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Analysis of COVID-19 and its Impact on Alzheimer's Patient using Machine Learning Techniques

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ABSTRACT In this world, there is fast growth in technology, as technology growth is there the human also move fast based on the growth in technology. New diseases also growing fast in the world. In this paper, a semi-supervised approach has been proposed for the classification of the COVID-19 and a study has been done to analyze the impact of the covid on Alzheimer's disease patients. Coronavirus disease is a respiratory infection disease and Alzheimer's disease is a brain disease. From the literature, it has been analyzed that, because of the coronavirus the immunity system will be affected in humans and there is a chance to affect the brain also. Classification and clustering have been done on the coronavirus dataset and validated using a 10-fold validation process. The classifiers applied are Naïve Bayes and Random Forest; the results obtained are 99.88% and 100% accuracy. Also, the clustering has been applied and 2 clusters are generated for grouping the classes. Then a study has been done for predicting the impact of the coronavirus on Alzheimer's patients.

KEYWORDS Alzheimer disease; COVID-19; classification; clustering; naïve Bayes; random forest.

I. INTRODUCTION

IN this fast-moving digital world, the population is increasing. As the population increases the disease also increases. Now the recent disease is Coronavirus disease. The whole world is affected by this disease and suffering a lot because of this disease. This disease affects animals and birds; through this, it affects humans [1]. In humans first, it affects the respiratory system and creates cold, fever and at last, it causes death. Coronavirus is first discovered in the year 1960. They found that the virus looks like a crown and in Greek, crown means corona so they gave it the name corona. This is an airborne disease; it spreads through the air from the infected person to the environment and to the others. It is an RNA-based virus of four types; they are alpha-coronavirus, beta-coronavirus, gamma-coronavirus, and delta-coronavirus. The gamma-coronavirus affects only the birds but the other types affect the birds, animals, and humans. Still, the researchers are doing research to find how this virus was created [2].

In China again this disease started spreading from 2019 onwards. More than 10 lakhs of people are dead due to the coronavirus. The World Health Organization (WHO) gave the name for this disease as COVID-19 means Coronavirus 2019. COVID-19 is caused due to the SAR-CoV2. The WHO announced this disease on 31 December 2019. As per the source from the WHO 80% of the people are getting recover from the disease without the help of hospital treatment, 15% of the people will go very serious and they need oxygen, 5% of the people will go very critical need intensive care treatment. The death will cause due to respiratory problems, septic shock, acute respiratory distress syndrome, thromboembolism, multi-organ failure such as heart, liver, kidney. Due to the long-term effect of this disease the immunity power will be reduced so that it causes the neuron issues like multiple-sclerosis, Alzheimer's disease, and encephalitis. If a human is affected by COVID-19 then the symptoms will begin from 5-6 days to 1-14 days. To prevent the spread of this virus the affected person is advised to stay away from others. The report of WHO says that, as of the date of 5th February 2021, globally 104,370550 people got confirmed of COVID-19 including 2,271,180 deaths [3].

Fig. 1, gives the information about the name of Coronavirus from 1965 to 2019. In 1965 the researchers from the common cold research unit, UK found the virus in a small boy; it affected the respiratory track and they named as B814. In 1966, the University of Chicago found the virus in a medical student with a cold and was given the name 229E. In 1967 Scientists from

the National Institute of Allergy found the virus in a human and was given the name OC43. In 1968 eight researchers found B814, 229E, and OC43 it is unnamed because it is not available for a longer time. June Almeida first imaged the structure of the coronavirus. In 2003 an international group of researchers found the human coronavirus in the south of China and termed as SARS. In 2004 the researchers at Erasmus Medical Center in the Netherlands found the coronavirus from a child affected with pneumonia and named NL63. In 2005, a team of investigators at the Hong Kong University found the coronavirus in two patients affected by pneumonia and named as HKU1. In 2012 the researchers at Erasmus medical center found the coronavirus from a person in Saudi Arabia with pneumonia and kidney failure; they named the new coronavirus MERS-CoV [4]. In 2019 a team of researchers in China found coronavirus in Wuhan and gave the name for the novel coronavirus as SARS-CoV-2. The WHO has given the name COVID-19. In 2021 a team in South Africa identified the Omicron and reported it to WHO.

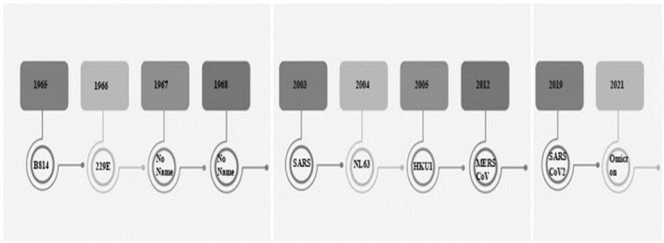

Figure 1. Evolution of Coronavirus from 1965 to till 2020

This paper gives the contribution of a framework of a semi-supervised approach; classification and the clustering of COVID-19 dataset and the effect of the Coronavirus on the Alzheimer patient. This paper is organized with the first section as Introduction, next Literature Review followed by Framework and Methodology, next section as Data and Result Discussion and finally the Conclusion.

II. LITERATURE REVIEW

The bio-informatics method is used to analyze the MERS-CoV sequence of the genome and the potential of the B-cell epitope of E-protein [5]. Five patient details are clustered and the report was generated using the epidemiological, clinical, laboratory, radiological, and microbiological data [6]. All the patients who came for the treatment in the hospital data were collected and analyzed using RT-PCR and next-generation sequencing method [7]. The sequence of the spike protein in SARS-CoV was analyzed with the similarity of the human proteins using multiple bioinformatics tools [8]. The patients are analyzed and based on that the key epidemiologic time-delay distributions were calculated [9]. The MERS-CoV disease affects humans and is caused by the camel [10]. Nine patient data were collected and analyzed using the next-generation sequencing method. Finally concluded that eight of them visited the seafood market then the phylogenetic analysis was done for finding the evolution of the virus [11]. Immunosensor was developed as an antibody-functionalized MoS2 and used the FRET for the antibody interaction. This detected the IBV spiked chicken serum and the result is produced [12]. Phylogenetic analysis is done with the maximum likelihood technique for the pattern variation in the MERS-CoV sequences collected. The sequence was classified into the four-country group and analyzed separately then compared and concluded that the Korea sequences and the Saudi Arabia sequences have minor variation and the USA and UK given the result of major variation in the sequences [13]. The children who are hospitalized because of the coronavirus with the respiratory infections and neural system were tested for anti-CoVIgM for exploring the cytokine expression. Finally, 12.02% was identified as anti-CoVIgM [14]. The coronavirus affected people have undergone the epidemiological study with multiple sclerosis. The tissue was tested for coronavirus antigen using the immune histochemical technique and two people were detected with multiple sclerosis. They concluded that the coronavirus will affect the neural system of humans [15]. The SARS-CoV-2 virus affects the central nervous system and creates risk for the life of Alzheimer's disease patients [16, 17]. The LSPCF biosensor is used to detect the coronavirus [18]. The authors applied AlGaN/GaN HEMTs to detect the protein in the coronavirus [19]. The missing data has been generated in the OASIS dataset for the prediction of the Alzheimer's disease [20]. A framework has been developed for the prediction of Alzheimer's disease [21]. COVID-19 prediction has been done using machine learning classifiers. The BayesNet, Logistic, IBk, CR, PART, and J48 classifiers are constructed and for validating the model the chest CT images and the chest X-ray images are applied to the models; the accuracy of the CR models has been given the best result of 84.21% [22]. COVID-19 classification has been done using deep learning methods. CNN method has been trained using the COVID-19 X-ray, COVID Chest X-ray, COVID-19 Radiography, and CoronaHack-Chest X-Ray data and the accuracy generated are 94.8%, 96.6%, 98.5%, and 98.6% [23].

The literature shows that only COVID-19 prediction has been done using various techniques and the impact of COVID-19 has not been analyzed. The proposed model classifies COVID-19 and analyzes the impact on AD patients. The accuracy of the model has been compared with [22, 23] and the proposed shows the best result.

A. FRAMEWORK AND METHODOLOGY

Fig. 2, the steps in the machine learning framework is given and the steps and briefed.

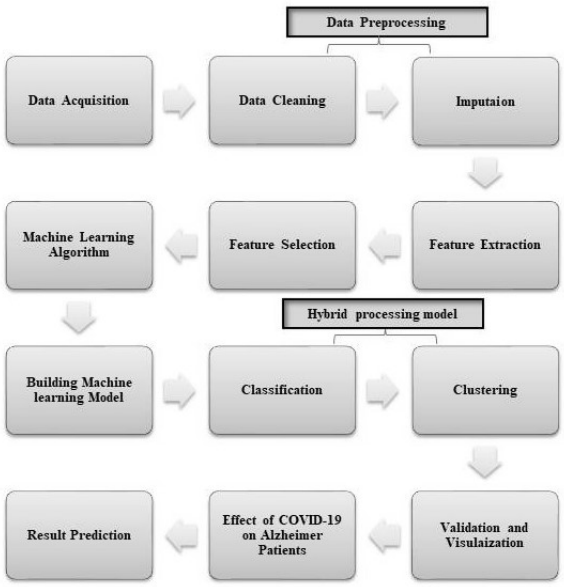

Figure 2. Steps in Hybrid Machine Learning Framework

Step 1: The data acquisition

The process of collecting the data and organizing the data for analysis is called data acquisition. The data has been collected from the covid.ourworldindata.org repository. The dataset has 63766 instances and it gives the details about the country, population, total cases affected by COVID-19, recovered cases, new cases, their age, etc.,

Step 2: Data Preprocessing

The process of converting the raw data to the format of analyzing the result is called preprocessing. The data cleaning and the imputation preprocessing have been done here.

- **Data cleaning:** Data cleaning is the process of removing or formatting unwanted data from the raw data collected. The data we collected is not supported as a CSV file, so we have done the data cleaning by removing some of the symbols which are not supported by the CSV and converting the dataset to a CSV file.
- **Imputation:** The process of replacing the missing value with another data value is called imputation. In this dataset, we have some of the attributes with missing values so we have generated the missing values using the replace missing value function in the Weka tool. This works based on the mean imputation technique.

Step 3: Feature Extraction

The process of reducing some of the features in the dataset is called feature extraction. The Principal Component Analysis method has been used for the extraction of the data. In this dataset, some of the features are reduced based on their less importance in the data classification.

Step 4: Feature Selection

The process of selecting the features for the best classification is called feature selection. We have applied the best first method and CFS Subset Evaluator for selecting the features for the classification. The dataset has 58 attributes and the 23 attributes has been selected for the classification.

Step 5: Machine Learning Algorithm

Machine Learning Algorithm is a portion of AI. It will learn the data and classify the data to produce the output.

Step 6: Building Machine Learning Model

Depending on the type of data the ML model will be constructed. The supervised learning or unsupervised learning algorithm can be applied to construct the machine learning model.

Step 7: Semi-supervised approach

The models can be supervised learning models and unsupervised learning models. Here both the models have been implemented; in the supervised learning model classification has been done and in the unsupervised model clustering has been done.

Classification: The process of categorizing the data into classes is called classification. In this dataset, there are two classes, so binary classification has been done to predict the output. The Naïve Bayes classifier and Random Forest classifier are applied for our dataset.

- **Naïve Bayes (NB):** The principle behind this classifier is the Bayes theorem. This is a supervised learning classifier.
- **Random Forest (RF):** This classifier works using the principle of bagging concept for the classification. This is a supervised learning classifier.

Clustering: The process of grouping the data in groups based on the similarities of the data.

- **K-Means:** The clustering is done based on the K-center data point; using the K-center data point similar data are clustered. This is an unsupervised learning model.

Step 7: Validation and Visualization

The process of checking the accuracy of the model is called validation and the process of representing the output predicted in a graphical representation is called visualization. After classifying and clustering validation have been done. The validation is done using the 10-fold cross-validation and the visualization is done by representing the output in the graphical charts.

Step 8: Effect of COVID-19 on Alzheimer Patients

A study is done to analyze the influence of COVID-19 on Alzheimer's Patients. The research articles related to the COVID-19 and the Alzheimer's disease has been collected and a study has been done to predict the influence of the COVID-19 on Alzheimer's Patients.

Step 9: Result Prediction

Based on the study the result is predicted whether the COVID-19 affects the Alzheimer Patients or not.

III. DATA DESCRIPTION

The data is taken from the covid.ourworldindata.org repository [24]; it has a total of 58 attributes and 63766 instances. In this dataset, preprocessing has been done for converting the data in a format for analyzing the data and predicting the output. The data cleaning and the imputation process are done and the preprocessed data is subjected to feature extraction and feature selection to reduce the unwanted data and select the important features to predict the output. After applying this process, we got 23 features; the selected features are subjected to classification and clustering then the validation and visualization are done. The human-development_index attribute has been considered as the target class. Binary classification has been done; because it has two-class labels. 0 represents the normal state and 1 represents the COVID-19 patient.

Table 1, gives the selected attributes and its description; these attributes are subjected for the process to predict the output.

Table 1. The selected attributes for the process

Sl. No	Data Attributes	Data Description
1.	Continent	Name of the Continent
2.	Location	Location
3.	Totalcase	Total number of patients
4.	new_cases	New patients affected by COVID-19
5.	total_deaths	Total number of death occurred
6.	new_deaths	New patients death
7.	icu_patients	Number of intensive care patients
8.	hosp_patients	Number of patients hospitalized

9.	total_tests	Total no. of COVID-19 test done
10.	new_tests	No. of new COVID-19 test done
11.	total_vaccinations	Total vaccinations
12.	people_vaccinated	No. of people vaccinated
13.	Population	Total population of the country
14.	population_density	Density of the population
15.	median_age	Number of patients with middle age
16.	aged_65_older	Number of patients with have nearly 65 age
17.	aged_70_older	Number of patients with have nearly 70 age
18.	cardiovasc_death_rate	Death rate COVID-19 patient due to cardio disease
19.	diabetes_prevalence	Death rate COVID-19 patient due to diabetes disease
20.	female_smokers	Number of female smokers affected by COVID-19
21.	male_smokers	Number of male smokers affected by COVID-19
22.	life_expectancy	Life expectancy of the COVID-19 patients
23.	human_development_index	The development of the COVID-19 patients.

A1. CLASSIFICATION

Classification is a supervised learning process; it categorizes the data into classes using the label. From the 58 attributes 23 attributes has been considered for the binary classification. NB classifier and RF classifiers are used for the classification of the COVID-19 dataset.

Naïve Bayes (NB):

NB classifier works based on the principle of Bayes theorem. NB classifier has been applied to the selected features and the model validation has been done using 10-fold cross-validation. The time taken for building this model is 1.06 seconds.

In the Table 2, NB classifier validating parameters values are specified. The accuracy of classification is 99.88%, and the kappa value is 0.99; the RMSE (root mean squared error) is 0.0034 and the root relative squared error generated is 4.78.

Table 2. NB classifier parameter metrics

Sl. No.	Validating Parameter	Values Generated
1	Classified Correctly	99.88%
2	Classified Incorrectly	0.11%
3	Kappa	0.99
4	RMSE	0.0034
5	Root relative squared error	4.78

Fig. 3, shows the graphical representation of the validating parameter metrics generated by the NB classifier. Fig. 3(a) shows the precision, recall, and F-measure value, and Fig. 3(b) shows the MCC, ROC, and PRC values of the NB classifier. Fig. 4 shows the confusion matrix for NB classifier.

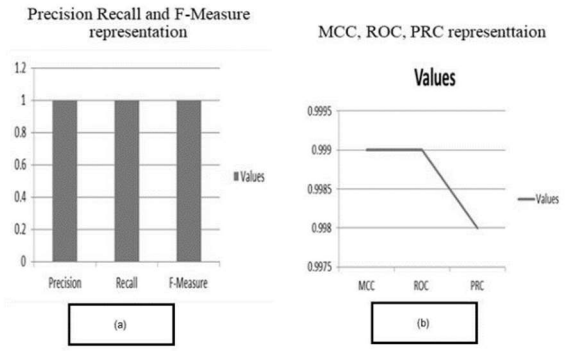

Figure 3. Graphical representation of the parameter metrics.

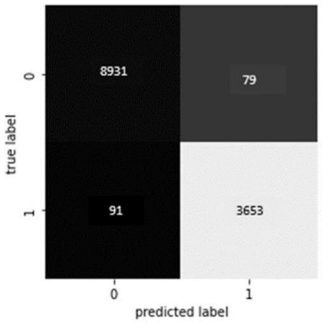

Figure 4. Confusion Matrix for NB classifier.

Precision is the positively classified value; recall is the sensitivity of the classifier. Balancing the precision and recall values are referred to as F-Measure. MCC is the Matthews Coefficient Correlation; for the calculation, it takes all the values of the confusion matrix and the MCC is generated. For the best classifier model, the MCC value should be 1. If the value of MCC is -1 it shows that the classifier is the worst model. ROC (Receiver Operating Characteristics) is a curve generated using the TP Rate and FP Rate; it shows the performance of the classifier. In the curve horizontal axis refers to the specificity and the Vertical axis refers to the sensitivity. PRC is the Precision-Recall Curve; it represents all the PRC areas of all classes.

$$Precision = \frac{True\ Positive\ Value}{True\ Positive\ Value+Fals\ \ PositivevValue}, \quad (1)$$

$$Recall = \frac{True\ Positive}{True\ Positve+False\ Negative}, \quad (2)$$

$$F-Measure = 2 * \frac{Precision*Recall}{Precision+Recall}, \quad (3)$$

$$MCC = TP * TN - FP * FN \frac{TP*TN-FP*FN}{\sqrt{(TP+F\ )*(TP+FN)*(TN+F\ )*(TN+FN)}}, \quad (4)$$

where MCC is the Matthews Coefficient Correlation, True Positive is represented as TP, True Negative is represented as TN, True Negative is represented as TN, and False Negative is represented as FN. The NB classifier's precision, recall, F-Measure, ROC curve, and MCC values are 0.999; the PRC value is 0.998.

Random Forest (RF):

RF classifier works based on the principle of bagging concept. RF classifier has been applied on the selected features and for validating the model 10-fold cross-validation is applied. The time taken for building this model is 84.48 seconds. The bagging process is taken place with 100 iterations.

In Table 3, the RF classifier validating parameters values are specified. The accuracy of classification is 100%, the kappa value is 1; the RMSE is 0.0003 and the root relative squared error generated is 0.355.

Table 3. Random Forest classifier parameter metrics

Sl. No.	Validating Parameter	Values Generated
1	Classified Correctly	100%
2	Classified Incorrectly	0%
3	Kappa	1
4	RMSE	0.0003
5	Root relative squared error	0.3553

In Fig. 5, it shows the graphical representation of the validating parameter metrics generated by the Random Forest classifier. Fig. 5(a) shows the precision, recall, and F-measure value, and Fig. 5(b) shows the MCC, ROC, and PRC values of the Naïve Bayes classifier. The RF classifier's precision, recall, F-Measure, ROC curve, MCC, and PRC values are 1. The value of the classifier shows that the RF classifier is the best classifier. Fig. 6 shows the confusion matrix for RF classifier.

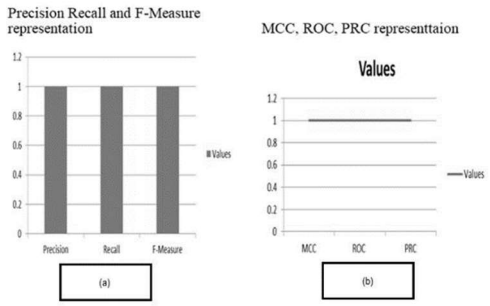

Figure 5. Graphical representation of the parameter metrics

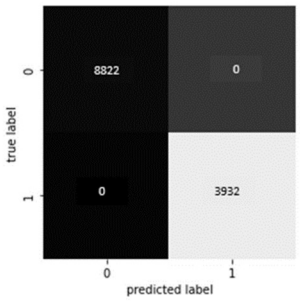

Figure 6. Confusion Matrix for RF classifier.

B. COMPARING THE PERFORMANCE OF THE CLASSIFIERS

In Fig. 7, it represents the comparison of validating parameter metrics generated by NB and RF. Fig. 7(a) represents the precision, recall, and F-measure value comparison and Fig. 7(b) represents the MCC, ROC, and PRC values comparison. The figure shows that the RF classifier gives the best result for all the parameter metrics.

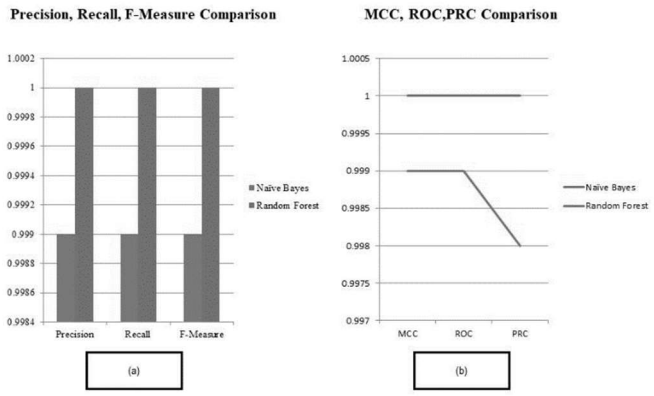

Figure 7. Graphical representation for comparing the parameter metrics of the classifiers.

In Table 4, the performance metrics of the NB and RF classifier is shown and from the comparison, it has been analyzed that the RF classifier gives the best result for all the performance metrics than the NB classifier.

Table 4. Comparison of performance metrics of the classifiers

Sl. No.	Validating Parameter	NB Classifier	RF Classifier
1	Classified Correctly	99.8%	100%
2	Precision	0.999	1
3	Recall	0.999	1
4	F-Measure	0.999	1
5	MCC	0.999	1
6	ROC	0.999	1
7	PRC	0.998	1

C. CLUSTERING

Clustering is done for the grouping of similar data points in a group; we have applied K-Means clustering and generated two clusters. 19 iterations are done for the clustering process. The locations are grouped using cluster. Cluster0 represents the Europe and Cluster1 represents the Asia. The model was constructed in 3.08 seconds. The first cluster has 24416 instances and the second cluster has 39350 instances. The clustering has been done before identifying the target class. This was done to analyze the performance of semi-supervised learning.

Table 5. Clustering representation

Sl. No.	Cluster Name	Number of Instances	% of instances
1	0	24416	38
2	1	39350	62

Table 4, represents the cluster name, the number of instances, and the percentage of the instances. When k-means clustering has been applied it grouped two clusters namely cluster 0 and cluster1; for cluster 0 it grouped 24416 instances and 38% of data. For cluster 1 it grouped 39350 instances and 62% of data.

Fig. 8 represents the clustering of the data. It is clustered as cluster0 and cluster1. In this semi-supervised approach, the classification and clustering have been done; NB and RF classifiers are used for the classification and for this dataset the RF classifier gives the best result than the NB; in the clustering, it generated 2 clusters. Based on the dataset the classification

and clustering will differ. After this step, a study has been done to find the influence of the COVID-19 on Alzheimer's persons.

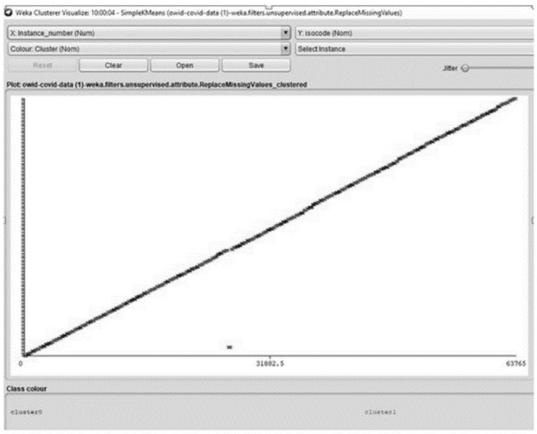

Figure 8. Graphical representation of the clustering

D. EFFECT OF THE COVID-19 ON THE ALZHEIMER'S PATIENTS

To find the influence of the COVID-19 on Alzheimer's Patients we have done a study because we don't have a dataset about that. Though the dataset is not available for both Alzheimer's and COVID-19 patients; we have compared the results of the selected dataset and studied the impact analysis of COVID-19 on Alzheimer's patients. The peoples need to do the hand wash frequently but the Alzheimer's patients have the problem of memory loss so they forget to wash their hands frequently. Due to this COVID-19 will affect Alzheimer's patients easily. The caregivers of the patients are to take safety measures to handle the risk [25]. In Pennsylvania, more than 753 people died due to Alzheimer's and diabetes. In New Jersey, more than 634 deaths happened due to these diseases. The researchers said that more death of Alzheimer's patients happened because of the undiagnosed COVID-19. Due to the stress and social isolation also, the more death happens among Alzheimer's patients. The family members or the visitors are not allowed to visit the Alzheimer's patients who are affected by the COVID-19. No researchers pointed out that Alzheimer's disease is a risk for the COVID-19 but age, health conditions increase the risk. The researchers' advised the caregivers of the Alzheimer's patients to take care of them, so it is considered as more risk for the caregivers [26]. The authors have done a review for finding the influence of COVID-19 on the AD patients and the related dementias and concluded that it this risk for the AD and related dementia persons with COVID-19 [27]. COVID-19 affects the seniors so need to show attention to the AD Persons. The authors conducted a study with the data of 19 AD persons with COVID-19 and 23 non-AD COVID-19 persons who were hospitalized at the same time and found that the median time period to discharge is lesser in AD person than non-AD persons [28]. Considered 61.9 million patients' electronic health records from the US and they found the COVID-19 patient with dementia has more risk than the COVID-19 patients without dementia [29]. The authors analyzed that the COVID-19 and the Alzheimer's disease have a link and it is a risk for Alzheimer's patients with COVID-19 [30].

VI. CONCLUSIONS

A semi-supervised machine learning framework has been proposed in this paper. The dataset collected is subjected to data pre-processing; in data preprocessing we have done the data cleaning and imputation process. Mean imputation is applied to generate the missing value. Then the feature extraction and feature selection are done; the best first method is applied for the feature selection and CFS Subset Evaluator is applied for the evaluation. The selected features are then subjected to the hybrid machine learning process; in the hybrid processing, we have done classification and clustering. The NB classifier produced 99.88% classification accuracy and the RF classifier produced 100% classification accuracy. Also, the Precision, Recall, F-measure, MCC, ROC curve, PRC values give the best result for the RF classifier than the NB classifier; so, we choose the RF classifier as the best classifier. In the clustering process, 2 clusters are created based on the similarities of the data point. For our dataset, the RF classifier gives the best result and for another dataset, the result of the models will be differing. The model is validated using a 10-fold cross-validation technique. Then we have done a study to analyze the influence of COVID-19 on Alzheimer's patients and based on the literature it is predicted that it is a risk for Alzheimer's patient due to COVID-19. In the future, we planned to do the classification with the other classifiers for various datasets.

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