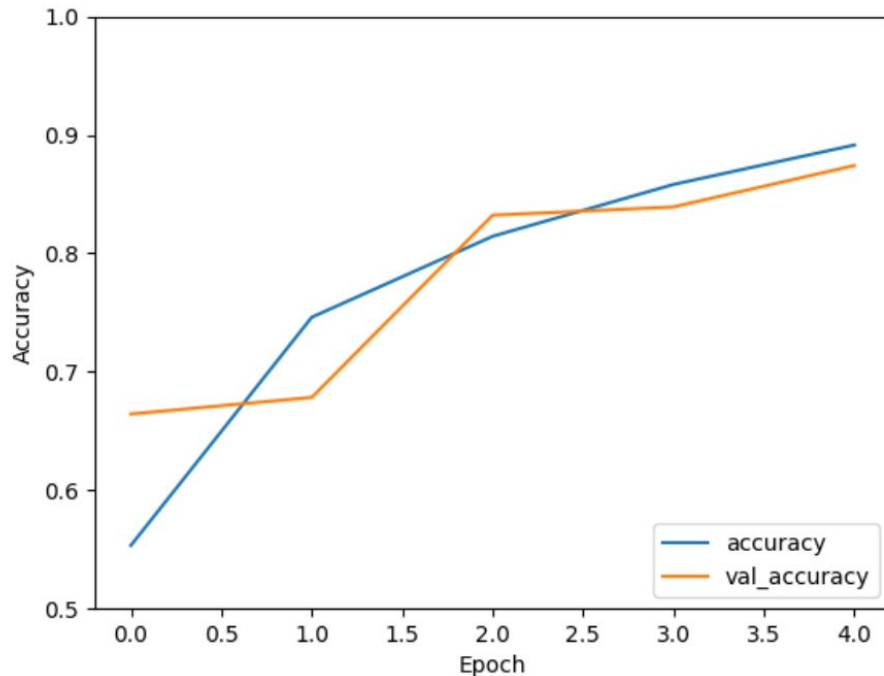


Model Performance

- 5 vs 10 vs 15 epochs
- **Overfitting** at higher numbers of epochs
 - 10 epochs
 - accuracy = 0.9412
 - val_accuracy = 0.8392
 - 15 epochs
 - accuracy = 0.9821
 - val_accuracy = 0.8951



Model Performance

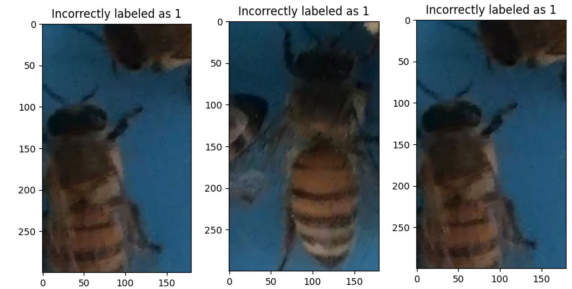
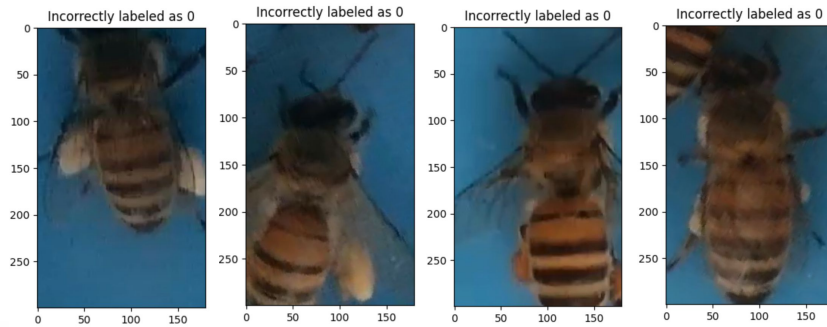


- 5 epochs
 - accuracy = 0.8782
 - val_accuracy = **0.8741**

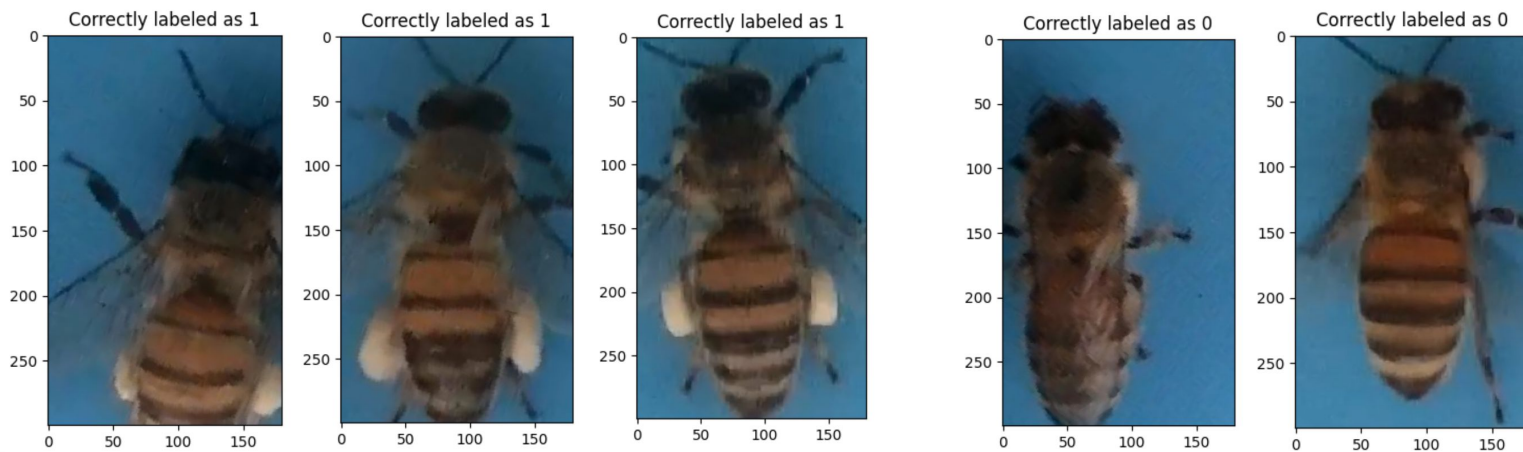


Model Performance

- 24 out of 143 test images were incorrectly classified
 - Most were pollen-bearing bees classified as non pollen-bearing

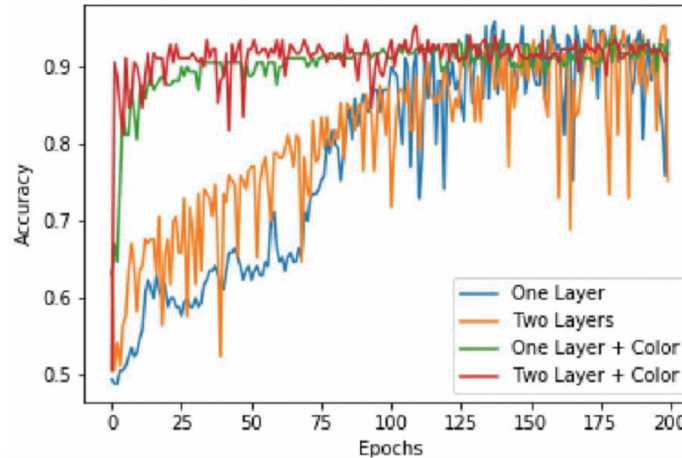


Model Performance



In Literature...

Recognition of Pollen-Bearing Bees from Video Using Convolutional Neural Network by Rodriguez et al., 2018

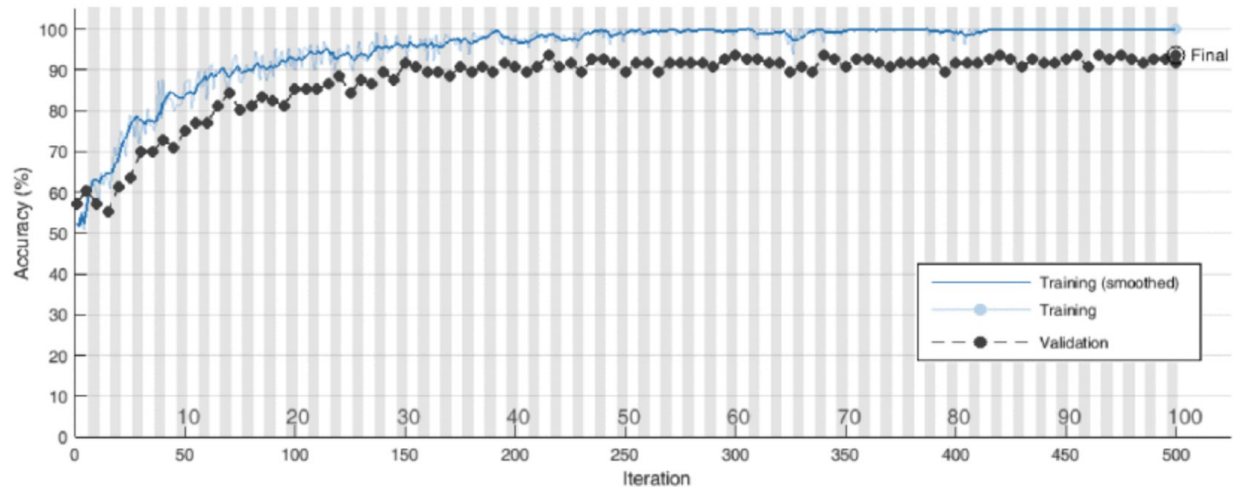


96.4%



In Literature...

The Application of Convolutional Neural Network for Pollen Bearing Bee Classification by Sledevič, 2018



94%



Thanks!

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