Classifying Bird Species With Image Recognition

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Problem Description

- Project goal: Classify images of birds into the correct species
- Potential use case: Bird population counts
- Method: A convolutional neural network optimized for image classification

Dataset

- The full dataset contains 525 unique species of birds with 100-200 images per species
- The training data was reduced to 20 species with 100 images per species
- The validation and test sets contain 5 image for each type of bird
- Each image contains only one bird, which comprises at least 50% of the pixels

Base Model Performance

Model Used	*EfficeintNetB0*
Weights Applied	ImageNet
Epochs Run	5
Best Validation Accuracy	100%
Best Validation Loss	0.0015

Simple Model Performance

```
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 conv2d (Conv2D)             (None, 222, 222, 32)      896

 max_pooling2d (MaxPooling2  (None, 111, 111, 32)      0
 D)

 flatten (Flatten)           (None, 394272)            0

 dense (Dense)               (None, 20)                7885460

=================================================================
Total params: 7886356 (30.08 MB)
Trainable params: 7886356 (30.08 MB)
Non-trainable params: 0 (0.00 Byte)
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```
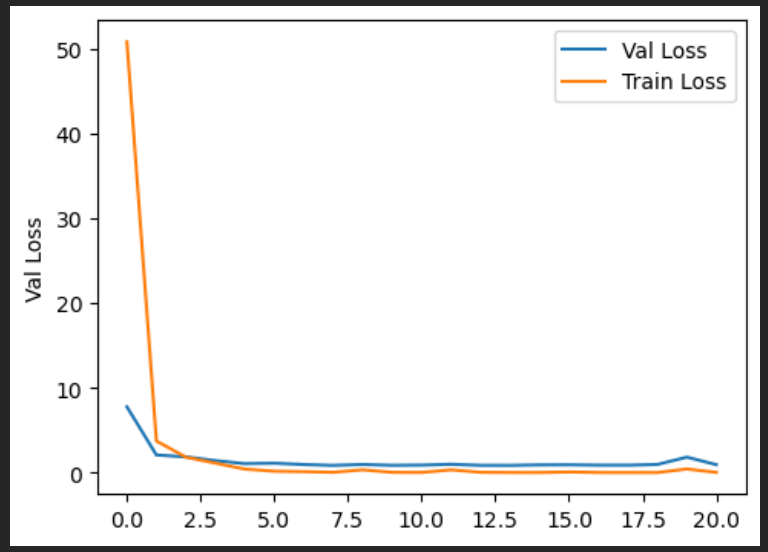
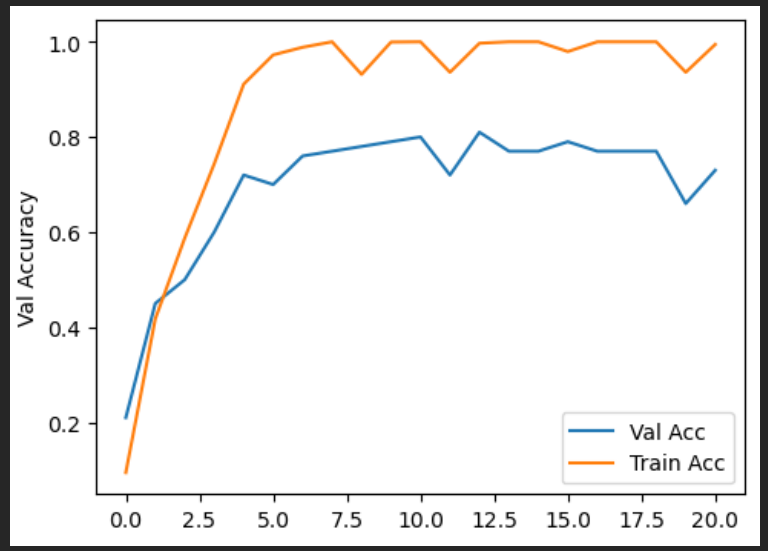
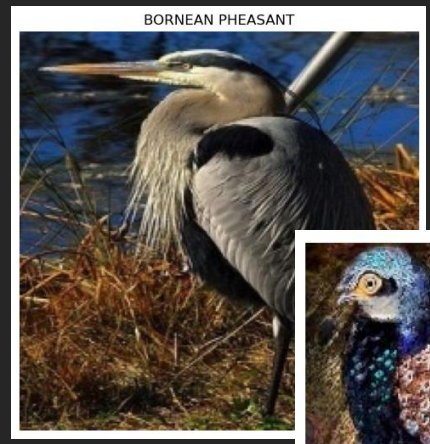

Epochs Run	21
Validation Accuracy	81%
Validation Loss	0.8571

Simple Model Evaluation







Simple Model Evaluation – Correct Birds

- Good Classification
  - Large, colorful patches
  - Unique characteristics (Quail's Crest)

- Bad Classification
  - Muted/blended Colors
  - Color Variance

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 222, 222, 32)      896

 max_pooling2d (MaxPooling2  (None, 111, 111, 32)      0
 D)

 conv2d_1 (Conv2D)           (None, 109, 109, 32)      9248

 max_pooling2d_1 (MaxPoolin  (None, 54, 54, 32)        0
 g2D)

 conv2d_2 (Conv2D)           (None, 52, 52, 32)        9248

 max_pooling2d_2 (MaxPoolin  (None, 26, 26, 32)        0
 g2D)

 flatten (Flatten)           (None, 21632)             0

 dense (Dense)               (None, 20)                432660

=================================================================
Total params: 452052 (1.72 MB)
Trainable params: 452052 (1.72 MB)
Non-trainable params: 0 (0.00 Byte)
```

Proposed Improvements

- Increase Model Complexity
  - Add more CNN layers to differentiate features more
  - Included MaxPooling to support model invariance

Complex Model Evaluation

Improvements

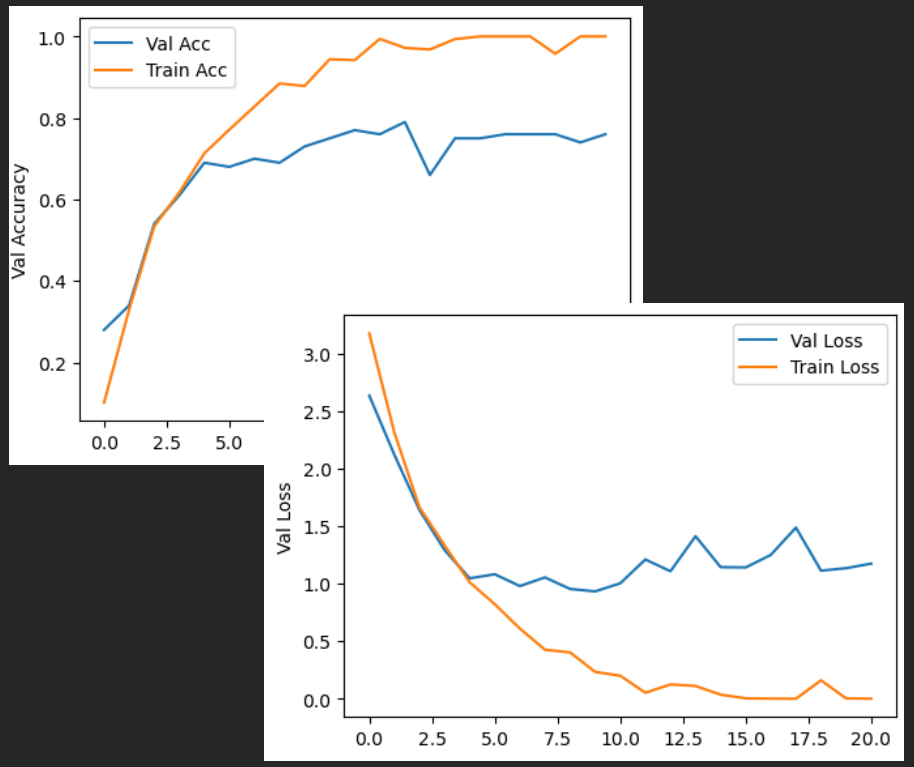
- More species 100% correctly classified
- Some classes improved their predictions

Challenges

- Significant decrease in some species
- Model overfitting

Validating Assumptions

- Distinctive features still taking precedent
- Grayscale model resulted in significant drop in accuracy



Progressive Resizing

- Models trained on progressively higher quality images
- Layered together to build a complex model
- Weights of smaller scale models are locked to avoid learning noise from higher quality images
- Filters, Dropout, and Epochs adjusted

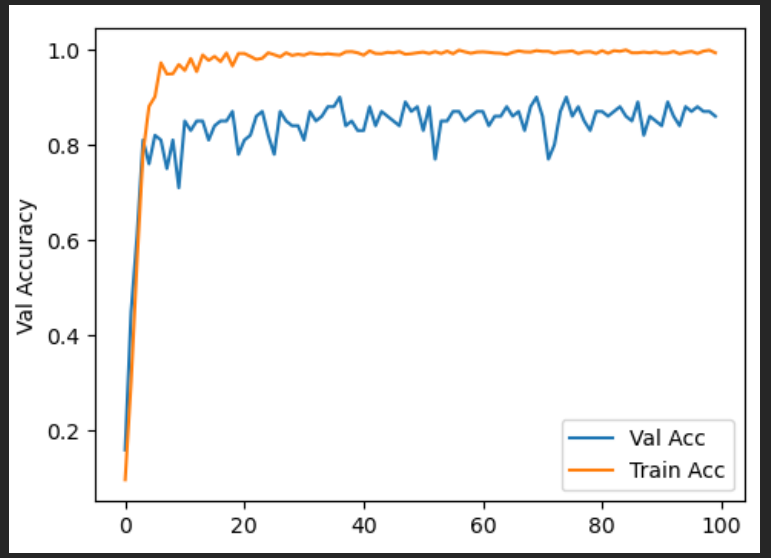
conv2d_9 (Conv2D)	(None, 224, 224, 16)	1168
max_pooling2d_5 (MaxPooling2D)	(None, 112, 112, 16)	0
conv2d_5 (Conv2D)	(None, 112, 112, 32)	4640
max_pooling2d_3 (MaxPooling2D)	(None, 56, 56, 32)	0
conv2d_1 (Conv2D)	(None, 56, 56, 128)	36992
max_pooling2d (MaxPooling2D)	(None, 28, 28, 128)	0
conv2d_2 (Conv2D)	(None, 26, 26, 64)	73792
max_pooling2d_1 (MaxPooling2D)	(None, 13, 13, 64)	0
conv2d_3 (Conv2D)	(None, 11, 11, 32)	18464
max_pooling2d_2 (MaxPooling2D)	(None, 5, 5, 32)	0
dropout (Dropout)	(None, 5, 5, 32)	0
flatten (Flatten)	(None, 800)	0
dense (Dense)	(None, 128)	102528
dense_1 (Dense)	(None, 20)	2580

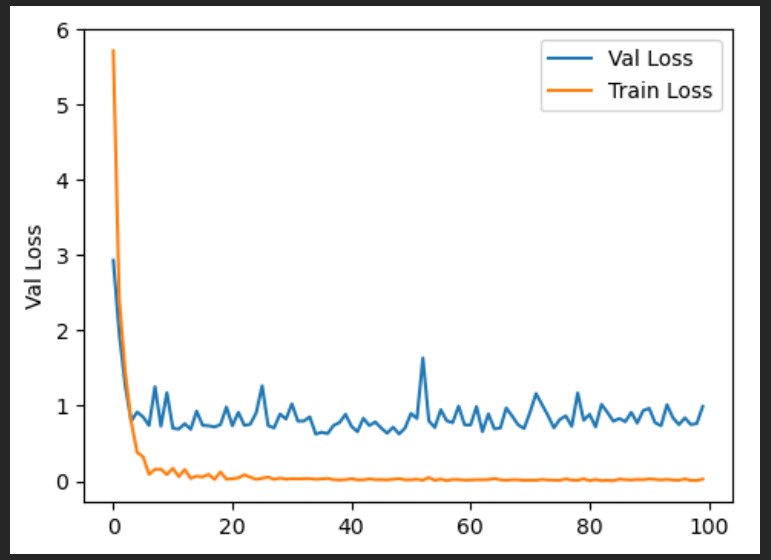
Total params: 240388 (939.02 KB)
Trainable params: 1392 (5.44 KB)
Non-trainable params: 238996 (933.58 KB)

Progressive Model Evaluation

	56x56	112x112	224x224
Accuracy	88.99%	89.99%	87.99%
Loss	0.8063	0.6321	0.5862

- Overfitting improved on this version
- 56x56 model gave a significant boost in accuracy
- 112x112 improved accuracy
- 224x224 dropped accuracy but loss improved

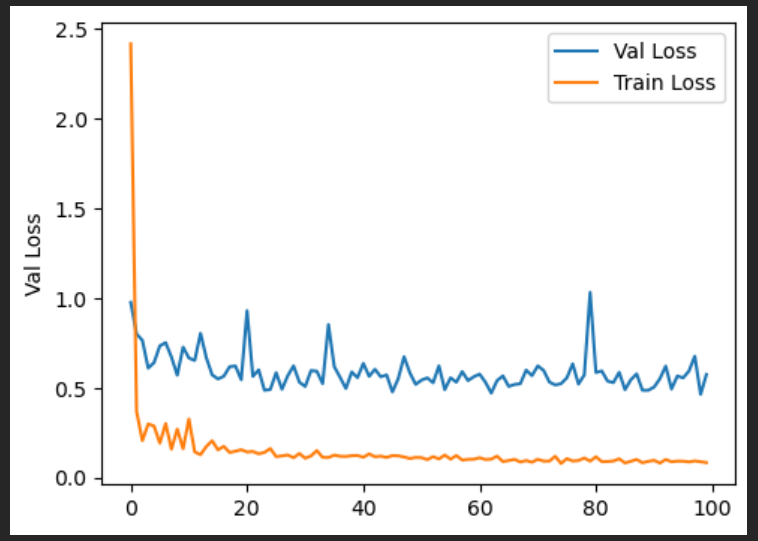


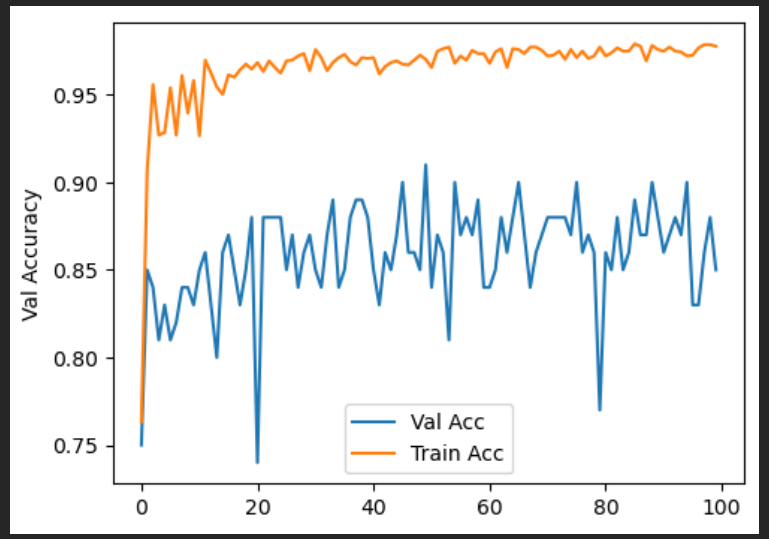


Additional Images

- 224x224 image quality not learning correct features for poorly classified birds
- Added additional images to diversify poorly classified species

Validation Accuracy	91%
Validation Loss	0.3924





Final Test

Accuracy	82.99%
Loss	0.5899

- Accuracy declined but loss was reasonably low
- Structure of the validation set likely contributed to this
- Next Steps include creating more robust validation set, increasing complexity, and introducing more image augmentation