Corn Disease Classifier

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Introduction

- Motivation
  - Provide farmers a tool for classifying corn diseases
- Objective
  - Given a picture of a corn leaf, have a model predict what disease the corn may have
- Result
  - Iteratively optimized a model to score as high as possible on test data while minimizing overfitting

Methodology

- **Data:**
  - 4,100+ labelled pictures of corn
  - Image Resolution Range: 256x256 - 4068x3456
  - RGB color channels
  - Link: https://www.kaggle.com/datasets/smaranjitghose/corn-or-maize-leaf-disease-dataset

- **Metrics:**
 - Pixel values on each RGB channel

- **Tools:**
  - Pandas, Keras, TensorFlow, ImageDataGenerator, Xception, InceptionResNetV2, NASNetLarge, EfficientNetV2L, VGG16, os, glob, sklearn, PIL, numpy, plotly, seaborn, Excel

Methodology Cont.

- EDA
- Preprocess Images to 128x128 with padding
- Linear Regression Baseline
- Employed Transfer Learning:
  - Weights = imagenet
- First Deep-Learning Trade Study:
  - Explored hyperparameters: Mini-Batch Size, Learning Rate, # Hidden Layers, # Perceptrons Per Layer
- Second Trade Study:
  - Explored hyperparameters: Transfer Learning Model, Activation Function
- Third Trade Study:
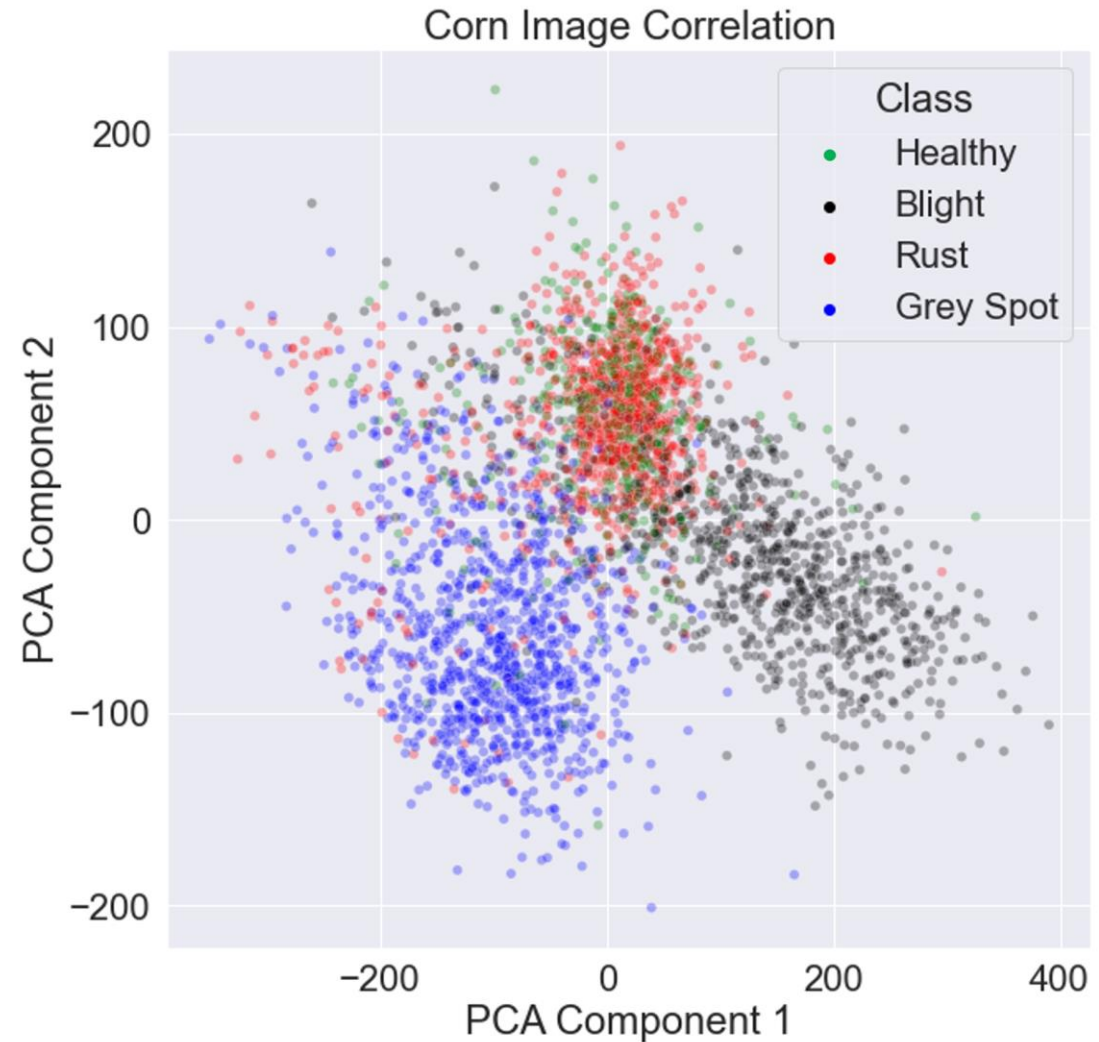 - Explore Hyperparameters: With/without data augmentation, # Epochs

EDA – Data Breakdown

1162

1306

1146

574

5
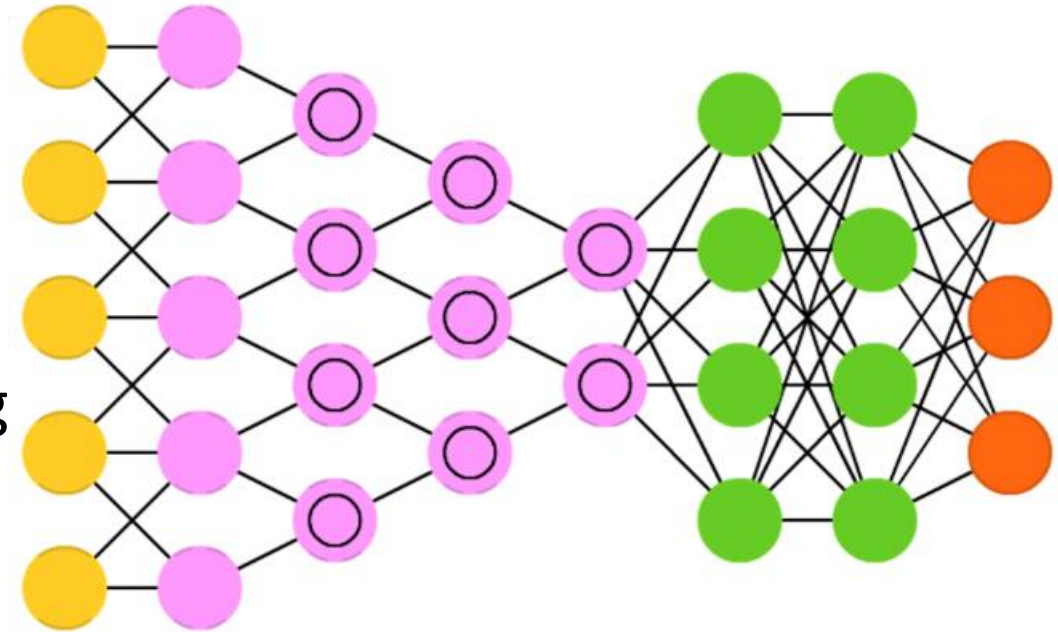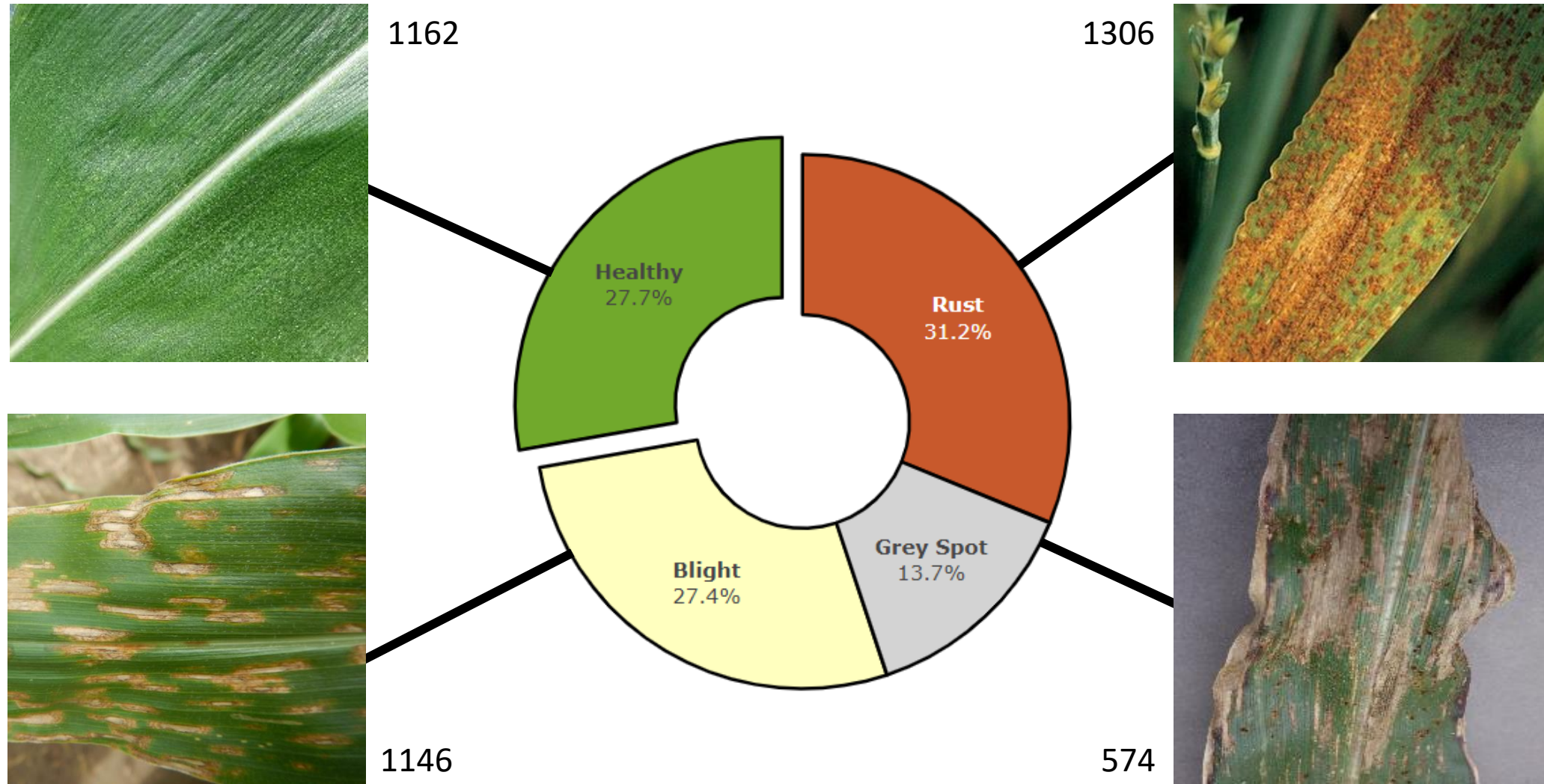
EDA – Data Breakdown Cont.

- Initial # Dimensions: 128x128x3 = **49,152**
- Reduced to **2** Dimensions for visualization
  - Explained Variance Ratio: 38.4%
- Blight & Grey Spot Easily Discernable
- Healthy & Rust Difficult to Discern


Corn Image Correlation

Results - Linear Regression Baseline Models

- First fit one LR model to 2 PCA axes:
  - With 'lbfgs' solver: 70% Test Accuracy

- Next fit three models on all original 49,152 features:
  1) With 'lbfgs' solver: 80.2% Test Accuracy
  2) With 'saga' solver: 80.8% Test Accuracy
  3) With 'sag' solver: 80.4% Test Accuracy

- Linear functions do capture most of the detail, but we can do better with DL
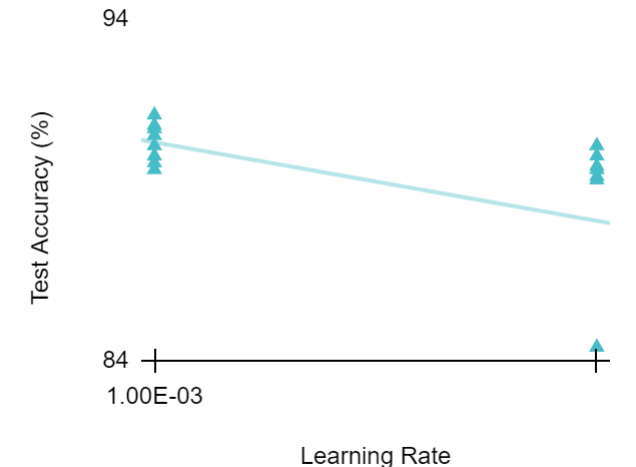
Results Cont. - First Trade Study Highlights

- Mini Batch Size: 32 vs 64
- Learning Rate: 0.01 vs 0.001
- Hidden Layers: 4 vs 8
- Perceptrons per Layer: 32 vs 64
- Total Test Cases: 16
- Best Overfit Score: **4.3**
  - MBS - 64
  - LR - 0.01
  - HL - 8
  - P/L - 32
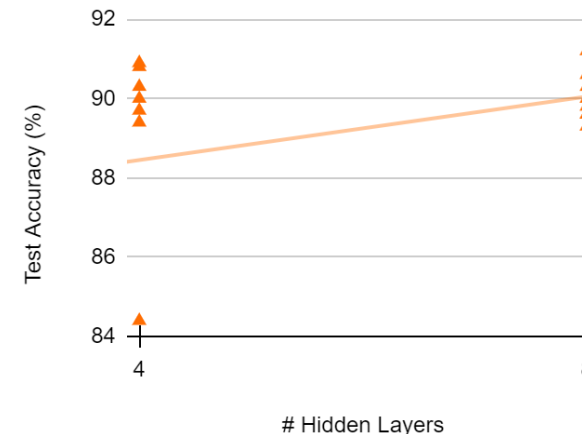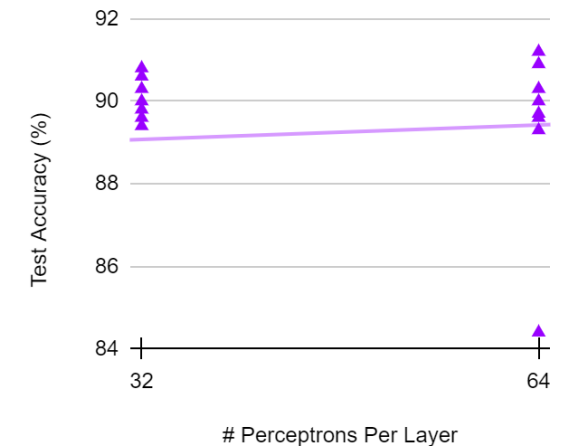- Test Accuracy: **89.6**

Test Accuracy VS Mini-Batch Size
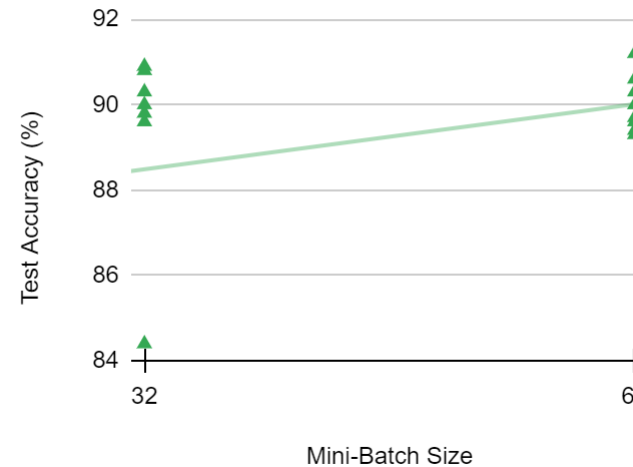
Test Accuracy VS Learning Rate

Test Accuracy VS # Hidden Layers

Test Accuracy VS # Perceptrons

Results Cont. - Second Trade Study Highlights

- Transfer Learning Structure:
  - VGG16
  - EfficentNetV2L
  - NASNetLarge
  - InceptionResNetV2
  - Xception

- Activation Functions:
  - ELU
  - RELU
  - LRELU

- Total Test Cases: 15

- Best Overfit Score: **1.4**
  - TLS - ENV2L
  - AF - ELU

- Test Accuracy: **88.4**

Average Test Accuracy VS Transfer Learning Base Model
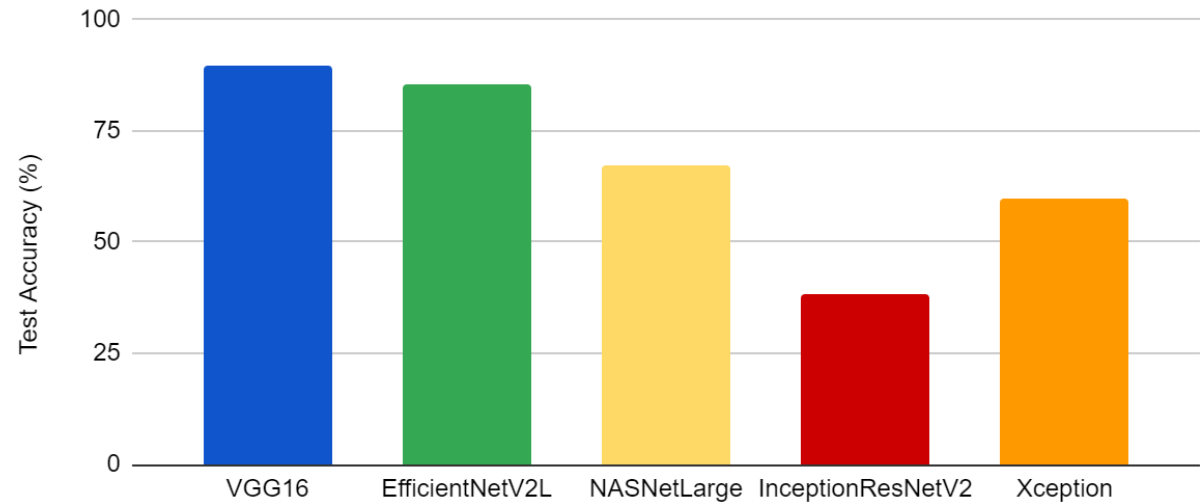
Average Test Accuracy VS Activation Function
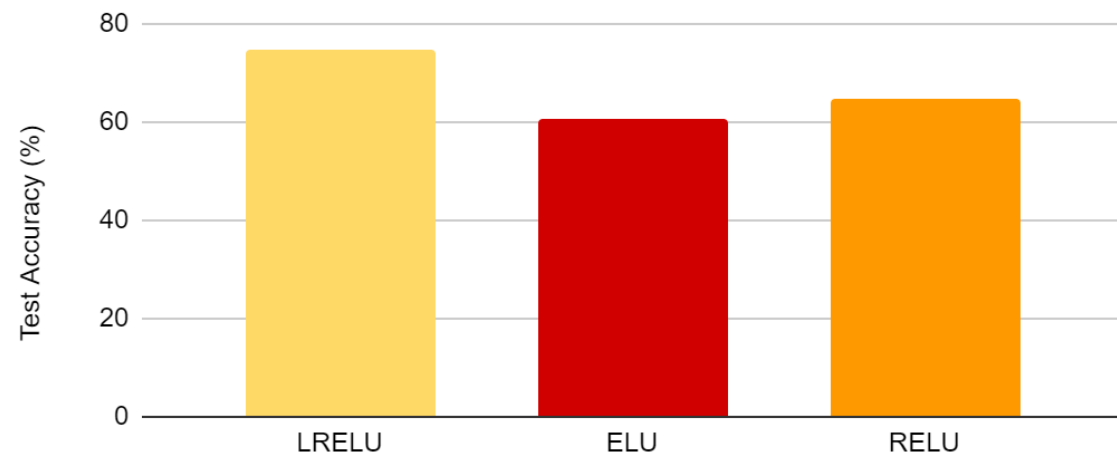
Results Cont. - Third Trade Study Highlights

- Data Augmentation:
  - Rotation range = 355
  - Vertical flip = True
  - Horizontal flip = True
  - Validation split = 0.25
- Epochs:
  - 6, 8, 10
- Total Test Cases: 6
- Best Overfit Score: **2.1**
  - No Data Augmentation
  - 6 Epochs
- Test Accuracy: **89.7**

Test Accuracy VS Epochs
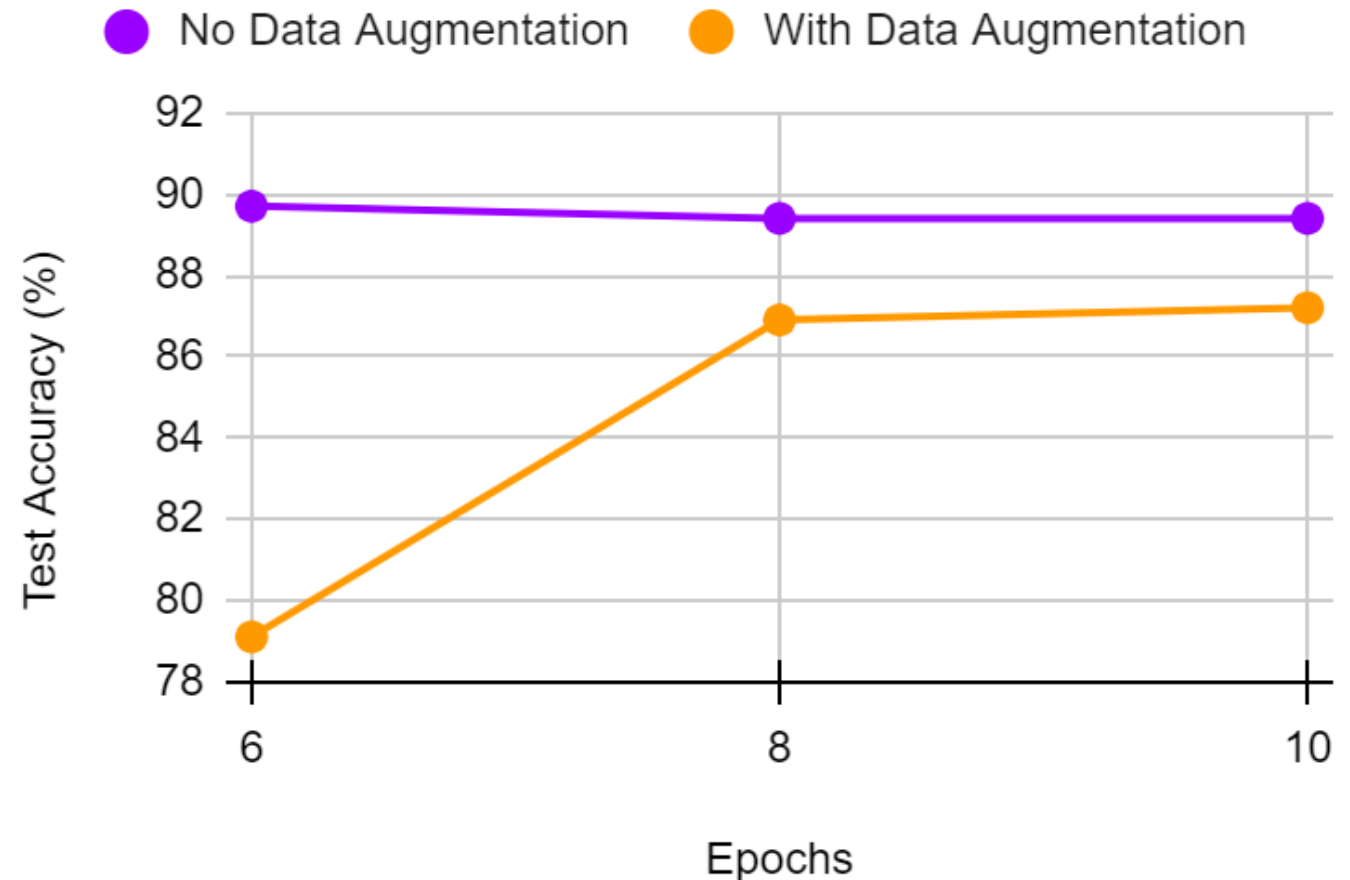
Conclusions

- Refined Setup:
  - Mini-Batch Size - 64
  - Learning Rate - 0.01
  - Hidden Layers - 8
  - Perceptrons per Layer - 32
  - Transfer Learning Structure - EfficentNetV2L
  - Activation Function - ELU
  - Data Augmentation - None
  - Epochs - 6

- Original Model:
  - Test Accuracy Score of 89.6
  - Overfit Score of 4.3

- Optimized Model:
  - Test Accuracy Score of 89.7
  - Overfit Score of 2.1

- Corn:
  - A Big Lump with Knobs
  - It has the Juice

Future Work

- Run more intensive trade study on all transfer learning structures
- Experiment with other deep learning structures
- Explore deeper ranges in hyperparameters
- Refined Model to have higher accuracy while maintaining low overfit

Appendix

Trade Study Phase 1

Mini-Batch Size	Learning Rate	# Hidden Layers	# Perceptrons Per Layer	Train Accuracy	Val Accuracy	Test Accuracy	Overfit Score
32	1.00E-02	4	32	90.4	82	82.1	8.3
			64	94.6	86	84.4	10.2
		8	32	94.6	90	90	4.6
			64	94.9	89	90.3	4.6
	1.00E-03	4	32	98.3	89	90.8	7.5
			64	99.1	90	90.9	8.2
		8	32	97.2	88	89.8	7.4
			64	98	88	89.6	8.4
64	1.00E-02	4	32	96.7	90	89.4	7.3
			64	96.8	89	89.7	7.1
		8	32	93.9	89	89.6	4.3
			64	95.1	88	89.3	5.8
	1.00E-03	4	32	98.4	89	90.3	8.1
			64	99.6	89	90	9.6
		8	32	98.2	90	90.6	7.6
			64	99	89	91.2	7.8

Appendix

Trade Study Phase 2

Transfer Learning Structure	Activation Functions	Train Accuracy	Val Accuracy	Test Accuracy	Overfit Score
VGG16	RELU	93.9	89	89.6	4.3
	LRELU	96.7	89	89.4	7.3
	ELU	95.9	88	90.2	5.7
EfficientNetV2L	RELU	84	83	82.4	1.6
	LRELU	90.7	86	86.2	4.5
	ELU	89.8	88	88.4	1.4
NASNetLarge	RELU	73.6	71	71.5	2.1
	LRELU	66	69	66.8	0.8
	ELU	71.9	64	63.9	8
InceptionResNetV2	RELU	32.3	28	30	2.3
	LRELU	48.2	56	54.5	6.3
	ELU	31.9	28	30	1.9
Xception	RELU	77.8	73	74.5	3.3
	LRELU	80.1	77	75.4	4.7
	ELU	30.7	28	30	0.7

Appendix

Trade Study Phase 3

Data Augmentation	Epochs	Train Accuracy	Val Accuracy	Test Accuracy	Overfit Score
No	6	91.8	73	89.7	2.1
	8	80.3	86	89.4	9.1
	10	93.6	89	89.4	4.2
Yes	6	83.4	80	79.1	4.3
	8	89.8	87	86.9	2.9
	10	89.5	90	87.2	2.3