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A Comprehensive Exploration of Artificial Intelligence Methods for COVID-19 Diagnosis

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Abstract

INTRODUCTION: The 2019 COVID-19 pandemic outbreak triggered a previously unseen global health crisis demanding accurate diagnostic solutions. Artificial Intelligence has emerged as a promising technology for COVID-19 diagnosis, offering rapid and reliable analysis of medical data.

OBJECTIVES: This research paper presents a comprehensive review of various artificial intelligence methods applied for the diagnosis, aiming to assess their effectiveness in identifying cases, predicting disease progression and differentiating from other respiratory diseases.

METHODS: The study covers a wide range of artificial intelligence methods and with application in analysing diverse data sources like chest x-rays, CT scans, clinical records and genomic sequences. The paper also explores the challenges and limitations in implementing AI -based diagnostic tools, including data availability and ethical considerations.

CONCLUSION: Leveraging AI’s potential in healthcare can significantly enhance diagnostic efficiency crisis management as the pandemic evolves.

Keywords: Machine Learning, COVID-19, Disease Diagnosis, Artificial Intelligence

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1. Introduction

The 2019 emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection is blamed for the current epidemic, dubbed COVID-19. The number of victims of the virus is rising significantly. There have been 692,576,573 documented 231 nations, leading to an estimated 6,903,976 deaths as of August 3, 2023 [1]. Figure 1 shows the COVID-19 cases reported from 2020 to 2023.

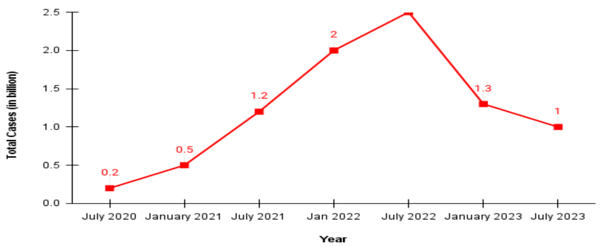

Figure 1: COVID-19 cases reported from 2020 to 2023

The COVID-19 outbreak has many consequences for global health and the lives of individuals in over 200 nations. The most important step towards gaining ground against setting up effective checking locations is forming afflicted patients. Primary diagnostics require identifying coronavirus DNA [2]. Various countries have implemented a variety of preventive and control measures, such as quarantining, closing and suspending transportation, dissuading gatherings of the public, and even conducting a range of public service activities and educational programs. Psychological manifestations like anxiety/stress, excessive shopping due to panic, apprehension and unease regarding participation in community events, as well as diminished personal control and worries about finances, employment stability, and related matters, have been noted within the populace due to the previously outlined measures. These measures have restricted access for students, employees, tourists, and others to their educational establishments, workplaces, and residences. If a child's home is not a secure place, then being there increases the likelihood that they will be a victim of, or witness to, child protection incidents or interpersonal violence. For fear of a possible pandemic, the government has initiated emergency measures and extended the travel ban due to the coronavirus.

Clinical symptoms, an appropriate epidemiological history, diagnostic confirmation with CT imaging, and pathogenic testing are required such that a COVID-19 diagnosis can be made. Pneumonia is brought on by COVID-19, Addition to other respiratory indicators such as elevated body temperature, coughing, difficulty breathing (dyspnea), and a sensation of breathlessness. However, these signs and symptoms are not specific, as there have been isolated cases where A chest CT scan and a virus pathogenicity test both showed pneumonia, as seen in a household with asymptomatic infection. Testing for the virus in lower respiratory samples, including bronchoalveolar lavage, tracheal aspirate, or sputum, also indicated its presence. is performed after a person is recognized as a person under investigation (PUI). The sequencing of viral nucleic acids and real-time RT-PCR form the basis of this laboratory technique. Several rate-limiting constraints, such as the presence and volume of testing kits within the impacted regions, have impacted efficiency of nucleic acid testing. In addition, the detection kits have iffy quality, stability, and repeatability [3]. Outsourced third-party storage at a cloud service provider is the norm for PHRs, which are patient-centric models for health information sharing. Patient privacy concerns [4] are at the forefront of the debate surrounding PHRs.

2. Search Strategy

For our analysis, we combed through reputable sources like IEEE Xplore, ScienceDirect, SpringerLink, ACM, ArXiv, and PubMed Central to find papers presented at Covid-19. In addition, a comprehensive search is conducted using Google Scholar. The articles are chosen based on the search terms "COVID-19," "Coronavirus," "Advanced Machine Learning Techniques," "Image Analysis," and "Identifying COVID-19 in medical images and/or patient symptoms through Machine Learning Methods". There were about 200 papers found using these keywords. We narrowed our search to 24 papers based on several factors, including content accessibility, data veracity, and access restrictions. The chosen works were published in 2020, 2021, 2022, and 2023.

The assessment of paper relevance hinged on the title, abstract, materials, and methods. Article inclusion was determined through a voting protocol by the current study's authors, who possess expertise in deep learning and machine learning techniques across diverse imaging modes. Papers of subpar quality and those from conferences were excluded. The initial database search yielded 200 articles. The article curation progressed through distinct phases adhering to exclusion-inclusion criteria. Of the 200 articles, the selection process commenced by eliminating duplicates, leading to the exclusion of 130 during the initial screening. Subsequently, English-language articles were evaluated based on their abstracts, occasionally including the introduction, in order to evaluate how well they fit the requirements for inclusion. Seventy items were included after the second round of vetting. During the third phase, 40 articles were excluded, as newer iterations of these publications had emerged, focusing on the same dataset and objectives. Twenty-four papers made it through all three phases of the inclusion/exclusion criteria set forth for this review. The ultimate compilation encompasses original research, review articles, and concise pieces such as perspectives, commentaries, and letters to the editor.

3. Artificial Intelligence

Since its inception in the 1950s when John McCarthy originated the phrase, AI emerged as significant topic technology. Using artificial intelligence (AI) has spread throughout many sectors in recent years. It's the brains behind everything from autonomous vehicles to AI personal assistants to weather predictions to surgical robots. ML, constituting fundamental element artificial intelligence, this process enables machine to learn from data autonomously, without the need for explicit programming. Multiple learning methods, including Transfer Learning, are included ML. [5]. Regression and Classification are two examples of supervised learning in which models make predictions using labelled training data. Models in this class include Linear Regression, Decision Trees, Logistic Regression, and many others. Predictions can be made by unsupervised learning models using data without labels. Cluster analysis and dimensionality reduction are a part of it. On the other hand, reinforcement learning is a strategy for teaching an agent to make decisions based on its experiences in the world. Value-based, policy-based, and model-based implementations are all viable options [6].

Deep Learning constitutes a specialised domain within the broader field of machine learning, wherein processes data using numerous layers of algorithms to simulate human thought or create abstractions. It is widely used for applications like automatic speech recognition and automatic object recognition. In most cases, a consistent method with an activation function is used for each layer. Feature extraction is another part of deep learning, and it is responsible for automatically creating useful data features for training, learning, and comprehending. It is common practice for data scientists or programmers to extract features [7]. Different algorithms are used in different deep learning models. While there is no ideal algorithm, knowing the most important ones will help you make better decisions. Data scientists can better serve their clients by selecting the most appropriate algorithm by understanding the benefits each provides. Figure 2 depicts various artificial intelligence algorithms.

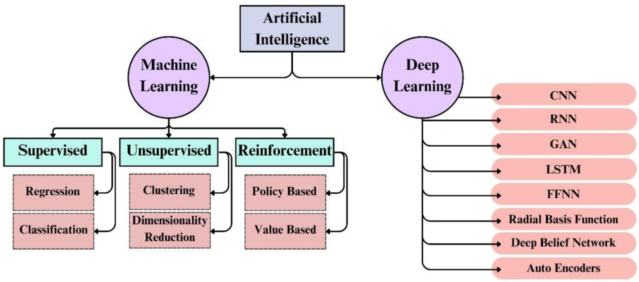

Figure 2: Artificial Intelligence (AI) Algorithms

Because of its contribution to early and accurate identification and subsequent fast medical action, the outbreak has been contained [8]. When you consider what IT constantly requires, namely the ability to scale up quickly in terms of capacity or add features on the fly without requiring the purchase of additional hardware, the hiring of additional staff, or the licensing of additional software [9] [38] cloud computing becomes clear.

4. Review and Analysis Discussion

Over 200 nations have been touched by COVID-19 pandemic, which shown between 2 to 20 million infections and at least 200,000 fatalities in just 4 months [10]. Biomedical picture segmentation and pneumonia identification from chest X-rays are only two examples of the growing number of medical uses for Deep Learning [11, 12]. Accuracy in predicting the wave was aided by research into a deep learning strategy based on the Political Squirrel Search Optimisation (PSSO) for detecting and categorizing lung cancer [13]. These ground-breaking studies show that preliminary diagnoses can be greatly aided and automated by Deep Learning given access to sufficient data, which is of great value to the medical community. In addition, a number of studies have applied transfer learning strategies to popular deep CNNs for COVID-19 identification from CXR pictures [14, 15]. These CNNs include AlexNet, VGGNet, Inception Net, ResNet, DenseNet, CheXNet, and MobileNet.

VGG19 Shines [16]

In a study from 2020, researchers employed algorithms to identify from chest radiographs. With an accuracy of 95%, Differentiating between COVID-19, viral pneumonia, and healthy people was a breeze with the use of VGG19. A total 657 X-rays were analysed, with the size increased with help of data augmentation techniques. InceptionV3 had weaker results than competing models. This research demonstrates how VGG19 and deep learning may be used to diagnose accurately.

A Comparative Study CT scans, RT-PCR Using CNN Models [18]

A 2020 study compared CT scans and RT-PCR for diagnosing COVID-19. Using CNN models, an AUC of 0.996 was achieved, accurately distinguishing COVID-19 from other cases. The process involved CT image preprocessing, 3D CNN segmentation, and image classification. This research demonstrates the potential of CT scans and CNN models for precise COVID-19 diagnosis. The study used a Noisy-or Bayesian function for overall analysis and compared two CNN models, one traditional and another with added location-attention mechanism, to improve accuracy.

Support Vector Machine Classification [19]

COVID-19 Detected in X-Rays pictures now done automatically with the help of this new method. The system uses Otsu's multi-level segmentation function, a median filter, and SVM categorised images. Overall, the proposed model was 95.76 percent sensitive, 99.7 percent specific, and 97.48 percent accurate when applied to lung categorization.

Analysing Chest X-ray and CT Images to Evaluate Convolutional Neural Network Models for Detection of COVID-19 [20]

Maghdid et al. (2020) discuss the use of COVID-19 detection in chest X-ray and CT scans. presented a CNN framework leveraging AlexNet transfer learning. However, the model's diagnostic accuracy for COVID-19 was found inadequate, despite its user-friendly design. Empirical findings highlighted superior performance with pre-trained networks, while the modified CNN exhibited comparatively lower accuracy.

Enhancing COVID-19 Detection Accuracy with CovidGAN: ACGAN-based Synthetic CXR Images [21]

To improve the speed with which COVID-19 can detect abnormalities in chest X-rays, Abdul Waheed et al. presented CovidGAN, an ACGAN-based model. Utilising CovidGAN's synthetic images along with CNN increased accuracy from 85% to 95%.

Categorising COVID-19 in CT scans via Extracted Features and Support Vector Machines [22]

For feature extraction, Mucahid Barstugan et al. used CT scans and the validations of the SVM classifier were used. Through 10 rounds of cross-validation using GLSZM feature extraction, we were able to improve accuracy to 99.68 percent.

Classifying Clinical Reports for COVID-19, SARS, and ARDS: A Comparative Study of Classical and Ensemble ML Algorithms [23]

Classifying clinical reports into four groups—COVID, SARS, ARDS, and Both (COVID, ARDS)—is the goal of the method proposed by Akib Mohi Ud Din Khanday et al., which makes use of both classical and ensemble machine learning methods. The researchers used a wide variety of feature engineering methods. The testing accuracy of 96.2% was significantly higher with logistic regression and multinomial naive Bayes than with any of the other machine learning methods we tried.

COVIDiagnosis-Net: Fast X-Ray Image-Based COVID-19 Diagnosis Using a Deep Bayes-SqueezeNet Model [2]

This model provides a simple device and uses multi-scale offline augmentation to fix dataset imbalance. It helps medical professionals make accurate diagnoses of COVID-19 during the current pandemic.

Effective Chest Data-Based COVID-19 Detection through Fuzzy Colour Restructuring, Deep Learning, and Support Vector Machines [24]

Research to identify COVID-19 utilising chest data with Fuzzy Colour restructuring was proposed by Mesut Toaçar et al. MobileNetV2 and SqueezeNet were two of the deep learning models employed, with features optimised using the Social Mimic technique. The effective features were categorised using Support Vector Machines (SVM), leading to a classification success percentage of 99.27%.

A High-Resolution CT scan-Based Deep Learning Method for Detection of COVID-19 Pneumonia [25]

Using UNet++, Chen, J. et al. created a deep learning system to find COVID-19 pneumonia high-resolution CT. the accuracy model's valid area extraction from 600 test CT images was 100%. Six hundred and ninety-one photos of pneumonia caused by the COVID-19 virus and three hundred images of pneumonia caused by other viruses were utilised for anomaly detection.

Naive Bayes Feature Correlation for Accurate COVID-19 Diagnosis [26]

The Feature Correlated Naive Bayes (FCNB) method for COVID-19 diagnosis was first published in 2021 in J Ambient Intell Humaniz Comput. Non experimental results showed its effectiveness with a maximum detection accuracy of 99%, outperforming recent competitive techniques. To classify patients, the FCNB method employs a weighted Naive Bayes algorithm with alterations to the feature correlation and a Genetic Algorithm for feature selection.

Classification of COVID-19 Patients from Chest CT Images Using Convolutional Neural Networks and Multi-Objective Differential Evolution [27]

Patients with COVID-19 can now be identified from chest CT scans because of the work of D. Singh et al., who created a convolutional neural network (CNN). Multi-objective differential evolution (MODE) was used to optimise the initial CNN parameters. The proposed model demonstrated notable accuracy in categorising chest CT images. Furthermore, CNN, ANN, and ANFIS models exhibited commendable performance in COVID-19 patient classification. However, it was noted that CNN encountered challenges related to hyperparameter tuning.

Using Support Vector Machines trained on Deep X-ray Image Features to Detect COVID-19 [28]

Sethy, P.K., et al. did research employing X-ray pictures and a support vector machine (SVM) trained on deep features to detect the Coronavirus. The classifier is trained using data supplied to it from a fully connected layer, from which deep features are extracted. For improved disease diagnosis, the features are given to a support vector machine classifier.

A Machine-Learning Framework finding COVID-19 Infections Using Adaptive Dimensionality Reduction and Hierarchical Bayesian Estimation [29]

Model utilized dimensionality reduction to identify key parameters and employed an unbiased hierarchical Bayesian estimator approach for predictive analysis, inferring past infections from current fatalities.

Severe COVID-19 Patient Outcomes Predicted Early Using Machine Learning Approaches [30]

Five machine learning methods were developed by Chuanyu Hu and Zhenqiu Liu to predict the most severe outcomes. A number of different statistical methods were used to build the models. These included logistic regression, partial least squares regression, elastic net, random forest, and bagged flexible discriminant analysis.

Age, high-sensitivity C-reactive protein, lymphocyte count, and d-dimer levels were the four variables chosen by all models. With an AUROC of 0.895 in the derivation set and 0.881 in the external validation set, the logistic regression model was selected for its simplicity and interpretability. Derivation set sensitivity was 0.892, specificity was 0.687, and validation set sensitivity was 0.839, all with a 50% mortality limit.

Regression Analysis-Based Models for Predicting COVID-19 Cases in Egypt: A Comparative Study [31]

Lamiaa A. et al. employed various growth models, including exponential, quadratic, cubic, quartic, quintic, sextic, and logit, in their regression analysis to estimate how many instances of COVID-19 there will be in Egypt. To this end, regression models were chosen for exponential, quartic, quintic, and sextic polynomial forms. Notably, the fourth-degree model demonstrated remarkable performance, proving especially beneficial for short-term projections. The inclusion of the logit growth regression model offered insightful epidemiological perspectives, aiding governmental decision-making in implementing essential strategies to combat the pandemic.

Automated Segmentation and Quantification of Infection Regions in Chest CT Scans Using Deep Learning for COVID-19 [32]

Fei Shan et al. developed a deep learning-driven method based on the "VB-Net" neural network architecture to automatically segment and measure COVID-19 infection areas and total lung volumes from chest CT scans. Two hundred and fifty COVID-19 patients were used for training, and another three hundred were used for validation. To aid in the fine-tuning of automatic annotations, a human-in-the-loop (HITL) technique has been implemented to involve radiologists in the process. The system performed admirably on the validation dataset, with an overall lung segmentation Dice similarity coefficient of 91.6% 10.0% and a low mean Percentage of Infection (POI) prediction error of 0.3%.

Automated Severity Evaluation of Chest CT Images for the Diagnosis of COVID-19 Using a Random Forest Approach [33]

In order to automatically categorise COVID-19 instances in chest CT scans as mild, moderate, or severe, Zhenyu Tang et al. used a random forest (RF) model trained via machine learning techniques. The RF model showed promise when tested using a three-fold cross-validation strategy, with results including a true positive rate of 0.933, a true negative rate of 0.745, an accuracy of 0.875, and an area under the receiver operating characteristic curve (AUROC) value of 0.91.

Enhancing Pneumonia Classification from Chest CT Images using ResNet-50 with FPN and Attention Module [34]

Using a ResNet-50, FPN, and attention module, Song et al. were able to record the top-K features and learn their significance in the overall picture. We used chest CT images from 88 COVID-19 patients, 101 cases of bacterial pneumonia, and 86 healthy subjects, and the results of the categorization were very promising. The model was able to classify cases of pneumonia with an accuracy of 86.0% and differentiate between cases with a diagnostic accuracy of 94.0%.

Prediction of COVID-19 with GoogleNet Inception v3 The CNN Pipeline: A Methodical Stack for Transfer Learning [3]

Using GoogleNet Inception v3 CNN as a transfer learning model, Wang et al. suggested a methodical process for COVID-19 prediction. Preprocessing the image, extracting features from the ROI, and classifying the image with fully connected layers are all part of the pipeline.

Intubation Prediction for COVID-19 Patients Using a Sliding-Window Machine Learning Algorithm [35]

To determine whether or not a COVID-19 patient will require intubation, Varun Arvind et al. Model outperformed ROX index, with AUC of 0.84 and AUPRC of 0.30, demonstrating its potential for predicting future intubation. The study followed the TRIPOD reporting criteria for model development and employed class weight balancing and tree depth optimization for improved performance.

Achieving Highly Accurate COVID-19 Detection in Chest Radiographs through Learning Without a Teacher and Compiling Information in Bulk [37]

High-precision CXR image-based COVID-19 detection was developed by Guang Li, Ren Togo, et al. The pre-training phase uses self-supervised learning to learn representations without human labelling, while the fine-tuning phase uses batch knowledge ensemble to boost detection performance. This technique considers unique COVID-19 features and similarities with other pneumonia cases and reduces memory usage.

COVID-19 Detection in Chest X-Rays Using an Ensemble Learning Approach [36]

The proposed COVID-19 detection method consists of preprocessing, feature extraction (inceptionv3, Local Vector Patterns (LVP), and Local Binary Pattern (LBP), and ensemble model classification (SVM, CNN, optimised NN, Random Forest). Self-Adaptive Kill Herd Optimisation (SAKHO) is a novel method used to fine-tune the weights of neural networks to improve classification accuracy and precision. In-depth comparison of available strategies using a variety of metrics.

The results of the RT-PCR test, chest X-rays, and chest CT scans are compared in Table 1 to determine the best method for diagnosing COVID-19.

Table 1: A Meta-Analysis of COVID-19 Diagnosis AI Methods

Authors	Research topic	Methods	Results	Advantages	Dis Advantages
M. Sevi et al. [16]	Finding Covid 19 using X-Rays	CNN, VGG16, VGG19 and InceptionV3	To date, VGG19 has shown to be the most effective model, with an accuracy rate of 95%.	Supplementing data effectively raises the number of Covid -19 detections.	Lung tomography suitable chest radiographs for achieving good model performance
S. Roy et al [17]	Covid 19 analysis u Ultrasonography (LUS) images	U-Net++ and Deep lab V3+	Achieved higher accuracy in COVID-19 diagnosis	Ultrasound on the go with a disposable plastic cover and premeasured gel packets ensures a low risk of cross-infection	Limited training on interpreting LUS images could hinder its practical use
Xu X et al [18]	Separates CT scans into infected (with COVID-19 or influenza virus) and uninfected categories.	ResNet23, ResNet23+, Location attention me chanism	AUC of 0.996	As a viable additional diagnostic approach, it shows great promise for use by frontline clinical.	Limited model samples and overlapping manifestations
Lamia Nabil Mahdy [19]	Finding Covid 19 using X-Rays	SVM	Accuracy of 97.48%	Helpful for clinicians in identifying COVID- infections in their patients	A larger dataset is needed for improved model generalization.
Maghdid et al [20]	Detection with Computed tomography (CT) and chest X-rays	CNN architecture / AlexNet	Inadequate precision for diagnosing COVID-1¢	Aids early COVID-19 diagnosis.	Proposed models' accuracy is insufficient, but detection can be enhanced by considering other disease symptoms.
Abdul Waheed et al [21]	Detection using synthetic generated CXR	CNN	Without use artificial images, CNN classification was only 85% accurate.	Improves COVID-19 d efficiency utilising minimum data and simulated chest X-rays.	This method does not aim to compete with laboratory testing.
Mucahid Barstugan et al [22]	Detection based on CT images	Support Vector Ma((SVM)	Accuracy of 99.68%	Coronavirus detection in its early stages presented.	Dataset diversity needs to be increased.
[23]	Detection based on clinical reports	Ensemble Method,	Multinomial Naïve Bayes demonstrated performance a testing accu of 96.2%.	An interactive chart co the various algorithms employed	Deep learning approach are essential for achieving results study.
Ferhat Ucar et al [2]	Coronavirus illness using X-ray imaging.	Bayes- SqueezeNet called COVIDiagnosis-Net	Achieved higher accuracy	outperforms existing designs, resulting in higher precision.	To achieve higher results, growing the size of the data used for training is necessary.
Mesut Toğaçar et al [24]	Detection based on chest CT images	Support Vector Machines (SVM)	99.27% accuracy	For better results, the s model incorporates an end-to-end learning strategy.	For thorough viral diagnosis, deep learning-based analysis can be expanded to include other organs.
Chen J et al. [25]	Detection based on chest CT images	UNet++	Got 100% testing accuracy	The proposed strategy has the potential to greatly reduce radiologists' workload in clinical practice and	Despite the model's predictive capabilities, the guidance of an expert radiologist is still necessary for

				significantly contribute to containing the COVID-19 pandemic.	accurate interpretation and diagnosis.
Mansour et al [26]	Naive Bayes with Correlated Features (FCNB).	Weighted Naïve Bayes algorithm	Accuracy of 99%	In comparison to the conventional weighted NB, the Proposed FCNB technique demonstrates superior performance.	Larger dataset required for model validation.
Singh, D et al [27]	Detection based on images	CNN, ANN, and ANFIS	CNN shows promising results, but hyperparameter tuning car challenging for optimal performance.	Overfitting of the model is avoided by using cross-validation to test the data 20 times	The model's performance is affected by hyperparameter tuning issues.
Sethy [28]	chest X ray images	SVM	96% accurate results	predicted the infection levels in different countries.	A larger dataset is needed for model validation.
Vaid S et al.[29]	Detection based on clinical reports	Dimensionality reduction, unbiased hierarchical Bayesian estimator	There were more than 1.6 million undiagnosed infections 60,000 to 86,000 undetected infections.	Determine patterns in the spread of new cases, diagnoses, and fatalities across the United States and Canada.	The estimate from documented fatal the true number of infections.
Chuanyu Hu, Zhenqiu Liu [30]	A prognostic early prediction clinical model for severe COVID-19 patients.	Techniques such as lasso, PCA, elasto-net, random forest, bagged flexible discriminant analysis.	AUROC 0.881	provides individual risk scores and corresp probabilities of death to assess mortality risk.	A larger dataset is needed for model validation.
Lamiaa A. et al. [31]	Final Size prediction based on the covid death rate cases.	The study used seven regressions analysis-based models: exponential, polynomial	Excellent results can be shown in the use of polynomial regression models of the fourth, fifth, and sixth degrees.	The forthcoming months will see the utility of these models Egyptian government's efforts manage the COVID-19 epidemic.	peak forecasting includes inherent uncertainty due to potential radical shifts in the social and environmental (climate) landscape.
Fei Shan et al. [32]	Infected areas are automatically se and quantified.	VB-Net neural network	An Error of 0.3 Percent in Estimating	The model automatically segments and quantifies infection zones in CT scans COVID-19 patients, facilitating exploration of the disti quantitative distribution lesions associated with COVID-19.	Since the validation CT datasets were only obtained nationally or internationally. Also, as the technique was designed specifically
Zhenyu Tang et al [33]	Chest computed ton image-based detection	random forest (RF)	AUROC of 0.91	Several numerical char were found to have the capacity to reflect the seriousness	The study focused solely on two COVID-19 severity categories, Specifically non-severe and severe, omitting the complete spectrum of mild, common, severe, and critical cases.

Song et al. [34]	Detection based on chest CT images	ResNet-50 and Feature Pyramid Network (FPN) are both pre-trained neural networks.	Classifies cases of pneumonia with an accuracy of 86.0% and diagnoses cases of pne (COVID-19 or healthy) with a precision of 94.0%.	The model accurately discriminates su extracts main le features, particularly ground-glass opacities (GGO), aiding doctors in assisted diagnosis.	The work was completed with limited number of samples available to develop the deep learning prototype.
Wang, S. et al [3]	Detection based on chest CT images	GoogleNet Inception v3 CNN	AUC of 0.93	Time spent on disease can be reduced since this technique can extract unique visual features	method faces challenges in efficiency and complexity of data integration.
Varun Arvind et al. [35]	A model for predicting future int among patients.	Multivariable Prediction Model	AUC of 0.84	Approaches aid in identifying high-risk patients for improved clinical care.	Rapid risk assessments are not possible withou 24-hour sampling window for data generation.
Guang Li, Ren Togo et al. [37]	Using CXR pictures for COVID-19 detection	Fine-tuning -based batch knowledge assembly	High detection accuracy achieved with minimal annotated CXR training images.	unbalanced datasets, with robustness to changes in hyperparameters.	Until now, the contrastive-based self-supervised learning approach has only been applied to convolutional neural networks (CNNs).
Balasubramaniam S et al.,[36]	Detection based on chest CT images	Ensemble model-SVM, CNN, optimized NN, RF	Achieved higher accuracy in COVID-19 diagnosis.	High Efficiency	The method does not prioritise categorical differentiation.

Through an extensive analysis of diverse techniques, it becomes evident that COVID-19 detection is primarily conducted through CT images. The distribution of each data type employed for COVID-19 diagnosis using AI-based methodologies is illustrated in Figure 3. Furthermore, Figure 4 illustrates the wide array of machine learning, deep learning models employed within COVID-19 methodologies.
As anticipated, CNN, Ensemble, and deep neural network models stand out prominently.

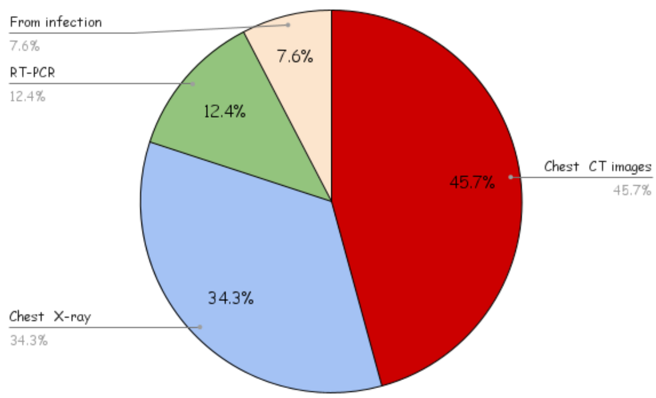

Figure 3: Covid 19 diagnostics using a variety of data types

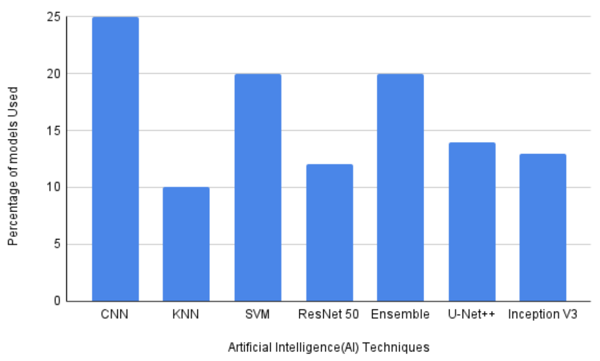

Figure 4: Covid 19 diagnostics using several forms of artificial intelligence

5. Conclusion

This pandemic has challenged global healthcare systems. Researchers and medical professionals are exploring AI techniques. This review evaluates AI effectiveness in improving patient outcomes during the pandemic. Early detection and isolation of COVID-19 patients can be aided by AI's ability to differentiate between the virus and other diseases. Deep learning models analyse imaging to identify COVID-19 pneumonia patterns. AI's integration with genomic data facilitates targeted therapies and vaccine development. Challenges remain in implementing AI-based diagnostics, including data standardisation and bias. Ethical considerations require collaboration between AI experts, medical practitioners, and policymakers. This review serves as a valuable resource for researchers, healthcare professionals, and policymakers, highlighting AI's strengths and limitations in COVID-19 diagnosis. Future research should focus on refining models and data sharing to enhance AI's role in global pandemic response and improve public health outcomes.

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