Identification of Bird Species by Image Classification

University of Canberra
Pattern Recognition and Machine Learning

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About The Author

- Alan Gaugler
- Master of Data Science at University of Canberra
- Studied Electronics Engineering at UC
- 20 + years of experience in RF Engineering

Dataset

Original Dataset: 400 Species, 62388 Images

Image Dimensions: 224 x 224 x 3 pixels

Reduced Dataset:

- 10 Species,
- 1475 Training/Test Images.
- 50 Validation Images

Incorrect species or subspecies removed.

Additional Images Added

- Cropped and Resized
- 1475 Training/Test Images.
- 50 Validation Images

Figure 1 Sample of Images in the Dataset

Methodology – Evaluation of Classifiers

Initial test run on a subset of 5 bird species.

5 Classifiers were evaluated:

- Support Vector Machine – 81.2%
- Random Forest – 80.2%
- Logistic Regression – 77.6%
- Multilayer Perceptron Classifier – 57.5%
- Decision Tree – 53.8%

Convolutional Neural Network

Selected after extensive literature review

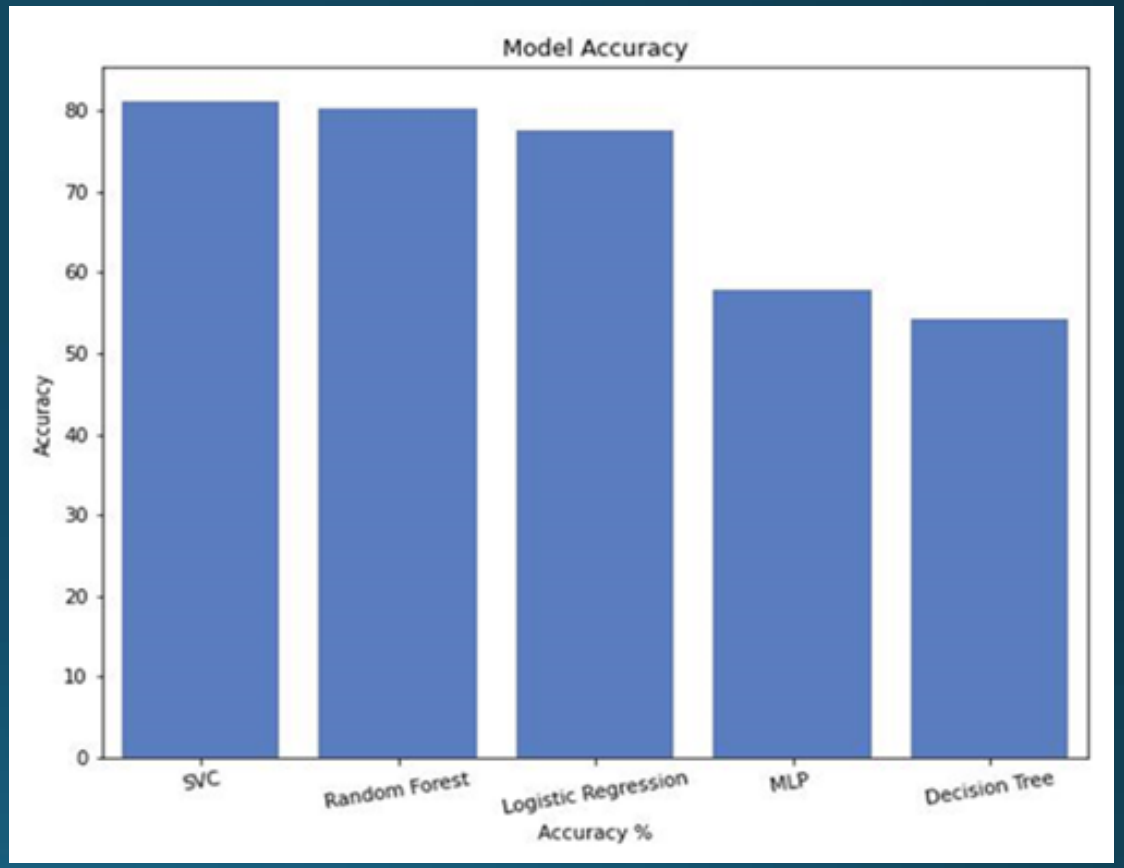

Figure 2. Model Prediction Accuracy on the Sample Dataset

Three models selected: SVM, Random Forest, CNN

Methodology – Building and Training the Models.

Random Forest and Support Vector Machine.

- Dataset imported and validated
- Data Split into training and test sets 80/20
- The default models were tested.
- Standardization was applied to the SVM model
- Hyperparameter tuning with cross-validation in a grid search
- Principal Component Analysis
- For the best model - Data Split into training and test sets 70/30
- Evaluate the final model on unseen validation data

Methodology – Building and Training the Models.

Convolutional Neural Network.

A multi-layered CNN was built

Activation function of ReLU

Compiled using the Adam optimizer

Various configurations:

- Activation Function
- Optimizer
- Network Architecture

Model: "sequential_19"

Layer (type)	Output Shape	Param #
conv2d_27 (Conv2D)	(None, 222, 222, 32)	896
max_pooling2d_18 (MaxPooling2D)	(None, 111, 111, 32)	0
conv2d_28 (Conv2D)	(None, 109, 109, 64)	18496
max_pooling2d_19 (MaxPooling2D)	(None, 54, 54, 64)	0
conv2d_29 (Conv2D)	(None, 52, 52, 128)	73856
flatten_19 (Flatten)	(None, 346112)	0
dense_38 (Dense)	(None, 128)	44302464
dense_39 (Dense)	(None, 10)	1290

Total params: 44,397,002
Trainable params: 44,397,002
Non-trainable params: 0

Figure 3 Architecture of the CNN Built for Image Classification

Results and Evaluation

Including CNN configurations, over 15 models were tested.

Model Name	Train/Test	Dataset/ Model	Accuracy	Precision	Recall	F1-Score
rfc_1	80/20	Regular	0.642	0.639	0.642	0.631
rfc_2	80/20	Regular, GS	0.642	0.639	0.642	0.631
rfc_3	80/20	1000 est	0.635	0.636	0.635	0.628
svc_1	80/20	Regular	0.663	0.681	0.663	0.666
svc_2	80/20	Stdn	0.670	0.685	0.670	0.671
svc_3	80/20	Stdn, PCA	0.653	0.676	0.653	0.652
svc_4	80/20	Stdn, PCA, GS	0.688	0.708	0.688	0.688
svc_5	70/30	Stdn, PCA, GS	0.682	0.694	0.682	0.683
cnn_1	80/20	Regular	0.828	0.845	0.828	0.830
cnn_2	80/20	Regular, early stopping	0.814	0.826	0.814	0.814
cnn_3	70/30	Regular	0.778	0.787	0.778	0.779

Table 1 - Summary of Accuracy Results of Evaluated Models

- Model cnn_1 is the most accurate.
- Overfitting was observed in all models

Results and Evaluation

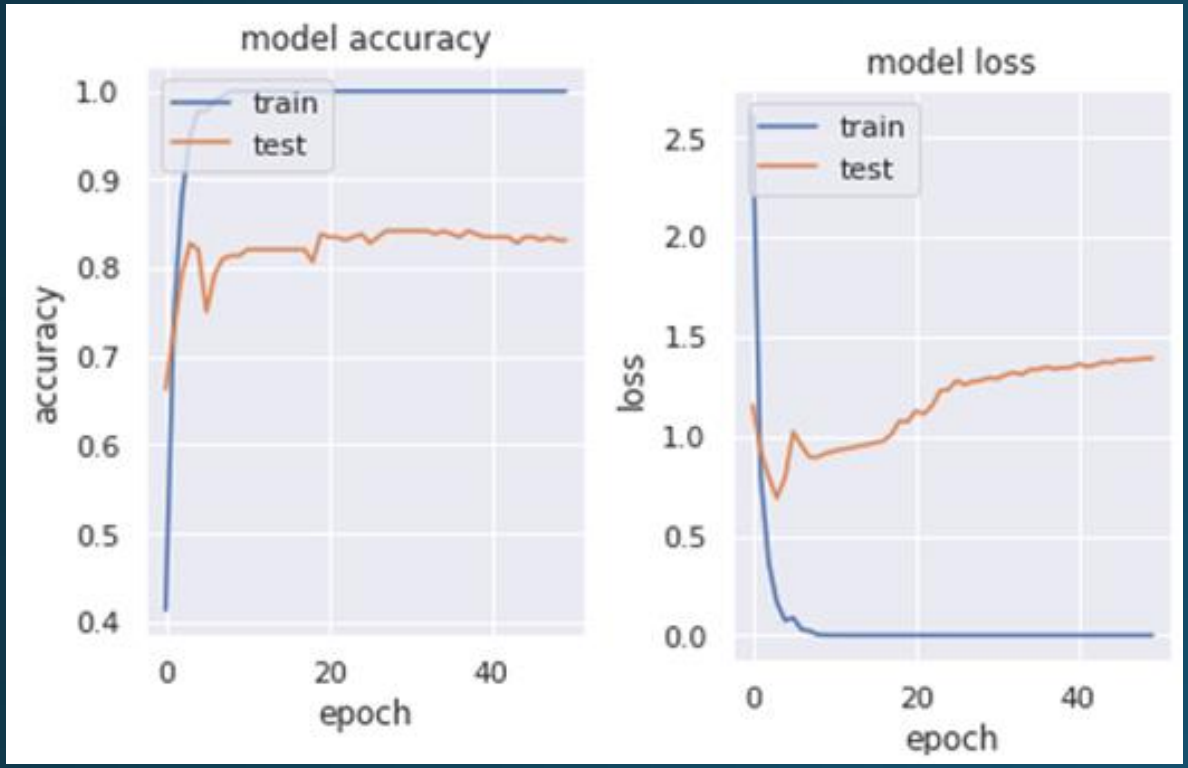

Figure 4 - Model Accuracy and Model Loss without Early Stopping

Figure 5 - Model Accuracy and Model Loss with Early Stopping

- Model cnn_2 with early stopping was chosen.
- 80% accuracy on unseen validation images

Conclusion

- The CNN classifier is clearly the best for image detection.
- Overfitting is present despite efforts to reduce it.

Further Work

- Data Augmentation and increasing the size of the dataset
- Evaluate further reconfigurations of the CNN architecture.
- Pre-trained neural network architectures – ResNet-50
- Expand the number of classifications

Thank you for your attention.

References

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