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Application of Machine Learning for SARS-CoV-2 Outbreak

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ABSTRACT

The plan to overcome disease outbreaks due to the novel Coronavirus (SARS-CoV-2) can be viewed from various sides, including the role of computer technology namely machine learning. This technology has been used to solve many problems, including medical-related problems. Due to the importance of research study of machine learning on COVID-19 issues, this research aim is to review literature of application of machine learning for COVID-19 outbreak by using PRISMA methodology. We obtained sixteen research articles as research data. As a result, we identified there three main aims of research study of machine learning on COVID-19 issues, including patient detection (based on the symptoms), epidemic trends or prediction, and social impact. Moreover, the method of machine learning that has been identified to solve COVID-19 issues, including Convolutional Neural Networks (CNN), Deep Neural Networks (DNN), Support Vector Machine (SVM), Random Forest (RF), K-Nearest Neighbors (K-NN), Logistic Growth Forecasting Model, Naïve Bayes, Unbiased Hierarchical Bayesian Estimator, Biterm Topic Model (BTM), Support Vector Regression (SVR), Confidence-Aware Anomaly Detection (CAAD), Deep Learning Survival Cox (DLSC), Partial Derivative Regression and Nonlinear Machine Learning (PDR-NML).

Keywords : SARS-CoV-2, COVID-19, PRISMA, machine learning

I. INTRODUCTION

Based on historical records, there have been many disease outbreaks that have caused death, loss and impact on human life. A disease outbreak needs to be controlled so that the disease is not widely spread and human life can return to normal. All parties need to be involved in resolving a disease outbreak. The outbreak is not only a medical problem that can be solved by medical personnel but also a social problem that can be stopped if the entire population in the population can comply with health protocols properly [1], [2].

The current disease outbreak that is currently happening is the Covid-19 (Coronavirus) outbreak. This outbreak began in December 2019 in Wuhan District, China. This disease is an epidemic because

this virus is transmitted quite quickly to humans around the world. On the 30th January 2020, the World Health Organization (WHO) announced that the novel Coronavirus or Covid-19 has become causing a pandemic and needs to be followed up globally [1], [2]

Strategies to overcome disease outbreaks due to the novel Coronavirus (SARS-CoV-2) can be viewed from various sides, including the role of technology. The technology to be discussed is a specific technology in the field of computer science, namely machine learning. The field of machine learning has helped to solve many problems, including medical-related problems [3][4].

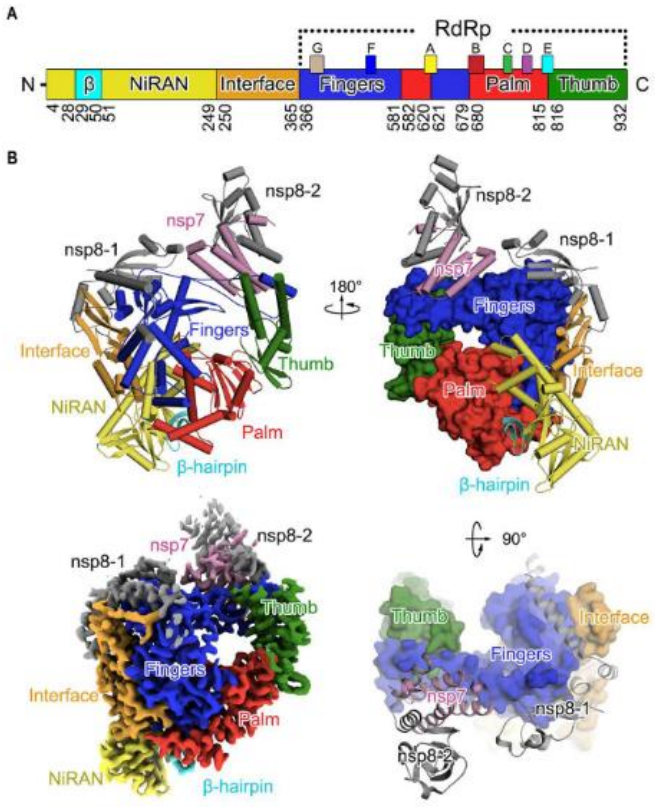

Figure 1: Structure of the novel Coronavirus (SARS-CoV-2) [5]

Due to the importance of research study of machine learning on COVID-19 issues, this research aim is to review literature of application of machine learning for SARS-CoV-2 outbreak. To complete this study well, we determine the research questions as follow:

RQ1: What is the machine learning method and its dataset to tackle COVID-19 issues?

RQ2: What is journal that published articles about machine learning for COVID-19 problem?

II. METHODS AND MATERIAL

This section will discuss the phase of research and data that is used to complete research goal.

A. Research Phase

This research study of machine learning on COVID-19 issues is adapted PRISMA method [6]–[8]. The completed phases with the number of data can be seen in Figure below.

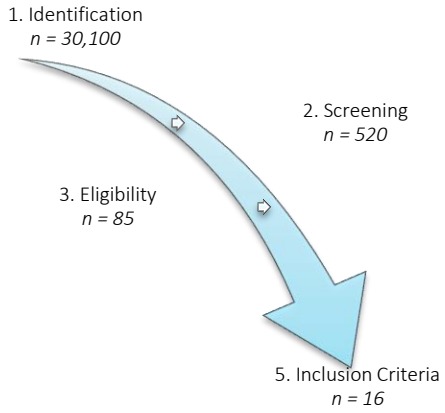

Figure 2: Phases of this study

To identify the research data, we explored the articles from Science Direct, Google Scholar, *IEEE Xplore* and ProQuest by using keyword "machine learning covid-19". The detail of review phases is depicted in Figure below.

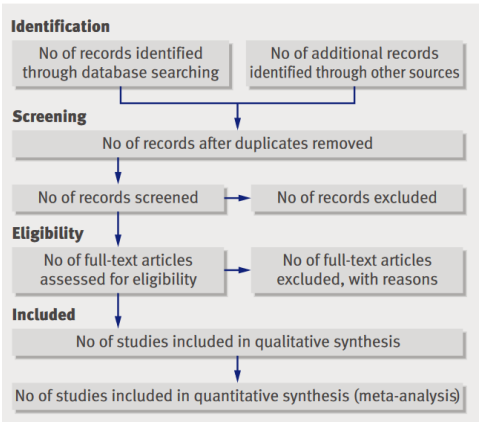

Figure 3: PRISMA phases in detail [6]

B. Data Collection

By using PRISMA method, we obtained the research data that can be used for answering research questions. This research gathered sixteen research articles as mentioned in Table below.

TABLE I

DATA COLLECTION N=16

Title	Source
Application of deep learning technique to manage COVID-19 in routine clinical practice using CT images: Results of 10 convolutional neural networks	[9]
Automated detection of COVID-19 cases using deep neural networks with X-ray images	[10]
Combination of four clinical indicators predicts the severe/critical symptom of patients infected COVID-19	[11]
Rapid and accurate identification of COVID-19 infection through machine learning based on clinical available blood test results	[12]
New machine learning method for image-based diagnosis of COVID-19	[13]
Prediction of epidemic trends in COVID-19 with logistic model and machine learning technics	[14]
Covid-19 public sentiment insights and machine learning for tweets classification	[15]
Artificial intelligence distinguishes COVID-19 from community acquired pneumonia on chest CT	[16]
Using machine learning to estimate unobserved COVID-19 infections in North America	[17]
Machine Learning to Detect Self-Reporting of Symptoms, Testing Access, and Recovery Associated With COVID-19 on Twitter: Retrospective Big Data Infoveillance Study	[18]
A hybrid deep transfer learning model with machine learning methods for face mask detection in the era of the COVID-19 pandemic	[19]
Common cardiovascular risk factors and in-hospital mortality in 3,894 patients with COVID-19: survival analysis and machine learning-based findings from the multicentre Italian CORIST Study	[20]
Analysis on novel coronavirus (COVID-19) using machine learning methods	[21]
Covid-19 screening on chest x-ray images using deep learning based anomaly detection	[22]
Early triage of critically ill COVID-19 patients using deep learning	[23]
Partial derivative nonlinear global pandemic machine learning prediction of Covid-19	[24]

III. RESULTS AND DISCUSSION

This section will discuss the result of research to answer RQ1 (machine learning method and its dataset to tackle COVID-19 issues) and RQ2 (journal that published articles about machine learning for COVID-19 problem).

A. Type of Dataset

Many research has been done by using several type of dataset using machine learning. For example, Sun et al. (2020) present how to used dataset of clinical and laboratory observations/records to predict critical symptom of patients infected novel coronavirus [11]. Wu et al. (2020) used clinical blood test dataset to detect patients infected COVID-19 [12]. Furthermore, Vaid et al. (2020) utilized novel coronavirus dataset by the JHU CSSE to predict unobserved COVID-19 infections in North America [17].

Moreover, Loey et al. (2020) used the Simulated Masked Face Dataset (SMFD), Real-World Masked Face Dataset (RMFD), and the Labeled Faces in the Wild (LFW) to detect face mask during novel coronavirus pandemic [19]. Di Castelnuovo et al.

(2020) used clinical data of Italian patients to identify cardiovascular risk factors [20].

The dataset also used to predict epidemic trends of COVID-19, for example, Yadav et al. (2020) used dataset containing the total number of COVID19 positive cases to analysis novel coronavirus trend [21] Wang et al. (2020) epidemical data to identify and predict epidemic trends of novel Coronavirus [14]. Kavadi et al. (2020) used COVID-19 dataset from Kaggle to predict trend novel Coronavirus [24].

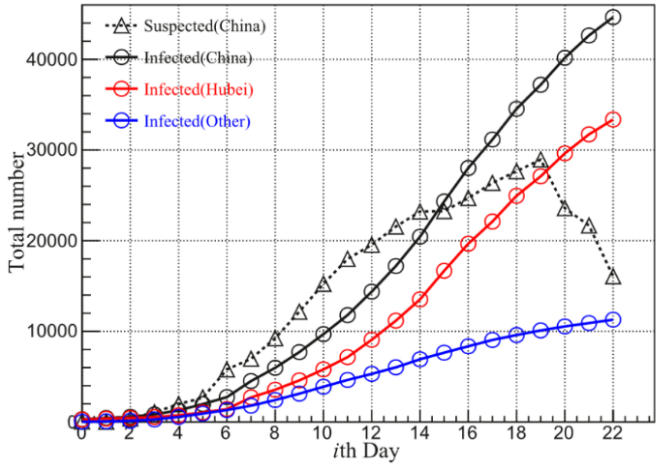

Figure 4: Example of trend and forecasting of the COVID-19 outbreak (Jan.20–Feb.11, 2020) in China [25]

The trend of the using of image dataset from CT or X-ray image to identify novel Coronavirus patients has been done by many researchers. Ardakani et al. (2020) using CT images for managing COVID-19 in routine clinical practice [9]. Ozturk et al. (2020) using X-ray images as dataset to identify COVID-19 cases automatically [10]. (Li et al. 2020) used chest CT dataset to diagnose novel Coronavirus patients [16]. Elaziz et al. (2020) used chest x-ray image to diagnose the novel Coronavirus patients [13]. Zhang et al. (2020) utilized X-ray images dataset for diagnose the Covid-19 patients [22]. Liang et al. (2020) utilized chest X-ray to identify early triage of critically ill novel Coronavirus [23].

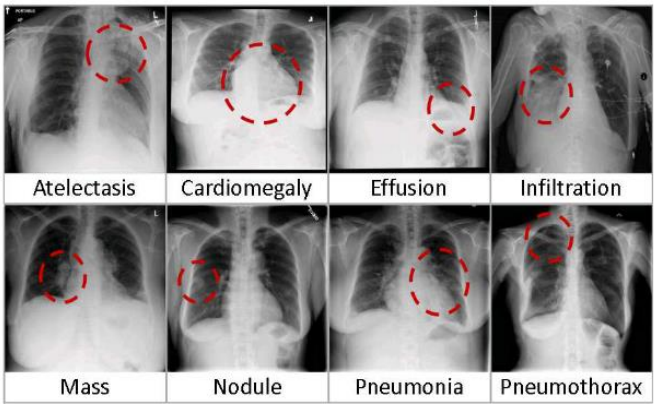

Figure 5: Example of X-ray dataset [26]

Several researchers attempted to use dataset from social media to tackle Coronavirus issues. For instance, study of Samuel et al. (2020) presented the study used specific Tweets of coronavirus dataset to analyse trend on public sentiment [15]. Moreover, Mackey et al. (2020) attempted to identify self-reporting of symptoms Coronavirus based opinion tweets dataset [18].

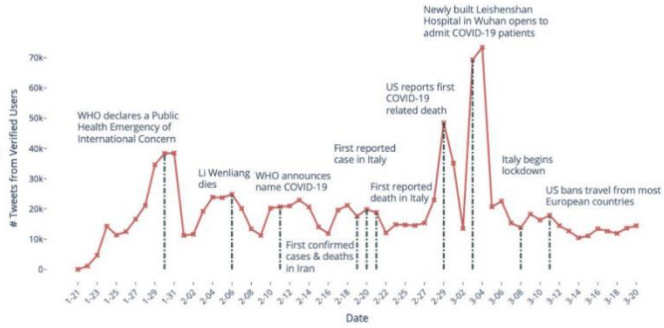

Figure 6: Number of COVID-19 tweets [27]

B. Trend on Method

The method of machine learning that has been identified to solve COVID-19 issues, including Convolutional Neural Networks (CNN), Deep Neural Networks (DNN), Support Vector Machine (SVM), Random Forest (RF), K-Nearest Neighbors (K-NN), Logistic Growth Forecasting Model, Naïve Bayes, Unbiased Hierarchical Bayesian Estimator, Biterm Topic Model (BTM), Support Vector Regression (SVR), Confidence-Aware Anomaly Detection (CAAD), Deep Learning Survival Cox (DLSC), Partial Derivative Regression and Nonlinear Machine Learning (PDR-NML). The articles source of machine

learning method implementation is presented in Table below.

TABLE II
RESEARCH DATA BASED ON METHOD

Author	Method	Source
(Ardakani et al. 2020) (Li et al. 2020)	Convolutional Neural Networks (CNN)	[9] [16]
(Ozturk et al. 2020)	Deep Neural Networks (DNN)	[10]
(Sun et al. 2020) (Loey et al. 2020)	Support Vector Machine (SVM)	[11] [19]
(Wu et al. 2020) (Di Castelnuovo et al. 2020)	Random Forest (RF)	[12] [20]
(Elaziz et al. 2020)	K-Nearest Neighbors (K-NN)	[13]
(Wang et al. 2020)	Logistic Growth Forecasting Model	[14]
(Samuel et al. 2020)	Naïve Bayes	[15]
(Vaid, Cakan, and Bhandari 2020)	Unbiased Hierarchical Bayesian Estimator	[17]
(Mackey et al. 2020)	Biterm Topic Model (BTM)	[18]
(Yadav, Perumal, and Srinivas 2020)	Support Vector Regression (SVR)	[21]
(Zhang et al. 2020)	Confidence-Aware Anomaly Detection (CAAD)	[22]
(Liang et al. 2020)	Deep Learning Survival Cox (DLSC)	[23]
(Kavadi et al. 2020)	Partial Derivative Regression and Nonlinear Machine Learning (PDR-NML)	[24]

The most used of machine learning method to tackle COVID-19 issues is Convolutional Neural Networks (CNN) [9] [16], Support Vector Machine (SVM) [11] [19] and Random Forest (RF) [12] [20].

C. Publication Journal

Based on the data of publication journal that is published articles about machine learning on COVID-19 issues, we found that the domain of journal not only from computer sciences domain, but also medical or natural science or its related domain. The completed data can be seen in Table below.

TABLE III
RESEARCH DATA BASED ON PUBLICATION JOURNAL

Authors	Journal	Source
(Ardakani et al. 2020)	*Computers in Biology and Medicine*	[9]
(Ozturk et al. 2020)	*Computers in Biology and Medicine*	[10]
(Sun et al. 2020)	*Journal of Clinical Virology*	[11]
(Wu et al. 2020)	*medRxiv*	[12]
(Elaziz et al. 2020)	*Plos one*	[13]
(Wang et al. 2020)	*Chaos, Solitons & Fractals*	[14]
(Samuel et al. 2020)	*Information*	[15]
(Li et al. 2020)	*Radiology*	[16]
(Vaid, Cakan, and Bhandari 2020)	*Journal of bone and joint surgery. American volume*	[17]
(Mackey et al. 2020)	*JMIR Public Health and Surveillance*	[18]
(Loey et al. 2020)	*Measurement*	[19]
(Di Castelnuovo et al. 2020)	*Nutrition, Metabolism and Cardiovascular Diseases*	[20]
(Yadav, Perumal, and Srinivas 2020)	*Chaos, Solitons & Fractals*	[21]

Authors	Journal	Source
(Zhang et al. 2020)	*arXiv*	[22]
(Liang et al. 2020)	*Nature communications*	[23]
(Kavadi et al. 2020)	*Chaos, Solitons & Fractals*	[24]

D. Discussion

Based on the research data, there three main aims of research study of machine learning on COVID-19 issues, including Coronavirus patient detection (based on the symptoms), Coronavirus epidemic trends or prediction, and Coronavirus social impact.

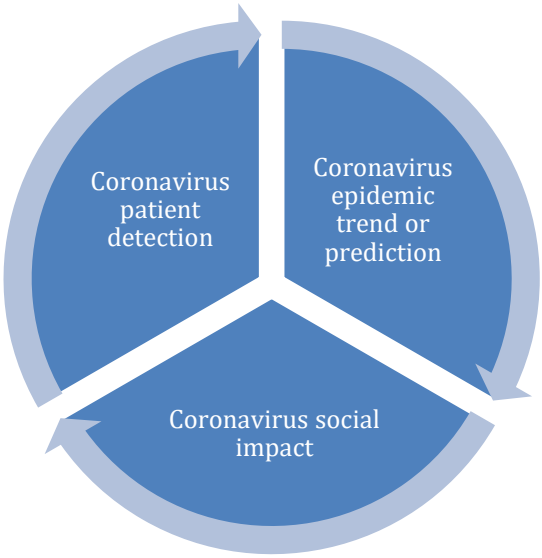

Figure 7: Research aims of machine learning on COVID-19 issues

IV. CONCLUSION

This paper addresses on recent research on machine learning application for COVID-19. Majority of the paper aims of related study of machine learning on COVID-19 issues discussed patient detection (based on the symptoms), epidemic trends or prediction, and social impact. Furthermore, this paper showed that the domain of journal of machine learning application for COVID-19articles not only from computer sciences domain, but also medical or natural science or its related domain. Moreover, this paper also discussed machine learning method application for COVID-19, including Convolutional Neural Networks (CNN), Deep Neural Networks (DNN), Support Vector Machine (SVM), Random Forest (RF), K-Nearest Neighbors (K-NN), Logistic Growth Forecasting Model, Naïve Bayes, Unbiased Hierarchical Bayesian Estimator, Biterm Topic Model (BTM), Support Vector Regression (SVR), Confidence-Aware Anomaly Detection (CAAD), Deep Learning Survival Cox (DLSC), Partial Derivative Regression and Nonlinear Machine Learning (PDR-NML).

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