

# COL333 A3.1

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## 1 Introduction

In this report, we analyze the performance of our machine learning model trained for the task Bird Species Classification. The report includes an overview of the model architecture, performance metrics across epochs, optimization techniques, and visual insights into the Class Activation Maps (CAM) for each class. The purpose is to demonstrate how well the model learns over time and to discuss the impact of different optimization techniques.

## 2 Model Architecture

Layer	Details	Output
Input	Image (300x300x3)	(300, 300, 3)
Conv2d	7x7, stride 2, padding 3	(64, 150, 150)
BatchNorm + ReLU Activation		(64, 150, 150)
MaxPool2d	3x3, stride 2	(64, 75, 75)
Conv2d	3x3, stride 1, padding 1	(64, 75, 75)
BatchNorm + ReLU Activation		(64, 75, 75)
Conv2d	3x3, stride 1, padding 1	(64, 75, 75)
Conv2d (Skip connection)	1x1, stride 1	(64, 75, 75)
Conv2d	3x3, stride 2, padding 1	(128, 38, 38)
BatchNorm + ReLU Activation		(128, 38, 38)
Conv2d	3x3, stride 1, padding 1	(128, 38, 38)
Conv2d (Skip connection)	1x1, stride 2	(128, 38, 38)
Conv2d	3x3, stride 2, padding 1	(256, 19, 19)
BatchNorm + ReLU Activation		(256, 19, 19)
Conv2d	3x3, stride 1, padding 1	(256, 19, 19)
Conv2d (Skip connection)	1x1, stride 2	(256, 19, 19)
Conv2d	3x3, stride 2, padding 1	(512, 10, 10)
BatchNorm + ReLU Activation		(512, 10, 10)
Conv2d	3x3, stride 1, padding 1	(512, 10, 10)
Conv2d (Skip connection)	1x1, stride 2	(512, 10, 10)
AdaptiveAvgPool2d		(512, 1, 1)
Flatten		(512)
Fully Connected Layer	Linear (512 to 10)	(10)

Table 1: Detailed Architecture of the birdClassifier with Conv2d Layers

## 3 Train and Validation Loss and Accuracies vs. Epochs

The following plot illustrates the training and validation loss and accuracies over the epochs.

The Train and Val Split used here was **80%** train to **20%** val.

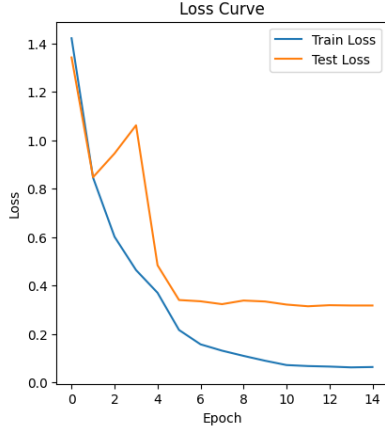


Figure 1: Loss vs Epochs Plot

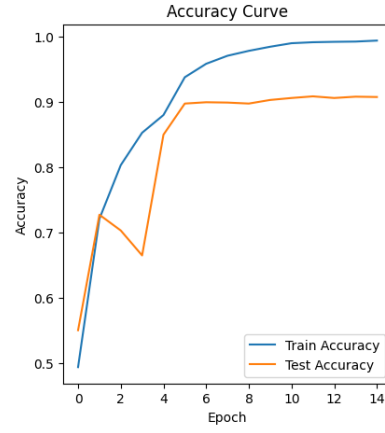


Figure 2: Accuracy vs Epochs Plot

## 4 Effect of Model Optimization

In this section, we provide a table summarizing the effect of various optimization techniques on the model’s validation accuracy. We experimented with data augmentation, dropout, and L2 regularization, and evaluated the impact of these methods on the model’s performance.

Technique	Validation Accuracy	Impact
No Optimization	60.13%	Baseline model without optimization.
Compound Scaling Laws	81.78%	Scaled using Compound Scaling Laws
Data Augmentation	89.98%	Improved generalization with augmented data.
Dropout	86.5%	Learning Became Slower.
StepLR	90.72%	Best performance with all techniques combined.

Table 2: Validation Accuracy for Different Optimization Techniques

**Note:** The Model Optimization Accuracies listed above are cumulative accuracies, i.e., the entry of **89.98%** in Data Augmentation Implies the model was scaled using Compound Scaling laws **and** Data Augmentation both were used. Similarly, in StepLR all methods were used.

## 5 Class Activation Maps (CAM)

The Class Activation Maps (CAM) were generated for each class to understand how the model interprets different image regions. These maps highlight the regions that the model focuses on when making a decision for a particular class.

The CAMs reveal that the model places more attention on the relevant features of each image, such as specific textures or objects, which helps the model in making accurate predictions. As we can see in the misclassified examples the relevant features are all over the place.

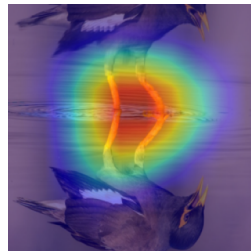


Figure 3: Class 5 misclassified as 1

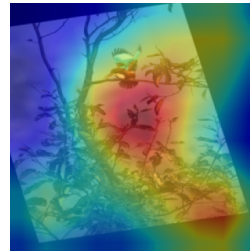


Figure 4: Class 9 misclassified as 2

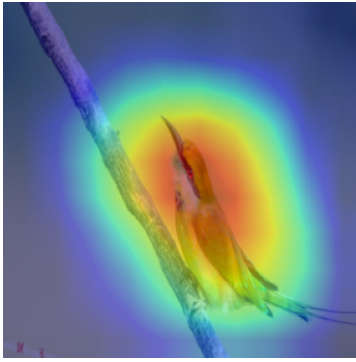


Figure 5: CAM for Class 1

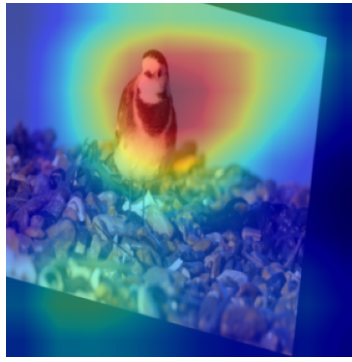


Figure 6: CAM for Class 2

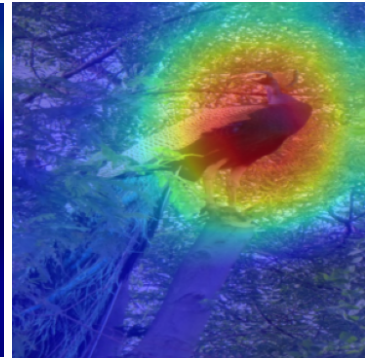


Figure 7: CAM for Class 3

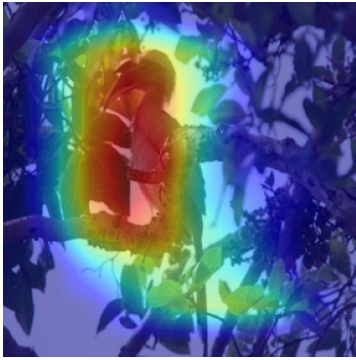


Figure 8: CAM for Class 4

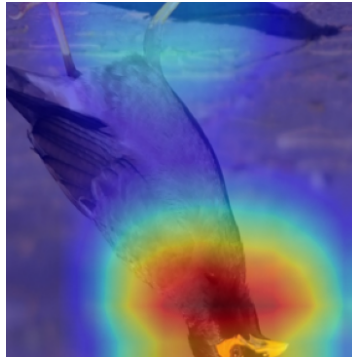


Figure 9: CAM for Class 5

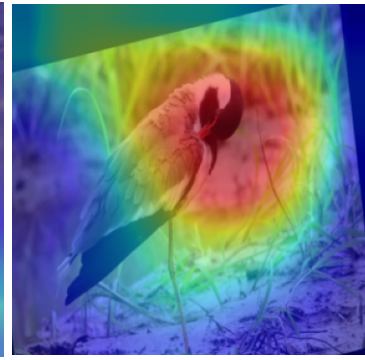


Figure 10: CAM for Class 6

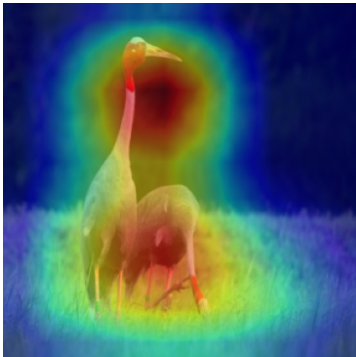


Figure 11: CAM for Class 7

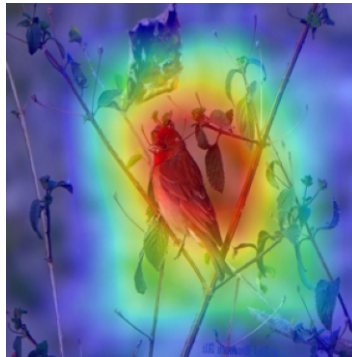


Figure 12: CAM for Class 8

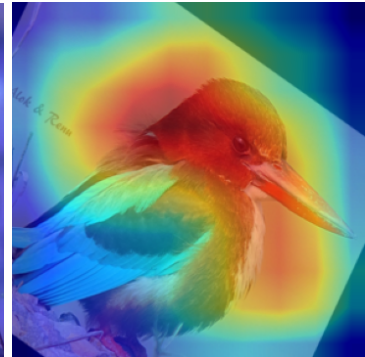


Figure 13: CAM for Class 9



Figure 14: CAM for Class 10

Figure 15: Class Activation Maps for all 10 classes