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Prediction of COVID-19 Severity by Applying Machine and Deep Learning Techniques

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Abstract: This paper aims to help doctors predict how serious a COVID-19 patient's condition might become using chest X-ray images and Artificial Intelligence (AI). By analyzing these images with advance deep learning and machine learning techniques, the system can identify patients at high risk early on, allowing doctors to act quickly and prioritize treatment. Key features are selected using smart methods like Principal Component Analysis (PCA), and models such as Bagging, AdaBoost, KNN, and LP Boost have shown excellent performance with up to 97% accuracy. This approach helps hospitals manage resources better and provide timely care to the patients who need it most. Proposed method outperforms the state of art techniques of Covid-19 severity prediction.

Keywords: machine learning, Covid-19 severity deep learning, PCA (Principal Component Analysis).

I. INTRODUCTION

The coronavirus disease (COVID-19) has been a major health crisis in the world, impacting millions of lives and collapsing the health care system in numerous countries. Its effects are considered to be mild respiratory symptoms to severe and devastating effects that include acute respiratory distress syndrome, organ failure, and even death. It is imperative to identify the patients that will develop severe symptoms early to ensure that medical resources are used effectively and in time. Fast and accurate tools to forecast the course of the disease can assist physicians in sorting out patients, setting priorities, and decreasing the hospital load.

The recent progress in ML and AI demonstrated encouraging performance in healthcare outcomes prediction and medical diagnosis. The deep learning models have been used in chest X-ray and CT images to identify COVID-19 infections and predict severity. As an example, Sayed et al. [1] trained an AI model on chest X-rays and hybrid feature selection methods (PCA + RFE) to achieve high accuracies in predicting COVID-19 severity. Equally, Alotaibi et al. [2] have shown how machine learning algorithms such as Artificial Neural Networks and Random Forests could assist in determining the severity of infection using clinical and laboratory data to facilitate early decision-making where resources are scarce.

It has also been found that the combination of different forms of patient data enhances prediction. Demographic, clinical, and lab features were utilized by Xiong et al. [3] to construct models with a high predictive accuracy, especially on Random Forest algorithms. Chieregato et al. [4] developed a deep learning and machine learning hybrid model that incorporated the 3D features of CT scans with clinical data in order to predict patients at risk of ICU admission or death. Not only did their model make accurate predictions, but it also gave insight into the critical risk factors via SHAP-based interpretability.

Also, pre-trained convolutional neural networks (CNNs) including AlexNet, DenseNet, and ResNet have been used in feature extraction, which has enhanced COVID-19 detection and severity classification. Aswathy et al. [5] proposed a two-stage framework in which COVID-19 infection was detected in the first stage by analyzing images and with the help of an Artificial Neural Network, and the severity was predicted on the second stage based on a combination of image and clinical features using Cubic SVM. Their method had high accuracy and was able to help attend to high-risk patients early.

In this article, we present a combined machine learning model that can forecast the severity of the COVID-19 illness based on both CT image attributes and clinical information of the patient. Our models based on deep learning are used to automatically extract features of images and classification approaches are used to assign a patient to one of the

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following groups: high, moderate, or low risk. We evaluate our method on publicly available datasets and it demonstrates high accuracy in detecting critical cases, which can aid doctors to make rapid and informed clinical decisions.

II. LITERATURE SURVEY

Researchers have trained an AI-based model to assist doctors in treating COVID-19 patients by estimating the severity of a patient condition based on the chest X-ray images of the patient. This prediction early in life assists in saving lives as well as hospital resources since it enables treatment to be offered much faster. The model applies a combination of both deep and machine learning. It takes the characteristics of a pre-trained model (CheXNet) and some of the significant image features through intelligent filtering techniques (PCA and RFE). XGBoost and SVM produced the best results of all the algorithms tested, with an accuracy of up to 99% in certain instances. During pandemic situations this system can significantly assist the doctors in making quicker and better decisions. [1]

This is because identifying early on the severity that a COVID-19 case could develop is an important way of saving lives, particularly in nations with minimal medical resources and a smaller number of specialists. The present work demonstrates that machine learning methods, such as Artificial Neural Networks, Support Vector Machines, and Random Forests may be used to predict the state of the patient depending on his/her medical history and laboratory tests. These risk assessment tools can help doctors to predict high-risk patients in advance and enable them to deliver timely care, which can increase survival rates and ensure the more efficient utilization of healthcare resources. [2]

The COVID-19 continues to spread worldwide, and machine learning has already demonstrated good results in assisting physicians in diagnosing the disease and estimating how severe the condition of a particular patient may get. In this research, the authors used the patients data in JinYinTan Hospital to test the hypothesis that computer models could effectively predict the severity of COVID-19 at the time of first admission. Various machine learning algorithms-RF, SVM, and LR were applied to information including age, lab tests, and chest scans. Approximately one-third of 287 patients showed severe symptoms. The Random Forest method allowed predicting who would fall ill seriously better than other tested models. Chest CT scans, neutrophil-to-lymphocyte ratio, and concentrations of some proteins in the blood such as lactate dehydrogenase and D-dimer were the most significant severity indicators. In general, the research indicates that machine learning, particularly the Random Forest model, may serve as an effective instrument to assist physicians in identifying high-risk patients within a short period of time and deliver timely treatment. [3]

The new coronavirus may provoke quite diverse effects on individuals: some have mild illnesses, others severe diseases that endanger lives. In this research, the scholars developed an AI model to assist physicians in identifying patients who may require intensive care or have a greater likelihood of death. They analyzed the cases of 558 patients who were hospitalized in the beginning of 2020 in the north of Italy. The model makes predictions by studying 3D CT scan images, as well as laboratory results and clinical data. It employs high-level methodology to select health features most significant and attained high accuracy during testing. This system does not only provide the risk score, but it also tells the doctors why the system predicted that based on specific patient factors. [4]

The COVID-19 has influenced individuals worldwide and led to severe complications concerning the lungs, resulting in the inability to breathe easily. As the virus primarily affects the lungs, it is difficult to distinguish it among other lung-related illnesses and to get an idea of a case severity. The researchers in this paper came up with a two-step approach to first identify COVID-19 in lung CT scans and subsequently determine the severity of the infection. The images are analyzed with the help of the system based on advanced and pre-trained computer models and an Artificial Neural Network (ANN) is utilized to verify the presence of COVID-19 in a person. Provided that the infection is detected, the system next applies another model (Cubic SVM) to integrate the features of the images with the medical data to characterize the illness as High, Moderate, or Low severity. This can assist physicians to concentrate within a short time on high risk patients. The algorithm was applied to publicly available data and demonstrated high accuracy 92 and 90 percent in identifying COVID-19 and severity levels, respectively

This paper underscores the extent to which COVID-19 has impacted the health and the society globally, and the critical importance of getting the right tools to forecast the same, given that new variants are emerging. It is devoted to the ways deep learning and AI may enhance the diagnosis, disease severity prediction, and treatment based on the analysis of X-rays, CT scans, lab tests, and patient records data. These solutions assist in surmounting the slow conventional tests such as RT-PCR and facilitate quicker and more intelligent decision-making. The paper also provides an overview of the current research, identifies challenges and future directions, such as employing various types of data, enhancing

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explainability of models and accelerating processing. In general, it can provide valuable information to those researchers who deal with COVID-19 prediction. [6]

III. PROPOSED METHOD

In this project, both ML and DL models will be used to predict the level of severity of COVID-19 infection based on chest X-ray images. The output of the system is expected to be four-fold where input images are classified as Normal, COVID, Cold, and Pneumonia. In order to do so, the methodology consists of pre-processing of the image data, dimensionality reduction, and training of various algorithms to compare the results.

3.1 Preparation of Image Dataset

The images of Chest X-rays are gathered and separated into four folders that correspond to the classes. The images are tagged according to the folder name.

3.2 Preprocessing of images

The Python libraries are used to read the images, after which they are normalized (scaled pixel values) and shuffled to make the training random. This is then accompanied by the viewing of a processed image sample to verify.

3.3 PCA Feature Selection

Principal Component Analysis (PCA) is utilized in order to diminish the computation and enhance the performance of the model. The method only picks the most significant characteristics of each picture, assisting the models to learn quicker and more precisely.

3.4 Training and Evaluation of the models

The PCA features are used to train various machine learning algorithms, including KNN, Bagging Classifier, AdaBoost, and XGBoost. Furthermore, a CNN is learnt on the original images.

3.5 Interface: Severity Prediction

There is a user-friendly interface where a user can load an X-ray image of a test. It subsequently makes predictions and shows the level of severity according to the learned models, providing a convenient means of medical professionals to utilize the tool in real-time.

IV. RESULTS

In this project, we are comparing the results of various machine learning algorithms - such as AdaBoost, Bagging, XGBoost, K-Nearest Neighbors (KNN) and deep learning network known as CNN - to predict the severity of a COVID case. To train above algorithms we are using CHEST X-RAY images consists of different labels such as Normal, COVID, COLD and Pneumonia.

To boost algorithm accuracy we have applied PCA dimension reduction algorithm to select relevant and important features from images.

In above screen we have 4 different folders and each folder contains images of that particular disease and just go inside any folder to view images

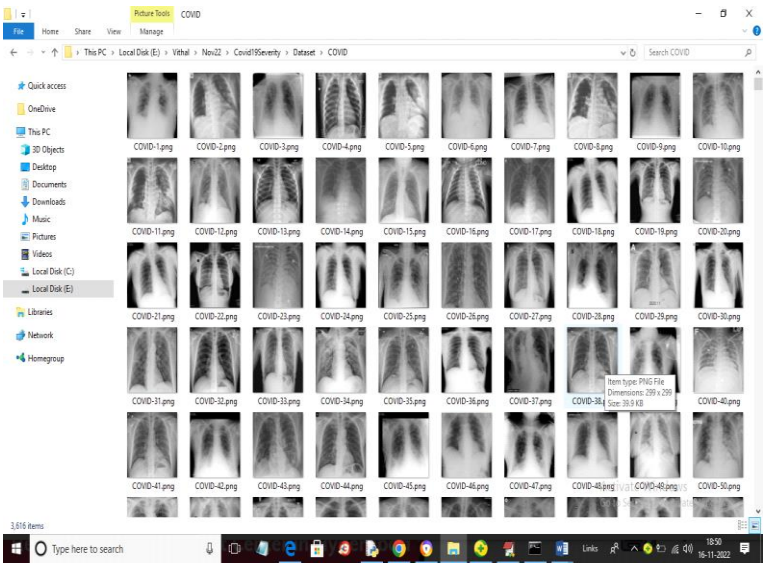

Fig.1 Images in dataset

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All the machine learning algorithms were written and executed in Jupyter Notebook and you can find the code snippets and their output screenshots below.,

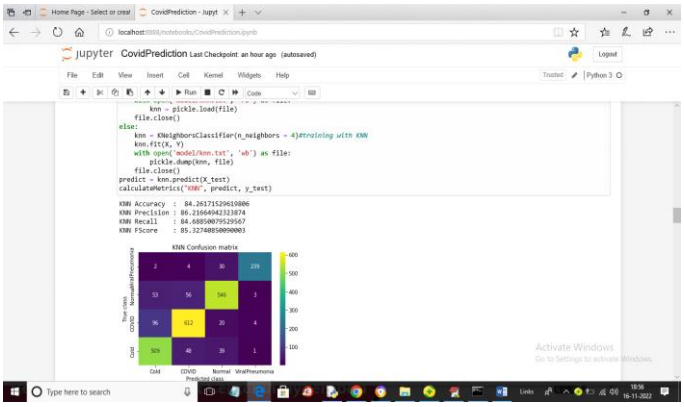

Fig.2 Confusion matrix of KNN classifier

In the above screen, we are training KNN algorithm and we are getting its accuracy as 84 percent and in the confusion matrix graph,

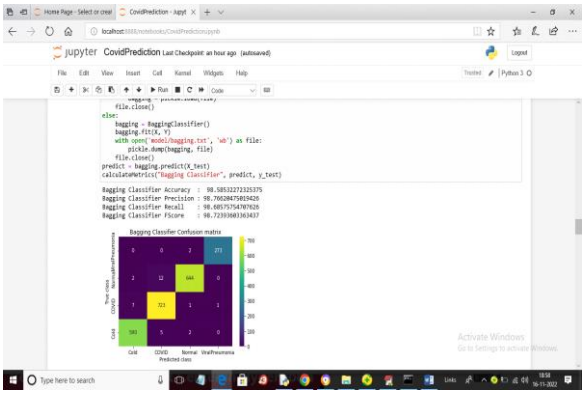

Fig.3 Confusion matrix of Bagging Classifier

In above screen we are training Bagging Classifier and we got its accuracy as 98.58% and you can see confusion graph also

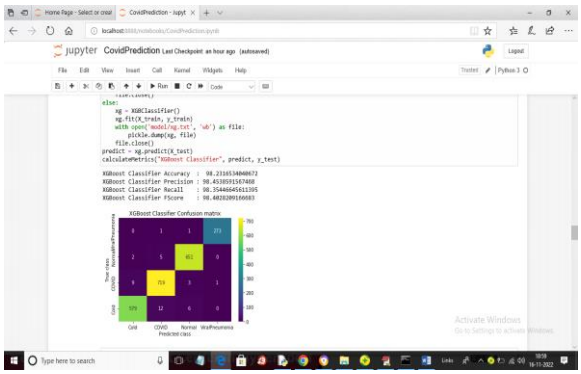

Fig.4 Confusion matrix of XGBOOST

In above screen we are training XGBOOST and we got its accuracy as 98.23% and we can see confusion matrix graph also

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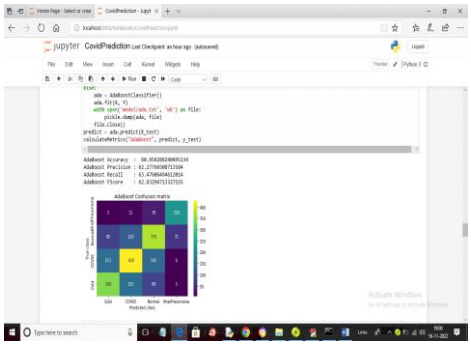

Fig.5 Performance of ADABOOST

In above screen we are training with ADABOOST and we got its accuracy as 60% and we can see its confusion matrix graph and its performance is not good

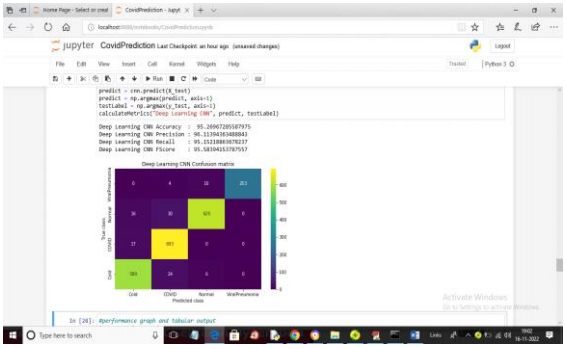

Fig.6 Performance of deep learning CNN

In above screen with CNN we got 95.26% accuracy and we can see its confusion matrix graph also

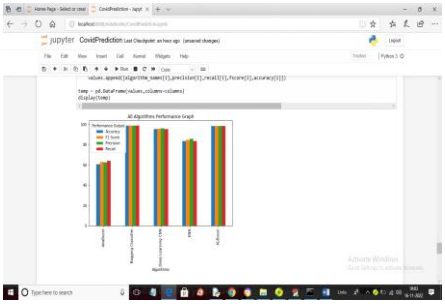

Fig.7 Graphical representation

In above graph we can see performance of each algorithm where x-axis represents algorithm different metrics such as accuracy, precision etc. In all algorithms CNN, Bagging Classifier and XGBOOST giving high performance

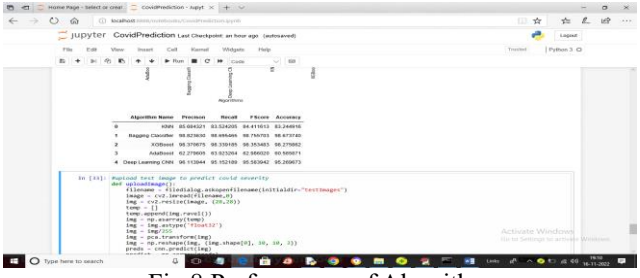

Fig.8 Performance of Algorithm

The table of the performance of every algorithm can be observed on the screen above. Finally, execute the last block of the code and obtain the following screen to upload an experimental image and forecast the grade of severity,

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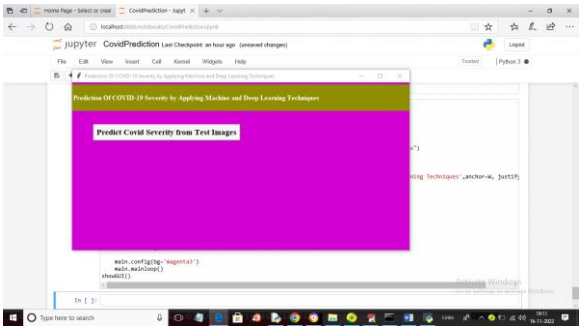

Fig.9 Prediction of Covid Severity

In the screen above, click on the 'Predict COVID Severity' button to upload a test image, as shown in the screen below,

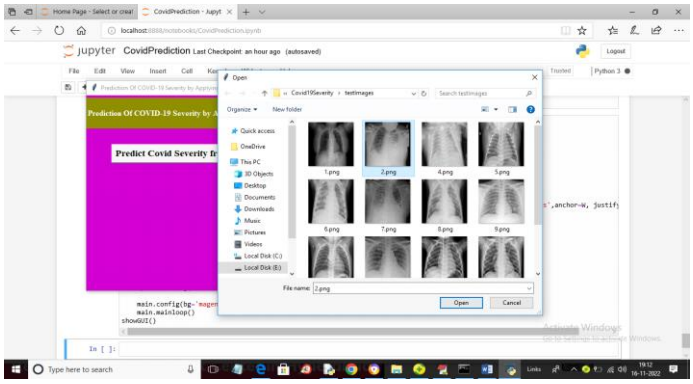

Fig.10 selecting and uploading 2.png

Upload another image

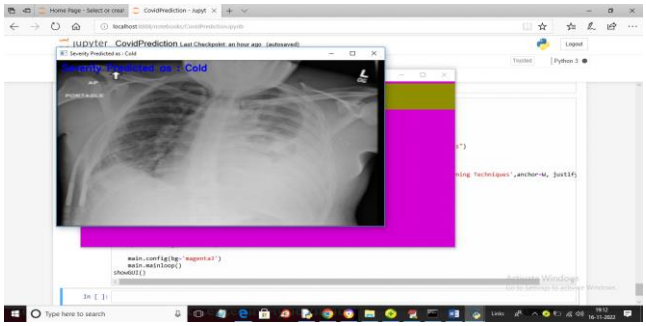

Fig.11 severity predicted as COLD

In the screen above, the severity has been predicted as COLD. Equally, you can upload and check other pictures. The outline of the results indicating the predicted severity of those images is shown below,

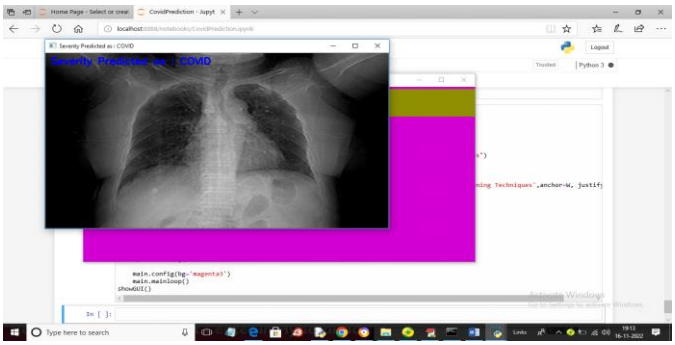

Fig12 COVID detected

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In above screen COVID detected

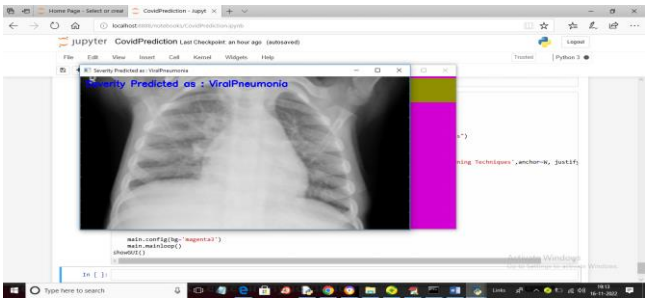

Fig13 pneumonia detected

In above screen pneumonia detected

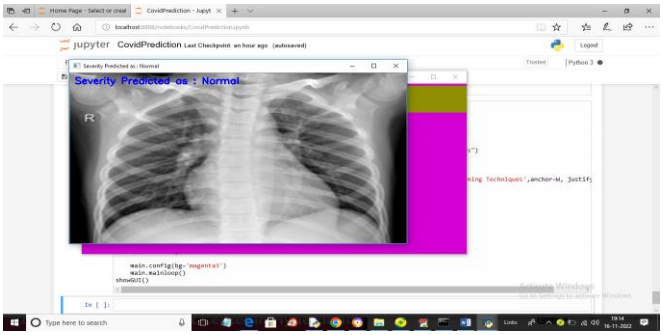

Fig14 Normal detected

In above screen Normal is predicted

V. CONCLUSION

In conclusion, this paper shows that using AI with chest X-ray images can help doctors quickly and accurately predict how serious a COVID-19 patient's condition might become. This can save lives by making sure that high-risk patients get treatment sooner, while also helping hospitals use their resources more efficiently. The models used in this system gave very high results, proving that AI can be a powerful support tool in healthcare.

In the future, this approach can be improved further by using larger and more diverse datasets from different hospitals and countries to make the system even more reliable. It can also be expanded to predict risks for other diseases, not just COVID-19. Adding real-time monitoring and combining other medical data (like blood tests or vital signs) with X-ray images could make the system even smarter and more helpful in saving lives.

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– Developed ML models (LR, Cox, SVM, RF) on 1,485patients; SVM achieved 98.45% accuracy (AUC 0.994). Key predictors included oxygenation index, age, respiratory rate (pmc.ncbi.nlm.nih.gov).

[8]. Obeidat et al. (2023), "Predicting the Severity of COVID 19 from Lung CT Images Using Novel Deep Learning." J. Med. Biol. Eng. (2023)

– Utilized ResNet 101 on 2,205 CT images; achieved 99.5% accuracy in multi class severity levels (researchgate.net).

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– Ensemble 3D models on STOIC dataset; ranked 4th in STOIC2021 COVID 19 AI Challenge (arxiv.org).

[10]. Li et al. (2025), "Predicting coronavirus disease 2019 severity using explainable machine learning." Scientific Reports (2025)

– Used explainable ML (reinforcement learning + logistic regression) on 3,301 patients; achieved AUC ~0.905 with four features (albumin, LDH, age, neutrophils) (nature.com).

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– Combined U Net lesion segmentation and k NN scoring of CT scans; infection severity MAE ≈0.505, comparable to radiologists (frontiersin.org).

[12]. Weisbrod et al. (2022), "An efficient deep learning model for COVID 19 severity estimation from Chest X Ray images (CoVSeverity Net)." Evolutions in Health Informatics (2022)

– CoVSeverity Net estimated severity levels (mild/moderate/severe) from CXR; achieved ~87–91% accuracy (link.springer.com).

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– Random Forest model on 1,795 admissions predicting 30 day mortality/mechanical ventilation; AUC 0.82, sensitivity 0.72, specificity 0.78 (bmcmedinformdecismak.biomedcentral.com).

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– Cascaded ED CNN and FPN-based methods for CT segmentation; severity classification achieved 98.3–100% sensitivity across categories (arxiv.org).

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– Developed 3D residual CNNs for volumetric CT data; improved upon 2D methods for severity scoring (arxiv.org).

