Title:
Enhancing Respiratory Disorder Diagnosis Through Deep Learning Analysis of Chest X-ray Images: A Heuristic-Based Approach for COVID-19, Viral Pneumonia, and Normal Cases.

Topic Outline

- Introduction
- Literature Review
- Challenges
- Thesis Objectives
- Methodology
- Datasets Details
- Tools
- Background Study
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Introduction

- Chest X-ray image classification is a deep learning-driven diagnostic technique designed to automatically analyze radiographic images, categorizing them into distinct classes.[1]

- it is possible to use X-rays to screen for COVID-19 without the dedicated test kits and separate those who are infected and those who are not. [2]

- X-rays aid in the detection of viral pneumonia by revealing distinctive pulmonary abnormalities.[3]

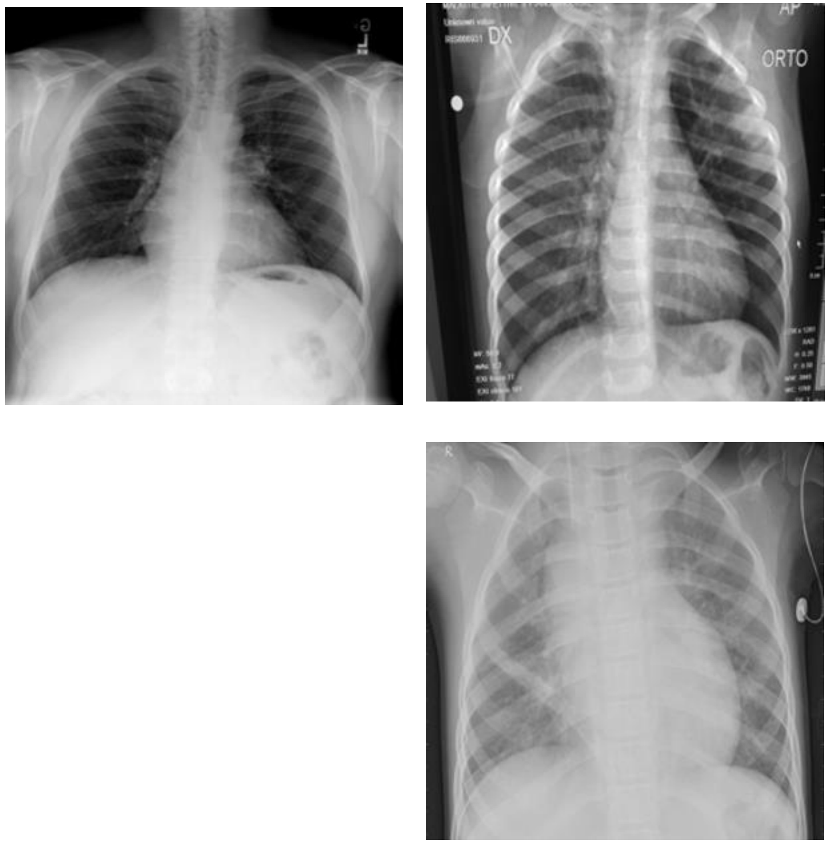


Figure 1 : X-ray Images: Normal, Covid-19, Viral Pneumonia. [4]

Literature Review

Paper Name	Year	Used Method , Result & Limitation
A Deep Learning Approach for COVID-19 & Viral Pneumonia Screening with X-ray Images [2]	2021	**Method:** Used deep learning model CNN to classify among Normal , COVID-19 and Viral Pneumonia. **Result:** Accuracy was around 90.64% . **Limitation:** Shortage of COVID-19 X-rays used
Pneumonia Classification Using Deep Learning from Chest X-ray Images During COVID-19 [3]	2020	**Method:** Used a transfer learning model from a pretrained model of AlexNet. **Result:** Accuracy was around 94.43% . **Limitation:** small dataset of COVID-19, pneumonia .

Literature Review

Paper Name	Year	Used Method , Result & Limitation
Chest X-ray Classifcation Using Deep Learning for Automated COVID-19 Screening[5]	2021	**Method:** Used a deep learning model for COVID-19 screening from chest X-rays, employing VGG-16, DenseNet-161, and ResNet-18 to classify normal, pneumonia, tuberculosis, and COVID-19 cases. **Result:** Accuracy is around 96-98% . **Limitation:** limited number of labeled data points
COVID-19 and Pneumonia Diagnosis in X-Ray Images Using Convolutional Neural Networks [10]	2021	**Method:** Used deep learning model CNN to classify among Normal , COVID-19 and Pneumonia. **Result:** Accuracy is around 98.2% . **Limitation:** Can be maximized by tuning the model hyperparameters.

Challenges

- ❑Model Selection
- ❑Handling Class Imbalance
- ❑Performance Improvement

Thesis Objective

The main objective is to predict among Normal ,COVID-19 and Viral Pneumonia from Chest X-ray with Custom CNN Model and Different Pretrained Models with transfer learning. Also try increasing the performance of the model is a part of my work.

Background Study

- **Convolutional Neural Network:**

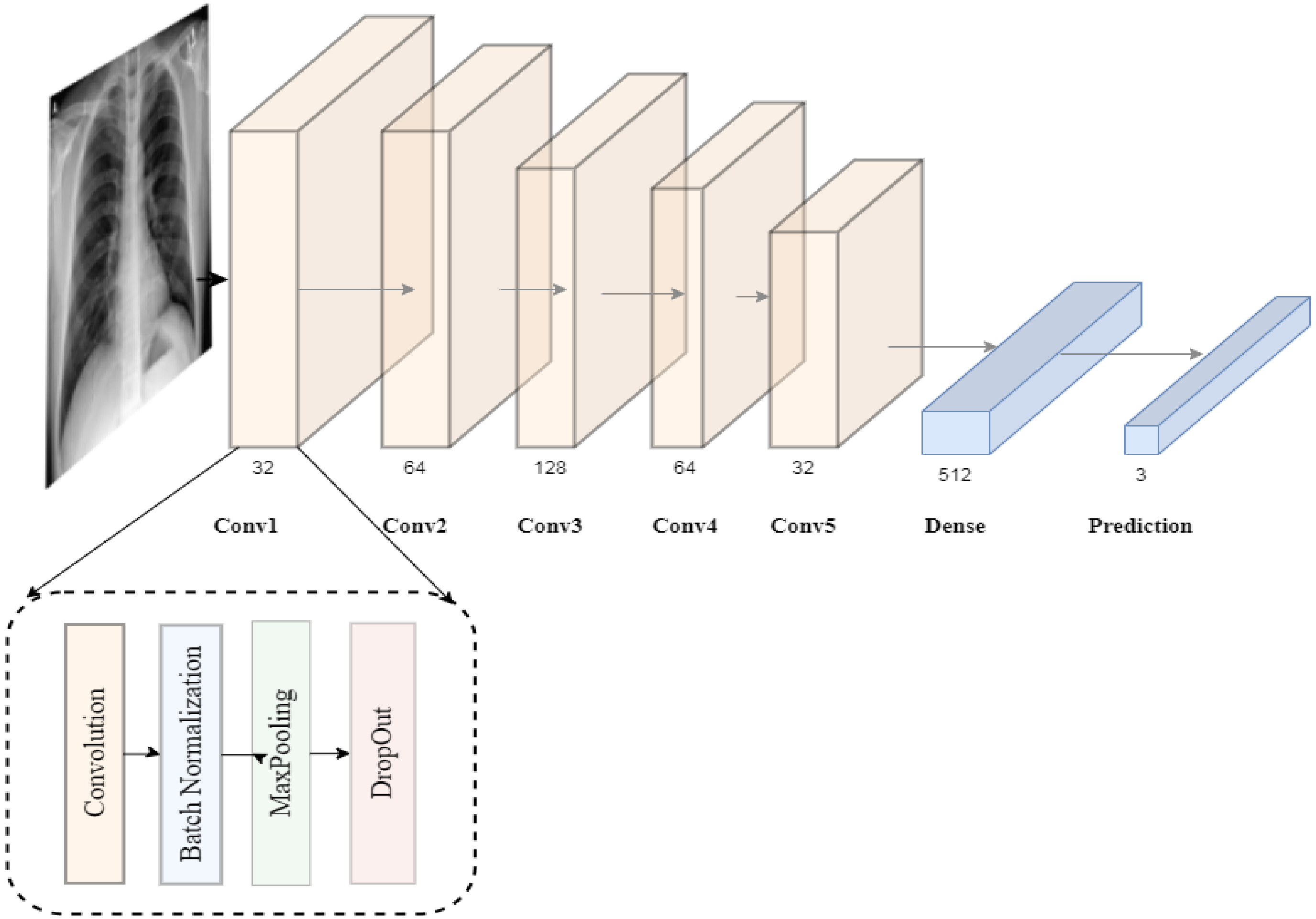


Fig 2 : Existing Convolutional Neural Network.[2]

Background Study

- **Transfer Learning:**

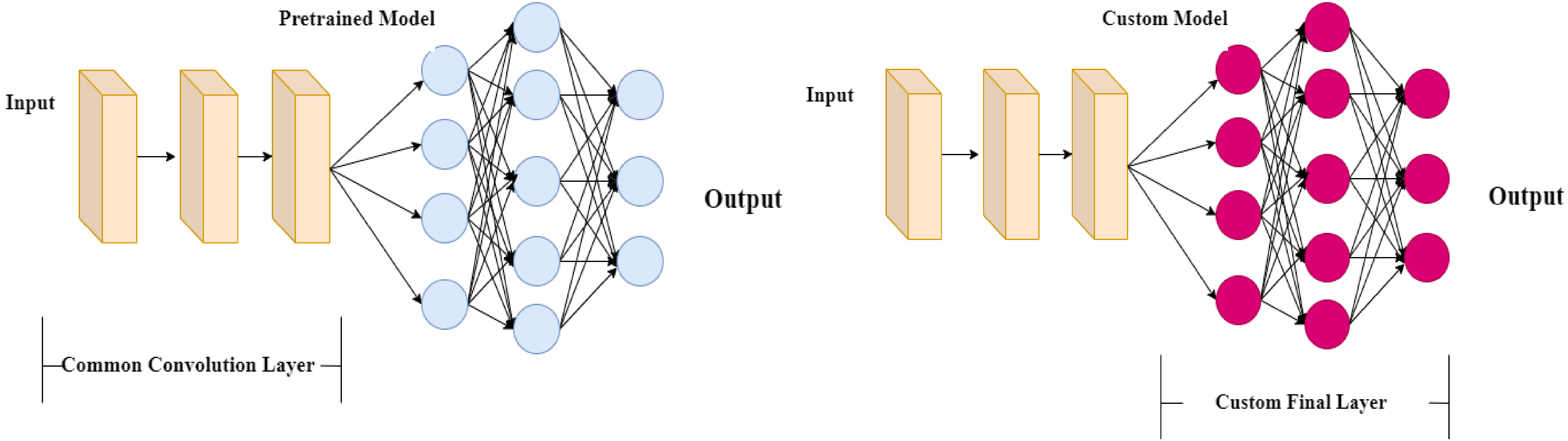


Fig 3: Method of working of Transfer Learning.

Background Study

- **Different Pretrained Models for Image Classification :**

Model	Details
DenseNet121	• Prameter: 8.1M • Size : 33 MB • Top-1 Accuracy:75.0% • Top-5 Accuracy:92.3%
DenseNet169	• Prameter: 14.3M • Size : 57 MB • Top-1 Accuracy:76.2% • Top-5 Accuracy:93.2%
VGG16	• Prameter: 138.4M • Size : 528 MB • Top-1 Accuracy:71.3% • Top-5 Accuracy:90.1%
VGG19	• Prameter: 143.7M • Size : 549 MB • Top-1 Accuracy:71.3% • Top-5 Accuracy:90.0%
ResNet-50	• Prameter: 25.6M • Size : 98 MB • Top-1 Accuracy:74.9% • Top-5 Accuracy:92.1%
ResNet-152	• Prameter: 60.4M • 16 Layers • Size : 232 MB • Top-1 Accuracy:76.6% • Top-5 Accuracy:93.1%

Fig 4: Pretained Model : DensNet121,DenseNet169,VGG16,VGG19, ,ResNet50,ResNet152 .[9]

Dataset Details

Feature	Description
Dataset Name	COVID-19 Radiography Database
Source	Kaggle
Total Images	15153
Classes	COVID-19, Normal, Viral Pneumonia
Image Size	299 × 299
Image Type	.png
Imbalance	Normal: 10192, COVID-19: 3616, Viral Pneumonia: 1345, Lung Opacity: 6012

Table 1: COVID-19 Radiography Database Dataset overview. Collected data from Kaggle.[4]

Feature	Description
Dataset Name	Chest X-Ray Images (Pneumonia)
Source	Kaggle
Total Images	5863
Classes	Normal, Pneumonia,
Image Size	944 × 640
Image Type	.jpeg
Imbalance	Normal:1583, Pneumonia: 4273

Table 2: Chest X-Ray Images (Pneumonia) Dataset overview. Collected data from Kaggle.[11]

Dataset Details

Feature	Description
Dataset Name	COVID-19 Patients Lungs X Ray Images
Source	Kaggle
Total Images	100
Classes	COVID-19, Normal
Image Size	1024 × 842
Image Type	.jpg
Imbalance	Normal: 28,COVID-19 :72

Table 3: COVID-19 Patients Lungs X Ray Images Dataset overview. Collected data from Kaggle.[12]

Methodology

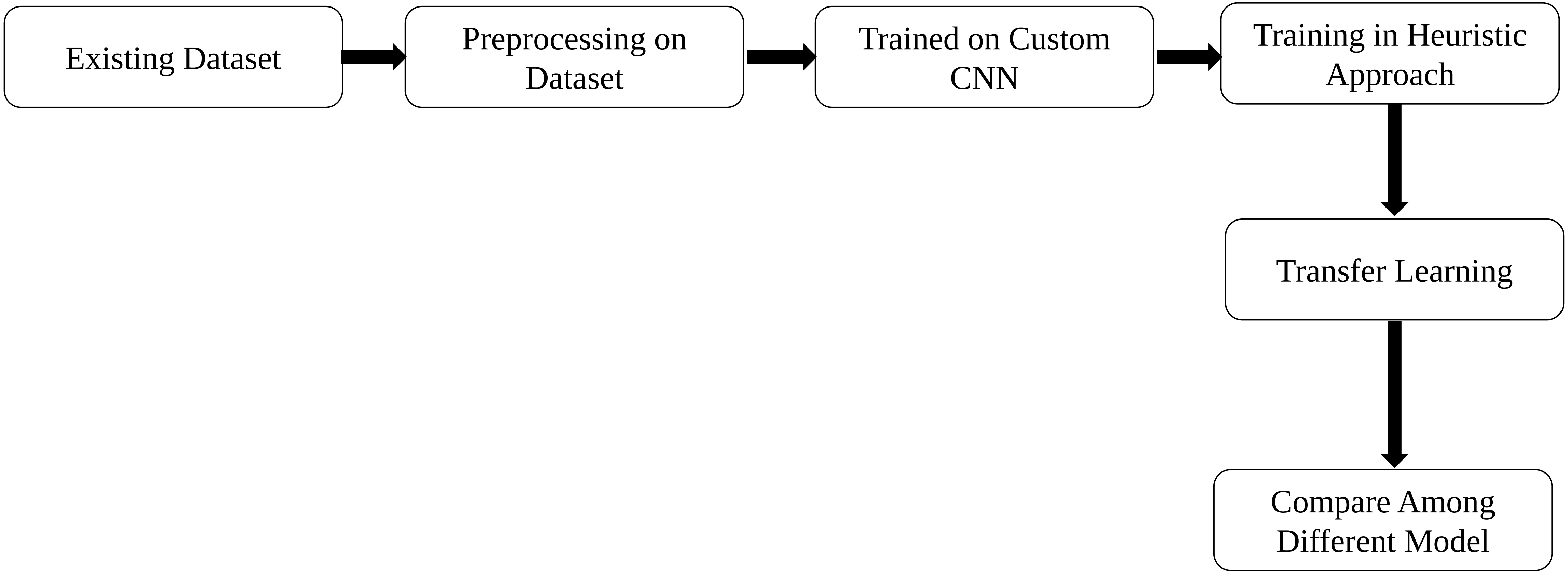


Figure 5 : Workflow

Methodology

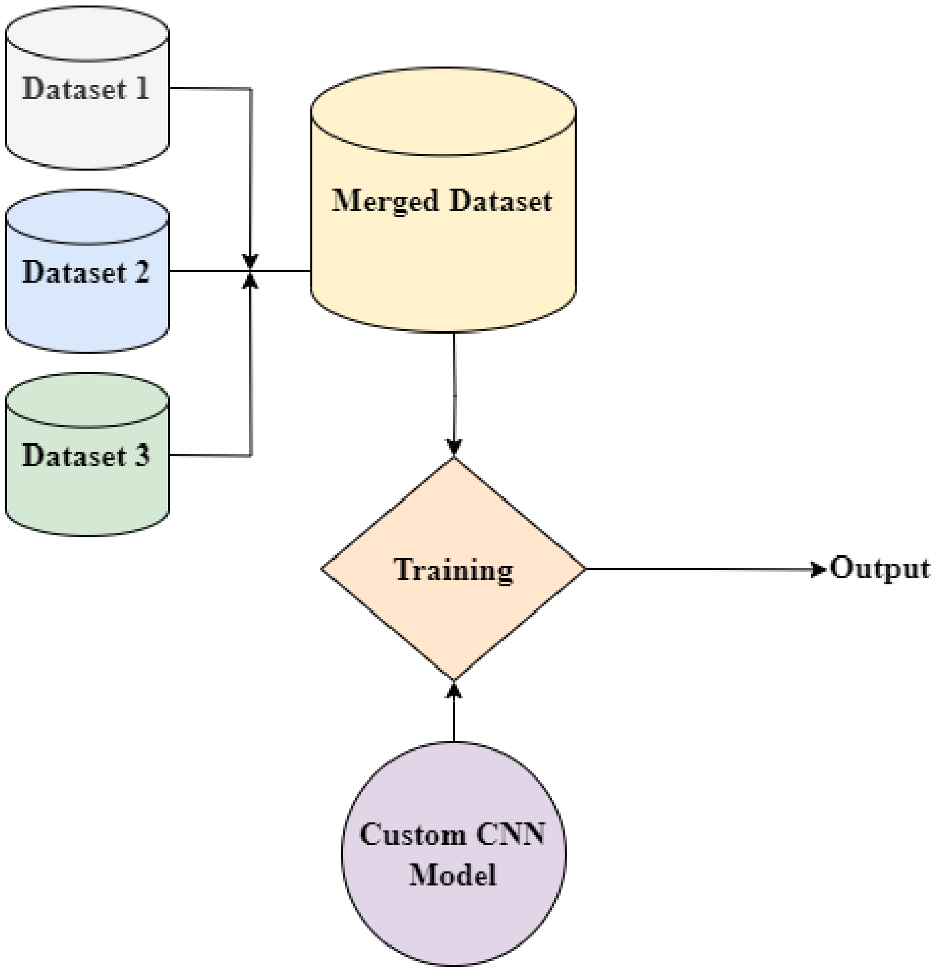


Figure 6 :Proposed Method 1

Methodology

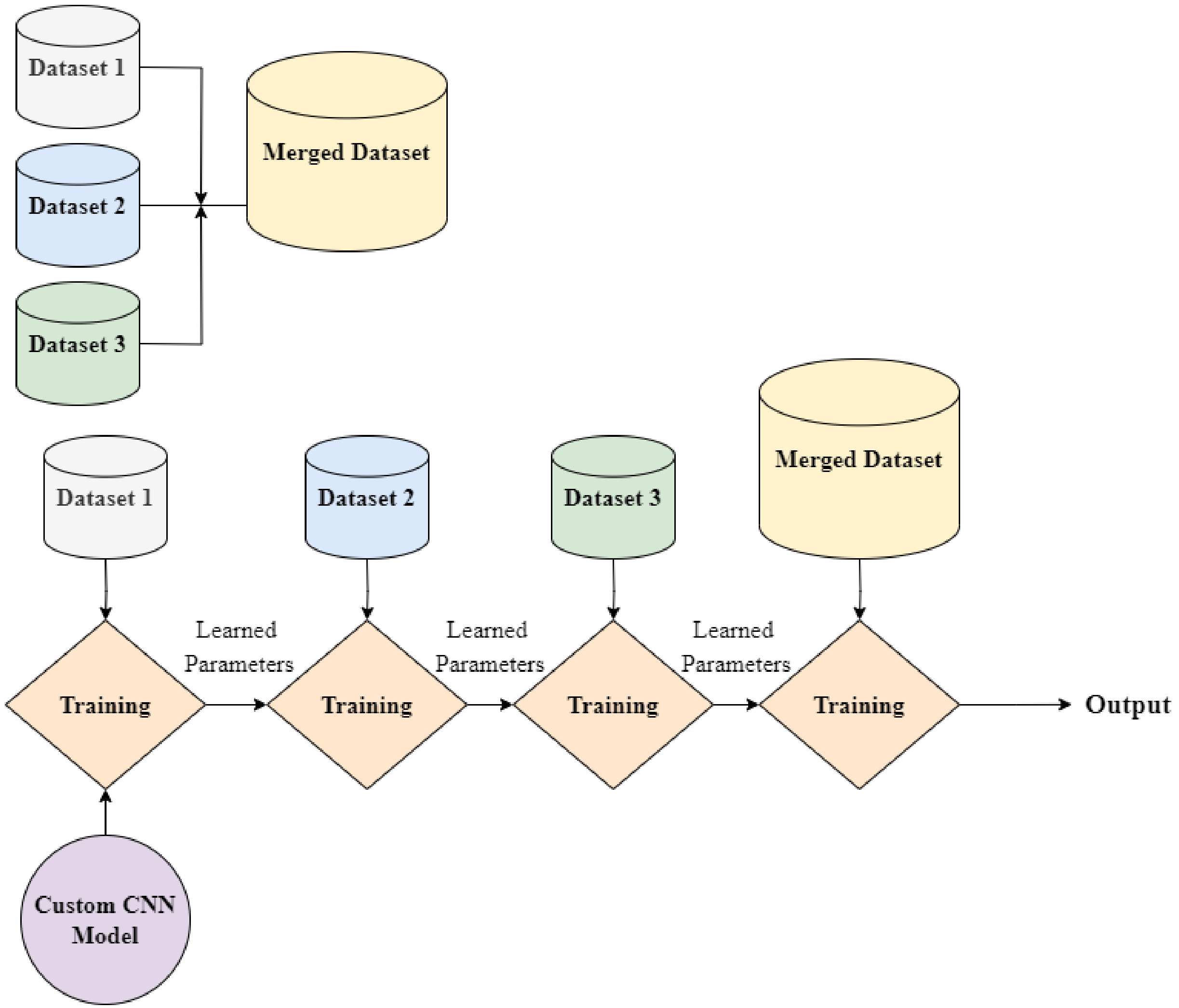


Figure 7 :Proposed Method 2

Tools

- **Software:**
  - Anaconda navigator to use Jupiter notebook .
  - VS Code
  - Also going to use Kaggle Notebook if necessary.

- **Language Support:**
  - Python

Figure 8: Required tools – Python , VS Code , Jupyter Notebook [6]

Dataset Preprocessing

- Balancing the Dataset by Oversampling.[13]
  - CLAHE(Contrast Limited Adaptive Histogram Equalization)
  - CLAHE + Median Filter
  - Contrast Straching + Median Filter
  - Histogram Equilization

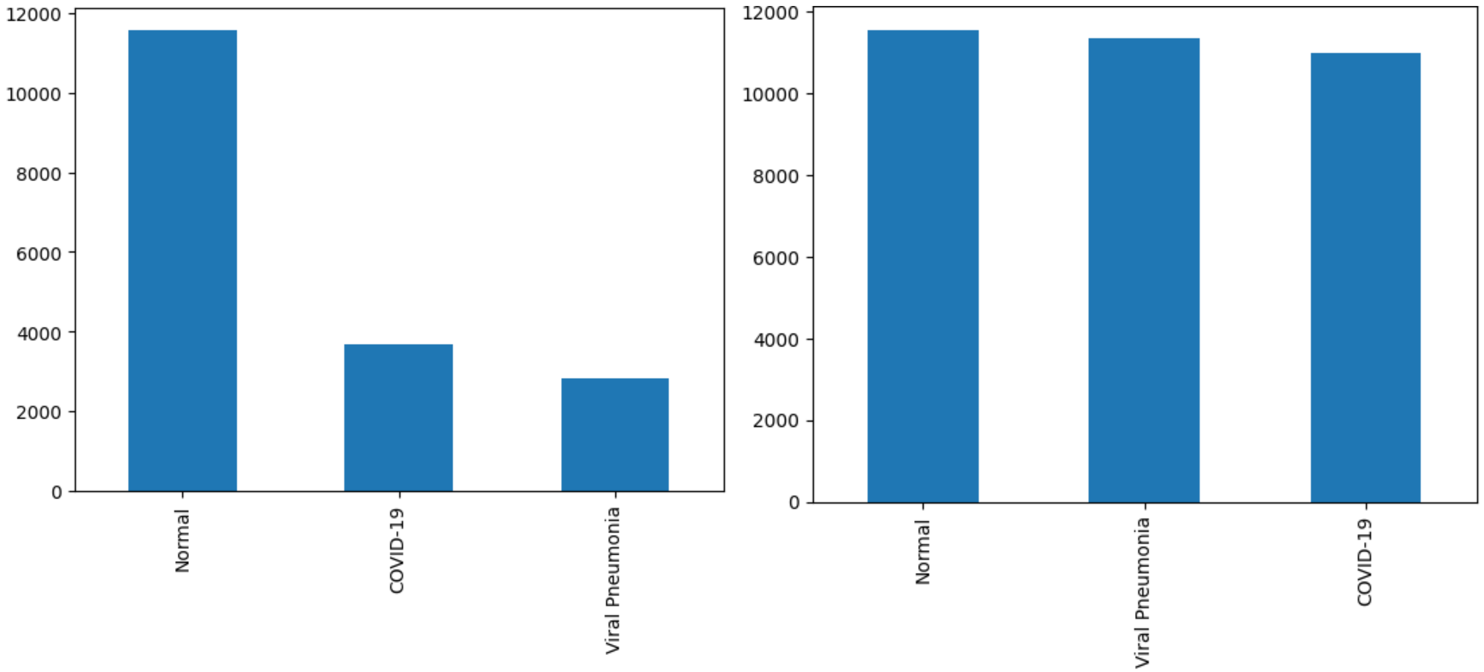


Fig 9 : Before and After of Oversampling

Implementation

CNN Model:

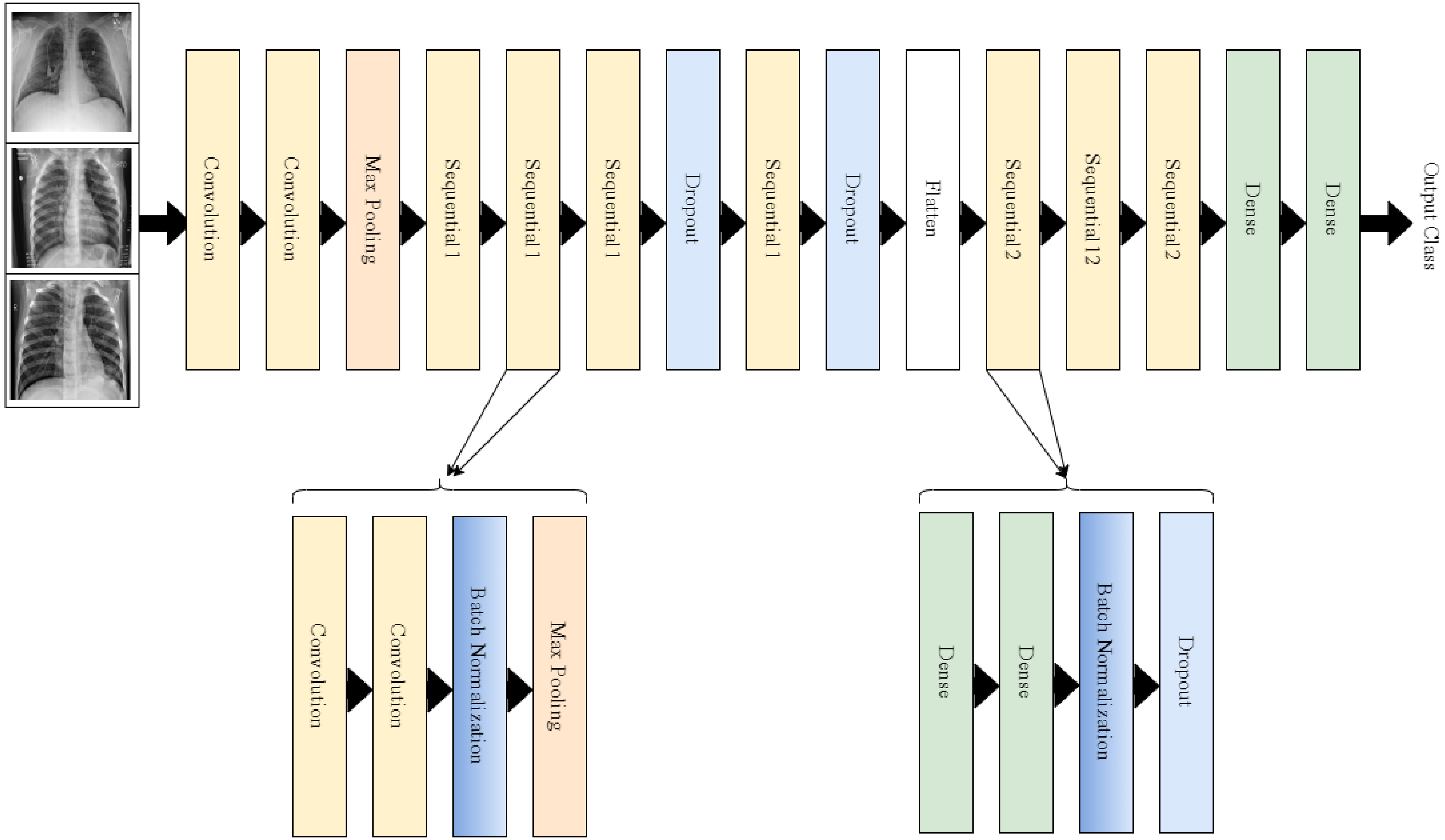


Fig. 10 : CNN Model from Similar Work [10]

Implementation(Continued)

Hyperparameters	Value
Learning Rate	0.001
Batch Size	16
Optimizer	Adam
Loss Function	Mean Square Error

Table 4: Model Hyperparameter

Implementation(Continued)

Loss Function of Previous work: Categorical Cross-Entropy:

$$-\frac{1}{N}\sum_{i} y_{true_i} * \log(p_i)$$

Current Loss Function : Mean Square Error:

$$\frac{1}{N}\sum_{i}^{N}(y_{true_i} - y_{pred_i})^2$$

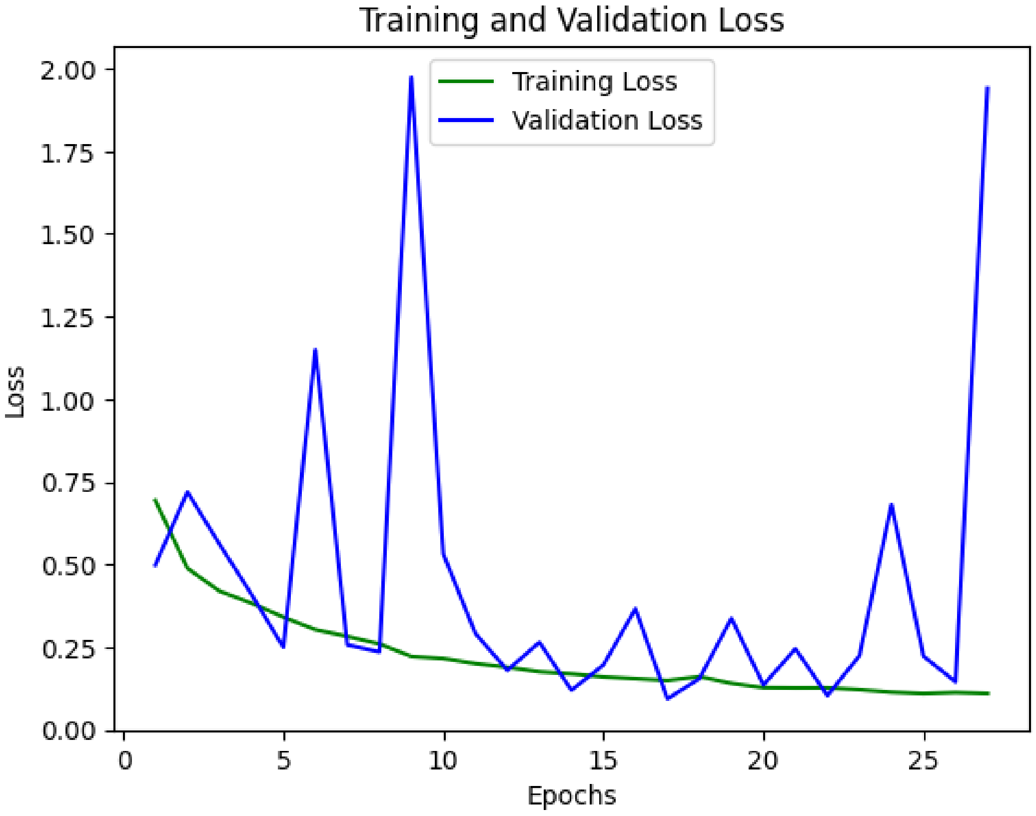


Fig 11 :Training and Validation loss using Categorical Cross-Entropy

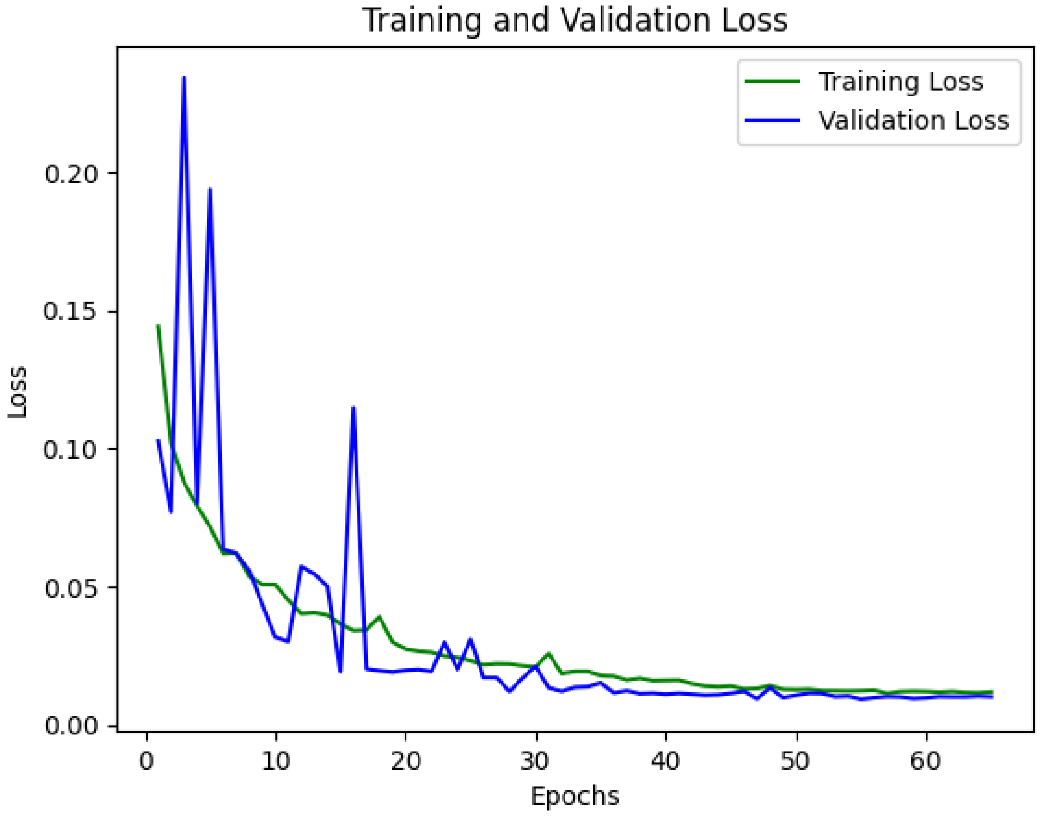


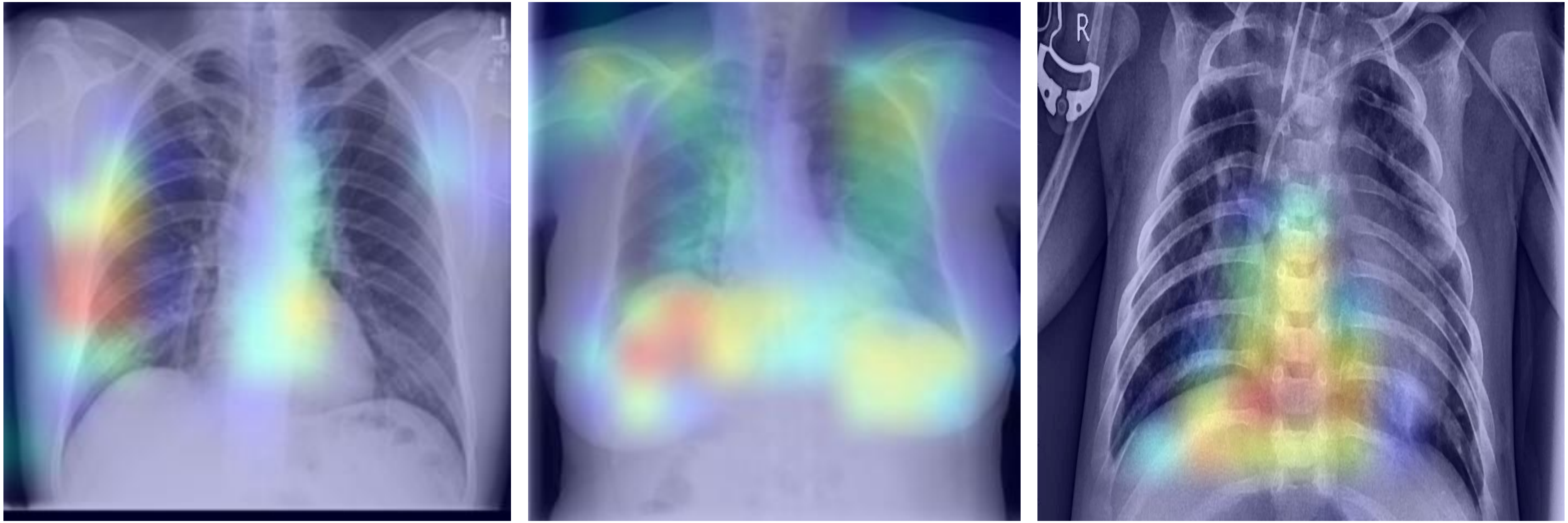
Fig 12 : Training and Validation loss using Mean Square Error.

Result & Analysis (Continued)

Method	Model Accuracy	Normal Accuracy	Covid Accuracy	Pneumonia Accuracy	Precision	Recall	F1-Score
ResNet-50	77.62%	61.68%	93.17%	79.11%	0.8	0.78	0.78
ResNet-152	69.80%	24.05%	89.84%	96.42%	0.75	0.69	0.65
DenseNet-121	94.04%	97.59%	86.89%	97.20%	0.95	0.94	0.94
DenseNet-169	95.08%	95.02%	91.87%	98.16%	0.95	0.95	0.95
VGG-16	97.40%	98.45%	97.14%	96.59%	0.97	0.97	0.97
VGG-19	98.08%	98.02%	97.88%	98.34%	0.98	0.98	0.98
Model-1	98.11%	98.88%	97.69%	97.73%	0.98	0.98	0.98
Model-2	98.26%	98.63%	98.06%	98.08%	0.98	0.98	0.98

Table 5: Performance of Different Model

Result & Analysis



Normal　　COVID-19　　Viral Pneumonia

Fig. 13: Grad-Cam Output

Conclusion

- Heuristic approach was applied with a CNN model.
- Mean Square Error perform better.
- Per class accuracy increased.
- Transfer Learning was applied

Future Works

Future Works:

- Ensemble Learning can be implemented.
- Explore advanced synthetic data generation models (eg. GANs).

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Thank you !

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