ANALYSIS PREDICTIONS OF SPREAD, RECOVERY AND DEATH CAUSED BY COVID-19 IN INDIA

A Thesis

Submitted in partial fulfillment of the

requirements for the award of the Degree of

MASTER OF TECHNOLOGY

IN

INFORMATION TECHNOLOGY

BY

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c. I have followed the guidelines provided by the Institute in writing the thesis.

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To the best of my/our knowledge, the contents of this thesis did not form a basis for the award of any previous degree to anyone else.

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ABSTRACT

The novel coronavirus outbreak became first pronounced in December 2019 and greater than 7 million people have been inflamed with this ailment and over 0.forty million global misplaced their lives. The first case became identified on 30 January 2020 in India and the parent crossed 0.24 million as of 6 June 2020. This paper affords a detailed observation of these days evolved forecasting fashions and predicts the variety of confirmed, recovered, and dying instances in India resulting from COVID-19. The correlation coefficients and linear regression implemented for prediction. The anticipated variety of instances shows an awesome settlement with 0.9992 R-squared rating to the real values. The locating shows that lockdown, social distancing and vaccination are vital elements that may assist to suppress the growing unfold fee of COVID-19.

INTRODUCTION

Coronavirus virus (CoV) is a special type of virus that is a disease in itself and that aggravates the existing disease in the human body, making it a very dangerous virus. This virus causes wheezing, shortness of breath, poor digestive system and agrimonia, seriously affects the human nervous system, and it also harms animals such as cows, horses and pigs that are kept, raised and used by humans and various wildlife. Acute Respiratory Syndrome (SARS) and, in 2012, the Middle East Respiratory Syndrome (MERS) outbreak have shown the likelihood of newly arrived human-to-human and animal-to-human and vice versa communicable COVID19, although there are far fewer such cases. , yes it does exist. Since the end of December 2019, the effects of secret pneumonia has been a remarkable study topic worldwide.

In India, the first case of Coronavirus Disease 2019 (COVID19) was reported on January 30, 2020, which spread to all of India (in its various districts) by the end of April 2020.In India, the total number of announced cases was 5,734, of which 472 recovered and 166 people died as of April 9, 2020. In India, the total number of announced cases was 236,184, of which 113,233 died as of June 6, 2020 and 6649 people recovered After this date, new cases will continue to be known every day, around 10,000. In India, the infection rate of COVID19 was lower than in some other countries to earlier. The worldometers website gives us all these details in a precise manner. Figure 1 is showing the structure of COVID-19, this structure looks like a crown. The different parts of this virus are also introduced in this diagram.

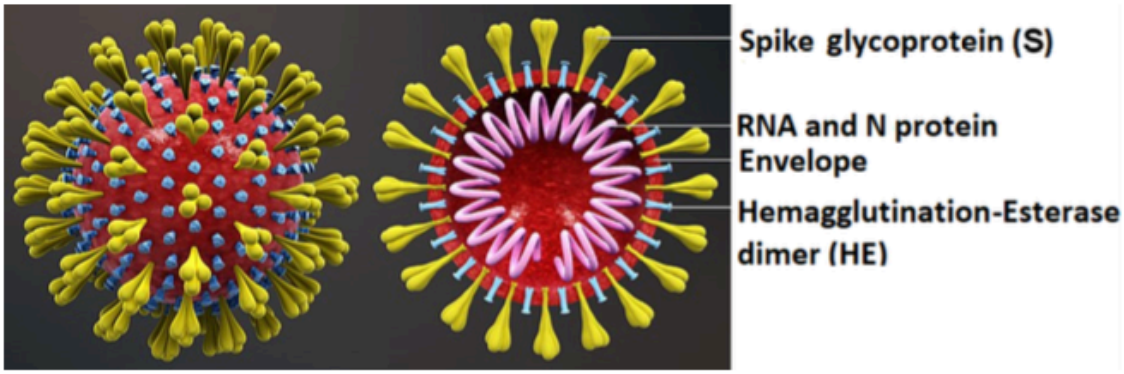


Fig. 1 Structure of coronavirus.

Transmission of Virus

In China, COVID-19 first case became mentioned in Huanan Seafood Wholesale Market, Wuhan. The predominant cause which became intended for the unfold of this virus is the

transmission from animal-to-human. Even so, the approaching COVID-19 instances had been now no longer associated with the subjection method. Hence the belief is that virus transmission is from people to people, and those with viruses indicative are the principle recurrent cause for the unfold of COVID-19. Before the signs progress, the transmission opportunity of COVID-19 seems to be very rare, even though, this virus transmission can't be prohibited. Besides these, the recommendation for everyone is that the folks that are symptomless or asymptomatic should by skip at the virus and social distancing is the simplest manner to be steady from this virus. Including rhinovirus and flu, extra wheezing bacterium, it's miles believed that the droplets of sneeze and cough of someone are the principle cause for virus imparting. In closed places, aerosol transmission is likewise feasible in case of lengthy publicity to deep-mouthed aerosol concentrations. In China, the end result of facts evaluation of SARS-CoV-2 unfold is that the near touch of human beings is the demanded situation for the unfold of the virus. The virus extension is particularly constrained to someone's own circle of relatives members, different almost contacted human beings and healthcare experts.

Treatment and prevention

- Wear a mask that covers your nose and mouth to help protect yourself and others.
- Stay 6 feet apart from others who don't live with you.
- Get a COVID-19 vaccine when it is available to you.
- Avoid crowds and poorly ventilated indoor spaces.
- Wash your hands often with soap and water. Use hand sanitizer if soap and water aren't available.

Symptoms

People with COVID-19 have had a wide range of symptoms reported – ranging from mild symptoms to severe illness. Symptoms may appear 2-14 days after exposure to the virus. Anyone can have mild to severe symptoms. People with these symptoms may have COVID-19:

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches
- Headache
- New loss of taste or smell
- Sore throat
- Congestion or runny nose
- Nausea or vomiting

- Diarrhea

This list does not include all possible symptoms. CDC will continue to update this list as we learn more about COVID-19. Older adults and people who have severe underlying medical conditions like heart or lung disease or diabetes seem to be at higher risk for developing more serious complications from COVID-19 illness.

OBJECTIVES

Owing to the widespread of COVID-19 and its devastating effects on humans, several research groups have investigated various aspects of the virus, such as its epidemiological characteristics, socio-economic effects, and factors and parameters aiding the spread of the virus.

The present work is report with the following objectives:

- Prediction of discharge ratio using linear regression.
- To observe the correlation between active cases and discharge.
- Visualization of other variables.
- To systematically review the prediction models that have been developed for COVID-19.

LITERATURE REVIEW

No.	Study	Objective	Type of model	Result	Quality assessment
1.	Bhandari et al., 2020	To predict the progression of COVID-19 in India using ARIMA	ARIMA	The COVID-19 forecast helps the government and policy makers to optimize resources and make decisions.	95% CI
2.	Chatterjee et al., 2020	To develop a stochastic mathematical model to predict COVID-19 cases	SEIR	To help in healthcare preparedness and in allocations of resources. · The model suggested that herd immunity may be achieved when 55% to 65% of the population is infected.	R0 was 2.28, growth rate of the epidemic in India was 1.15.
3.	Arora et al., 2020	To forecast the number of COVID-19 positive cases in 32 states and union territories of India using deep learning-based models.	Deep learning: LSTM, RNN	· Model was highly accurate for short-term predictions (1–3 days) ahead.	· MAPE range <3% · Weekly Forecast 4%–8%
4.	Salgotra et al., 2020	To forecast COVID-19 outbreaks in India and use time series study and model on CC and DC in 3 states of India, Delhi. Maharashtra, Gujarat, and Delhi.	GEP model	· The model was highly effective in forecasting both reported cases and deaths around India.	· Lowest R value: 0.9881, DC in Delhi. highest value was 0.999,RC in India.

5.	**Ghosal et al., 2020**	**To forecast the number of deaths due to Covid-19 in India**	**Multiple regression and auto-regression technique**	**The estimated mortality rate (*n*) at the end of the 5th and 6th weeks was 211 and 467.**	**Multiple R was 0.9903 R squared was 0.9807. Adjusted R was 0.97 standard error Was 234.13.**
6.	**Sujath et al., 2020**	**To forecast COVID-19 pandemic using machine learning**	**Machine learning: MLP**	**95% CI with MLP**	**95% CI**
7.	**Tomar & Gupta, 2020**	**To predict new COVID-19 cases ases using LSTM based techniques.**	**LSTM**	**Prediction corresponded to the original information with a reasonable CI.**	**±5% CI**

METHODOLOGY

Dataset and its features

Coronaviruses are a large family of viruses that may cause illness in animals or humans. In humans, several coronaviruses are known to cause respiratory infections ranging from the common cold to more severe diseases, such as MERS and SARS. The most recently discovered coronavirus causes coronavirus disease in 2019 (COVID-19).The number of new cases is increasing day by day around the world. This dataset has information from the states and union territories of India daily. The effect of preventing measures, like social distancing, face mask, and the lockdown, has also been considered.

The dataset consists of features of COVID-19 data which are taken from https://www.kaggle.com and also from the Ministry of Health & Family Welfare. The dataset consists only of 350 samples of COVID-19 cases in India from 30 January 2020 to 26 May 2020. Table 1 shows the attributes/features used in this study and a glimpse of the dataset is presented in Table 2.

Tabel 1: Feature for the prediction of COVID-19 cases in India.

Name	Description
State/UTs	It is the name of the state/union territory of India where Covid-19 cases were found.
Total Cases	It is the total number of confirmed Covid-19 cases found.
Active	It is the total number of active Covid-19 cases in India.
Discharged	It is the total number of discharged Covid-19 cases.
Death	It is the total number of death caused by Covid-19.
Active Ratio	It is the ratio of active Covid-19 cases.
Discharge Ratio	It is the ratio of discharge Covid-19 cases..

Death Ratio	It is the ratio of death caused by Covid-19

Correlation Matrix

The correlation gap is the worst-case ratio between the cost when the random variables are correlated to the cost when the random variables are independent. A correlation matrix is a table showing correlation coefficients between variables. Each cell in the table shows the correlation between two variables. A correlation matrix is used to summarize data, as an input into a more advanced analysis, and as a diagnostic for advanced analyses. Applications of a correlation matrix There are three broad reasons for computing a correlation matrix:

- To summarize a large amount of data where the goal is to see patterns. In our example above, the observable pattern is that all the variables highly correlate with each other.
- To input into other analyses. For example, people commonly use correlation matrixes as inputs for exploratory factor analysis, confirmatory factor analysis, structural equation models, and linear regression when excluding missing values pairwise.
- As a diagnostic when checking other analyses. For example, with linear regression, a high number of correlations suggests that the linear regression estimates will be unreliable.

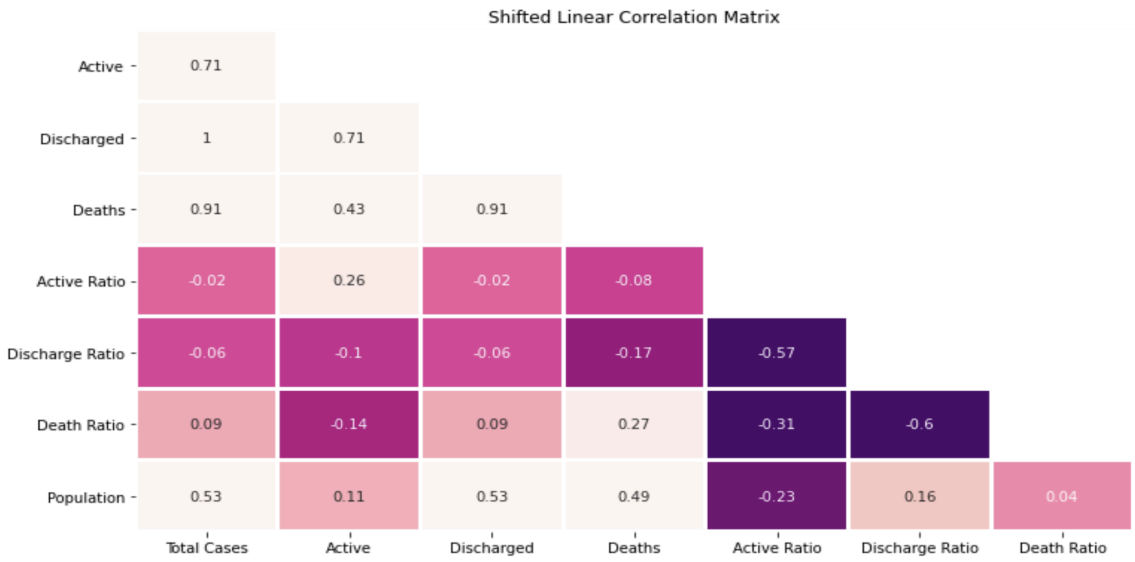
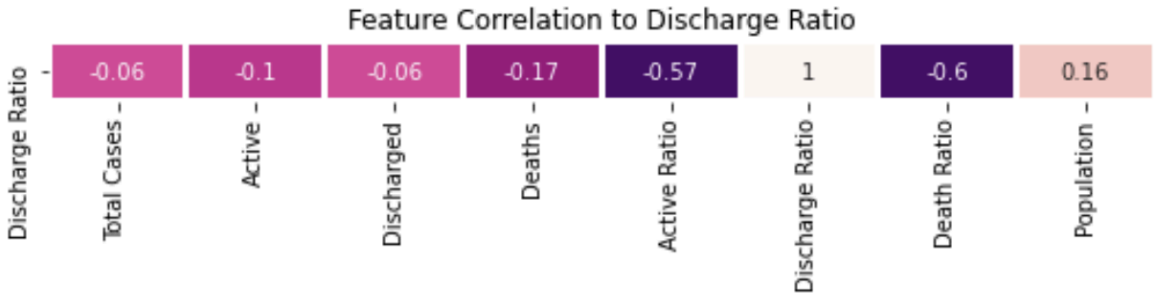


Fig:-Correlation matrixes



Discharge ratio is highly negatively corerlated with Active Ratio

Tabel 2: Dataset on Covid-19 India

	State/UTs	Total Cases	Active	Discharged	Deaths	Active Ratio	Discharge Ratio	Death Ratio
0	Andaman and Nicobar	7629	10	7490	129	0.13	98.18	1.69
1	Andhra Pradesh	2055999	8310	2033447	14242	0.40	98.90	0.69
2	Arunachal Pradesh	54865	389	54196	280	0.71	98.78	0.51
3	Assam	604536	4114	594506	5916	0.68	98.34	0.98
4	Bihar	725983	34	716288	9661	0.00	98.66	1.33
5	Chandigarh	65273	43	64410	820	0.07	98.68	1.26
6	Chhattisgarh	1005485	211	991705	13569	0.02	98.63	1.35
7	Dadra and Nagar Haveli and Daman and Diu	10672	2	10666	4	0.02	99.94	0.04
8	Delhi	1439136	399	1413649	25088	0.03	98.23	1.74
9	Goa	176980	748	172907	3325	0.42	97.70	1.88
10	Gujarat	826099	176	815838	10085	0.02	98.76	1.22
11	Haryana	770975	279	760821	9875	0.04	98.68	1.28
12	Himachal Pradesh	220254	1402	215156	3696	0.64	97.69	1.68
13	Jammu and Kashmir	330352	1099	324827	4426	0.33	98.33	1.34
14	Jharkhand	348334	112	343087	5135	0.03	98.49	1.47
15	Karnataka	2980170	11437	2930867	37866	0.38	98.35	1.27
16	Kerala	4774639	117237	4631330	26072	2.46	97.00	0.55
17	Ladakh	20848	60	20580	208	0.29	98.71	1.00
18	Lakshadweep	10364	3	10310	51	0.03	99.48	0.49
19	Madhya Pradesh	792606	111	781973	10522	0.01	98.66	1.33
20	Maharashtra	6573092	36604	6397018	139470	0.56	97.32	2.12
21	Manipur	121706	1683	118141	1882	1.38	97.07	1.55
22	Meghalaya	82283	1326	79542	1415	1.61	96.67	1.72
23	Mizoram	104659	15957	88358	344	15.25	84.42	0.33
24	Nagaland	31410	289	30452	669	0.92	96.95	2.13
25	Odisha	1030518	4566	1017714	8238	0.44	98.76	0.80
26	Puducherry	126893	646	124402	1845	0.51	98.04	1.45
27	Punjab	601821	236	585056	16529	0.04	97.21	2.75
28	Rajasthan	954354	38	945362	8954	0.00	99.06	0.94
29	Sikkim	31636	326	30922	388	1.03	97.74	1.23
30	Tamil Nadu	2675592	16379	2623459	35754	0.61	98.05	1.34
31	Telengana	667535	4345	659263	3927	0.65	98.76	0.59
32	Tripura	84237	136	83285	816	0.16	98.87	0.97
33	Uttar Pradesh	1709928	145	1686887	22896	0.01	98.65	1.34
34	Uttarakhand	343645	166	336083	7396	0.05	97.80	2.15
35	West Bengal	1574801	7625	1548294	18882	0.48	98.32	1.20

Visualization Of Features

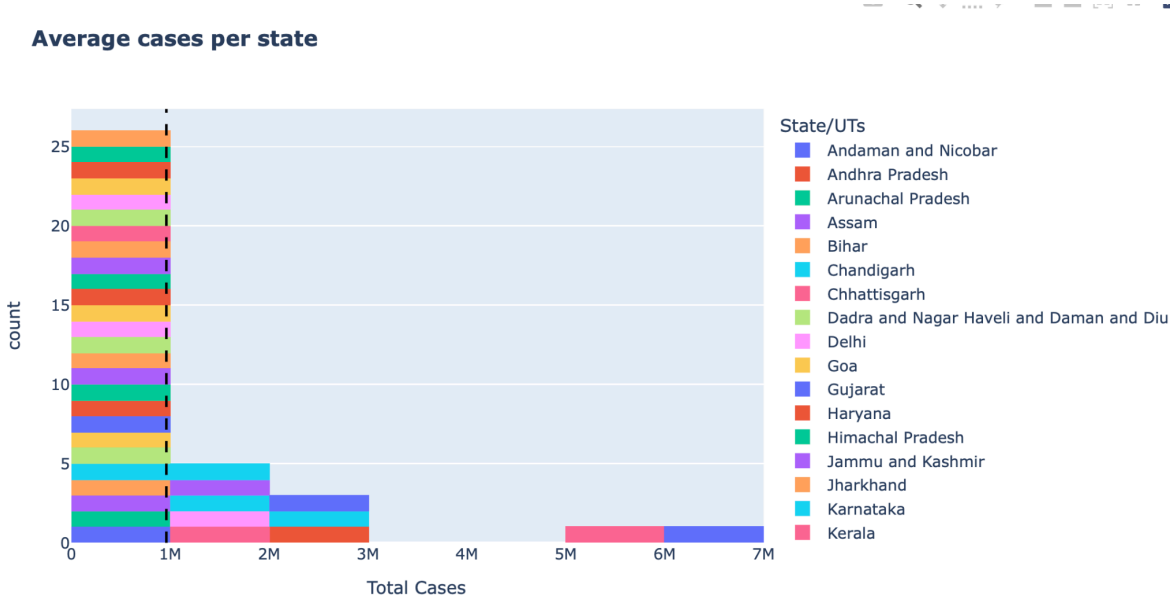


Fig:-Average case per state

Maharasatra has highest cases 6.5M followed by kerala 4.5M

10 states have total cases morethan 1M

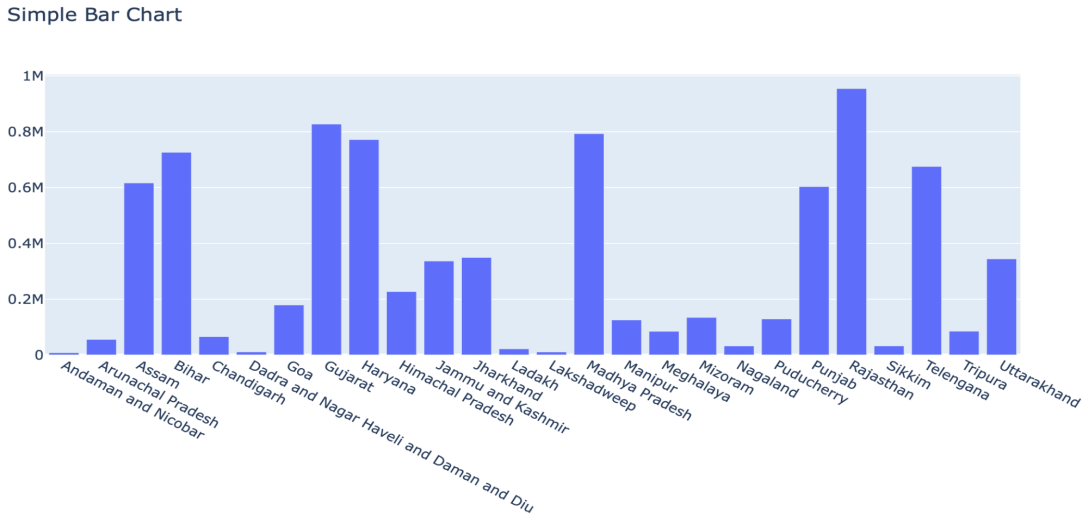
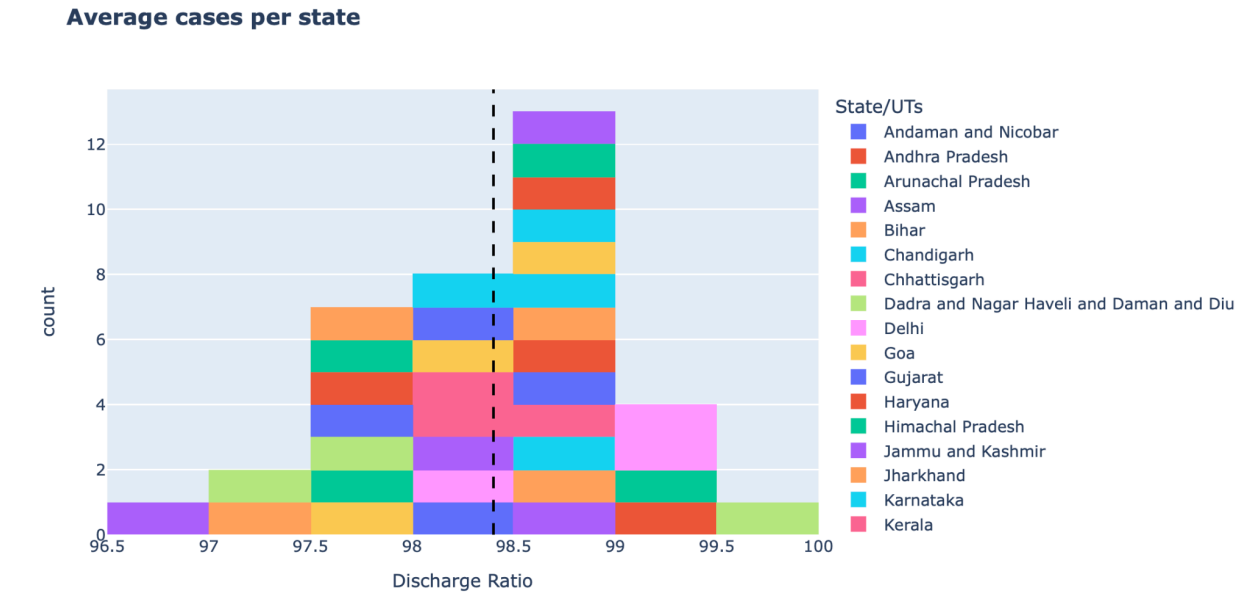


Fig:-A simple bar chart



except mizoram all states had discahrge rate morethan 95%

Fig:-Average cases per state with discharge ratio

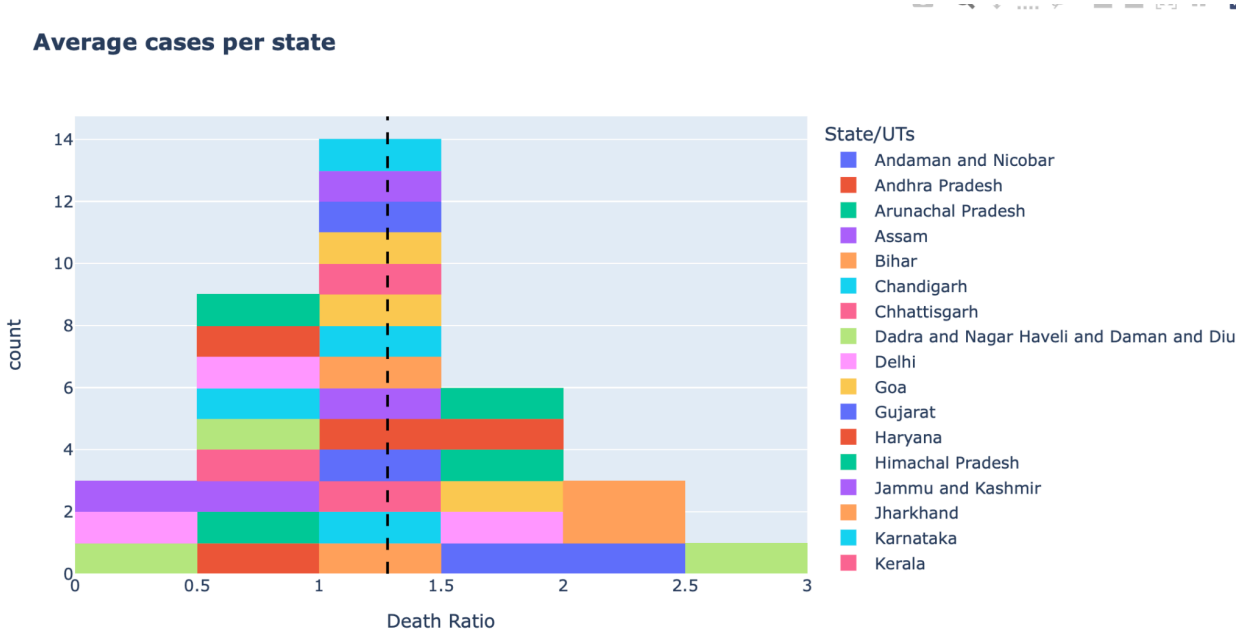


Fig:-Average cases per state with death ratio

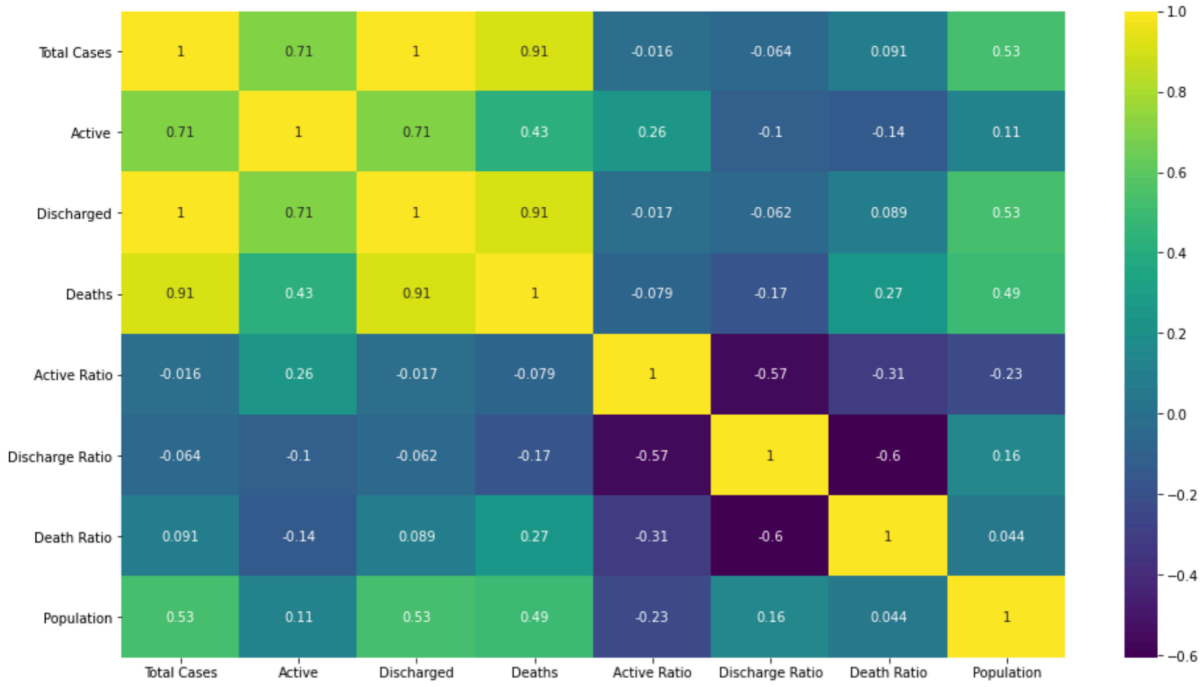


Fig:-Heat map

A heat map (or heatmap) is a data visualization technique that shows the magnitude of a phenomenon as color in two dimensions. The variation in color may be by hue or intensity, giving obvious visual cues to the reader about how the phenomenon is clustered or varies over space.

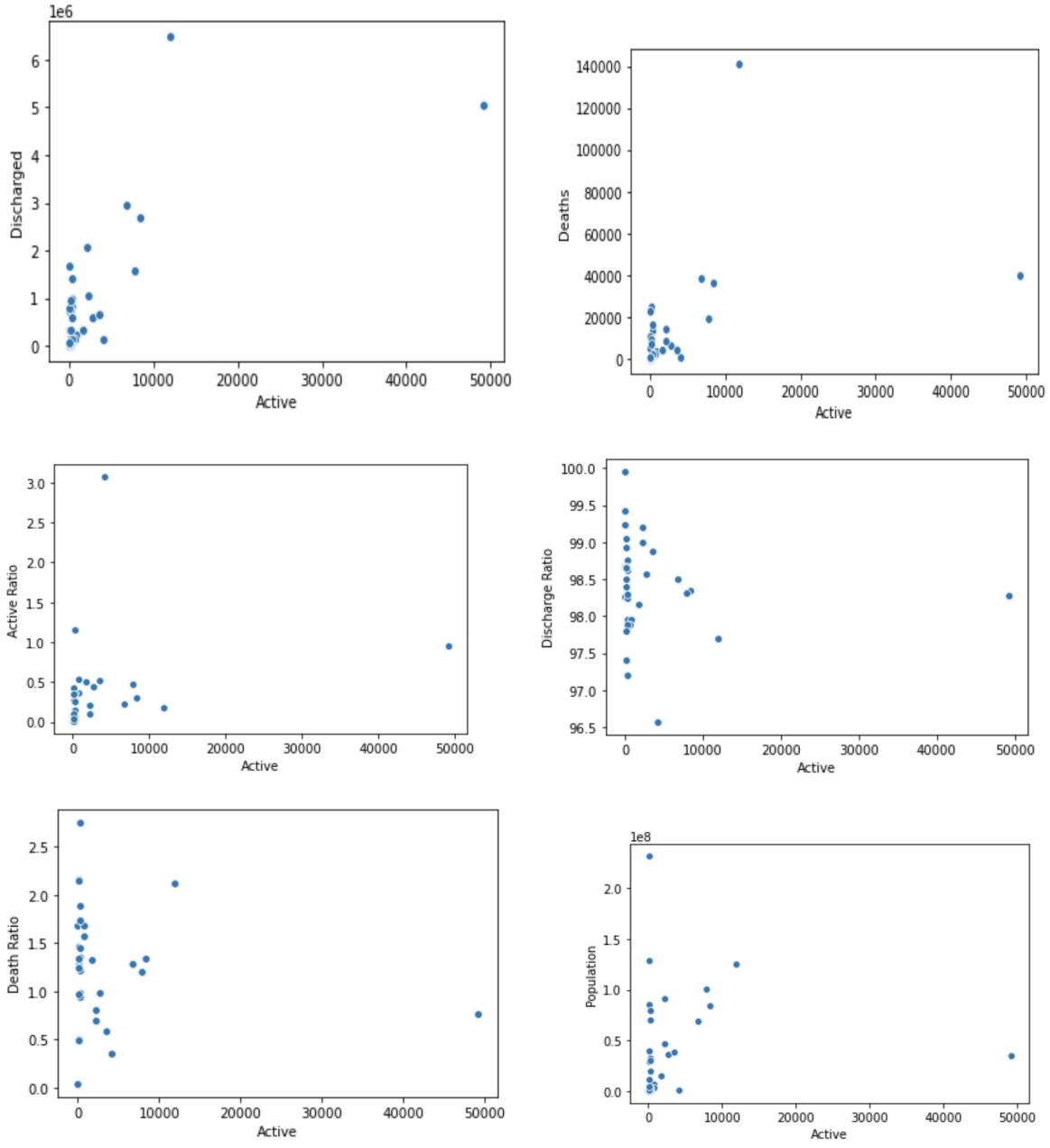


Fig:- Scatterplot

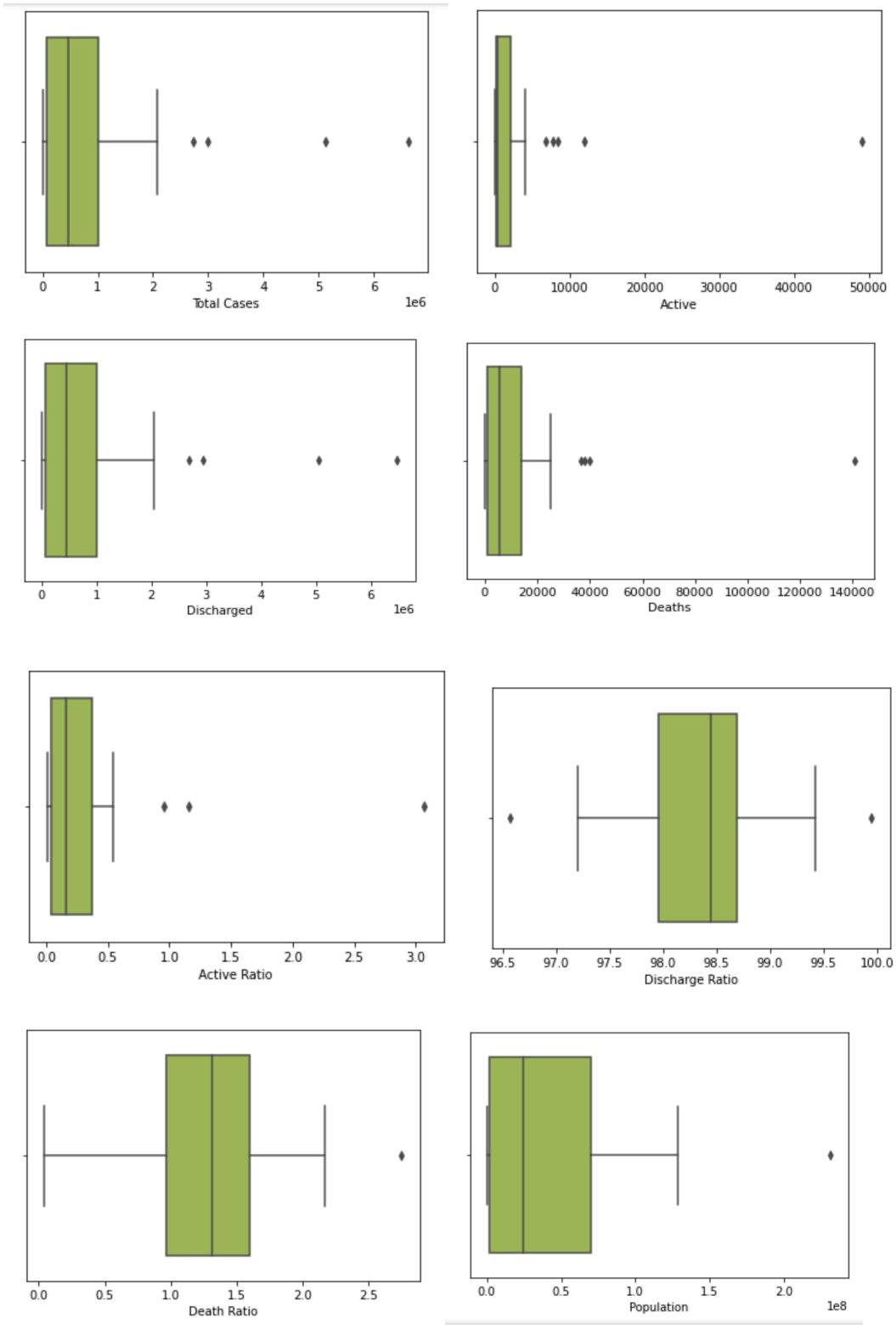

0 1 2 3 4 5 6
Total Cases
1e6
0 10000 20000 30000 40000 50000
Active
0 1 2 3 4 5 6
Discharged
1e6
0 20000 40000 60000 80000 100000 120000 140000
Deaths
0.0 0.5 1.0 1.5 2.0 2.5 3.0
Active Ratio
96.5 97.0 97.5 98.0 98.5 99.0 99.5 100.0
Discharge Ratio
0.0 0.5 1.0 1.5 2.0 2.5
Death Ratio
0.0 0.5 1.0 1.5 2.0
Population
1e8

Fig:- Boxplot

Feature Selection

During the process of model building, feature selection is used to select the most relevant features out of all the features. It reduces the complexity of the prediction model. Here, we performed feature selection using random forest importance algorithm in Python programming language.The classification model features are calculated using the above algorithm, whose input parameters are all the features of dataset of COVID-19 cases in India.

Multiple ways to scale

- Standard Scaler (Standardization): Scale the feature by shifting the mean back to 0 and variance to 1. By this way, we only shift the mean value to 0 and keep the distribution the same. Furthermore, this way can preserve the outliers in case they can contribute additional information to the problem.
- Min-max Scaler (Normalization): This one scales the range of values to between 0 and 1 and also eliminates the outliers.

```
In [117]: X = df.drop('Discharge Ratio',axis = 1)
          Y = df['Discharge Ratio']
          X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size = 0.3,random_state=44)
```

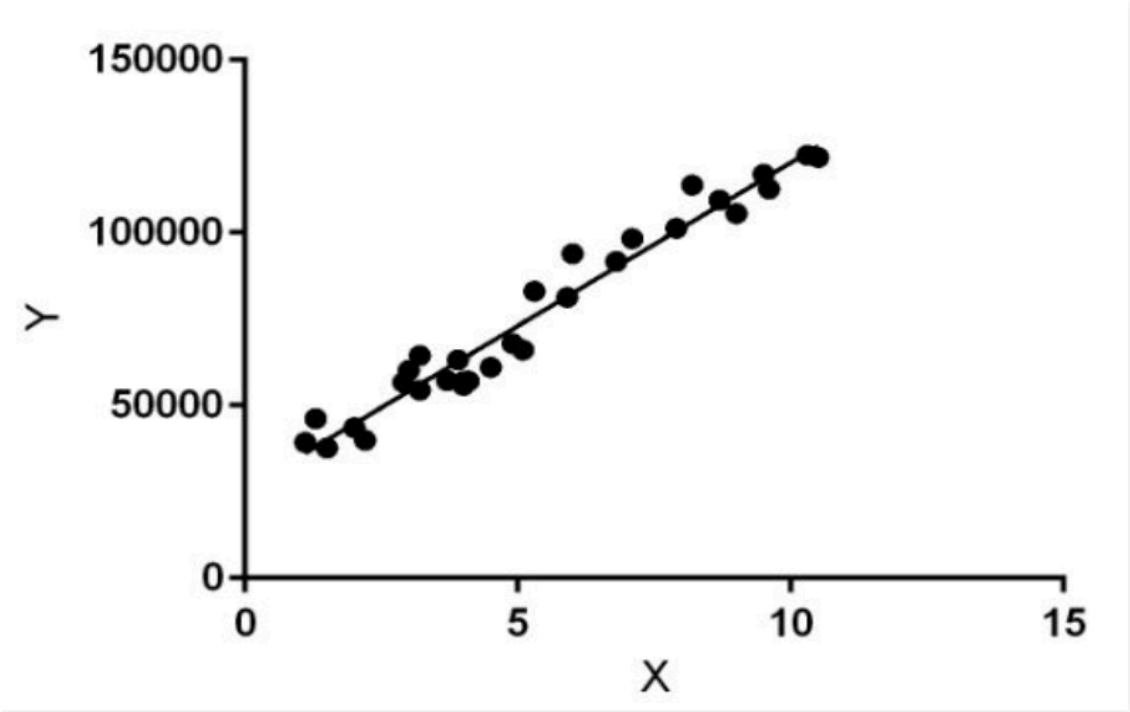
The train-test split is a technique for evaluating the performance of a machine learning algorithm. It can be used for classification or regression problems and can be used for any supervised learning algorithm. The procedure involves taking a dataset and dividing it into two subsets. The first subset is used to fit the model and is referred to as the training dataset. The second subset is not used to train the model; instead, the input element of the dataset is provided to the model, then predictions are made and compared to the expected values. This second dataset is referred to as the test dataset.

- **Train Dataset:** Used to fit the machine learning model.
- **Test Dataset:** Used to evaluate the fit machine learning model.

The objective is to estimate the performance of the machine learning model on new data: data not used to train the model. This is how we expect to use the model in practice. Namely, to fit it on available data with known inputs and outputs, then make predictions on new examples in the future where we do not have the expected output or target values. The train-test procedure is appropriate when there is a sufficiently large dataset available

Linear Regression

Linear Regression is a machine learning algorithm based on supervised learning. It performs a regression task. Regression models a target prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Different regression models differ based on – the kind of relationship between dependent and independent variables they are considering and the number of independent variables being used.



Linear regression performs the task to predict a dependent variable value (y) based on a given independent variable (x). So, this regression technique finds out a linear relationship between x (input) and y(output). Hence, the name is Linear Regression.

In the figure above, X (input) is the work experience and Y (output) is the salary of a person. The regression line is the best fit line for our model.

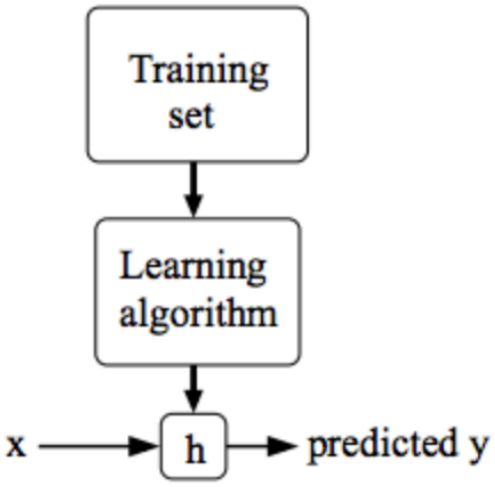


Fig: Flow chart for Linear Regression

Hypothesis function for Linear Regression :

$$y = \theta_1 + \theta_2.x$$

While training the model we are given :

x: input training data (univariate – one input variable(parameter))

y: labels to data (supervised learning)

When training the model – it fits the best line to predict the value of y for a given value of x. The model gets the best regression fit line by finding the best θ1 and θ2 values.

θ1: intercept

θ2: coefficient of x

Once we find the best θ1 and θ2 values, we get the best fit line. So when we are finally using our model for prediction, it will predict the value of y for the input value of x.

Cost Function (J):

By achieving the best-fit regression line, the model aims to predict y value such that the error difference between predicted value and true value is minimum. So, it is very important to update the θ1 and θ2 values, to reach the best value that minimizes the error between predicted y value (pred) and true y value (y).

$$minimize \frac{1}{n} \sum_{i=1}^{n} (pred_i - y_i)^2$$

$$J = \frac{1}{n} \sum_{i=1}^{n} (pred_i - y_i)^2$$

Cost function(J) of Linear Regression is the **Root Mean Squared Error (RMSE)** between predicted y value (pred) and true y value (y).

RESULT

Predicted correlation matrices

```
In [119]: reg.coef_
```

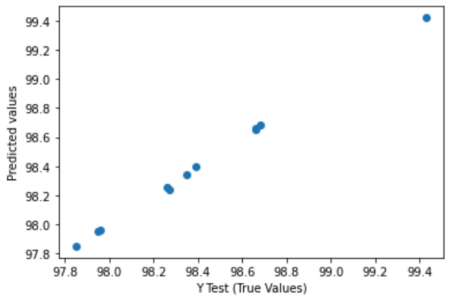
```
Out[119]: array([-1.97666209e-04, -2.60920615e-07, -6.96329330e-07,  2.65383416e-07,
                  1.70645992e-07, -9.97939520e-01, -1.00018471e+00, -4.05953042e-12])
```

```
In [120]: pred = reg.predict(X_test)
          pred
```

```
Out[120]: array([97.8497679 , 97.95947397, 98.6809336 , 98.34585261, 98.24148026,
                 98.64877606, 97.94898349, 98.39583706, 99.42091812, 98.65919447,
                 98.25093538])
```

Predicted Linear Regression

```
In [121]: plt.scatter(Y_test,pred)
          plt.xlabel('Y Test (True Values)')
          plt.ylabel('Predicted values')
          plt.show()
```



Predicted variance score

```
In [122]: metrics.explained_variance_score(Y_test,pred)
```

```
Out[122]: 0.9995755453195743
```

CONCLUSION

This study discussed the spread of COVID-19 in different states of India and proposed a model for prediction of discharge ratio using linear regression.

FUTURE WORK

In terms of future scope, we extend our work to predict the future risk from Covid-19 and to find more factors that can help us to fight this pandemic.To study the different variants of covid-19 virus, its measure and what precautions we can take.

The proposed model may be extended to predict the end of this pandemic in a particular region. Total causality and total economic losses may be predicted with the help of this model.

Multiple linear regression and autoregression will be used to predict the possible number of cases in the future.

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