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MACHINE LEARNING &AI-BASED TECHNIQUES FOR COVID-19 FORECASTING

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Abstract:

The COVID-19 epidemic has tremendously influenced society as a whole, the economy, and public health on a global scale. Scientists and researchers worldwide are looking into several solutions to this problem, including using artificial intelligence (AI) techniques to forecast the virus spread and develop effective control measures. AI-based solutions have demonstrated great promise by analysing complex data patterns and identifying potential risk factors for COVID-19. These tactics include machine learning algorithms, data mining, natural language processing, and other cutting-edge analytical tools to analyse large datasets from many sources, including medical records, social media, and public health databases. The insights generated by AI-based algorithms are used by policymakers, healthcare professionals, and academics to create effective vaccination regimens, forecast the pandemic's spread, and identify potential COVID-19 epidemic hotspots.

1. Introduction:

People's lives and the global economy have both been touched by the COVID19 epidemic. It has impacted the world in unheard-of ways. The propagation of the virus may be foreseen and the quantity of cases that may emerge in the future with the aid of AI-based tools.Machine learning algorithms are used to analyse datasets of COVID-19 cases, demographics, and other pertinent data in AI-based strategies for COVID-19 forecasting. By utilizing these methods, forecasting for COVID-19 may be more accurate, empowering medical personnel to make wise decisions and take preventative action.

Analysis of datasets of COVID-19 cases using an AI-based approach for COVID-19 prediction. The analysis of the data using machine learning methods, such as support vector machines (SVM) and Exponential Smoothing (ES) [1]. Time series forecasting is one of the COVID-19 forecasting models that has included AI-based approaches [3]. The propagation of the virus, the number of cases, hospitalizations, and potential fatalities are predicted using these models. Analysis of the effect on GDP is done using the Adaboost method [6]. With the help of these methods, medical practitioners can make wise choices and act proactively to stop the virus's spread and limit its effects on human life and the world economy. A person who has been exposed to a virus from the vast family of coronaviruses will become infected in their nose, sinuses, or upper throat, which can result in fatal acute respiratory distress syndrome [5]. Animals like camels, cuttles, cats, and bats are also affected by COVID-19 in addition to humans [5]. The first case was detected in Wuhan, China, in late 2019[1,2,5], and because of the movement associated with the Chinese Spring Festival, it flourished throughout China before spreading beyond. When an infected person coughs, sneezes, or even talks, the discharged droplets stay in the air and can infect anyone within six feet of the infected person [5]. After identifying COVID-19 as a threat to human life, state governments placed restrictions across state lines to slow the spread of the disease's exponential growth. A significant loss of revenue has been seen in the nation as a result of the lockdown to give complementing results trend forecasting is done using the ARIMA Model [5].

This paper reviews the analysis of COVID-19 case and demographic data using AI-based technologies and machine learning algorithms to produce precise forecasts and predictions. These techniques, which include Exponential Smoothing (ES), Support Vector Machines (SVM), and Time Series anticipating Models [1,4], aid in anticipating the propagation of the virus, the quantity of cases, hospitalisations, and potential fatalities.

The effect of COVID-19 on the global economy, specifically GDP, is also examined using the Adaboost approach [4]. These AI-based methods allow medical practitioners to make well-informed decisions and take preventative action to slow the spread of the virus and lessen its effects on human life and the economy. COVID-19 can infect animals like camels, cuttlefish, cats, and bats, and it draws attention to the virus's initial discovery in Wuhan, China [5]. It also highlights how the disease spreads by respiratory droplets and how state governments have implemented lockdowns and limitations to slow the disease's exponential spread.

To supplement the outcomes of the lockdown measures, the usage of the ARIMA Model for trend forecasting is also mentioned [4].Artificial Intelligence (AI) stands at the forefront of technological advancements, reshaping the landscape of numerous fields and industries [7]. Rooted in the pursuit of creating machines capable of simulating human-like intelligence [8,9], AI embodies the amalgamation of cutting-edge computer science, mathematics, and cognitive psychology [10-12]. As a transformative force, AI has propelled innovations in natural language processing, computer vision, robotics, and decision-making systems, fostering revolutionary applications across healthcare, finance, transportation, and beyond [13,14]. With its potential to augment human capabilities and address complex challenges, AI

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continues to captivate researchers, academics, and industry leaders worldwide, spurring relentless exploration and development [15-19]. This research paper delves into the realm of artificial intelligence, unravelling its historical evolution, core methodologies, current state-of-the-art technologies, and the ethical considerations surrounding its pervasive integration [20-23]. Through an in-depth analysis of AI's past, present, and future implications, this study aims to shed light on the profound impact of AI and its trajectory towards shaping a more intelligent and interconnected world [24].

2. COVID-19 Future Forecasting Using Supervised Machine Learning Models:

SARS-CoV-2, another name for the new coronavirus and officially named COVID-19 by the WHO, has become a severe threat to human life globally. Following the discovery of the first case in Wuhan, China, in December 2019, the infection has rapidly spread worldwide. Any medicine cannot cure the virus as of now. A total of 685,459,24 cases have been reported worldwide, and considering how lethal it is, it is crucial to foresee the future to stop its widespread, with thousands of cases and new cases every day.MachineLearning is a sophisticated and effective method for forecasting future numerical data associated with CoVID-19. Numerous industries, including healthcare, autonomous vehicles, natural language processing, commercial applications, gaming, intelligent robotics, climate, voice, and image processing, have demonstrated the remarkable effectiveness of machinelearning[1].

The algorithm is given a data collection that spans ten days to estimate future variables. Since this is a regression problem, important metrics like R-Squared Score, Adjusted R^2 Score, Mean Square Error, Mean Absolute Error, and Root Mean Square Error are used to assess how accurate the model is. Taking preventive measures based on the prognosis produced by Machine Learning is advantageous.

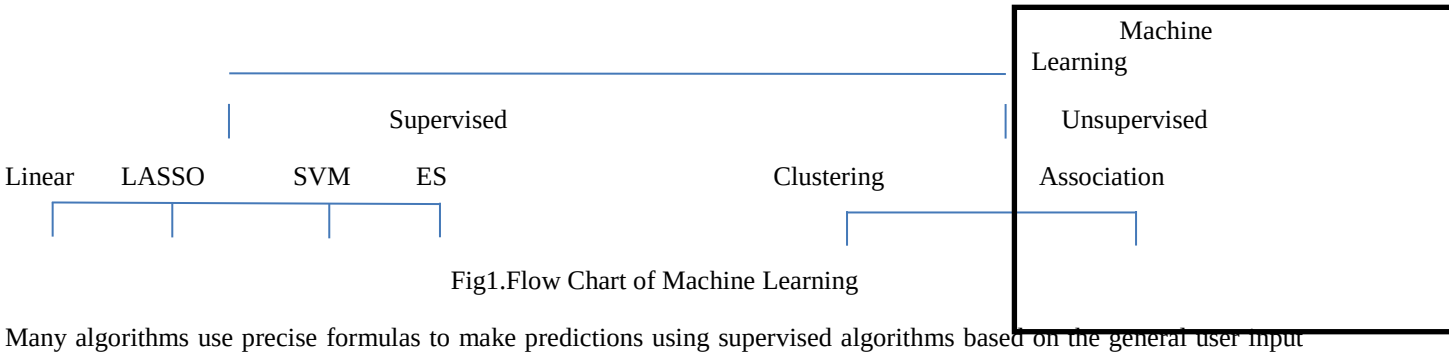

Fig1.Flow Chart of Machine Learning

Many algorithms use precise formulas to make predictions using supervised algorithms based on the general user input data:

Table1: Machine Learning Algorithm Formulas

Linear Regression	$y = \beta 0 + \beta 1x + \varepsilon$ $E(y) = \beta 0 + \beta 1x$
LASSO (Least Absolute Shrinkage and Selection Operator)	$\sum_{i=1}^{n}(yi - \sum_j xij\beta j)^2 + \lambda\sum_{j=1}^{p}\lvert\beta j\rvert$
SVM (support vector machine)	$f(y) = y\,0\beta + b$
ES (Exponential Smoothing)	$U_t = \alpha B_{t-1} + (1-\alpha)U_{t-1}$

The machine learning technique was evaluated by:

Table2: Evaluation Parameters Formulas

R^2 Score	Variance explained by model/Total variance
R^2Adjusted	$1 - [(1 - S^2)\frac{m-1}{m-(k+1)}]$
Mean Absolute Error	$\frac{1}{n}\sum_{j=1}^{n}\lvert y\,j - \hat{y}\,j\rvert$
Mean square error	$\frac{1}{n}\sum_{j=1}^{n}(y\,j - \hat{y}\,j)2$

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Mean square error	$[\sqrt{\frac{1}{n}(y\,j\ -\ \hat{y}\,j)}]$

The dataset mainly consists of information abouthow many fresh cases of infection there are, the count of recoveries, finally the aggregate of deaths.

The forthcoming newly infected cases, deaths, and recoveries are foretell using the four machine learning methods and presented on graphs. Exponential smoothing has demonstrated the most accurate prediction of all the models for a range of data set sizes. The LinearRegression and LASSO started making better predictions as the size of the data set increased. Using the given data set, SVM generated a very subpar analysis. The government can take the required steps to combat and stop the spread of the COVID-19 virus thanks to the future forecast.

3. Analysing and forecasting the COVID-19 outbreak in India:

The first positive case was found in India in Kerala on January 30, 2020. India is one of the nations that has been impacted. The government has advised a lockdown nationwide to stop the spread of the virus. The situation has impacted several kinds of businesses, including education, agriculture, small-scale manufacturing, entertainment, and many other services, and has left the nation in an unstable position.

The spread of the virus is classified into three categories: Local outbreak, Community transmission, and Large-Scale Transmission. To forecast and analyse the COVID-19 epidemic in India, ARIMA and Prophet models by Facebook are used. The analysis parameters of COVID-19 are:

1) Confirmed cases: C_T
2) New cases: $N_T = C_T - C_{T-1}$
3) Recorded cases: R_T
4) Mortality rate: D_T / C_T
5) Deaths: D_T
6) Active cases: $I_T = C_T - (R_T + D_T)$
7) Recovery rate: R_T / C_T
8) Rate of Daily Infection: $I_T-(I_{T-1}/I_{T-1})$

For vaticinate the COVID-19 epidemic in India, the ARIMA model(Autoregressive Integrated Moving Average) is utilized. This model uses a great search approach AND FOLLOWS the p,d,q model.

- Autoregressive p model for observation and lagged observation:

$$Z_t = C + \sum_{i=0}^{P} \varphi i\, Zt - i + \varepsilon_t \qquad (1)$$

- Moving Average (q):

$$Z_t = \mu + \varepsilon_t + \sum_{l=1}^{Q} \theta i \varepsilon t - i \qquad (2)$$

Both of these are for stationary time series datasets.

- Differencing parameter(d) is introduced for a nonstationary time series data set:

$$Z_T{}' = Z_T - Z_{T-1}, \quad \text{if d=2 then } Z_T{}'' = Z_T{}' - Z_{T-1}{}' \qquad (3)$$

$$Z_t = C + \varepsilon_t + \sum_{i=1}^{P} \varphi i Zt - i + \sum_{i=1}^{q} \theta i\, \varepsilon t - i \qquad (4)$$

Performance matrices used here are:

Root Mean Square Error (RSME), Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE), Mean Square Error.

Table3: Performance matrices Formulas

RSME	$\sqrt{\sum_{i=1}^{n} \frac{yi\ -\ \hat{y}i^2}{n}}$
MAE	$\frac{1}{n}\sum_{i=1}^{n} \lvert yi\ -\ \hat{y}i\rvert$
MAPE	$\frac{100}{n}\sum_{i=1}^{n} \frac{\lvert yi\ -\ \hat{y}i\rvert}{yi}$
Mean Square Error	$1 - \frac{\sum(yi\ -\ \hat{y}i)^2}{\sum(yi\ -\ y)^2}$

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These matrices are used to find the average percentage of error between predicted versus observed values [2].

4. Forecast of CoVID-19 in India using the ARIMA model:

ARIMA is the model of supervised Machine Learning which performs better in forecasting dengue fever, hemorrhagic fever, and various diseases. Better than SVM, In India, it is required to study the rate of infection of COVID-19 to stop the death and spread of the disease and to remove lock dots which helps increase India's economy. ARIMA and ES use an approach of time series forecasting of problems. ARMA, a time series model, is differentiated and applied for nonstationary [4]. The process carried out in ARIMA is shown below:

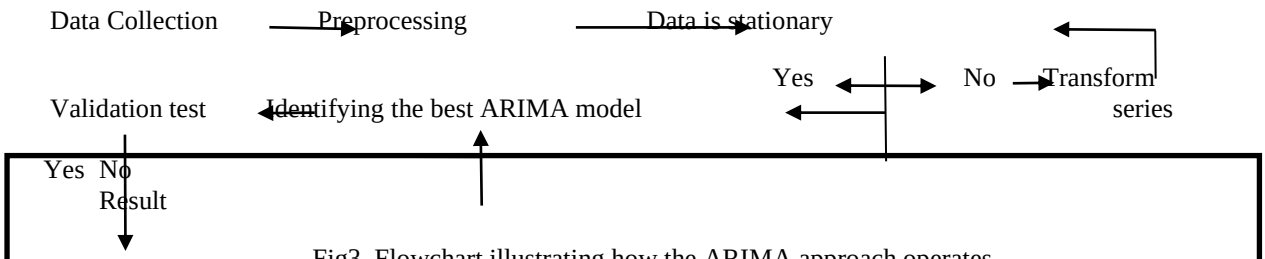

Fig3. Flowchart illustrating how the ARIMA approach operates

The data set provided by the ARIMA model generated results with an accuracy of 95% in comparing predicted values to the original values.

5.Analysis and prediction of COVID-19 using regression models and time series forecasting:

A massive data set is collected from various time series, which consists of null values and requires cleaning, which is then visualized using graphs and heat maps. And then, we can obtain the final results of the Analysis and prediction of COVID-19 by tabulating the Time Series Forecast [3].

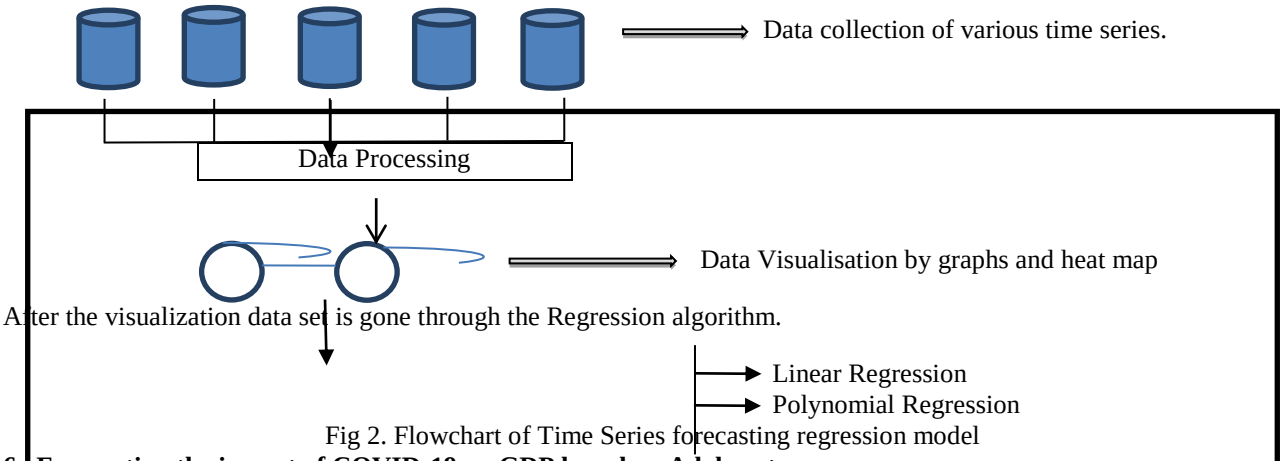

Fig 2. Flowchart of Time Series forecasting regression model

6. Forecasting the impact of COVID-19 on GDP based on Adaboost:

India has imposed a strict lockdown at the time of COVID-19. In this time of lockdown, every service in the state in between states has been resumed, which caused an impact on the economy and GDP due to restrictions. The AdaBoost model, which has been tested with more than 50,000 data records, is used for forewarning the impact of GDP due to COVID-19 in India. Many tiny enterprises have withdrawn from the market due to disturbances caused by the capital amount and weekend total supply. Global economic recession and destruction of the supply chain are caused due to the fall of GDP, which results in researchers looking for preventive measures to stop losing the jobs of millions of people.

The novel economic scheme was proposed to promote economic activities using a bidirectional extended short-term memory model by Vekaria et al. The data set used in the regression model consists of Gross Domestic Product per capture(GDP), Human Development Index (HDI), Stringency index (STI), and the Total number of cases (TC). Total deaths(TD), COUNTR, Population (POP), Recorded dates (Dates). Since it is massive data, it consists of missing values, deviations, and errors, so to normalize it, we can use this slope formula, i.e.,

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$$x=\frac{x-\min(x)}{\max(x)-\min(x)}$$

(5)

The working mechanism of the Adaboost model is a basic explanation of how Adaboost functions. A weak learner must first be trained from the training set with the initial weight to focus more on learning the features of these bad cases to get later learners to focus more on learning the features of these bad cases. Then, the weights of the training samples must be updated by the bad cases output by the weak learner. The training is repeated as described above until a specific number of weak learners is reached. Ultimately, the boosting approach integrates all weak learners to produce the final strong learners.

7. Generalized Mechanistic model for Assessing and Broadcasting the spread of COVID-19 Pandemic:

The virus is transmitted through the air or surface of the objects. On steel items, it may endure for two to three days and up to three hours in the air.

The evolution of COVID-19 is composed of 8 states protected, susceptible, exposed, infectious, recovered, hospitalized, quarantined, and deaths. Phenomenological models utilize a method of evidence to establish a connection between the patterns of the data and the physical laws without any specific bias. While considering physical principles, a mechanical model is used to explain data patterns. To calculate the case-fatality and total infection-fatality ratios, the SEIR mathematical model for the description of infection transmission and mortality was created. SIDARTHE modern distinguishes between determined and undetermined cases varying in sickness severity.

The extended model to get advanced overview of different scenarios is shown using below flow chart and these will character the crowd and their effect on spread of COVID-19.

Total Population=P(Total)= S(t)+E(t)+P(t)+I(t)+H(t)+Q(t)+D(t)+R(t) → (6)

Confirmed cases=I^{rep}=I(t)+H(t)+Q(t) w.r.t (t) → (7)

Not Reported= I^{Nrep}=E (t) w.r.t (t) (8) →

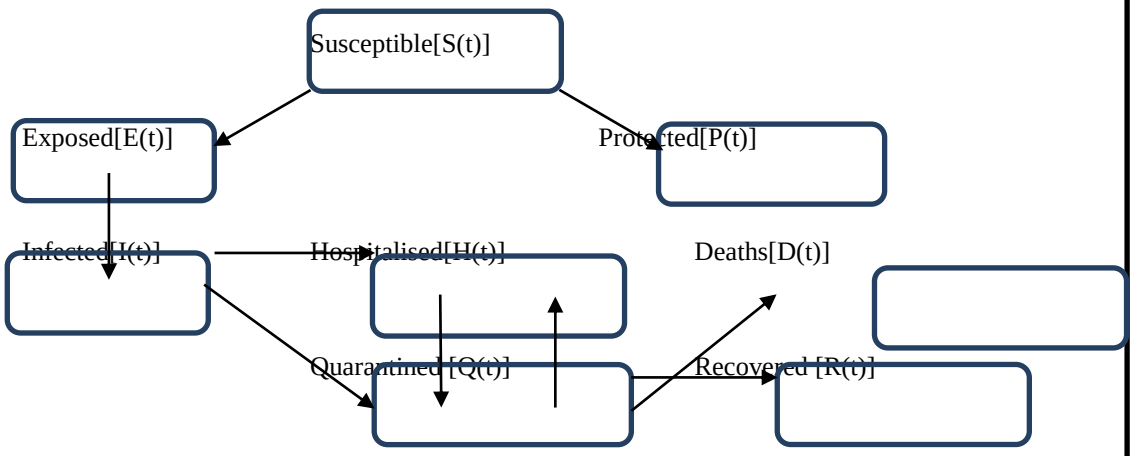

Fig 4.Flowchart of for generalised model analysis

The obtained results from this model depend upon Every state. Because every state has its regulations and policies. A generalized model for the different forms with different regulation policies can give accurate results [5].

8. Role of IoT in forecasting COVID-19:

IOT plays a prominent role in the forecasting of covid19. Any AI and ML model requires a dataset for future forecasting or results. IOT plays a crucial role in gathering the whole dataset into one place. IoT is used to obtain the health parameters of patients continuously to monitor his/her real-time status. The parameters IoT devices measure are temperature, oxygen saturation, and respiratory rate of the body. It enables detecting the distance between two patients and tracking their movement. IoT devices provide suitable environmental parameters that help stop the spread and create

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a proper atmosphere for patients. Exchanging data provides real-time information, and it is capable of providing whole data without human intervention.

9. Role of Embedded Systems during COVID-19:

In the struggle against COVID-19, embedded systems are essential. Embedded systems are specialized computer systems built into other machinery or devices, like consumer electronics, medical equipment, and automotive systems. They are designed to perform specific tasks efficiently and reliably. Embedded systems are essential to numerous medical devices, including patient monitors, oxygen concentrators, and ventilators. These tools support the monitoring, diagnosis, and care of COVID-19 patients. Wearable technology that can track patients' vital indicators like heart rate, respiration rate, and oxygen saturation uses embedded systems. These tools, which can track people's activities and conversations, enable medical professionals to monitor patients remotely, lowering the danger of viral exposure. These tools can assist in identifying potential virus exposure and stop future spread.

Disinfection systems that employ UV light or other technologies to sanitize surfaces and the air using embedded systems. These devices are utilized in hospitals, public transit, and other public areas to lower the risk of viral transmission. Overall, by enabling quick testing, precise treatment, and efficient patient monitoring, embedded technologies play a significant part in the COVID-19 response. They are crucial parts of numerous medical tools and programs that aid in the fight against the pandemic for healthcare professionals.

10. Conclusion:

Artificial intelligence-based methods have demonstrated considerable promise in forecasting and predicting the spread of COVID-19. These methods employ information from sources to create precise and trustworthy models that may be used to predict the spread of the infection. With evaluation against the real-time findings, Exponential Smoothing has produced reliable forecasts for a range of data set sizes. Other Machine Learning algorithms in future forecasting include Linearregression, LASSO, SVM, and ES. Time series forecasting models like ARIMA and Prophet have localized the results for India. The trends Machine Learning models have produced have accurately depicted the daily infection rate and the rapid growth of active cases. This type of forecasting is the best for the short term because it is unaffected by data noise. Overall, AI-based methods to combat COVID-19 have shown considerable promise. These methods have the potential to dramatically increase our capacity to anticipate and control upcoming pandemics with more research and development.

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