IMPLEMENTATION OF CONVOLUTIONAL NEURAL NETWORK APPROACH FOR COVID-19 DISEASE DETECTION

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Abstract

Two CNNs

- **Binary classification**
  (Detects the presence)
- **Multiclass classification**
  (COVID-19 vs pneumonia vs normal cases)

Accuracy

- **Model 1 (binary)**
  98.92% accuracy
- **Model 2 (Multiclass)**
  98.27% accuracy

Highlights

- Most extensive clinical dataset (4,575 images)
- Hyperparameter Optimized with Grid Search
- No manual Extraction of Diseased Areas

Introduction

COVID 19 OVERVIEW

- Identified in December 2019, Wuhan, China
- Highly contagious, global health crisis
- Typical diagnosis: swabs (time consuming, sampling errors)

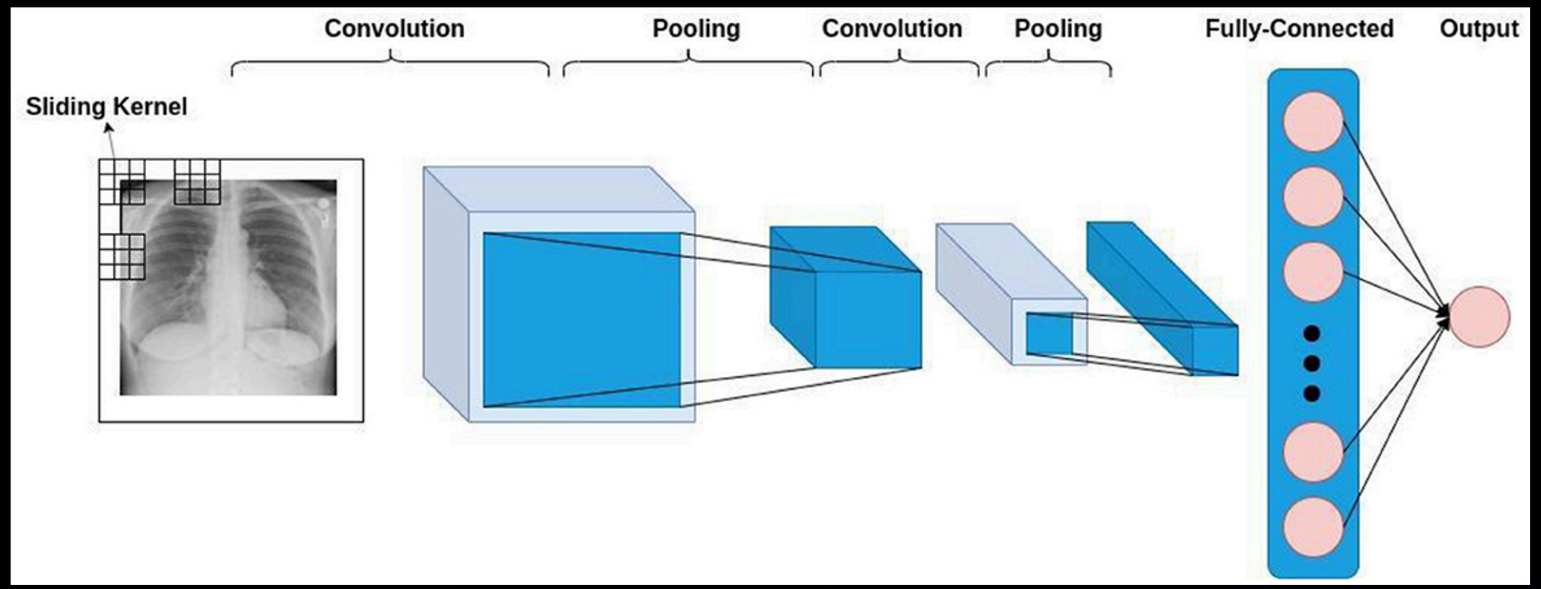
NEED FOR INNOVATION

- Computer-Assisted Diagnostic systems enhance diagnostic speed and accuracy
- Chest X-rays present potential for early detection of COVID-19

OBJECTIVE OF STUDY

- To leverage Convolutional Neural Networks (CNNs) for efficient and automated diagnosis using X-ray images

CNN Layers



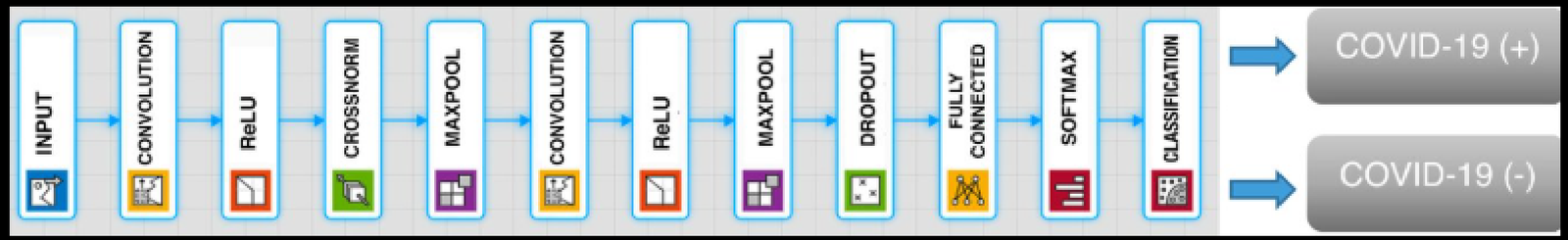
- Input Image (e.g., resized chest X-ray)
- Convolutional Layers: extract features like edges or shapes
- ReLU Activation: introduce non-linearity
- Pooling Layers: reduce dimensionality and focus on important features
- Fully Connected Layer: process these features for final classification

Methodology

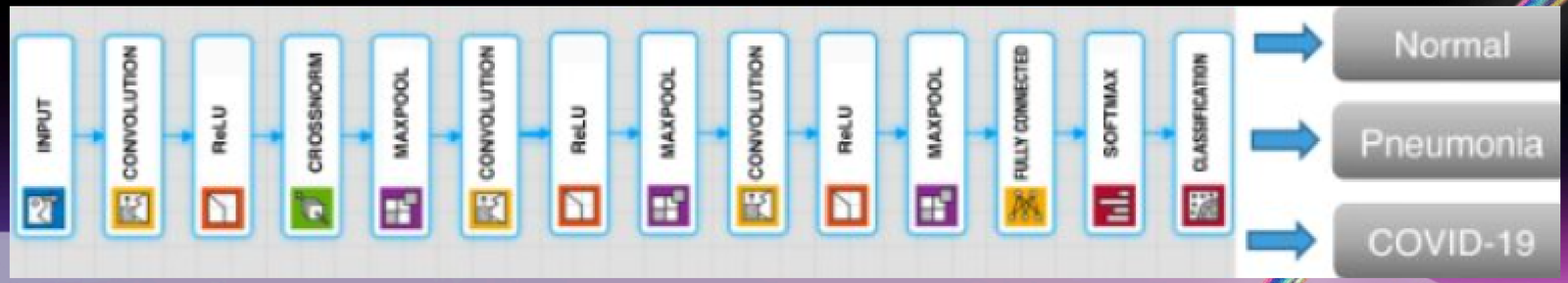
Dataset used: 4,575 chest X-ray images:
-1,524 COVID-19 images
-1,527 pneumonia images
-1,524 normal images

Two CNN architectures designed for:

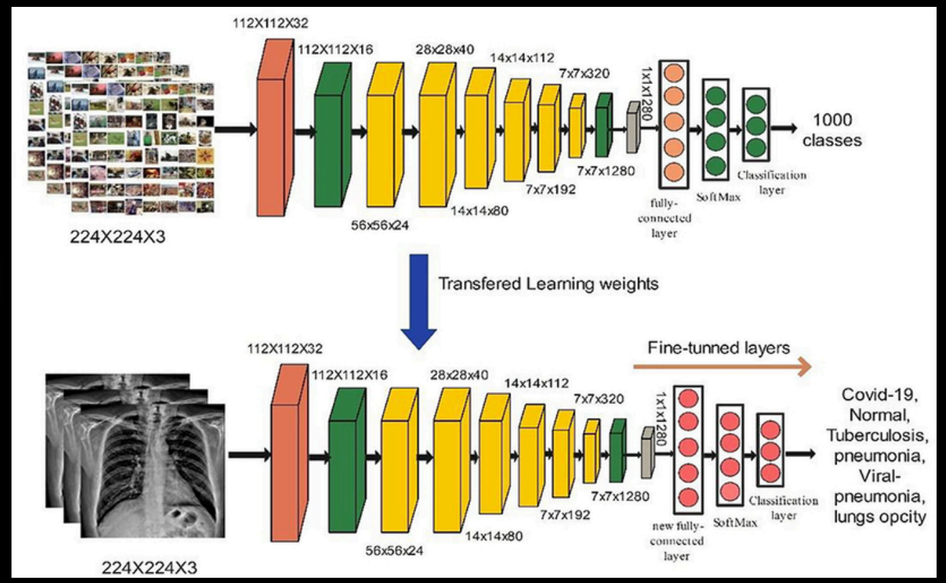
- Task 1: Binary Classification (positive vs. negative) with 12 weighted layers

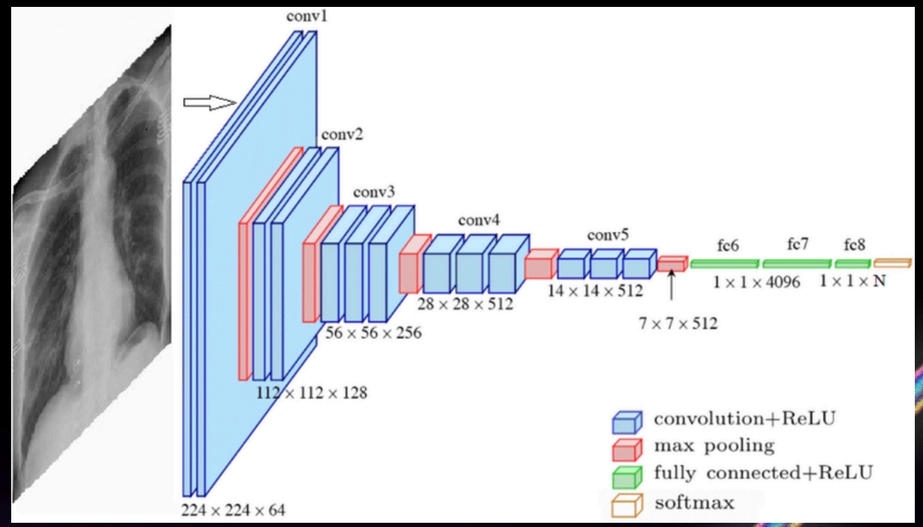


- Task 2: Multiclass classification (Normal, Pneumonia, COVID-19) with 14 weighted layers



Grid Search


112X112X32
112X112X16
28x28x40
14x14x112
7x7x320
1x1x1280
1000 classes
224X224X3
56x56x24
14x14x80
7x7x192
7x7x1280
fully-connected layer
SoftMax
Classification layer
Transfered Learning weights
Fine-tunned layers
Covid-19, Normal, Tuberculosis, pneumonia, Viral-pneumonia, lungs opcity
new fully-connected layer


conv1
conv2
conv3
conv4
conv5
fc6
fc7
fc8
224 × 224 × 64
112 × 112 × 128
56 × 56 × 256
28 × 28 × 512
14 × 14 × 512
7 × 7 × 512
1 × 1 × 4096
1 × 1 × N
convolution+ReLU
max pooling
fully connected+ReLU
softmax

Technical Approach & Experimental Setup

Task 1
Binary Classification

- Input 227x227 pixel images
- 12 Layers: Convolutional layers, ReLU, Max-Pooling, Fully Connected layer, Softmax
- Hyperparameters optimized using Grid Search

Task 2
Multiclass Classsification

- Input 227x227 pixel images
- 14 Layers: Convolutional layers, ReLU, Max-Pooling, Fully Connected layer, Softmax
- Grid Search for hyperparameter tuning

Optimizer: Stochastic Gradient Descent with Momentum (SGDM)- helps the model maintain stability during training, avoiding oscillations in the optimization process

Result and Performances

TASK 1: (BINARY CLASSIFICATION)

Accuracy: 98.92%
Area Under Curve (AUC): 0.9957.

TASK 2: (MULTICLASS CLASSIFICATION)

Accuracy: 98.27%
Demostrated effectiveness for large clinical dataset

THE STUDY OUTPERFORMED EXISTING STATE-OF-THE-ART METHODS

Togacar et al.: 99.27% accuracy (small dataset).
Ozturk et al.: 87.02% for multiclass classification.

This study utilized the largest dataset and achieved state-of-the-art performance.

Conclusion

Two novel CNN models successfully detect and classify COVID-19 from chest X-rays.

High accuracy and robustness achieved for binary and multiclass tasks. Providing a rapid, accurate alternative to traditional methods.

Demonstrates potential for broader medical imaging applications.

Future Ideas

Enhancing Dataset Diversity

e.g., Broader datasets incorporating varying disease severities.

Resource-Efficient AIModels

Optimize models for resource-limited environments (e.g., mobile devices).

Fostering Clinical Trust

Improve model interpretability for clinical trust

Expanding Application Scope

Extend methodology to other diseases (e.g., tuberculosis, lung cancer).

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