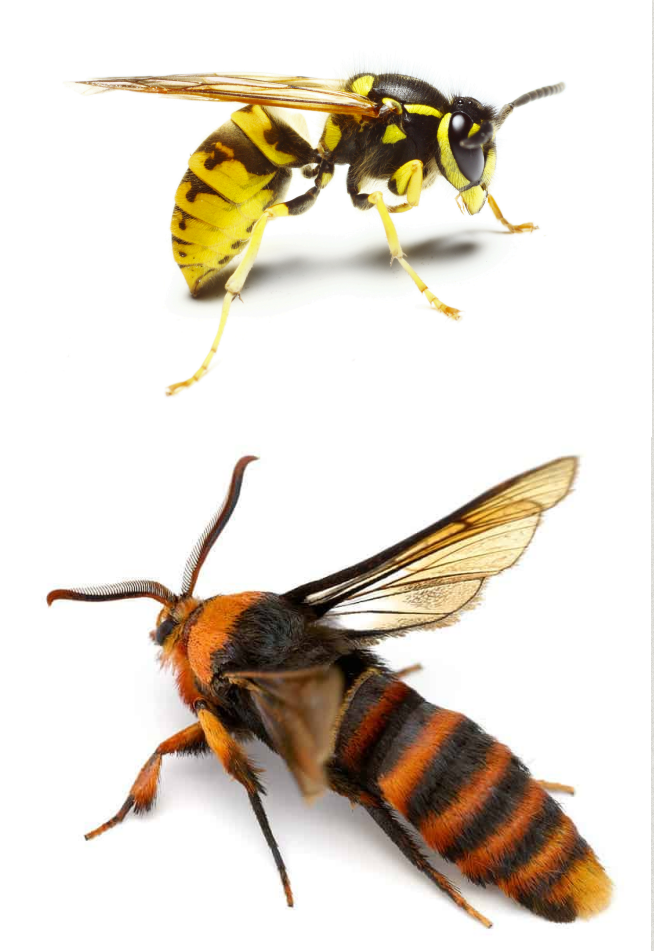
CODESTATES AI_BOOTCAMP14 CHANHYUNG YOON

DISTINGUISH THE DIFFERENCE

TENSORFLOW MODELING FOR INSECT CLASSIFICATION

Project Goal

- 1. Modeling to classify similar-looking insects
- 2. Further tuning to distinguish natural mimicry
  - (e.g. Bartesian, and Mullerian mimicries)
- 3. Model development to identify resembling objects other than insects



Dataset

- Hand-curated, close-up photos of Bee/Wasp/Insects/Other
- Total >11,000 Photos
- Source: https://www.kaggle.com/datasets/jerzydziewierz/bee-vs-wasp

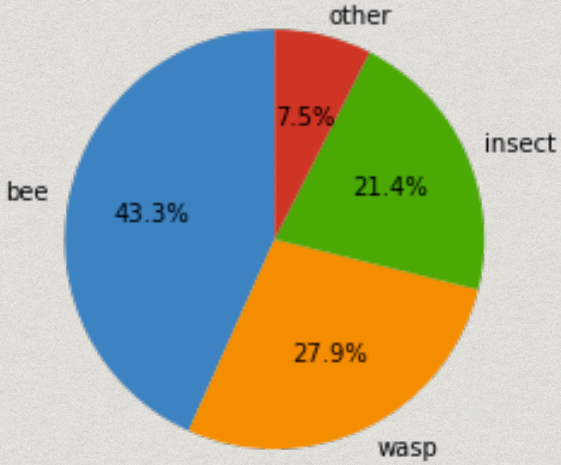
Data Insight

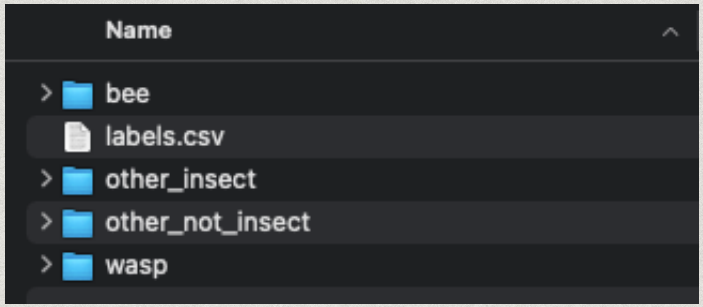
Wasp

Bee

Other Insect

Others





Data Preprocessing Modeling Fitting

- **Preprocessing**
  - Image Resize: (250px by 250px)
  - Normalization: 0-1, float-type
- **Modeling**
  - Early Stopping
  - Learning Rate Decay

Modeling

- **ResNet50**
  - ILSVRC(ImageNet Large Scale Visual Recognition Challenge) 2015 winner
  - Easy to apply for further modeling study
  - Residual block added
  - Great accuracy/Inference time balance

Available models

Model	Size (MB)	Top-1 Accuracy	Top-5 Accuracy	Parameters	Depth	Time (ms) per inference step (CPU)	Time (ms) per inference step (GPU)
Xception	88	79.0%	94.5%	22.9M	81	109.4	8.1
VGG16	528	71.3%	90.1%	138.4M	16	69.5	4.2
VGG19	549	71.3%	90.0%	143.7M	19	84.8	4.4
ResNet50	98	74.9%	92.1%	25.6M	107	58.2	4.6
ResNet50V2	98	76.0%	93.0%	25.6M	103	45.6	4.4
ResNet101	171	76.4%	92.8%	44.7M	209	89.6	5.2
ResNet101V2	171	77.2%	93.8%	44.7M	205	72.7	5.4
ResNet152	232	76.6%	93.1%	60.4M	311	127.4	6.5
ResNet152V2	232	78.0%	94.2%	60.4M	307	107.5	6.6
InceptionV3	92	77.9%	93.7%	23.9M	189	42.2	6.9
InceptionResNetV2	215	80.3%	95.3%	55.9M	449	130.2	10.0
MobileNet	16	70.4%	89.5%	4.3M	55	22.6	3.4
MobileNetV2	14	71.3%	90.1%	3.5M	105	25.9	3.8
DenseNet121	33	75.0%	92.3%	8.1M	242	77.1	5.4
DenseNet169	57	76.2%	93.2%	14.3M	338	96.4	6.3
DenseNet201	80	77.3%	93.6%	20.2M	402	127.2	6.7
NASNetMobile	23	74.4%	91.9%	5.3M	389	27.0	6.7
NASNetLarge	343	82.5%	96.0%	88.9M	533	344.5	20.0

Model Validation

```
Epoch 1/50
250/250 [==============================] - 738s 3s/step - loss: 0.4844 - accuracy: 0.8172 - val_loss: 3.3570 - val_accuracy: 0.2107 - lr: 3.0000e-04
Epoch 2/50
250/250 [==============================] - 728s 3s/step - loss: 0.1834 - accuracy: 0.9405 - val_loss: 1.8336 - val_accuracy: 0.3637 - lr: 3.0000e-04
Epoch 3/50
250/250 [==============================] - 728s 3s/step - loss: 0.1230 - accuracy: 0.9615 - val_loss: 0.5152 - val_accuracy: 0.7904 - lr: 3.0000e-04
Epoch 4/50
250/250 [==============================] - 723s 3s/step - loss: 0.0836 - accuracy: 0.9746 - val_loss: 0.2509 - val_accuracy: 0.9142 - lr: 3.0000e-04
Epoch 5/50
250/250 [==============================] - 723s 3s/step - loss: 0.0616 - accuracy: 0.9809 - val_loss: 0.1912 - val_accuracy: 0.9405 - lr: 3.0000e-04
Epoch 6/50
250/250 [==============================] - 726s 3s/step - loss: 0.0487 - accuracy: 0.9869 - val_loss: 0.1882 - val_accuracy: 0.9399 - lr: 3.0000e-04
Epoch 7/50
250/250 [==============================] - 725s 3s/step - loss: 0.0323 - accuracy: 0.9917 - val_loss: 0.1992 - val_accuracy: 0.9405 - lr: 3.0000e-04
Epoch 8/50
250/250 [==============================] - 727s 3s/step - loss: 0.0273 - accuracy: 0.9937 - val_loss: 0.2041 - val_accuracy: 0.9370 - lr: 3.0000e-04
Epoch 9/50
250/250 [==============================] - 724s 3s/step - loss: 0.0242 - accuracy: 0.9949 - val_loss: 0.2098 - val_accuracy: 0.9375 - lr: 3.0000e-04
Epoch 10/50
250/250 [==============================] - 726s 3s/step - loss: 0.0172 - accuracy: 0.9974 - val_loss: 0.2030 - val_accuracy: 0.9387 - lr: 1.5000e-04
Epoch 11/50
250/250 [==============================] - 731s 3s/step - loss: 0.0146 - accuracy: 0.9971 - val_loss: 0.2024 - val_accuracy: 0.9387 - lr: 1.5000e-04
Epoch 12/50
250/250 [==============================] - 730s 3s/step - loss: 0.0144 - accuracy: 0.9975 - val_loss: 0.2064 - val_accuracy: 0.9381 - lr: 1.5000e-04
Epoch 13/50
250/250 [==============================] - 729s 3s/step - loss: 0.0120 - accuracy: 0.9984 - val_loss: 0.2100 - val_accuracy: 0.9387 - lr: 1.5000e-04
Epoch 14/50
250/250 [==============================] - 728s 3s/step - loss: 0.0131 - accuracy: 0.9971 - val_loss: 0.2069 - val_accuracy: 0.9375 - lr: 1.5000e-04
Epoch 15/50
250/250 [==============================] - 732s 3s/step - loss: 0.0108 - accuracy: 0.9982 - val_loss: 0.2127 - val_accuracy: 0.9387 - lr: 1.5000e-04
Epoch 16/50
250/250 [==============================] - ETA: 0s - loss: 0.0108 - accuracy: 0.9981Restoring model weights from the end of the best epoch: 6.
250/250 [==============================] - 727s 3s/step - loss: 0.0108 - accuracy: 0.9981 - val_loss: 0.2176 - val_accuracy: 0.9410 - lr: 1.5000e-04
Epoch 16: early stopping
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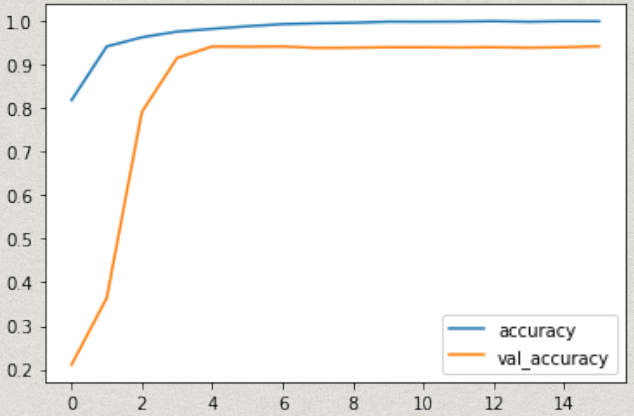
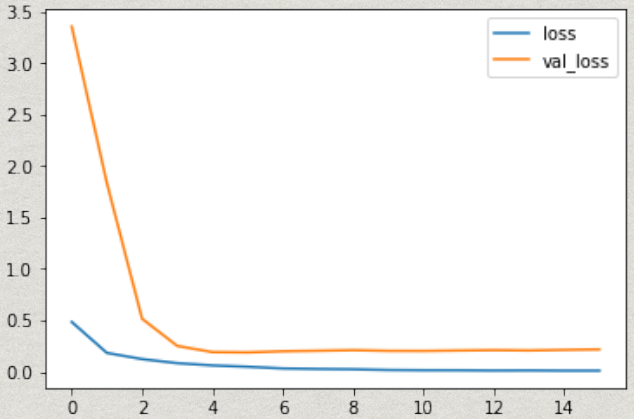
16 Epochs → 94% Validation Accuracy



Accuracy over Epochs



Loss over Epochs

Mimics Test

- **Hand-picked Challenge Set**
  - Naturally wasp-mimicking moths
  - Difficult in human eyes to distinguish
  - Model Accuracy: 24.32%

Limitation, Lessons and Future Development

- **Google Colab RAM limitation**
  - Learning process had to be restarted many times
- **Mimicry-specific dataset needed**
  - Different species of similar patterns
- **Dataset Quality**
  - Correctly-labeled large image dataset needed for a better modeling
- **Further Model Development**
  - Scraping a larger, reliable dataset
  - Different Goal: Self-Driving Cars
    - Road Sign vs Traffic Light
    - Bicycle vs Motorcycle