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Evaluation of performance of an LR and SVR models to predict COVID-19 pandemic

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ABSTRACT

Recently, in December 2019 the Coronavirus disease surprisingly influenced the lives of millions of people in the world with its swift spread. To support medical experts/doctors with the overpowering challenge of prediction of total cases in India, a machine-learning algorithm was developed. In this research article, the author describes the possibility of predicting the COVID-19 total, active cases, death and cured cases in India up to 25th June 2020 by applying linear regression and support vector machine. It is extremely tricky to manage the occurrence of corona virus since it is expanding exponentially day to day and is difficult to handle with a limited number of doctors and beds to treat the infected individuals with limited time. Hence, it is essential to develop a machine learning based computerized predicting model. The development effort in this article is based on publicly available data that is downloaded from KAGGLE to estimate the spread of the disease within a short period. We have calculated the RMSE, R2, MAE of LR and SVR models and concluded that the RMSE of linear regression is less than the SVR. Therefore, the LR will help doctors to forecast for the next few days.
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1. Introduction

As coronavirus disease was raised in China and spread in almost all countries. The WHO announced that this disease is pandemic in the second week of March 2020 and named as a novel coronavirus. As of writing, the total cases were 5,08,953 and mortality due to disease is 15,685 all over India[1]. COVID-19 is impacting more on the global economy very deeply. It is caused mainly through small drops of infected person's saliva that is ejected from mouth or rhinorrhea from nose. A big alert is needed to the globe where high dense populated countries. A person suffering from coronavirus disease is having the following symptoms: cough, temperature, feeling difficult in taking breath.

The COVID-19 expands very instantly from one person to another person by small respiratory drops. Coronavirus disease is transmitted in 4 stages. Stage 1: without local origin, the people who are imported from the affected countries. Stage 2: local spread by the affected people who travelled from the affected country. Stage 3: community transmission where the contacted persons are untraceable. Stage 4: most severe stage [2]. Due to inadequate diagnosis tools available, there is a necessity of a development of novel frameworks to identify the early diagnosis and predicting the disease by researchers, academicians. As per the information received from expert doctors, the person who is infected by coronavirus disease has to be in treatment for one week or two week and should be isolated from the healthy persons.

The various datasets of COVID-19 were available in websites like IEEE-dataport, KAGGLE, Github, Johns Hopkins in different formats [3]. For this article, we gathered daily updated COVID- 19 data, which is in XLSX format and downloaded from KAGGLE website from 30th January 2020 to 21st May 2020. This data is utilized to find RMSE, R^2 and MAE of linear regression and support vector machine models to predict the active, total, death and cured cases in India for next few days [4]. To investigate various types of data machine-learning tools are used. In this tool, analysis of regression and using support vector machine models plays a vital role. Nowadays most of the data are being analyzed by machine learning algorithms. To have cost effective health management, perfect and early prediction of the corona virus has to be implemented by young scientists/researchers.

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The corona virus is in exponential nature and hence it is tricky to manage with inadequate experts in the hospitals to handle such a huge number of infected persons. Hence, a suitable machine learning/deep learning model needs to develop that would represent all the information regarding the whole disease system and it tells the nature of disease and forecast the total confirmed cases in India for next few days. Many authors published few articles regarding the prediction of the disease by proposing their own mathematical models by introducing quarantine by following government measures to reduce the disease transmission [5]. With the advent of computational tools and software, any one with little knowledge can easily develop and solve any issues related to infectious disease. In this epidemic analysis and predicting the corona virus disease, machine- learning algorithms play a vital part. ML is a division of artificial intelligence and is used to train and test the system with the information gathered from KAGGLE.

2. Related work

R. Sujath, et.al. [6] carry out LR, MLP and VAR models for Coronavirus Kaggle data to predict the epidemiological issue. Natrayan L and senthil kumar et.al. [7] employed two algorithms such as Jaya and Multi output regressor algorithms to train and test the models in terms of binary classification. Shreshth Tuli, et.al.[8] developed an ML model to foresee the future of coronavirus cases worldwide. Generalized Inverse Weibull distribution is a best model for real time prediction of the behavior of epidemic COVID-19. Ramjeet Singh Yadav [9] presented six various regression models namely exponential, 2nd, 3rd, 4th, 5th, 6th degree polynomials of the COVID-19 data and found RMSE of all the six models and concluded 6th degree polynomial model is generating best model for predicting the situation of next 6 days of COVID-2019. S. Magesh, et al.[10] presented a deep convolutional neural network technique to detect COVID-19 using real database. For forecasting the number of confirmed cases, they proposed ARIMA, PA and LSTM algorithms. Akib Mohi Ud Din Khanday et.al. [11] used ensemble learning algorithm to classify the clinical data into four classes. Kabir Abdulmajeed, et.al. [12] developed an algorithm which combines ARIMA and PA and Holt-Winters Expo- nential Smoothing model combined with GARCH to predict the exponential nature of covid-19 disease.

Model Formulation And Methodology

a) Machine Learning

The model solutions need to be repeated till to find the best solutions that are capable of predicting the amount of confirmed, active, migrated, death cases of coronavirus in India. The goals of this study are stated as following:

The models of LR and SVR are used to find the amount of expansion of the infection.

To predict the coronavirus cases: confirmed, active, death, cured in India for further 25 days so that government authorities will take control measures.

ML is being taught as a computerized model to analyze data in a variety of fields like therapeutic engineering, statistical engineering, commerce and financial sectors. The purpose of machine learning is to understand the data and fit the data that should be understood by the users to utilize this model for their own data. Machine learning algorithms allow computer systems to train input data and analyze the statistical output values within a particular range. Machine learning builds the models to automate the decision making process based on the input data. Machine learning methods are broadly classified into three methods: [13]

i) Supervised learning

ii) Unsupervised learning

iii) Reinforcement learning

Supervised learning is provided with the labeled inputs to the system to get desired labeled outputs. The main objective of this method is to learn by comparing real output with the trained outputs to get errors so that the model can be modified accordingly. To forecast the label values, supervised learning is used. Unsupervised learning is used to find the similarities in the input data that has been provided. In this method, the data to be used is unlabeled and this unlabeled data is richly available. This unsupervised learning allows the machine to discover the patterns that are needed to classify from the original data automatically. In addition to the above-mentioned two methods, the last learning method is reinforcement learning. This algorithm focuses on the study to make balance between the investigation and utilization of the input and output pairs.

b) Methodology

The dataset of corona virus utilized in this research article is gathered from KAGGLE website from January 30, 2020 to May 21, 2020. The data includes all the active cases, confirmed cases, death cases and migrated cases in India. The data was reorganized into date wise confirmed cases, active cases, cured cases and death cases in India and is available in time series format. For predicting purpose, the data is divided into training dataset and testing dataset.

Model 1

i) Regression analysis. Regression analysis is to foresee a continuous parameter (y) which depends up on the value of the forecaster variable (x). A regression analysis can be classified into three types:

i. LR model

ii. Multi LR model

iii. PR model

3. Linear regression

The reorganized data was applied to the regression model. In statistics, a mathematical regression model is a process of estimating the relation between dependent and independent variables. Regression may have one or more independent variables. Most commonly used regression model is LR model. Linear regression models try to attempt the relation among two different parameters by fitting the data in a straight line that is observed between dependent parameter and independent parameter in Fig. 1. Here one parameter is considered as a dependent variable and the other

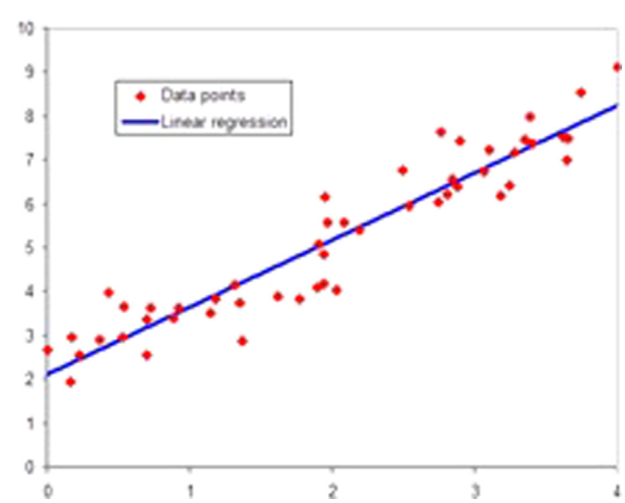

Fig 1. Model graph of linear regression in which data points are fitted on a straight line.

is considered as an independent variable. Regression analysis can be applied to two distinct purposes: one is to predict and the other is to forecast. LR is represented as a combination of input parameters and the foresee output parameters. Here both parameters have numeric values.

In simple regression analysis, the linear regression is expressed as:

$$y = b0 + b * x + e \quad (1)$$

where, b0 is constant (intercept), b is weight of regression and e is residue error.

3.1. Multi LR

Multi LR model consists of more than one predictor. The simple equation for multi linear regression is given by

$$Yi = b0 + b1x1 + b2x2 + \ldots + e \quad (2)$$

Where, b0 is constant term, b1 is x1 coefficient variable, b2 is x2 coefficient variable, b3 is x3 coefficient variable and e is error associated with predicted value.

3.2. Polynomial regression

Polynomial regression is a non-linear regression. With this type, the analysis can be done by taking relation of the reliant variable is fixed to the nth degree of the independent variable. The equation of polynomial regression is as follows

$$Y = b0 + b1xi + b2xi2 + b3xi3 + \ b4xi4 + \ldots bnxin + e \quad (3)$$

ii) Model 2

Support Vector Machine

The reorganized data was applied to support vector machine (SVM) to analyze the model perfor- mance in terms of R^2, RMSE, and MAE. SVM is divided into regression and classification problems. It is a non linear generalization and can be used as algorithm for learning purpose. The main objective of this algorithm is to minimize the error occurred by observed training so that generalized performance is achieved. As earlier discussed, SVM has two classes namely SVC and SVR. SVR model depends only on subgroup of data which is used for training as the cost function is used to build the model that neglects the training data to predict the model [1314] Whereas SVC model is a binary classifier in machine learning method whose output is positive or negative result based on the input provided[13]. In general, the learner regression problem is as follows where the machine under the learning process is arranged to provide D data for training purpose (Fig. 2) where the machine tries to be taught the relation between the input and output values which is expressed as a function f(x). The training set of regression is expressed as D=(x1,y1),(x2,y2),...,(xi,yi) where the inputs are represented as × and the outputs are continuous values.

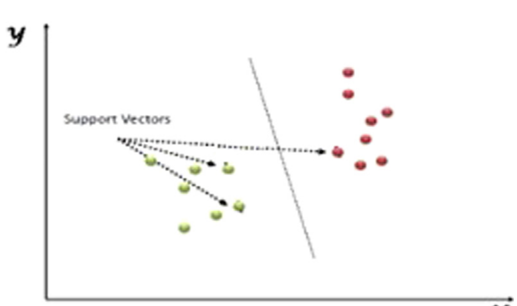

Fig 2. Model graph of support vector machine.

The SVR function provides the relation with input vector and the target vector and is simply expressed as

$$f(x) = wx - b \quad (4)$$

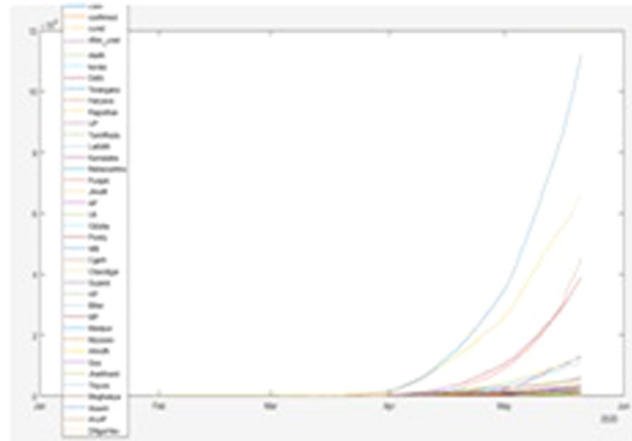

Fig 3. Plot of covid-19 cases all the states up to May 21, 2020.

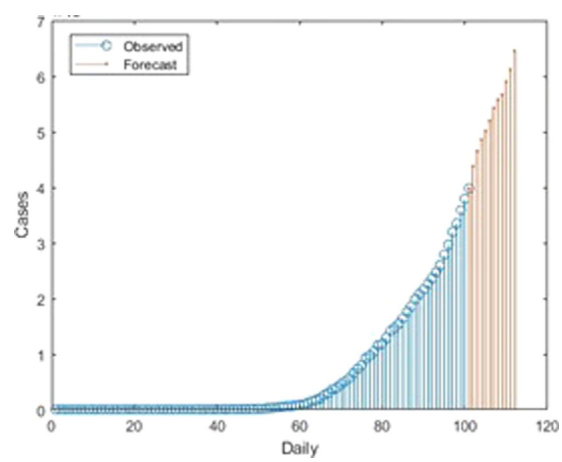

Fig 4. Plot of observed and forecasted confirmed cases.

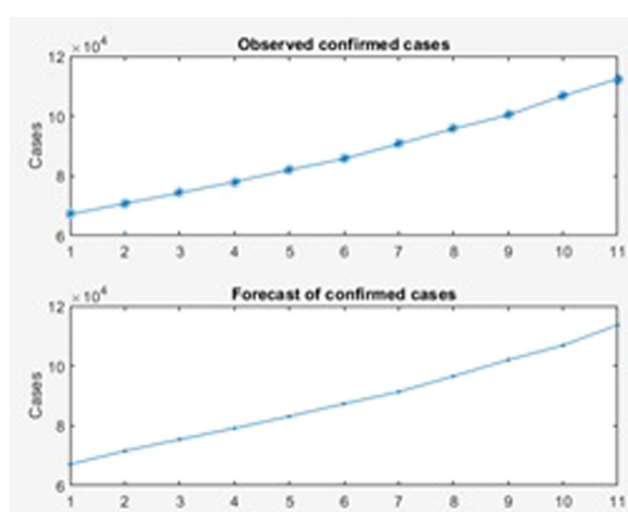

Fig 5. Observed and forecasted confirmed cases in India.

where w is the weight vector, b is the bias. SVR describes how much error is good enough with the model and will locate an appropriate line to fit the data. The role of SVR is to reduce the coefficients i.e., vector coefficient Support Vector Regression attempts the best line to fit within a preset value.

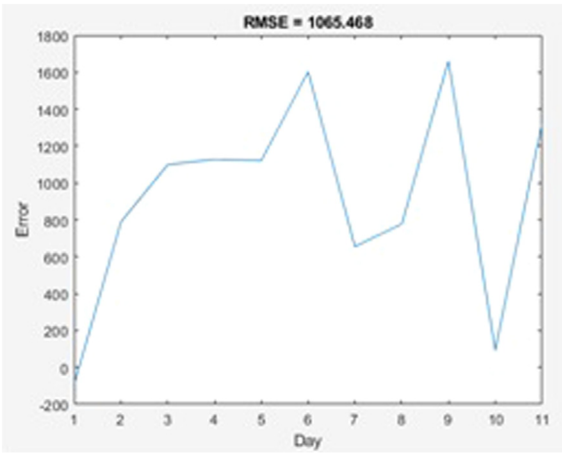

Fig 6. RMSE plot of observed and forecasted confirmed cases.

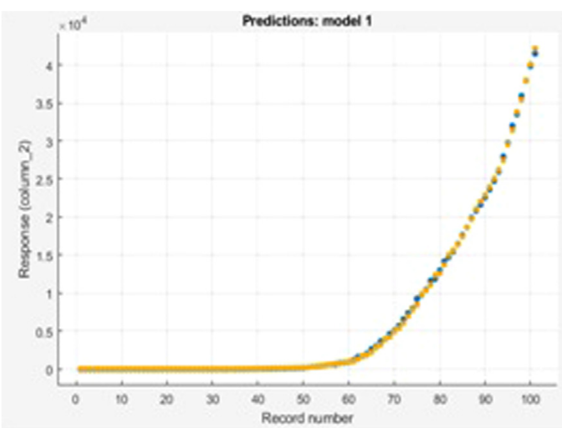

Fig 7. Response plot of the dataset with 10 fold validation.

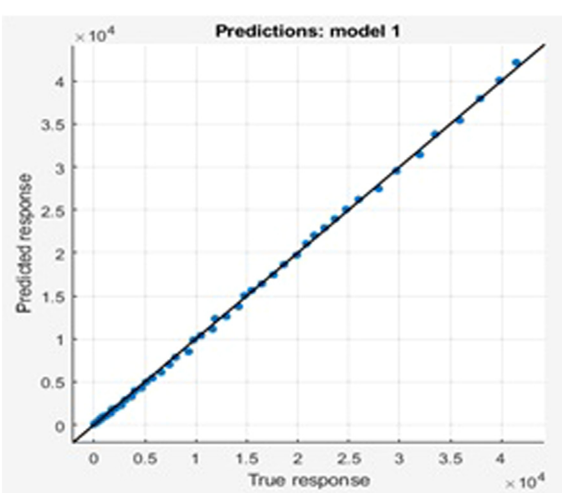

Fig 8. Predicted response with true response.

4. Performance metrics

The performance of linear regression model and support vector regression model is evaluated by the following parameters: RMSE, R^2, MAE [14].

i) Mean Absolute Error (MAE)

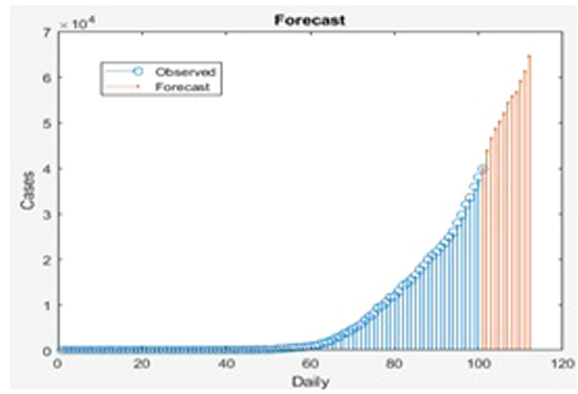

Fig 9. Plot of observed and forecasted active cases.

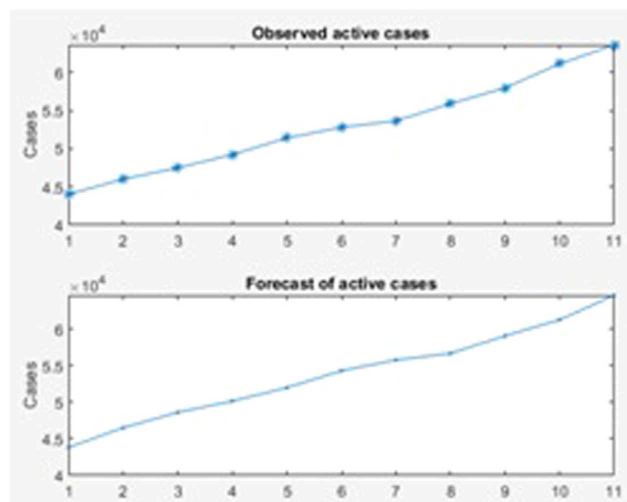

Fig 10. Observed and forecasted active cases in India.

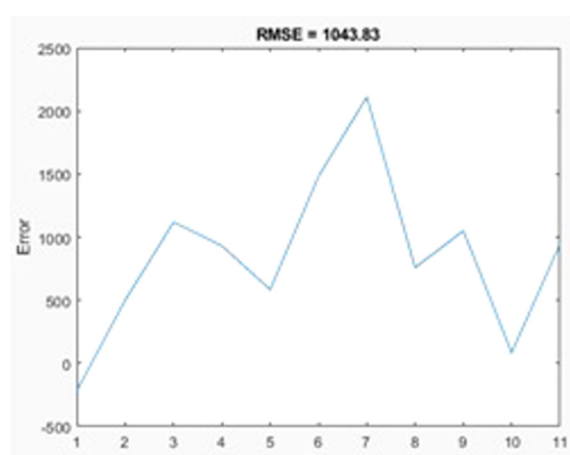

Fig 11. RMSE plot of observed and forecasted active cases.

MAE gives the total variation of forecasted and estimated parameter values [14].

$$MAE = \frac{1}{n}\sum_{n}^{i=1}\left|P^i - A^i\right| \quad (5)$$

Where i = sample index, Pi = Forecasted values, Ai = Actual values, n = dataset sample numbers

ii) Root Mean Square Error (RMSE)

It is the square root of mean of variation of prediction results and expected results. [15]

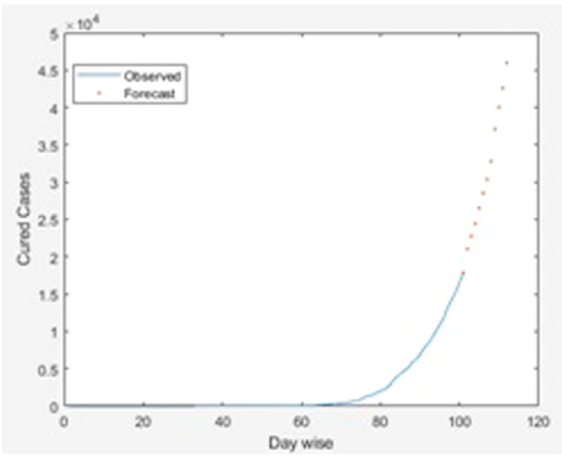

Fig 12. Plot of observed and forecasted cured cases.

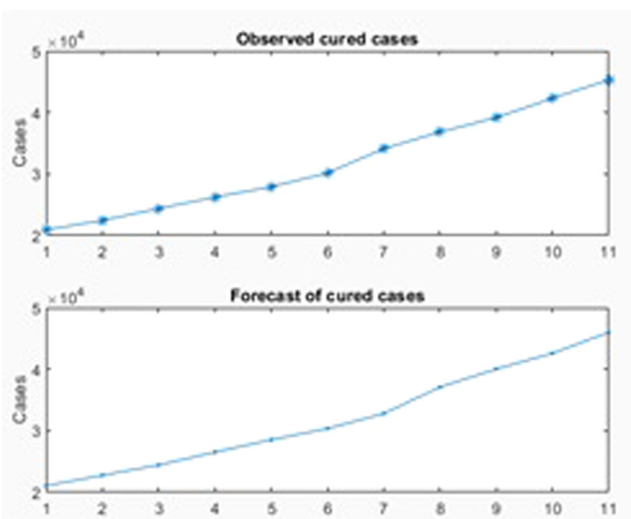

Fig 13. Observed and forecasted cured cases in India.

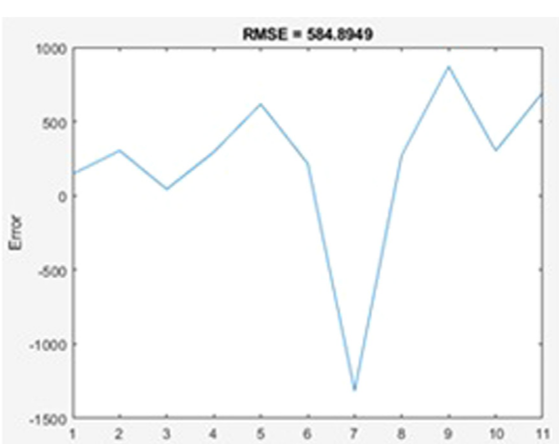

Fig 14. RMSE plot of observed and forecasted cured cases.

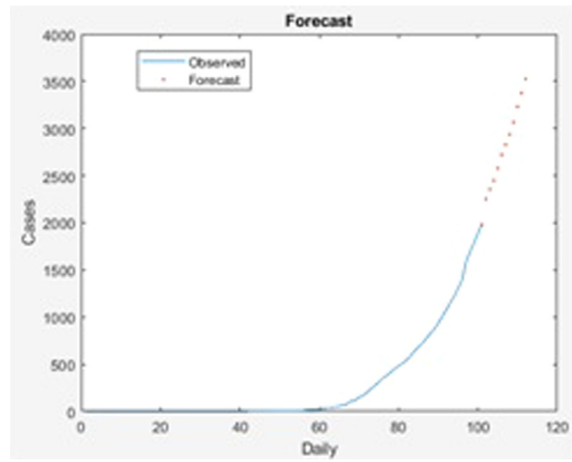

Fig 15. Plot of observed and forecasted death cases.

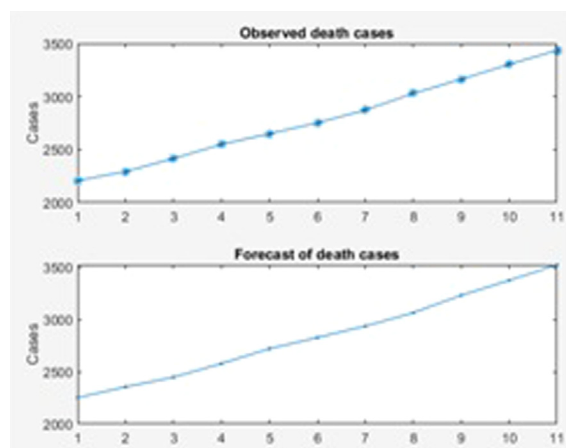

Fig 16. Observed and forecasted death cases in India.

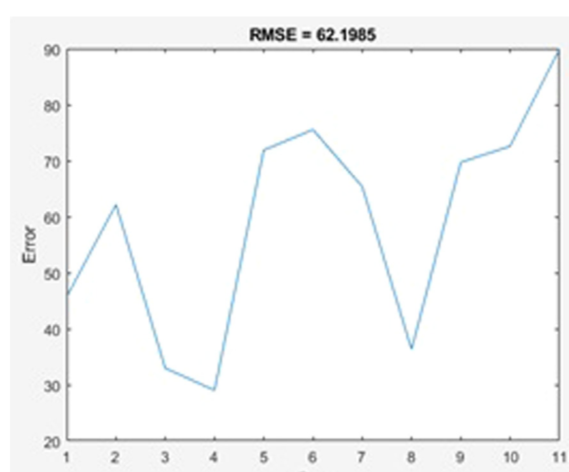

Fig 17. RMSE plot of observed and forecasted death cases.

$$RMS = \sqrt{\sum_{i=1}^{n} \frac{\left(P^i - A^i\right)^2}{n}} \quad (6)$$

Where i = sample index, Pi = Forecasted values, Ai = Actual values, n = dataset sample numbers.

iii) Correlation Coefficient

$r = \frac{\sum(x-\bar{x})-(y-\bar{y})}{\sqrt{\left[\sum(x-\bar{x})^2(y-\bar{y})^2\right]}}$ The value of correlation coefficient is defined as the values representing the independent parameter (x) and dependent parameter (y). It is denoted by r and is expressed as:

$$r = \frac{\sum(x-\bar{x})-(y-\bar{y})}{\sqrt{\left[\sum(x-x)^2\left(y-\bar{y}\right)^2\right]}} \quad (7)$$

iv) R-squared values

R-square value draws the variation of dependent parameter and independent parameter in the model in terms of percentage.

$$R^2 = \frac{explainedvariation}{totalvariation} \quad (8)$$

Table 1
Result analysis of learning methods i.e., linear regression and linear SVM regression models.

Learner Method	RMSE	R^2	MSE	MAE	Prediction Speed	Training Speed
Active Cases						
Linear regression	223.89	1.0	50,128	157.78	230 obs/sec	19.815 sec
Linear SVM	586.52	1.0	344,000	531.63	1300 obs/sec	108.08 sec
Confirmed Cases						
Linear regression	262.76	1.0	69,045	179.57	670 obs/sec	8.2682 sec
Linear SVM	606.57	1.0	367,930	561.21	460 obs/sec	19.215 sec
Death Cases						
Linear regression	13.494	1.0	182.1	6.5145	190 obs/sec	18.96 sec
Linear SVM	26.788	1.0	717.58	23.29	240 obs/sec	57.609 sec
Cured Cases						
Linear regression	96.10	1.0	9236.6	56.512	96 obs/sec	32.113 sec
Linear SVM	147.33	1.0	21,706	130.85	950 obs/sec	148.02 sec

Table 2
Shows predictions based on linear regression model.

S.No.	Date	Active cases	Confirmed cases	Cured cases	Death cases
1	5/21/2020	67,059	112,359	45,300	3435
2	5/22/2020	67,178	119,650	49,258	3666
3	5/23/2020	70,927	127,410	53,559	3912
4	5/24/2020	74,881	135,670	58,234	4174
5	5/25/2020	79,051	144,450	63,315	4453
6	5/26/2020	83,449	153,800	68,837	4751
7	5/27/2020	88,088	163,750	68,837	5069
8	5/28/2020	92,981	174,330	74,838	5408
9	5/29/2020	98,141	185,600	81,359	5770
10	5/30/2020	103,584	197,590	88,447	6155
11	5/31/2020	109,325	210,340	96,151	6566
12	6/1/2020	115,380	223,920	104,523	7004
13	6/2/2020	121,766	238,360	113,621	7471
14	6/3/2020	128,502	253,730	123,510	7969
15	6/4/2020	135,606	270,090	134,257	8500
16	6/5/2020	143,099	287,490	145,937	9066
17	6/6/2020	151,003	306,010	158,630	9670
18	6/7/2020	159,338	325,720	172,426	10,314
19	6/8/2020	168,130	346,690	187,419	11,000
20	6/9/2020	177,402	369,010	203,714	11,732
21	6/10/2020	187,183	392,750	221,423	12,513
22	6/11/2020	197,498	418,020	240,669	13,345
23	6/12/2020	208,378	444,910	261,586	14,232
24	6/13/2020	219,853	473,530	284,318	15,179
25	6/14/2020	231,956	503,980	309,024	16,188
26	6/15/2020	244,721	536,380	335,875	17,263
27	6/16/2020	258,185	570,860	365,056	18,410
28	6/17/2020	272,386	607,550	396,770	19,633
29	6/18/2020	287,363	646,590	431,238	20,937
30	6/19/2020	303,161	688,130	468,697	22,328
31	6/20/2020	319,822	732,340	509,408	23,810
32	6/21/2020	337,396	779,380	553,652	25,391
33	6/22/2020	355,931	829,440	601,738	27,077
34	6/23/2020	375,480	882,710	653,997	28,874
35	6/24/2020	396,099	939,390	710,793	30,791
36	6/25/2020	417,846	999,710	772,519	32,834

5. Experimental results

Forecasting gives relevant and reliable input regarding to present, past and future activities with definite numerical and scientific methods. There are few steps involved in predicting the numerical values for a specific task. First step is to understand the problem with entire analysis and second is collecting the relevant data to analyze the problem for further estimation. After estimation, compare the actual and estimated values with necessary actions. The data was arranged in such a way that confirmed, active, deaths, recovered cases are plotted according to date i.e., daily counts of all the cases are shown below:

The Fig. 3 gives the data of COVID-29 of all the states of India which are rising exponentially. Among those Maharashtra is showing highest cases.

The above Fig. 4 gives the plot of confirmed cases which were observed and forecasted based on training data sets in Fig. 5.

The Fig. 6 shows the plot of root mean square error of observed and forecasted confirmed cases in Fig. 7 and the value is 1065.468 approximately observed in Fig. 8.

The above plot is showing that all the predicted data that was fit in a straight line. The Fig. 9 shows the plot of forecasted and observed values of active cases in India. And similarly Fig. 10 and Fig. 11 gives the information about the root mean square error value of active cases and the value we got is 1043 approximately. Like this we have plotted the graphs for cured, migrated and death cases (Fig. 12) and the RMSE value of cured and death cases were given as 584 (Fig. 13) and 62 approximately and the graph was shown in Figs. 14 to 17.

We tabulated the performance metrics of linear regression and SVM regression models and table 1 provides the performance metrics i.e., RMSE, MAE, R^2, training time needed to train the model and prediction speed to forecast the cases (confirmed, active, cured/migrated, death) in India. We have analyzed and predicted the data of cases till 25th June 2020 and table 2 provides the predicted cases (confirmed, active, cured/migrated, death) by using linear regression model. These numerical values are predicted as per the actual values give as input to the system model.

6. Conclusion

This research is accomplished the comparison of linear regression and SVM regression in terms of performance metrics and concluded that linear regression holds better results than SVM regression. Much advancement is needed to achieve higher performance with the machine learning/deep learning models developed by young researchers/scientists to predict/forecast the pandemic. This research article was given with the generalized linear regression and SVM regression. Deep learning methods are using in our future work to forecast the data in time series to achieve attain improved predictions. With these prediction values, one can analyze the situation of the pandemic and the affected people in India, so that necessary precautions can be taken to avoid too much spread of corona virus.

CRediT authorship contribution statement

N.P. Dharani: Validation, Resources, Investigation. **Polaiah Bojja:** Conceptualization, Writing - review & editing, Supervision. **Pamula Raja Kumari:** .

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] Samir Kumar Bandyopadhyay and Shawni Dutta. 2020. Machine learning approach for confirmation of covid-19 cases: Positive, negative, death and release. medRxiv (2020).
[2] V.K.R. Chimmula, L. Zhang, Time series forecasting of COVID-19 transmission in Canada using LSTM networks, Chaos, Solitons Fractals 2020 (2020) 109864.
[3] P.S.S. Sundaram et al., Smart clothes with bio-sensors for ECG monitoring, Int. J. Innov. Technol. Explor. Eng. 8 (4) (2019) 298–301.
[4] K. Hemalatha et al., Analysis of RCC T-beam and prestressed concrete box girder bridges super structure under different span conditions, Mater. Today: Proc. (2020), https://doi.org/10.1016/j.matpr.2020.07.119.
[5] N. Hasan, A METHODOLOGICAL approach for predicting COVID-19 epidemic using EEMD-ANN hybrid model, Inter. things. 11 (2020) 100228, https://doi.org/10.1016/j.iot.2020.100228.
[6] R. Sujath, J.M. Chatterjee, A.E. Hassanien, A machine learning forecasting model for COVID-19 pandemic in India, Stoch. Env. Res. Risk Assess. 2020 (2020) 1.
[7] L. Natrayan, M. Senthil Kumar, Optimization of squeeze casting process parameters on AA2024/Al_2O_3/SiC/Gr hybrid composite using taguchi and Jaya algorithm, Int. J. Control Automation 13 (2s) (2020) 95–104.
[8] ShikharTuli ShreshthTuli, R. Tuli, S.S. Gill, Predicting the growth and trend of COVID-19 pandemicusing machine learningand cloud computing, Inter. Things 2020 (2020) 100222.
[9] Ramjeet Singh Yadav, Data analysis of COVID-2019 epidemic using machine learning methods: a case study of India, Int. J. Inform. Technol. 2020 (2020) 1–10.
[10] S. Magesh et al., Pervasive computing in the context of COVID-19 prediction with AI-based algorithms, Int. J. Pervasive Comput. Commun. 16 (5) (2020) 477–487.
[11] A.M.U.D. Khanday, S.T. Rabani, Q.R. Khan, N. Rouf, M. Mohi Ud Din, Machine learning based approaches for detecting COVID-19 using clinical text data, Int. J. Inform. Technol. 12 (3) (2020) 731–739.
[12] K. Abdulmajeed, M. Adeleke, L. Popoola, Online forecasting of covid-19 cases in nigeria using limited data, Data Brief 30 (2020) 105683, https://doi.org/10.1016/j.dib.2020.105683.
[13] L. Natrayan, M. Senthil Kumar. An integrated artificial neural network and Taguchi approach to optimize the squeeze cast process parameters of AA6061/Al2O3/SiC/Gr hybrid composites prepared by novel encapsulation feeding technique. Mater. Today Commun., 25 (2020), 101586, 10.1016/j.mtcomm.2020.101586.
[14] M.H.D.M. Ribeiro et al., Short-term forecasting COVID-19 cumulative confirmed cases: Perspectives for Brazil, Chaos, Solitons Fractals 2020 (2020) 109853.
[15] N.P. Dharani et al., Detection of breast cancer by thermal based sensors using multilayered neural network classifier, Int. J. Eng. Adv. Technol. (2019) (2019).5615-5618.

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