



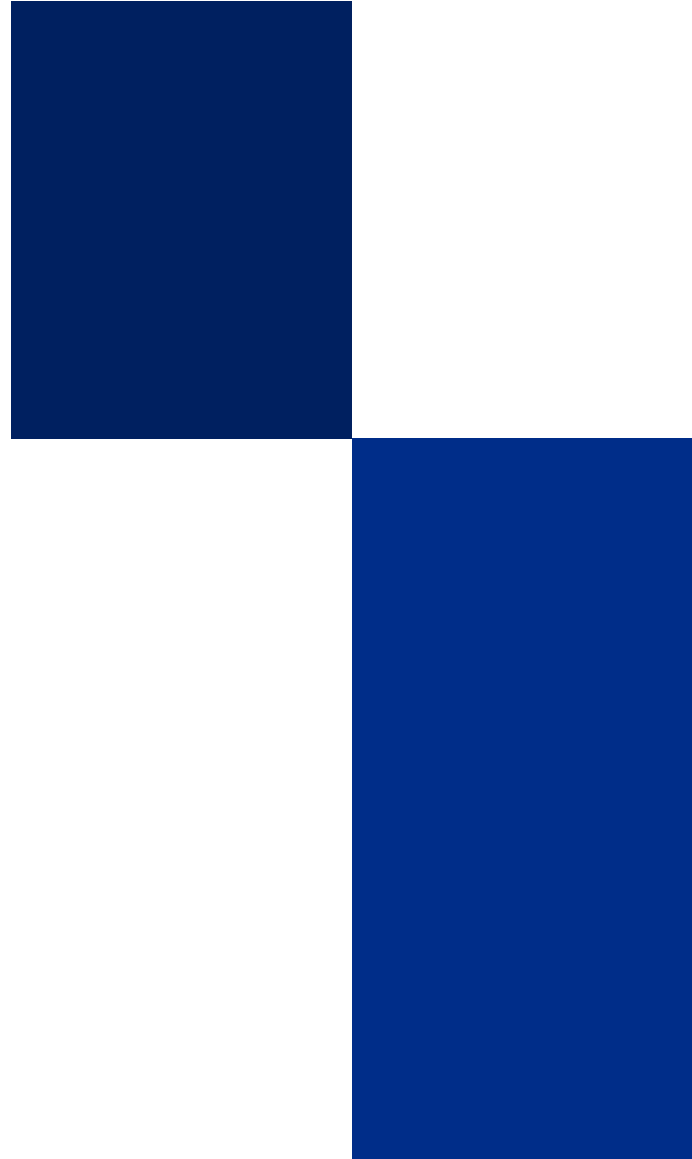
Deep Learning for Medical Image Classification: A Comprehensive Study

Roya Ghamari - Berker Senol

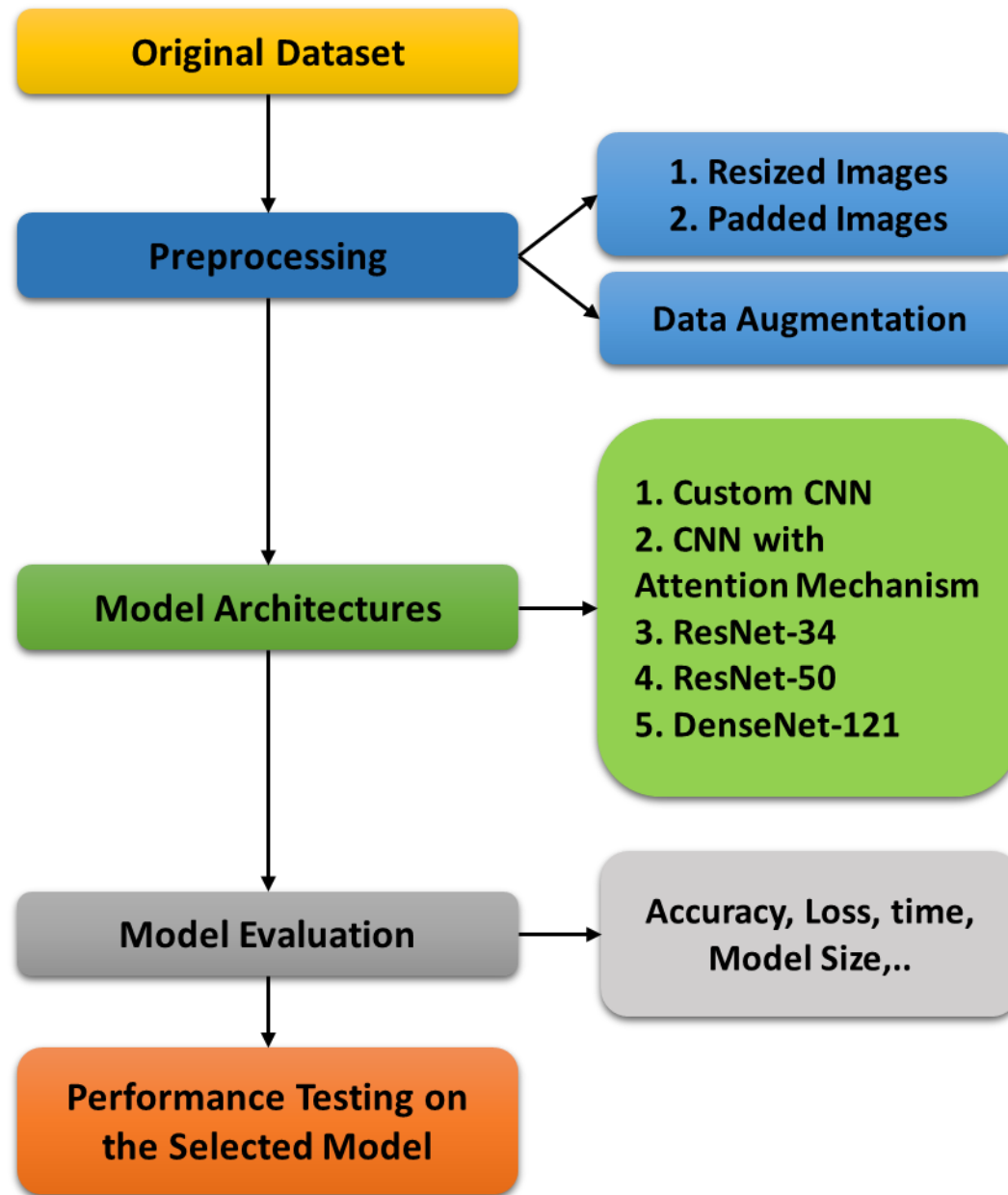
Human Data Analysis
July 2024

Objectives

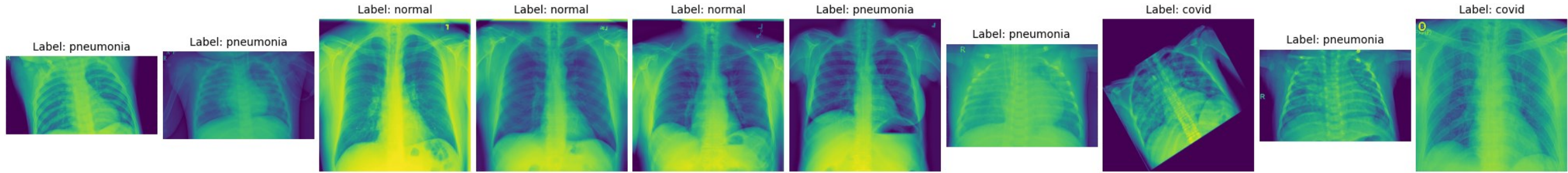
- ❑ **Classifying X-ray Images into COVID-19, Non-COVID Pneumonia, and Normal Conditions**
- ❑ **Identifying Optimal Neural Network Architectures for Image Classification**



Overview



Original Data



- Total of 4575 chest X-ray images
- Three classes: COVID, normal, and pneumonia, each with 1525 images.
- Variability in image sizes and aspect ratios
- Presence of rotated and flipped images complicating model training

Pre-processing

» Normalizing Data

» Converting to grayscale

» Two strategies:

1. Resized images:

Resizing to 224x224 size

2. Padded images:

Padding to 224x224 size

» Data Augmentation:

- Random flipping
- Brightness adjustment
- Rotation

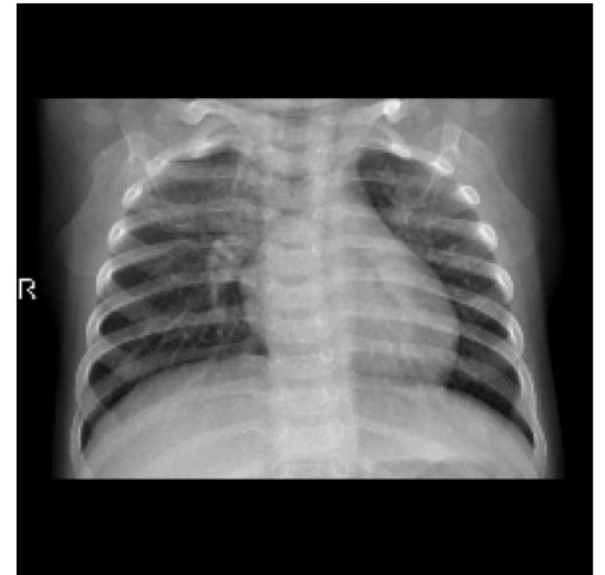
» Splitting:

- Train set 60%
- Validation set 20%
- Test set 20%

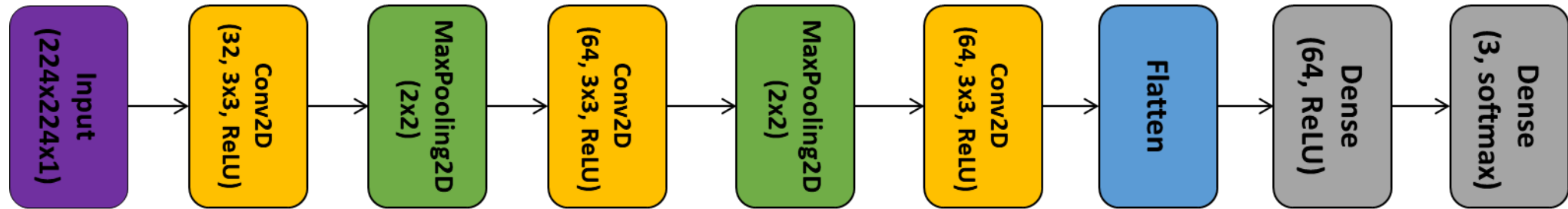
Resized Image



Padded Image

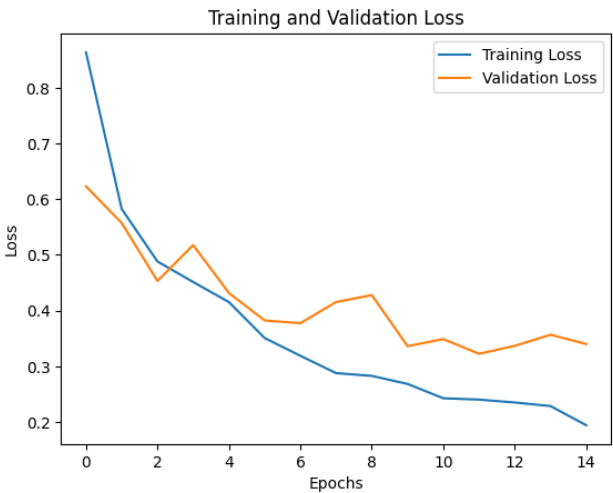
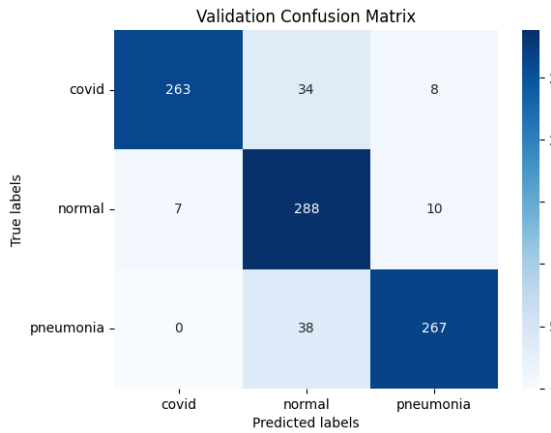
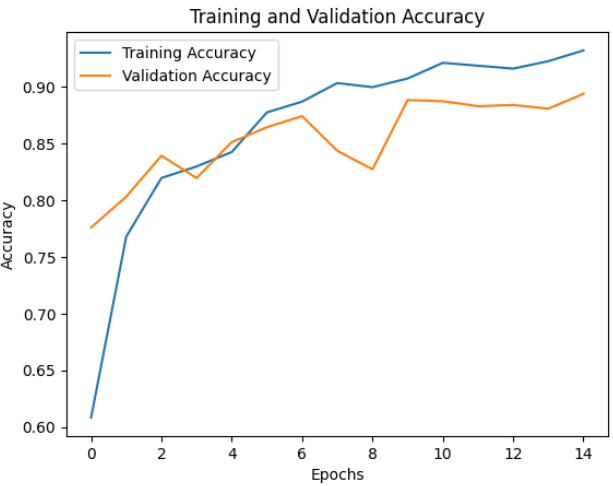


Model: Custom CNN - Architecture



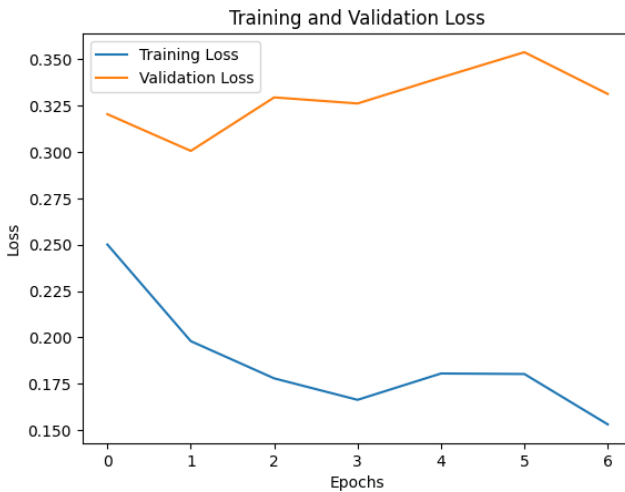
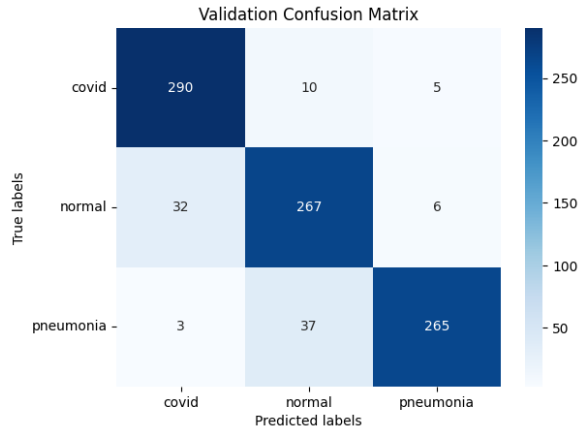
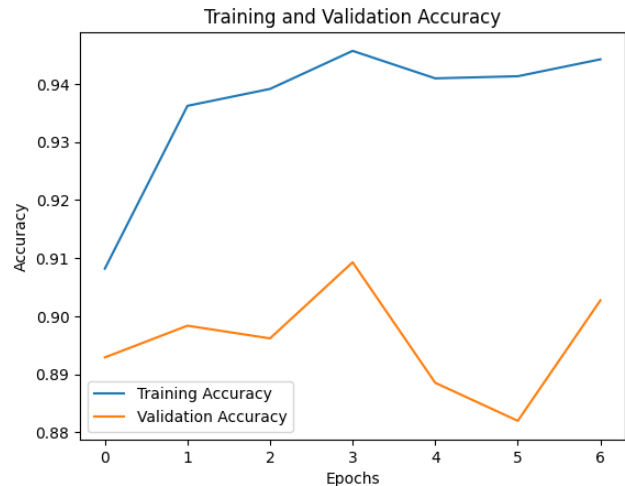
- Total parameters: 11,131,587
- Adam optimizer
- Learning rate 1e-3
- Early stopping callback with number of patience equal to 5

Model: Custom CNN - Results



Train accuracy: 0.938
Train loss: 0.186
Validation accuracy: 0.893
Validation loss: 0.34

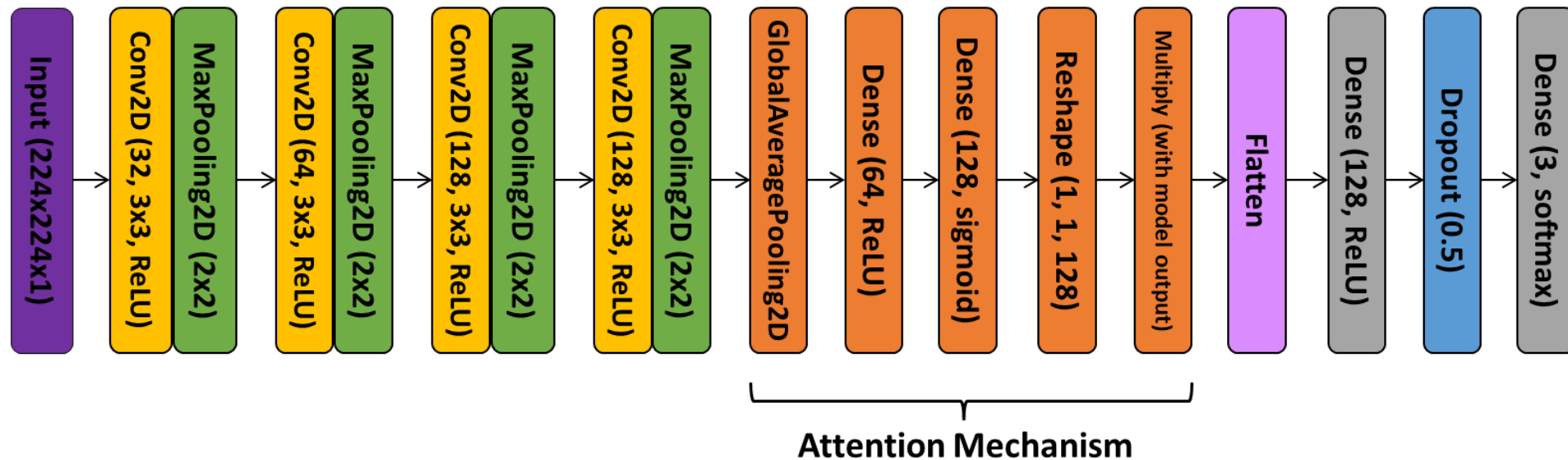
Results for resized dataset



Train accuracy: 0.943
Train loss: 0.166
Validation accuracy: 0.898
Validation loss: 0.3

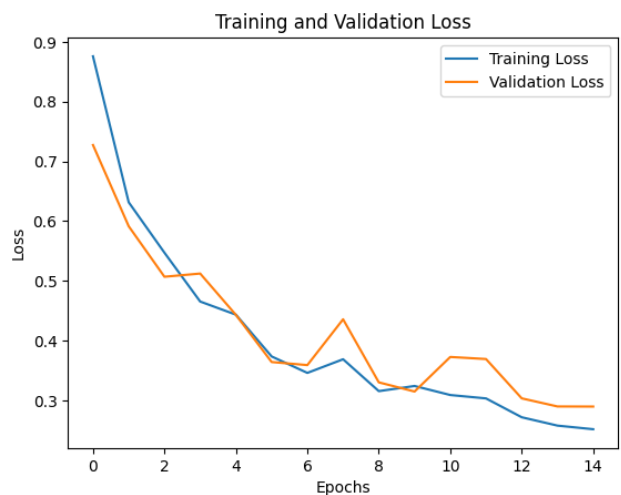
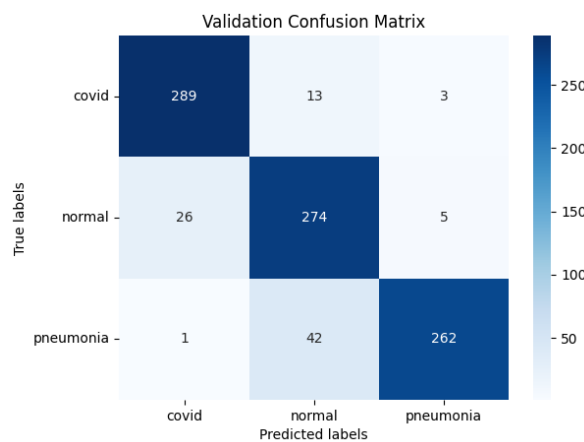
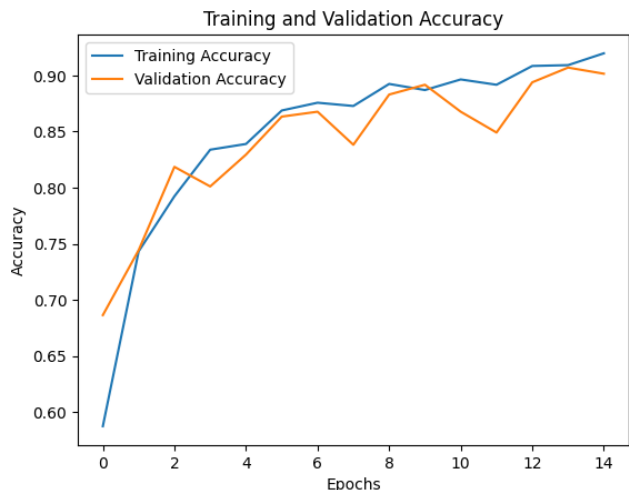
Results for padded dataset

Model: CNN with Attention Mechanism - Architecture



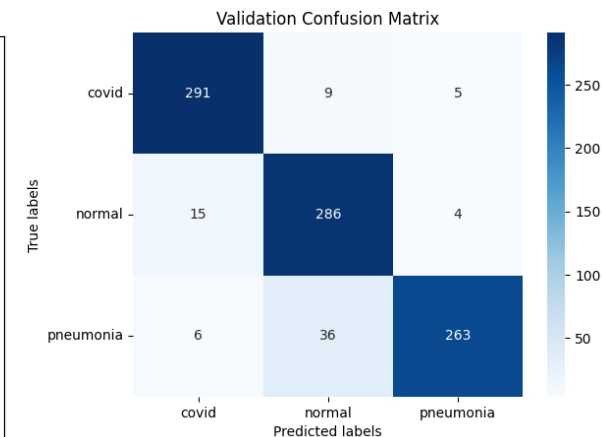
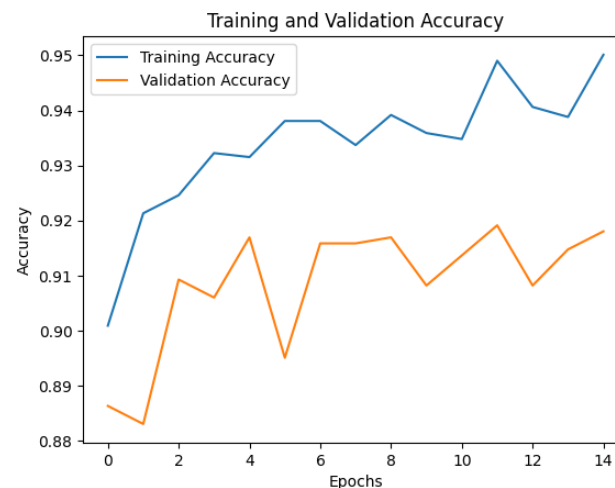
- Total parameters: 2,616,643
- Adam optimizer
- Learning rate $1e-3$
- Early stopping callback with number of patience equal to 5

Model: CNN with Attention Mechanism - Results



Results for resized dataset

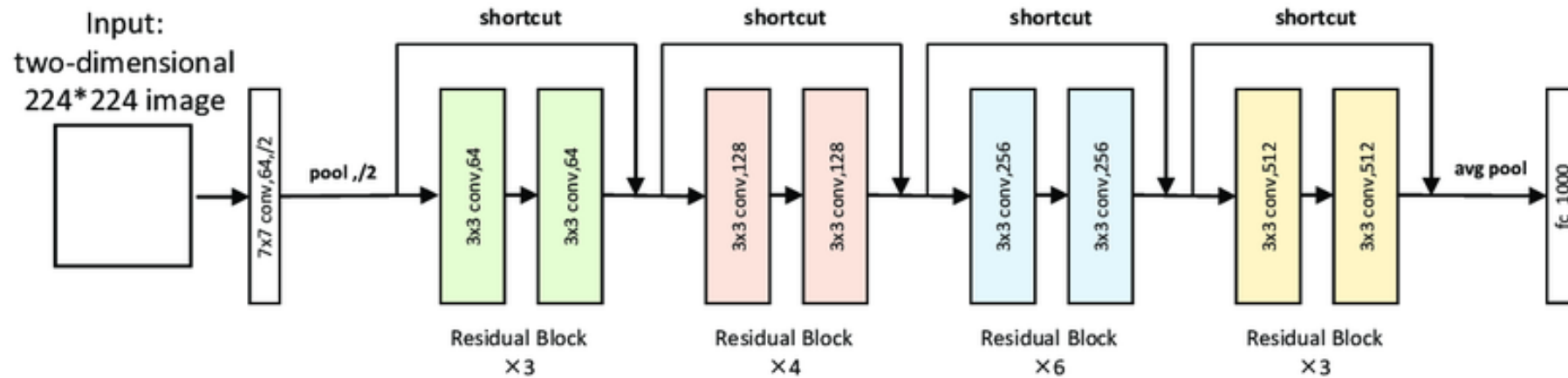
Train accuracy: 0.939
Train loss: 0.188
Validation accuracy: 0.901
Validation loss: 0.289



Results for padded dataset

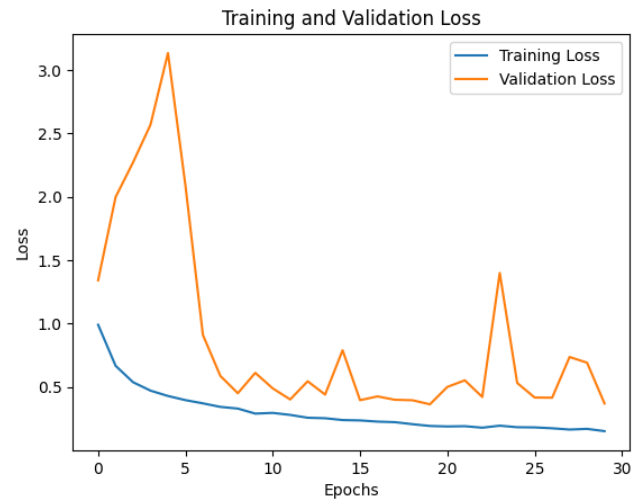
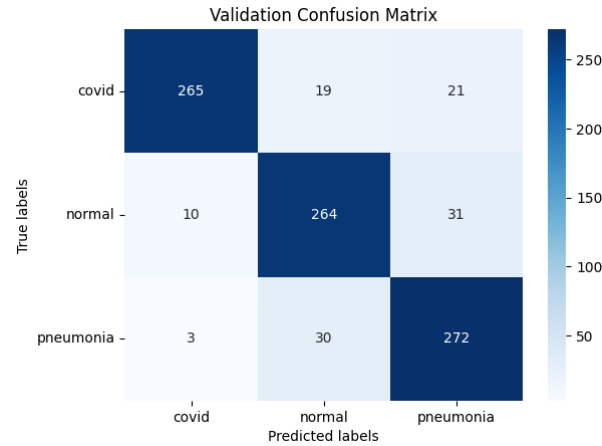
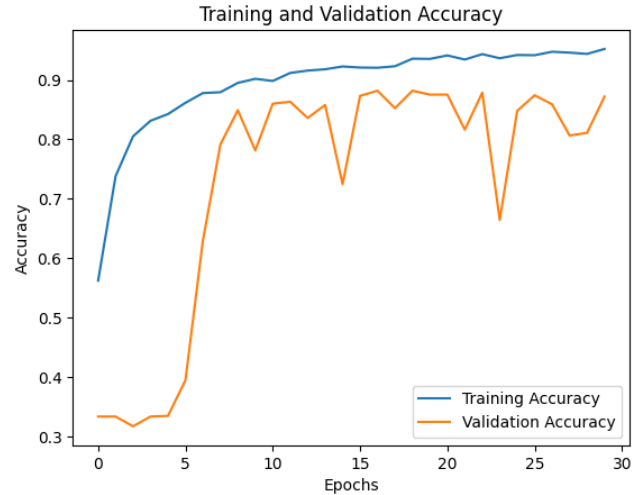
Train accuracy: 0.961
Train loss: 0.117
Validation accuracy: 0.918
Validation loss: 0.249

Model: ResNet-34 - Architecture



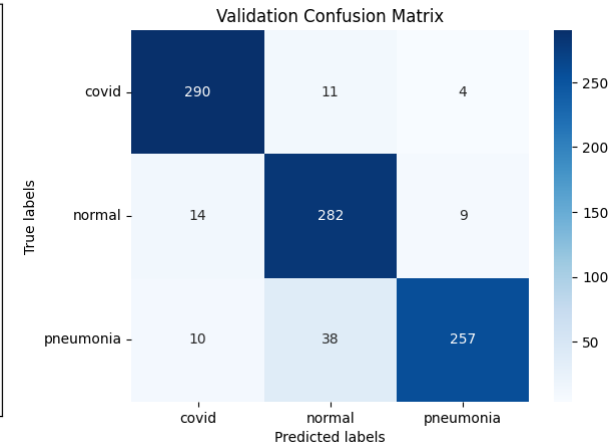
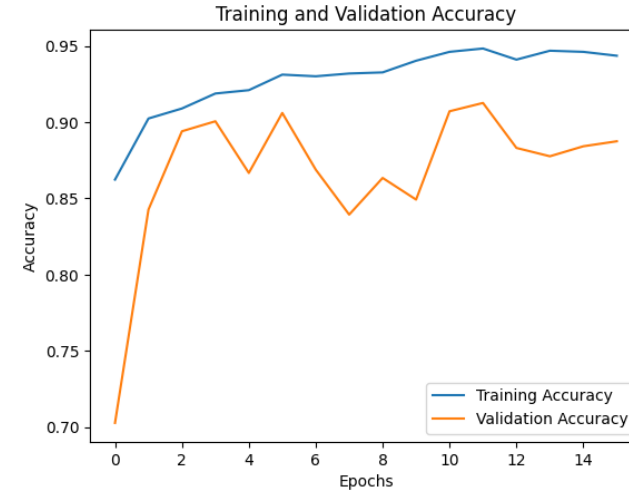
- Total parameters: 21,305,475
- Adam optimizer
- Learning rate 1e-5
- Early stopping callback with number of patience equal to 10

Model: ResNet-34 - Results



Train accuracy: 0.93
Train loss: 0.21
Validation accuracy: 0.875
Validation loss: 0.362

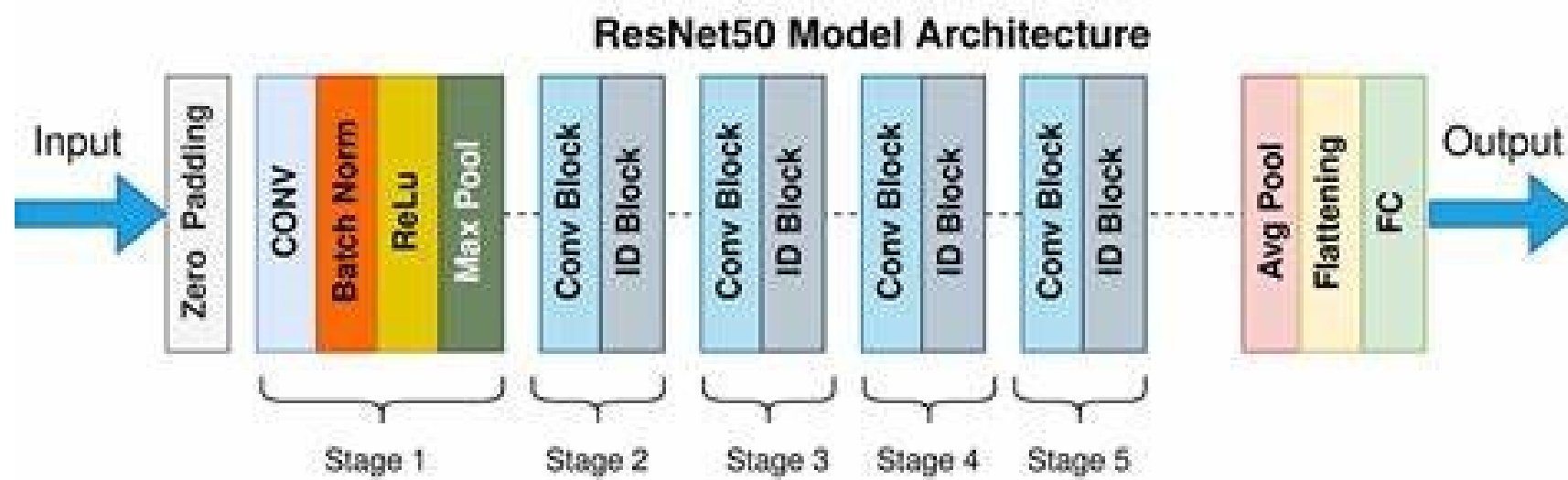
Results for resized dataset



Train accuracy: 0.904
Train loss: 0.255
Validation accuracy: 0.906
Validation loss: 0.311

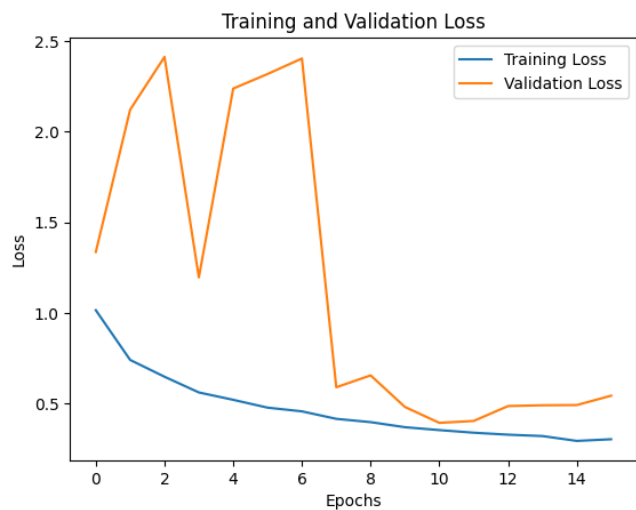
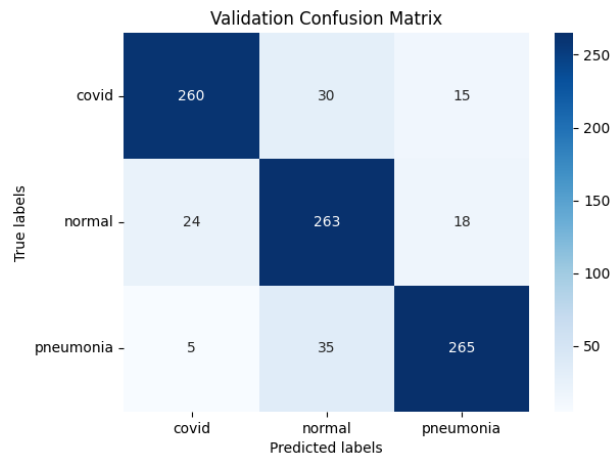
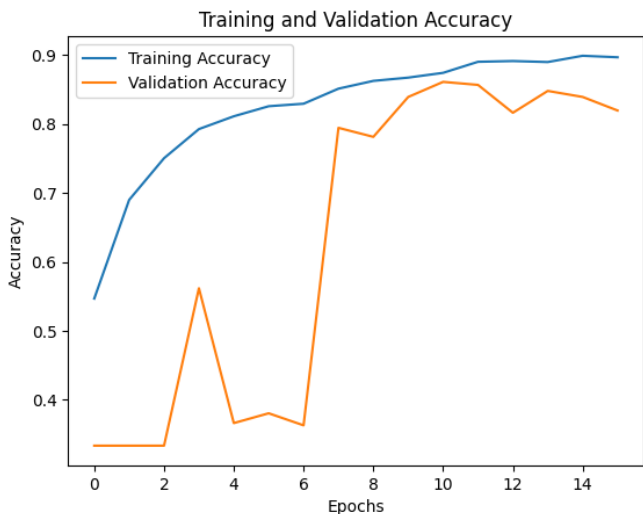
Results for padded dataset

Model: ResNet-50 - Architecture



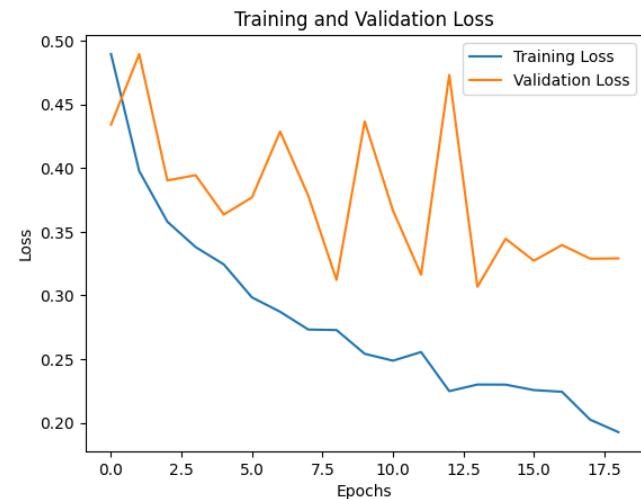
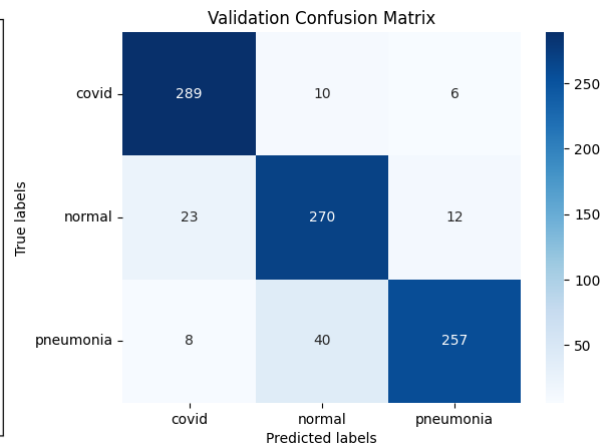
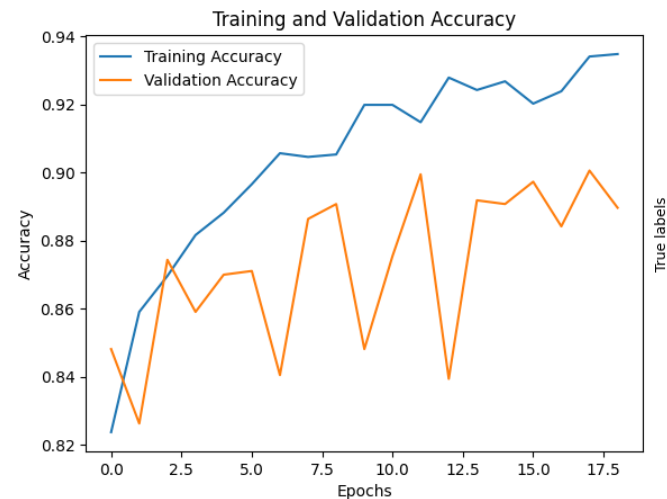
- Total parameters: 23,587,587
- Adam optimizer
- Learning rate $1e-5$
- Early stopping callback with number of patience equal to 10

Model: ResNet-50 - Results



Train accuracy: 0.881
Train loss: 0.338
Validation accuracy: 0.861
Validation loss: 0.394

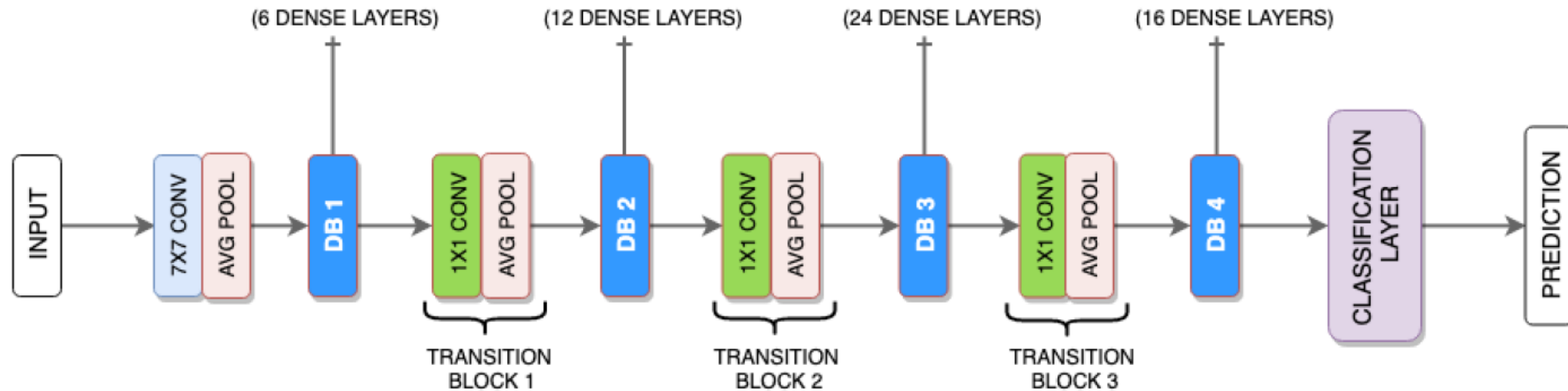
Results for resized dataset



Train accuracy: 0.922
Train loss: 0.23
Validation accuracy: 0.891
Validation loss: 0.306

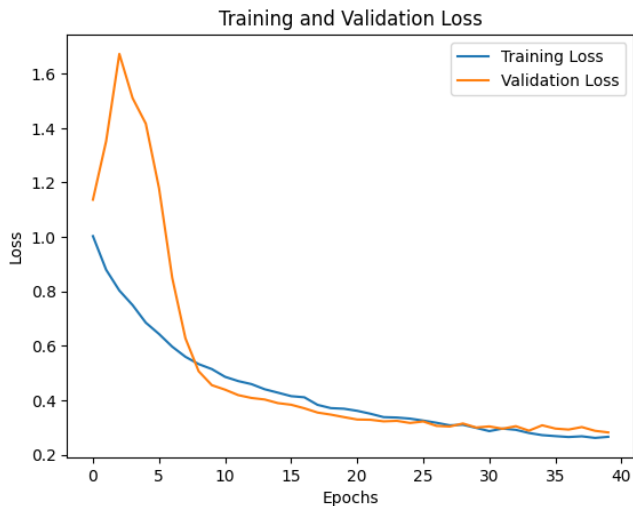
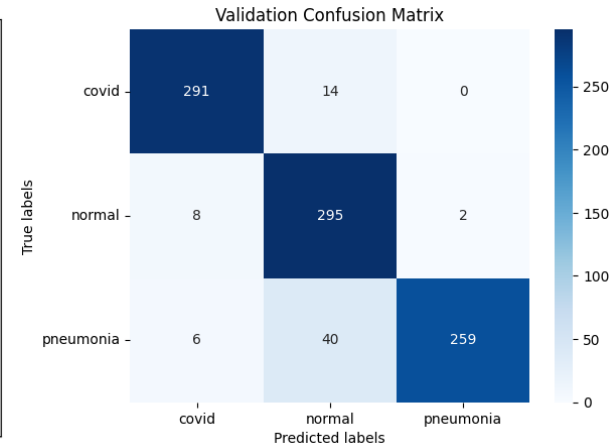
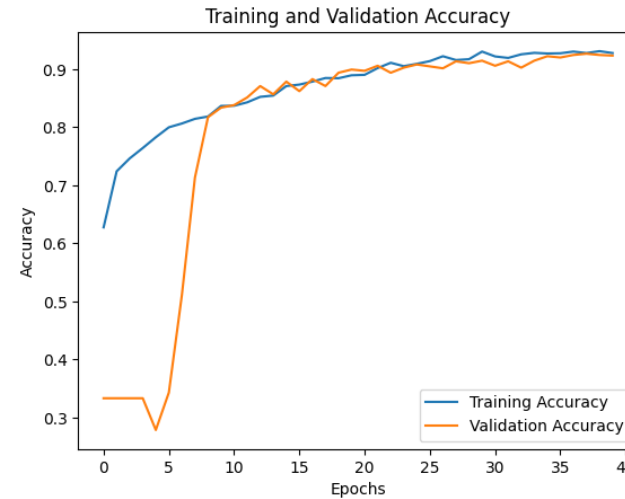
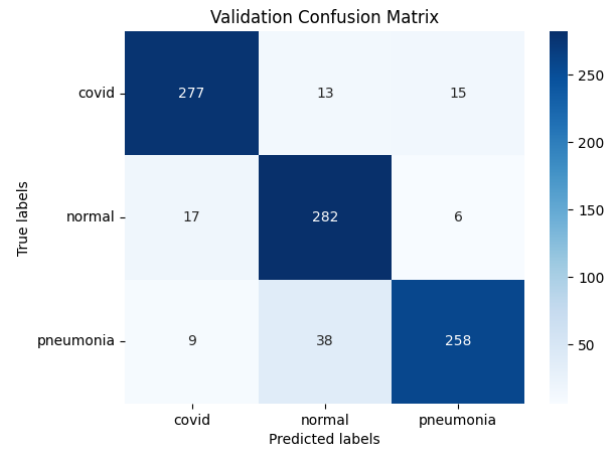
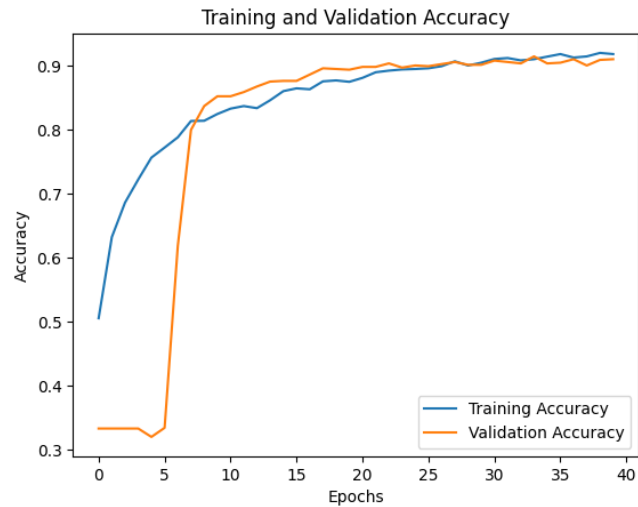
Results for padded dataset

Model: DenseNet-121 - Architecture



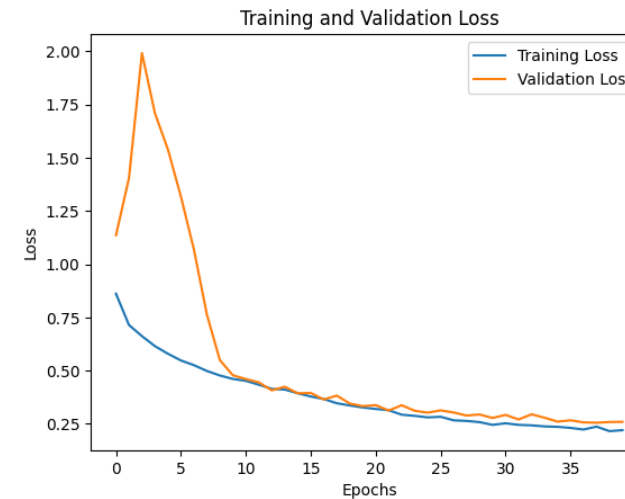
- Total parameters: 37,410,243
- Adam optimizer
- Learning rate $1e-6$
- Early stopping callback with number of patience equal to 10

Model: DenseNet-121 - Results



Train accuracy: 0.931
Train loss: 0.223
Validation accuracy: 0.91
Validation loss: 0.281

Results for resized dataset



Train accuracy: 0.945
Train loss: 0.179
Validation accuracy: 0.923
Validation loss: 0.258

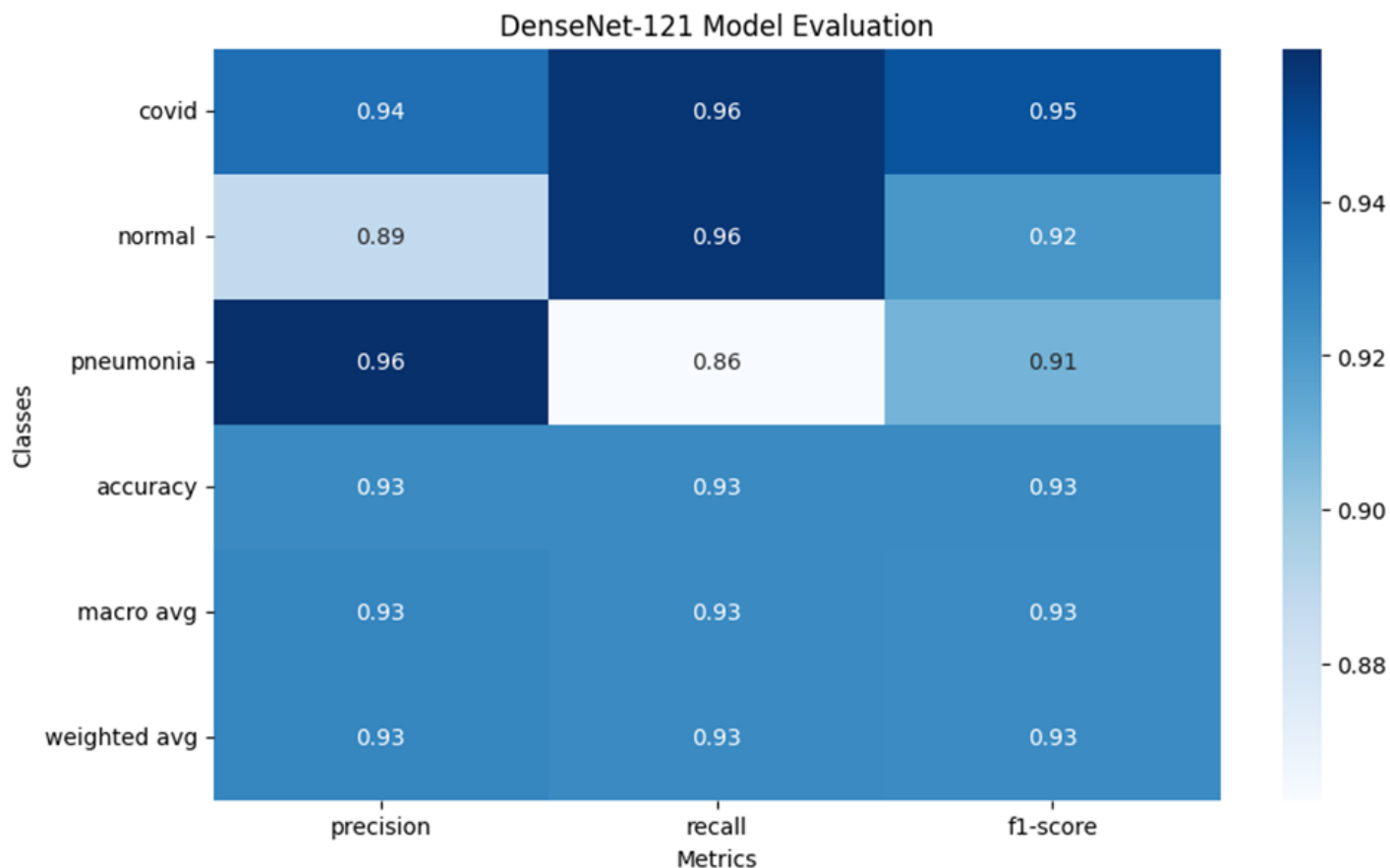
Results for padded dataset

Model Comparision

Architecture and Data	Train Accuracy	Train Loss	Validation Accuracy	Validation Loss	Training Time	Size (MB)	Epochs to Train
Custom CNN resized	0.938	0.186	0.893	0.34	1109.13	42.46	15
Custom CNN padded	0.943	0.166	0.898	0.3	426.2	42.46	7
CNN with Attention resized	0.939	0.188	0.901	0.289	924.05	9.98	15
CNN with Attention padded	0.961	0.117	0.918	0.249	913.16	9.98	15
ReSnet-34 resized	0.93	0.21	0.875	0.362	2121.52	81.27	30
Resnet-34 padded	0.904	0.255	0.906	0.311	1137.41	81.27	16
ResNet-50 resized	0.881	0.338	0.861	0.394	1526.04	89.98	16
ResNet-50 padded	0.922	0.23	0.891	0.306	1483.49	89.98	19
DenseNet-121 resized	0.931	0.223	0.91	0.281	4290.28	142.71	40
DenseNet-121 padded	0.945	0.179	0.923	0.258	4305.44	142.71	40

Optimal Model Testing

DenseNet-121 model trained on padded data emerged as the superior choice based on validation accuracy and loss metrics and was selected for final testing.



- Accuracy of 93% on test set
- Precision
- Recall
- F1-score