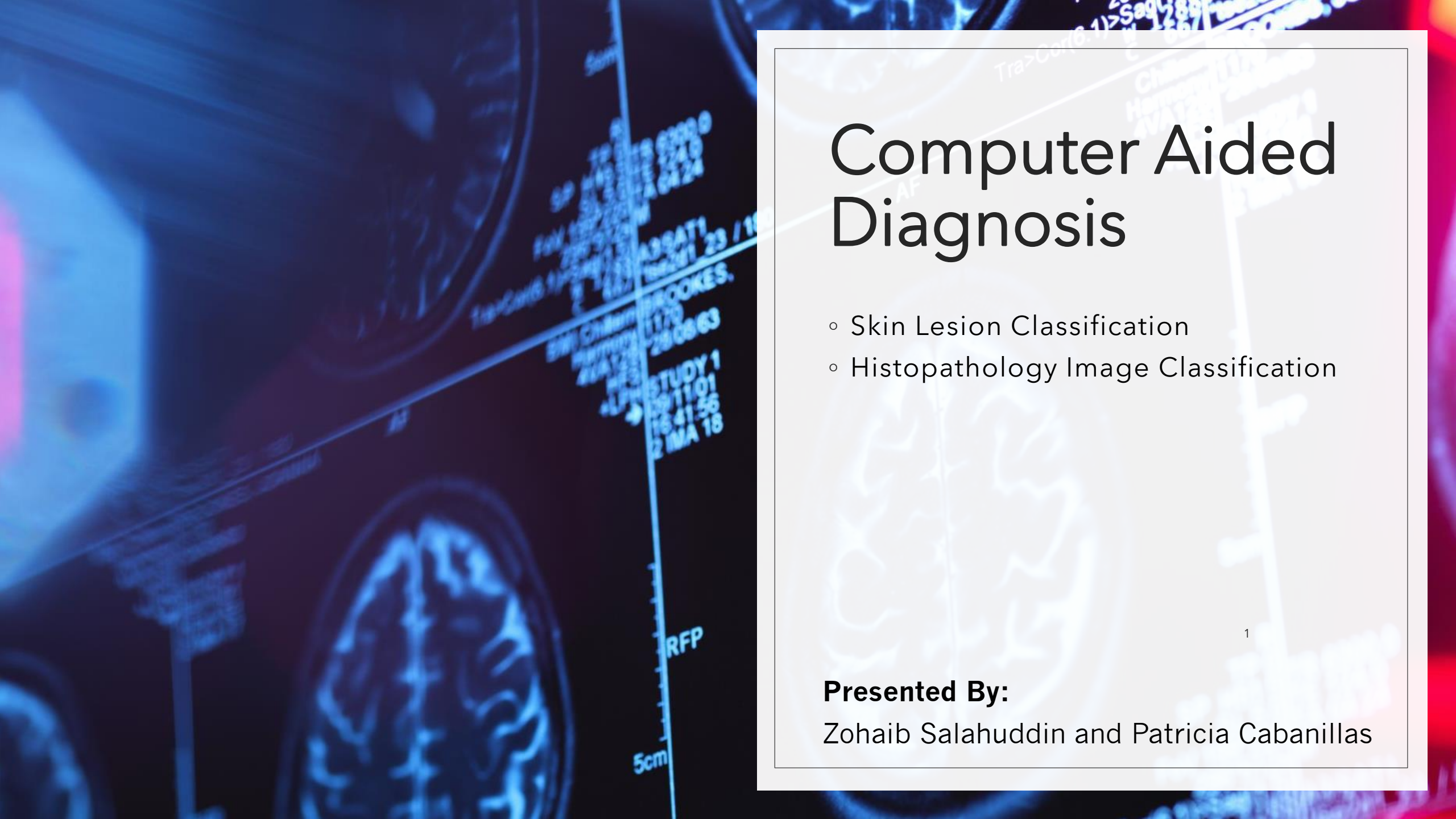


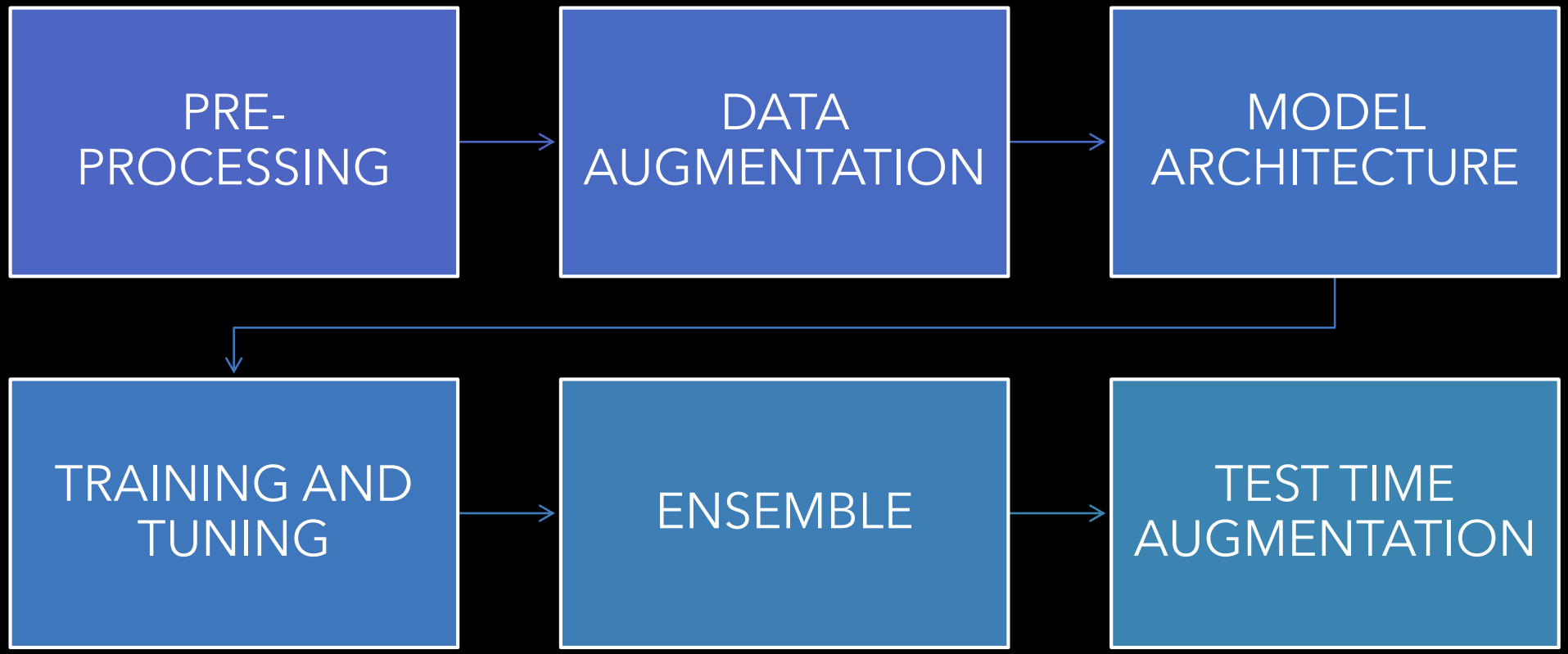
Computer Aided Diagnosis

- Skin Lesion Classification
- Histopathology Image Classification

Presented By:

Zohaib Salahuddin and Patricia Cabanillas

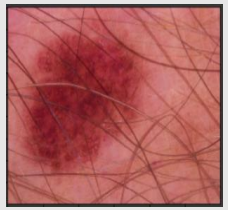
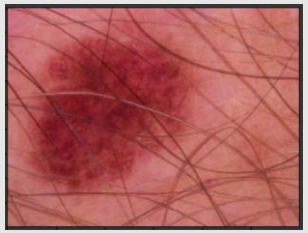
Skin Lesion Classification Pipeline



Pre-Processing

1. **Trail No. 1:** Using Image Resized to **224 x 224.**
2. **Trial No. 2 :** Using elliptical color normalized image to remove artifacts at corner and hair removal.
3. **Trial No. 3 :** Using Image with Segmentation Mask.
4. **Trial No. 4 :** Using Image with Original Dimensions **600 x 450.**

Mean and Std Color Normalization was applied to all the channels of image as recommended for training with pretrained ImageNet Weights.

1. 
2. 
3. 
4. 

Data Augmentation

Horizontal and Vertical Flip

Random Affine

Brightness

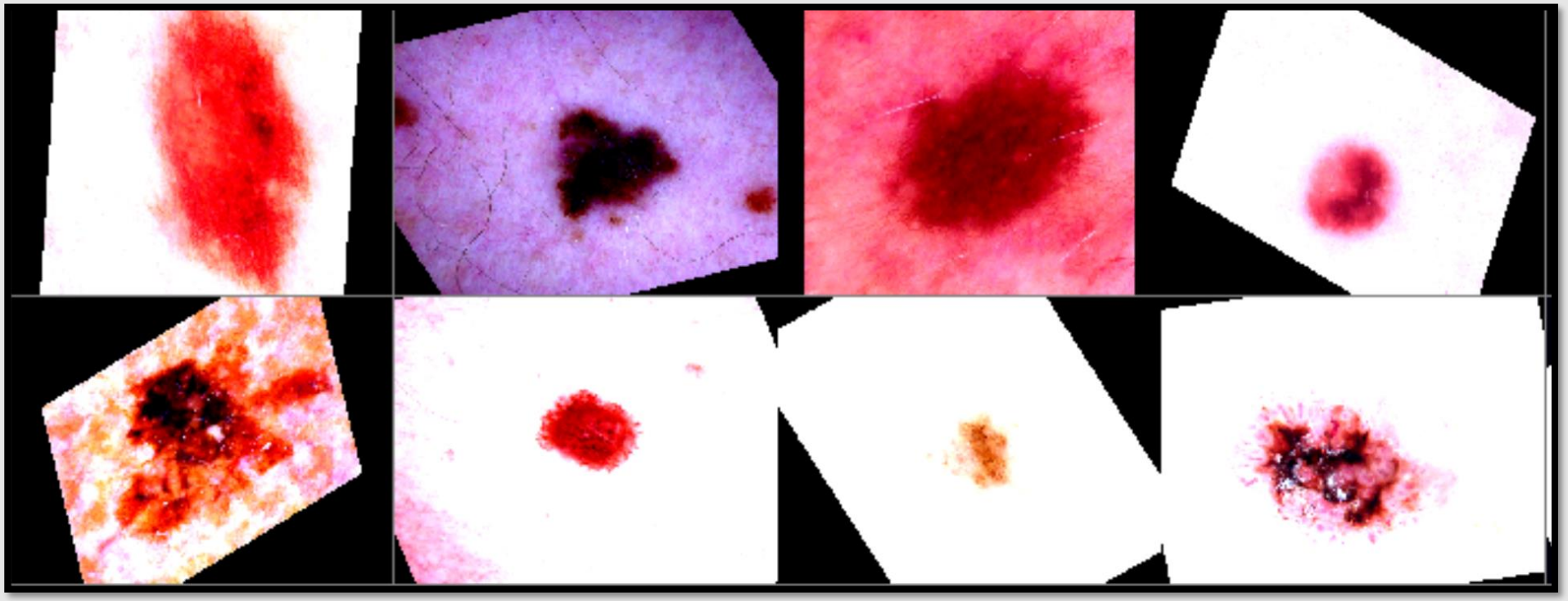
Color

Saturation

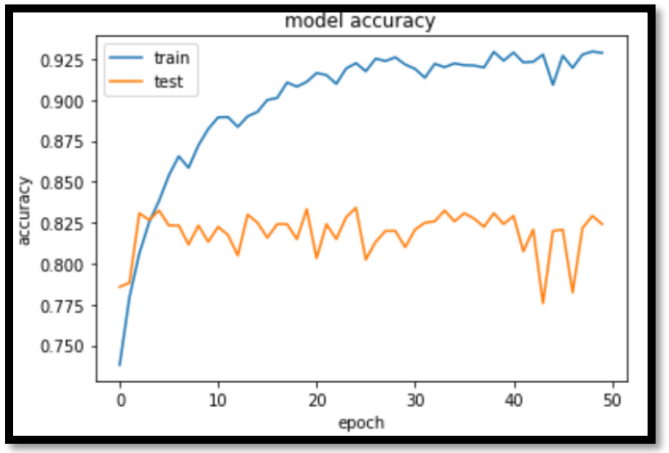
Hue

Random Erasing

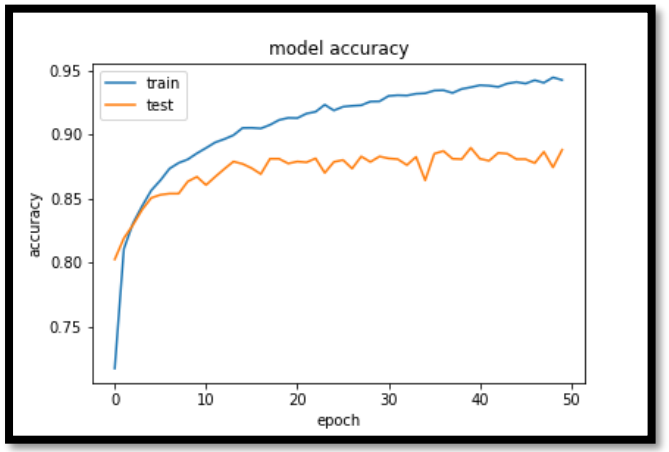
Data Augmentation



Fine Tuning Limitation



Training the Densely Connected Layers at the End



Tuning the last few convolutions blocks at the end of VGG-16

Pre-trained Models

- **Training From Scratch**.
- Training from Scratch with **ImageNet** Weight Initialization.
  1. VGG16
  2. **VGG16_bn**
  3. VGG19
  4. **VGG19_bn**
  5. **ResNet18**
  6. **ResNet34**
  7. ResNet50
  8. DenseNet201
  9. DenseNet121
  10. DenseNet 161
  11. EfficientNet b0 – b3
  12. MobileNet v2

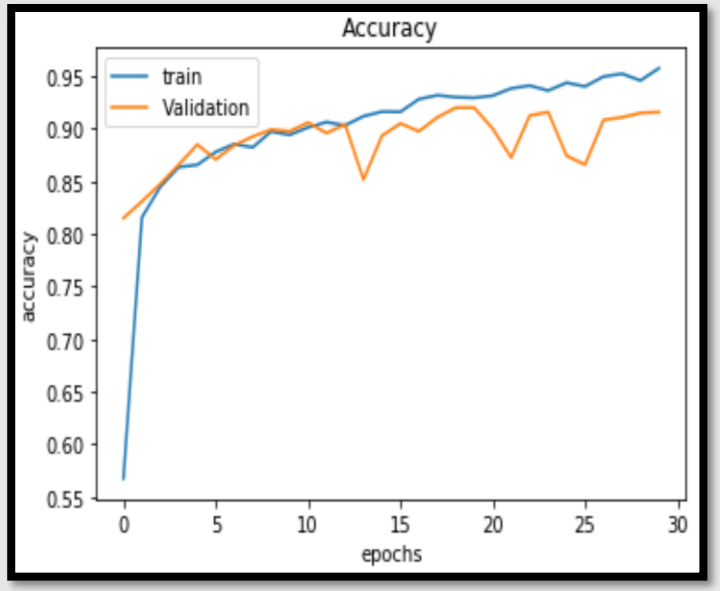
Training and Tuning

- **Optimizer :** **Adam**, **AdaDelta**, SGD.
- **Learning Rate Scheduler :** **CosineAnnealingLearningRate**, ReduceLROnPlateau.
- **Training Methodology:**

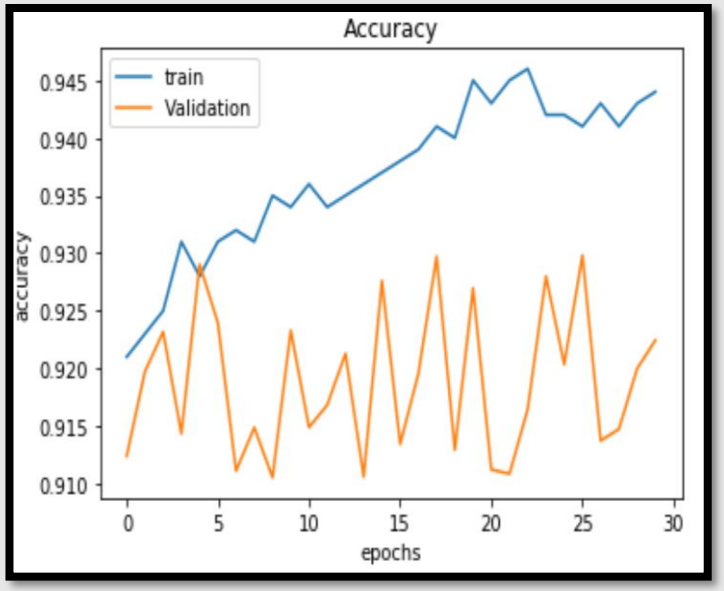
1. **Three Step Training with Less Deep Networks:**
   A. Train for 30 Epochs with Learning Rate : 1e-5 and ReduceLROnPlateau Scheduler.
   B. Train for 20 Epochs with Learning Rate : 1e-6 and ReduceLROnPlateau Scheduler.
   C. Train for 20 Epochs with Learning Rate : 1e-7 and CosineAnnealingLearningRate Scheduler.

2. **Two Step Training with Very Deep Networks:**
   A. Train for 30 Epochs with Learning Rate : 1e-6 and ReduceLROnPlateau Scheduler.
   B. Train for 30 Epochs with Learning Rate : 1e-7 and ReduceLROnPlateau Scheduler.

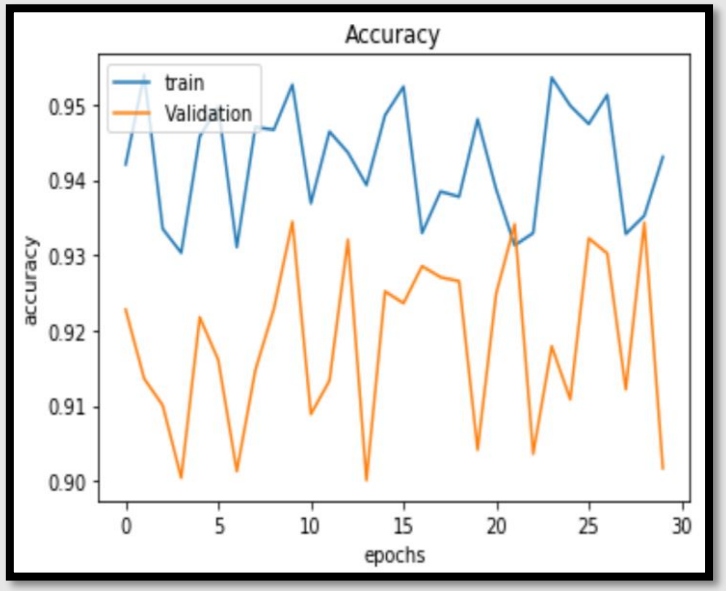
3 Step Training



Step 1 : ReduceLROnPlateau – 10e-5



Step 2 : ReduceLROnPlateau – 10e-6



Step 3 : CosineAnnealingRate – 10e-7

Experiments

Model	Training Accuracy	Validation Accuracy	Training Loss	Validation Loss
VGG16	93.2	88.1	0.153	0.273
VGG16_bn	95.6	88.3	0.087	0.281
VGG19	94.2	88.5	0.092	0.287
VGG19_bn	94.3	89.1	0.118	0.259
ResNet18	96.1	89.6	0.142	0.251
ResNet34	96.2	90.5	0.125	0.242
MobileNet v2	94.5	89.7	0.023	0.255
DenseNet 201	97.3	90.1	0.072	0.258
ResNet50	93.5	90.6	0.142	0.235

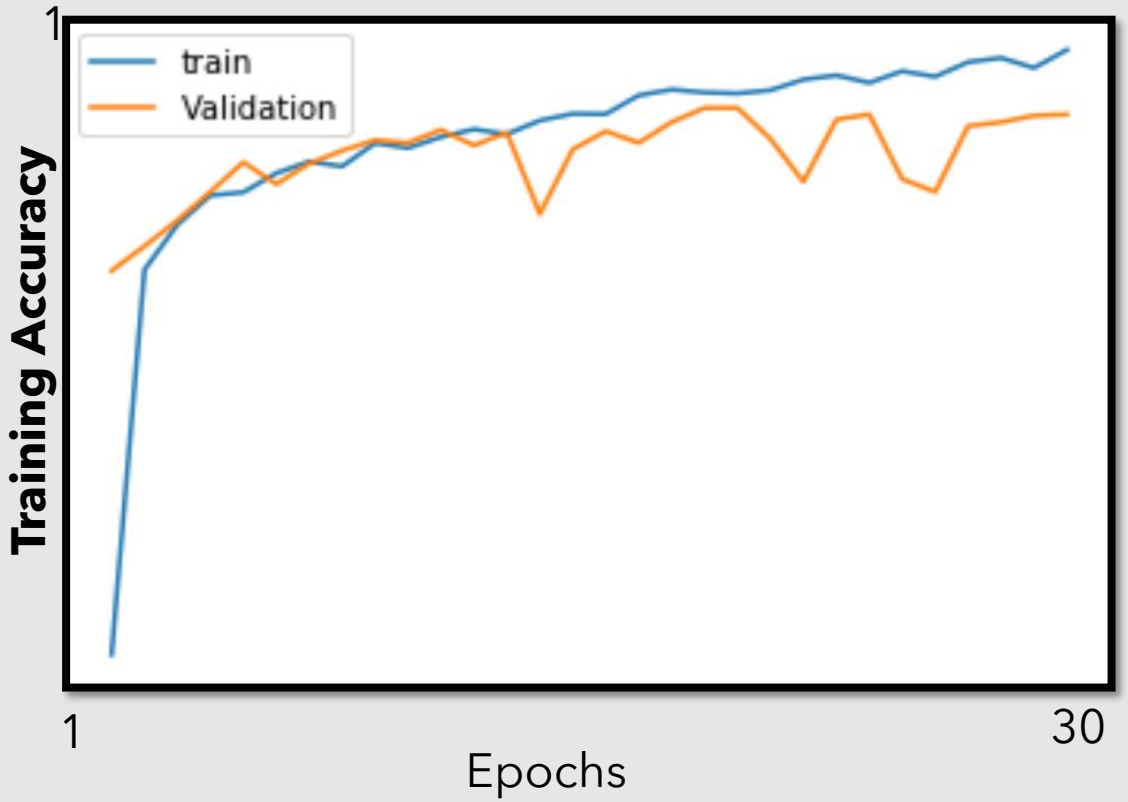
Results of Experiments with different models with Minimal Augmentation and Resizing the Images to 224 x 224.

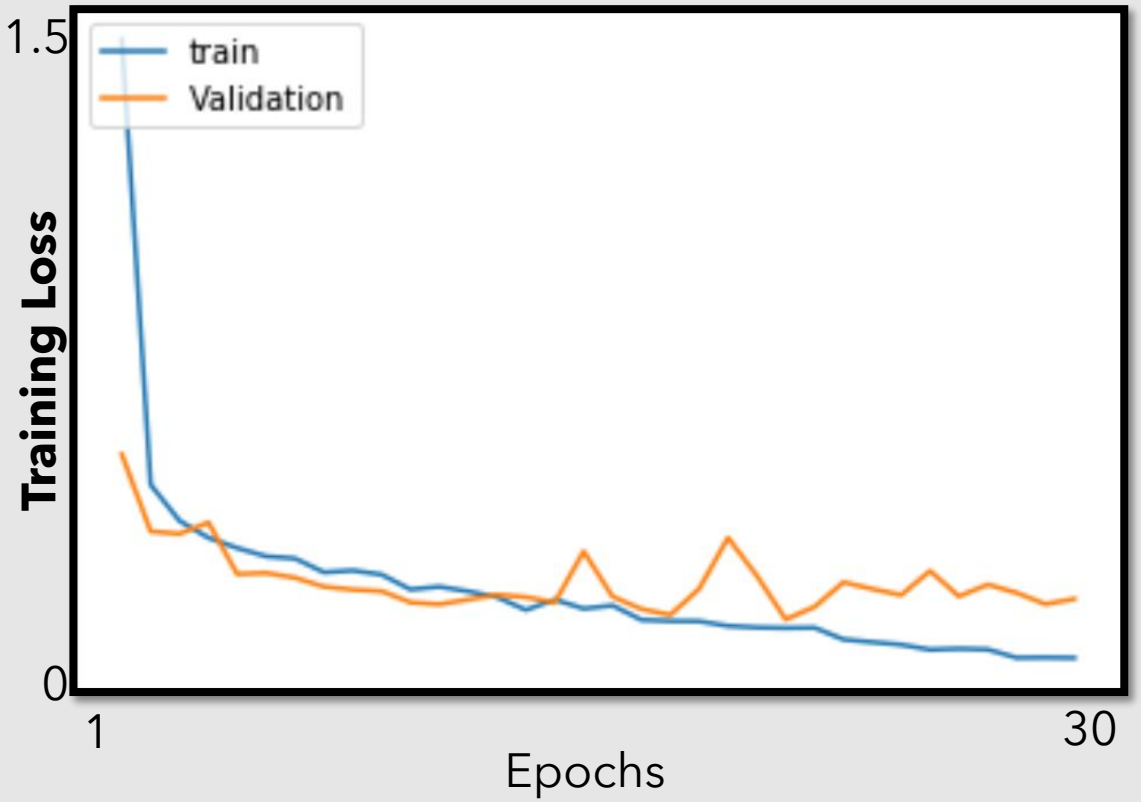
Experiments

Model	Training Accuracy	Validation Accuracy	Training Loss	Validation Loss	TTA Validation Accuracy
VGG16	91.5	88.5	0.244	0.253	89.3
VGG16_bn	90.7	90.7	0.201	0.233	90.5
VGG19	90.5	89.5	0.221	0.248	90.1
VGG19_bn	90.4	90.8	0.215	0.259	90.9
ResNet18	91.1	90.5	0.226	0.228	90.7
ResNet34	90.2	90.7	0.221	0.223	91.1
Resnet50	93.5	92.5	0.206	0.2133	93.6
DenseNet 201	94.5	91.8	0.185	0.228	91.38
SqueezeNet	87.6	87.1	0.273	0.305	87.5

Results of Experiments with different models with Aggresive Augmentation and Original Image Size.

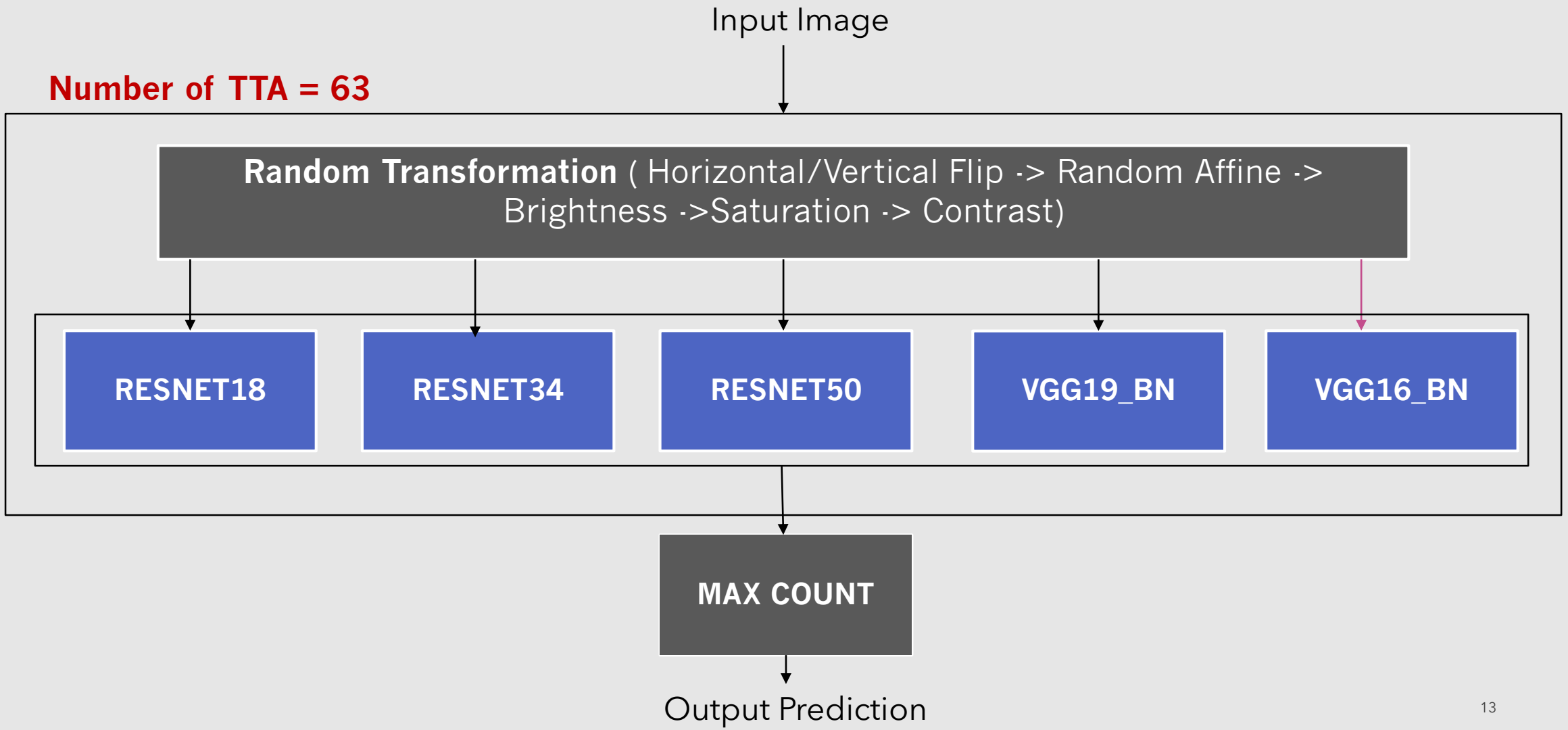
Experiments and Results



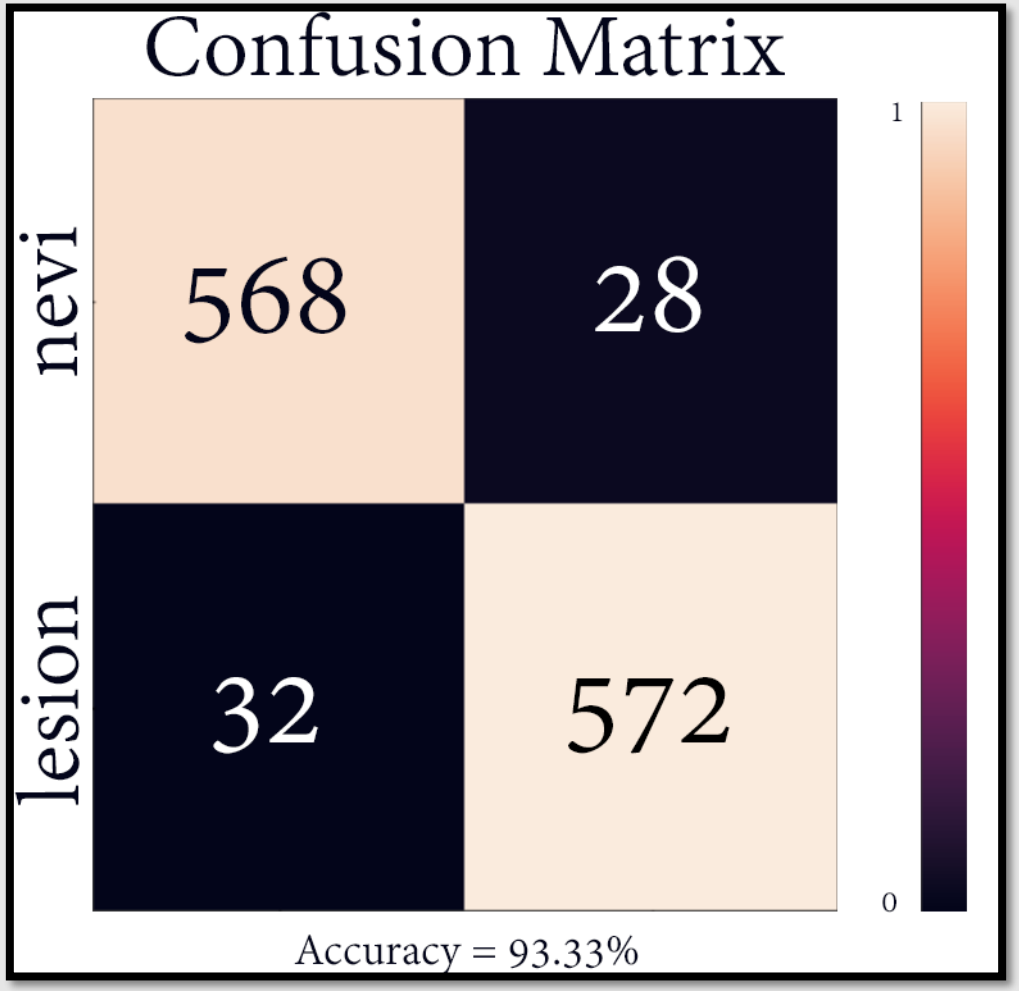


Training and Validation Curves for ResNet50 Model

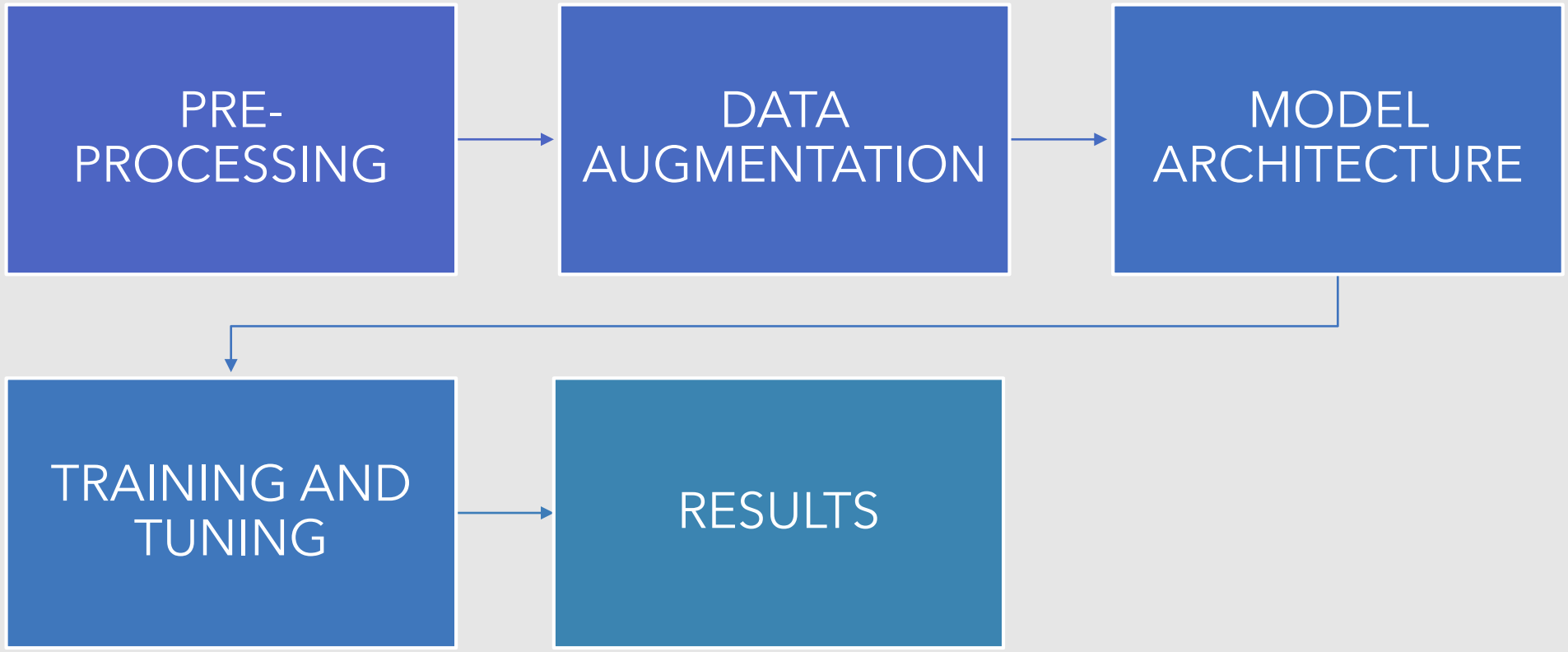
Ensemble and Test Time Augmentation



Final Validation Results



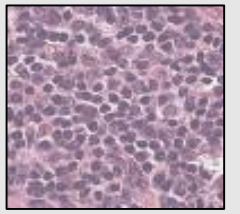
Histopathology Classification Pipeline



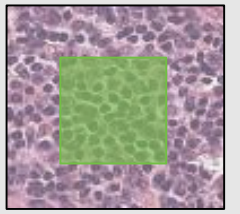
Pre-Processing

1. **Trail No. 1:** Using Image Resized to **224 x 224.**
2. **Trial No. 2 :** Using center crop **32x32.**
3. **Trial No. 3 :** Using Vahane Normalization.

1.

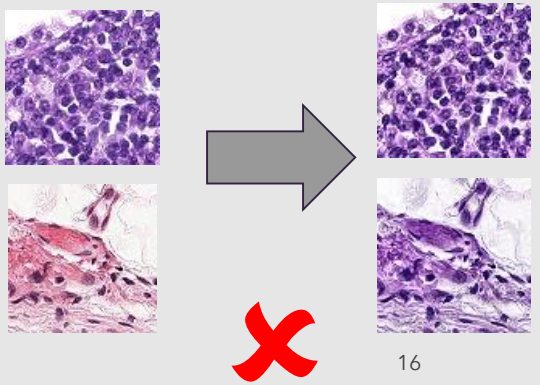


2.



- *Mean and Std Color Normalization* was applied to all the channels of image as recommended for training with pretrained ImageNet Weights.
- Mean = [0.485, 0.456, 0.406]
- Std = [0.229, 0.224, 0.225]

3.



Data Augmentation

Horizontal and Vertical Flip

Color

Random Erasing

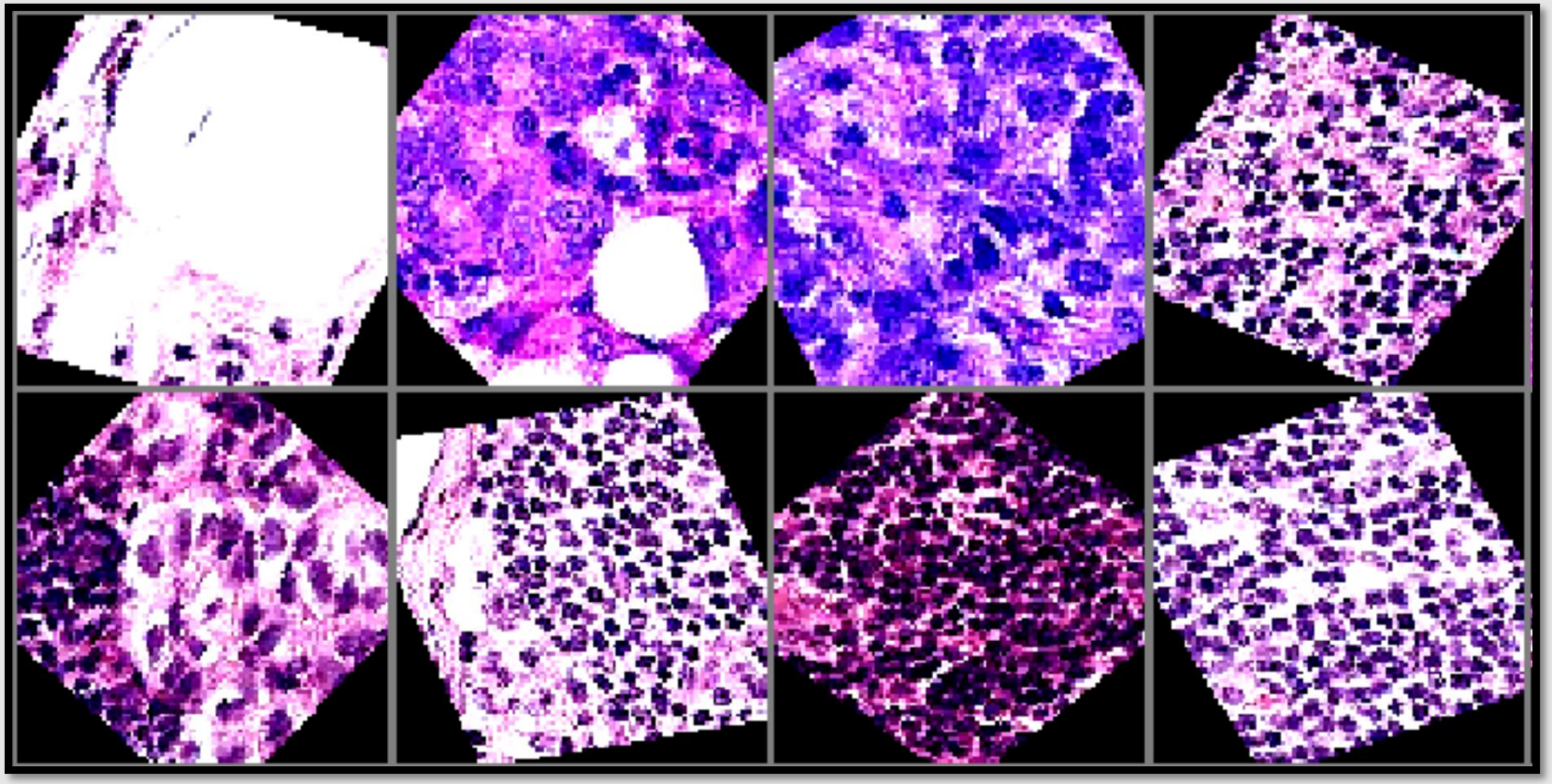
Rotation

Saturation

Brightness

Hue

Data Augmentation



Pre-trained Models

- **Training From Scratch**.
- Training from Scratch with **ImageNet** Weight Initialization.
  1. **DenseNet121**
  2. VGG16_bn
  3. VGG19
  4. **VGG19_bn**
  5. ResNet18
  6. ResNet34
  7. ResNet50
  8. **DenseNet201**
  9. EfficientNet b0 – b3
  10. **MobileNet v2**

Training and Tuning

- **Optimizer :** **Adam**, **AdaDelta**.
- **Learning Rate Scheduler :** ReduceLROnPlateau.
- **Training Methodology:**

1. **Step Training with Very Deep Networks:**
   - Train for 60 Epochs with Learning Rate : 1e-6 and ReduceLROnPlateau Scheduler.
2. **Step Training with Less Deep Neworks:**
   - Train for 60 Epochs with Learning Rate : 1e-5 and ReduceLROnPlateau Scheduler.

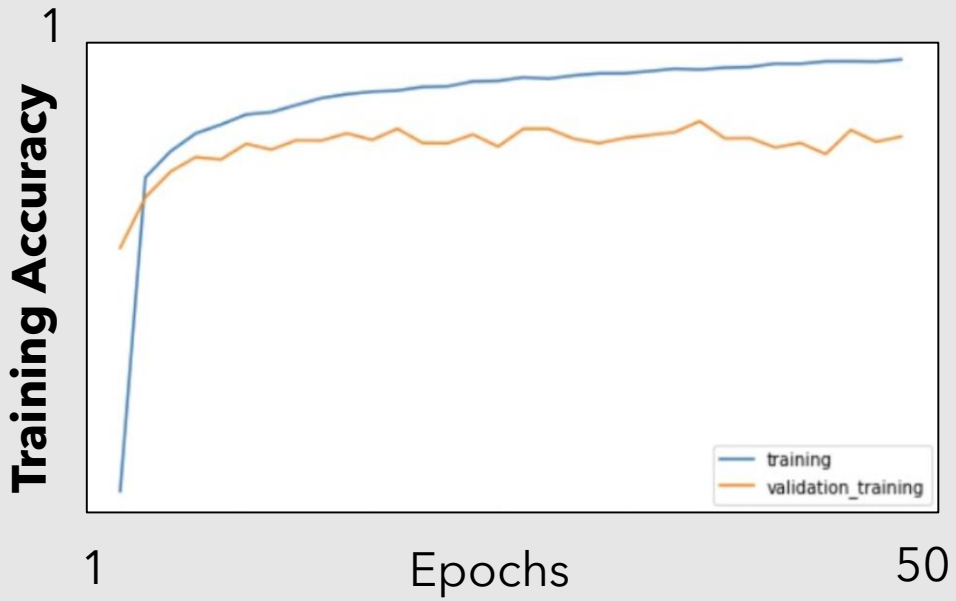
Experiments

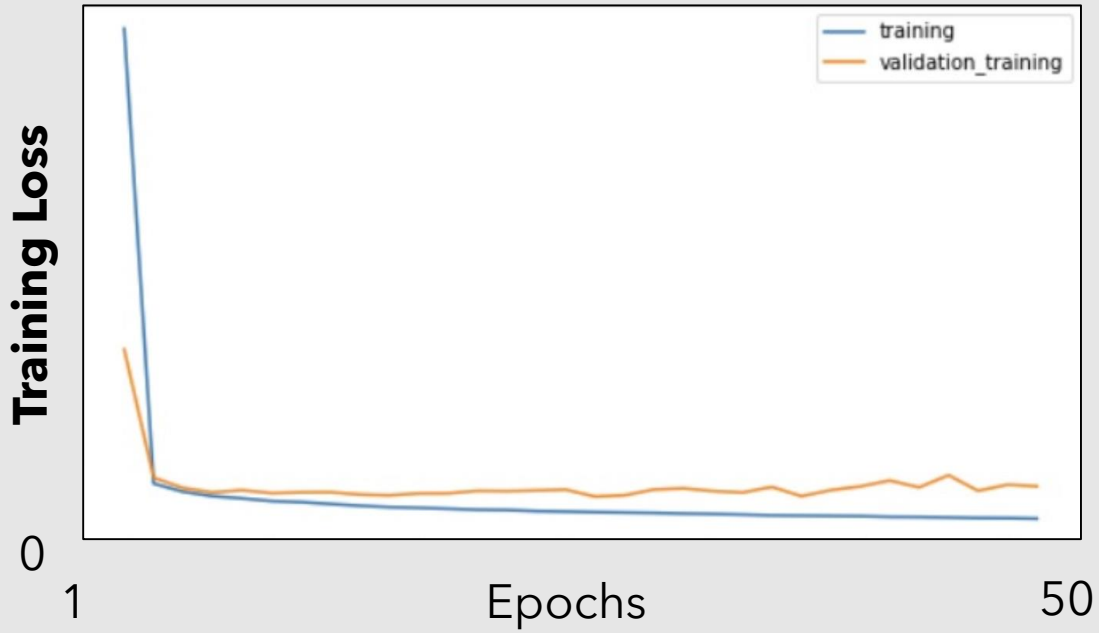
Model	Training Accuracy	Validation Accuracy	Training Loss	Validation Loss
VGG19	0.941	0.890	0.154	0.274
VGG19_bn	0.929	0.879	0.183	0.283
ResNet18	0.934	0.853	0.176	0.337
ResNet34	0.969	0.73	0.089	0.373
ResNet50	0.912	0.863	0.216	0.352
ResNet101	0.917	0.898	0.212	0.237
MobileNet v2	0.948	0.881	0.2093	0.2775
DenseNet 121	**0.945**	**0.893**	**0.147**	**0.268**
DenseNet 201	0.964	0.904	0.1	0.278

Results of Experiments with different models with Augmentation and size 96x96.

NOTE: with Center Crop was not able to reach more than 80%

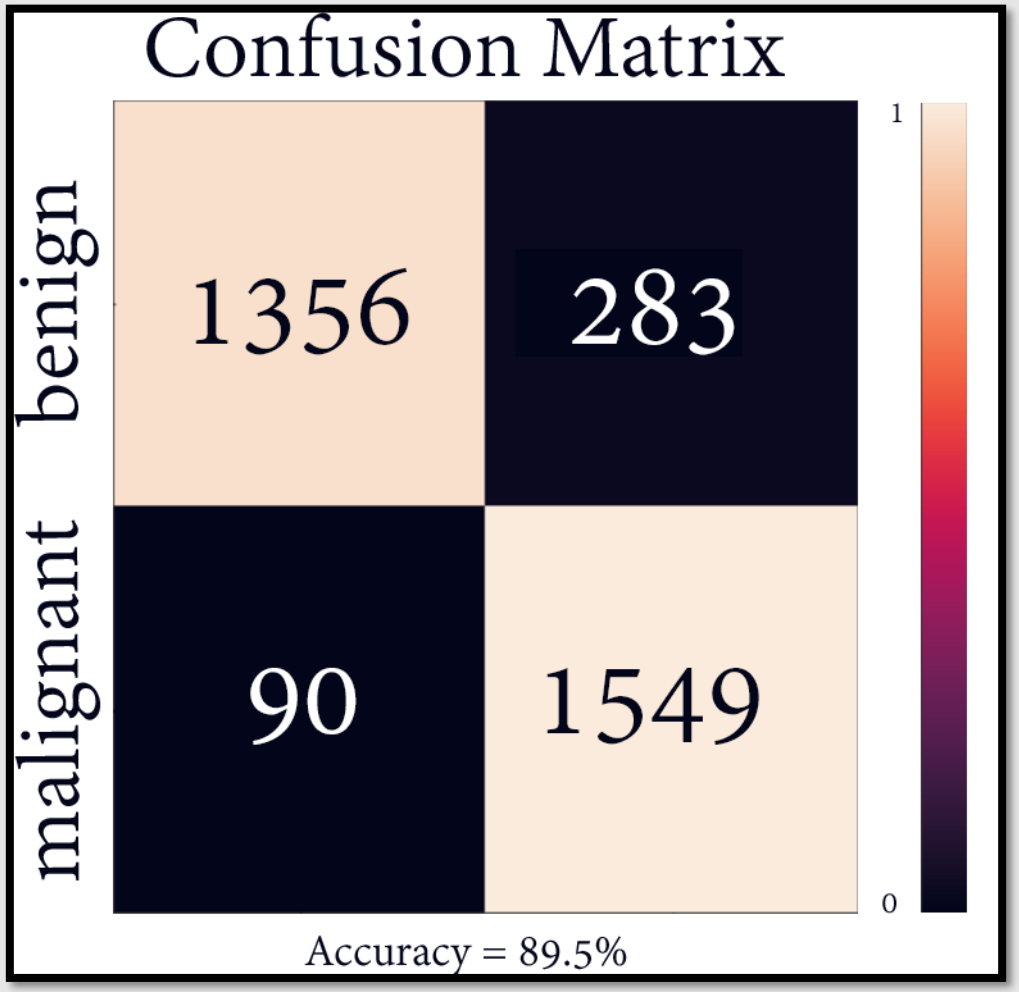
Experiments and Results



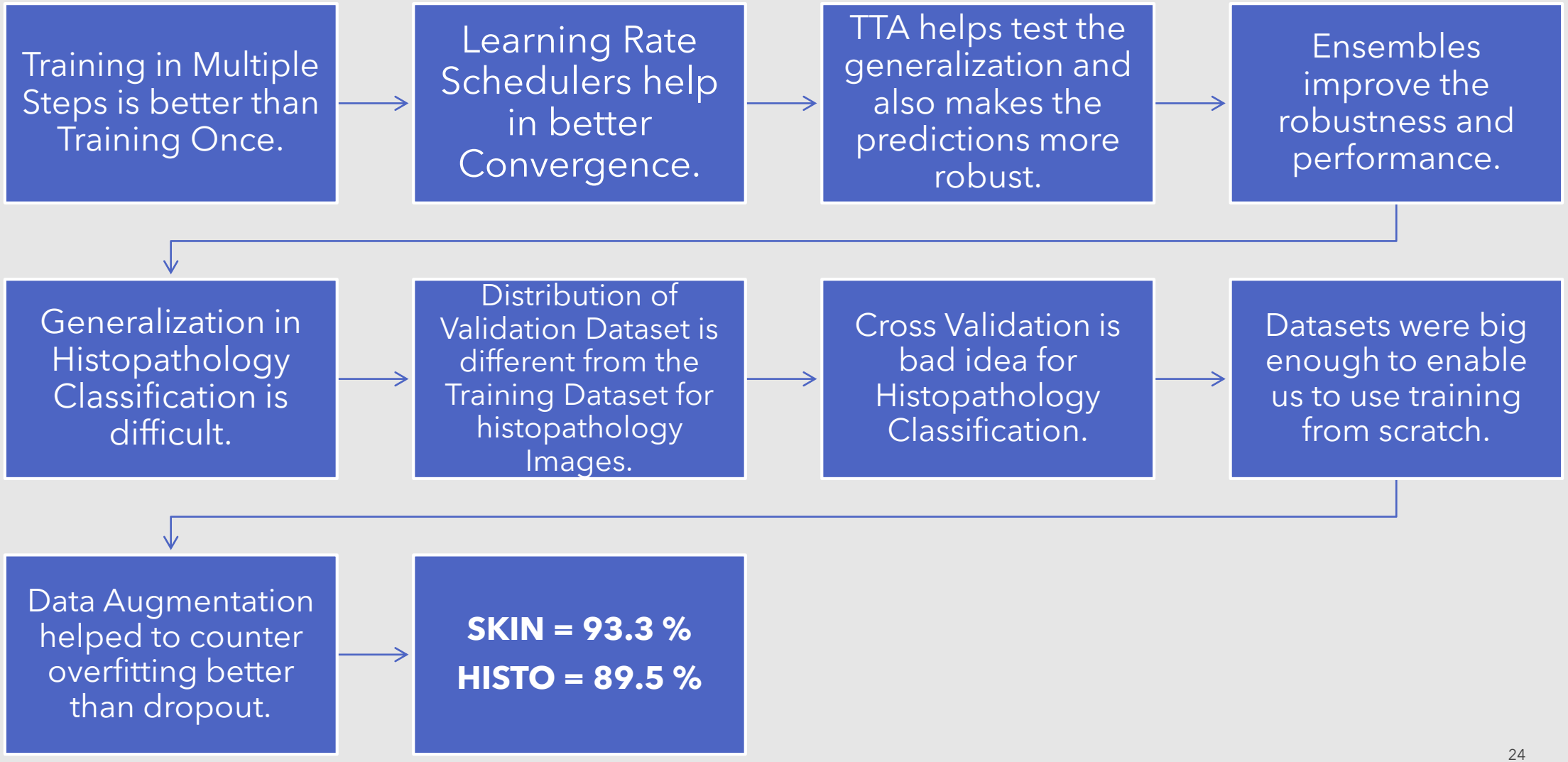


Training and Validation Curves for DenseNet121 Model

Final Validation Results



Conclusions



THANK YOU.