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Research Paper

Post COVID-19 Unemployment Rate Prediction in India: A Machine Learning Perspective

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Abstract: Unemployment continues to be a major factor for both developed and developing countries, as a result of which they losing their overall financial and economic influence. Over the last few years, unemployment rate prediction has gained a lot of interest from researchers. The unemployment crisis has been going on for a long time. At the same time, the COVID-19 pandemic lockdown has had a devastating impact on India's unemployment rate, with most private firms firing their staff.
Predicting the growth and trend of the COVID-19 pandemic using machine learning. COVID19 is affecting lives in various ways. Unemployment is one of them. Unemployment can cause mental illness, stress, an increase in suicides, premature deaths, etc. That is why it is important to predict the pattern of unemployment in the post COVID19 situation. Machine Learning (ML) can be deployed effectively to predict the change in the unemployment rate. An ML-based model has been proposed to predict the post COVID19 unemployment rate in India. How the lockdown is affecting employment is shown and further future more effective analysis can be done by looking at various other aspects of the employment sector. The goal of our study is to look at the impact of the coronavirus on India's unemployment rate. These models are proposed to provide the most accurate predictions for the future.

Keywords: COVID-19; Machine Learning; Unemployment; Prediction

1. Introduction

At the time (January 2023), the COVID-19 pandemic had infected 661 million people worldwide and deaths about 6.69 million [15]. COVID-19 was first reported in China on December 31, 2019 [1], and the WHO declared it a pandemic [23].

Unfortunately, the pandemic was still spreading at the time, so the final impact before mass vaccination was expected to be much greater [16]. Globally, the pandemic has affected international travel and the local economy (via depressed consumer mobility due to fear of infection, as well as the usage of "lockdowns" that shut down some workplaces and social settings, resulting in widespread unemployment) [17].

Financial data such as GDP and employment statistics are used by investors to forecast monetary trends and choose appropriate investment strategies. Similarly, the unemployment rate becomes a crucial economic indicator for each country due to its association with state production as well as its impact on fiscal strategy [2].

In addition, some studies have recently investigated the impact of the Coronavirus. Climate variables were combined with socioeconomic vulnerability factors to examine the impact of COVID-19 on rural and urban populations in 623 pandemic-affected areas in India. The author discovered that wind speed was the most crucial climatic element among the research factors in the evolution of the cases using non-stationary extreme value analysis to model the different quantiles of cumulative COVID-19 cases. [3]

The COVID-19 pandemic lockdown has had a disastrous effect on India's unemployment rate, with most private companies fired their employees as a result. The informal sector workers have been the hardest hit by the lockdown, as the majority of them have lost their jobs while construction sites were closed. Thousands of people fled cities for the lack of a capital, marching hundreds of miles to their homelands in the absence of official transportation, demonstrating their desperation. The purpose of this study is to determine the influence of COVID-19 on unemployment in our research area. We mostly used secondary data acquired from books, journals, newspapers, and reliable online sources to analyse this study [4].

In India, unemployment is the most challenging socioeconomic issue. The problem cannot be solved with a single golden touch; the burden on the unemployed can only be reduced by long-term planning. In India, unemployment is viewed as a development curse, especially among the literate unemployed. On a regular person-year basis in India,

everyone who works for around 8 hours per day for 273 days each year is considered employed. As a result, in order to be considered employed, a person must labour for a minimum of 2184 hours every year. An unemployed person is someone who is unable to find a job for a period of time [5].

The global labour market and governments have been crippled by the COVID-19 pandemic. However, they are not considering how they will outfit such a large number of unemployed people. India is in a similar situation, since its income in the coming years 2021-22 and 2022-23 will be significantly lower than in the years 2019-20. There will be massive economic suffering ahead, and both politics and policymaking must work together to alleviate it [6].

According to a research by the International Labor Organization (ILO), the spread of the novel coronavirus has put more than 2.5 crore employment at risk around the world. It has been noticed that four out of five people, or around 81 percent of the world's 3.3 billion people, have been affected by the partial or complete shutdown of their workplaces. India, The United Kingdom, the United States, Canada, and a number of other European and Asian countries have all experienced significant job losses, raising their unemployment rates [6].

The most important problem that the country is currently facing is unemployment, which planners have been very concerned about and have emphasized in each plan to minimize unemployment by raising the growth rate. The majority of planners say that a higher growth rate can clear the unemployment backlog and offer jobs for the people, however this theory has yet to be proven [7]. Despite being one of the world's first eight industrially developed countries, India is still largely underdeveloped [8].

Every day, new bottoms of a fall-down in economic activity are being dug up by analyst and agency reports. In this hour of crisis, the Indian economy, on the other hand, has a slightly different story to tell. Since the outbreak of the COVID-19 virus pandemic, analysts and researchers around the world have been racing to forecast ever-increasing economic problems for the global economy. With each passing day, new forecasts depict an even more terrible picture than the previous one [9].

On March 24, 2020, the Indian government ordered a nationwide lockdown to slow the spread of Covid-19. Covid-19 exacerbated pre-existing imbalances in urban India, with those at the lowest end of the economic scale suffering the most. Growing urbanization and an even faster-growing young population had already posed significant issues for the Indian labour market. Workers in the lower half of pre-covid labour income lost more money than those in the upper half. [11]. For 21 days, the lives of 1.3 billion people came to a halt. Businesses, factories, schools, and public transportation were all shut down, and nearly everyone was asked to stay at home. The lockdown was one of the strictest in the world [10], and it was prolonged three times till 31 May.

Despite the fact that the state wide lockdown was executed without discrimination, there were considerable differences in the rise in the jobless rate among regions. It investigates the causes of such discrepancies and finds out that migration is a significant factor. [12].

The outbreak of the COVID-19 pandemic in early 2020 exacerbated the situation, resulting in a sharp drop in aggregate demand and output. To combat the economic crisis, India and the United Kingdom have implemented monetary and fiscal stimulus measures. Inflation–unemployment dynamics in India and the United Kingdom throughout the recession and during the COVID-19 period. [13]

The Indian economy dropped by 23.9 percent in the second quarter of 2020, and is expected to drop by 4.5 percent in 2020 [14]. The unemployment rate initially dropped, but by mid-2017, it had begun to rise, indicating that the recession had given place to stagflation. The economy has taken a hit as a result of the pandemic-induced lockdown, with the unemployment rate rising.

The pandemic of Coronavirus Disease 2019 (COVID-19) has had a major impact on labor market measures in every state and economic sector. The COVID-19 pandemic has a diverse influence on economic sectors, with some of the highest unemployment rates throughout the pandemic [18].

ILO is assisting governments in developing a response mechanism while providing updates and knowledge on the impact of COVID-19 on the world of work. The International Labor Organization (ILO) was quick to identify national and sectoral objectives. It urges member countries to emphasise health-protection measures for all, as well as economic assistance for both demand and supply. Since May 2020, the Indian government has gradually eased the lockdown, and most economic activity began to resume in July 2020. The Indian government has set up a package of US$25 billion, or around 0.8 percent of GDP, as an immediate support measure during the lockdown. [19].

Covid-19 had a sectoral impact since the lockdown immediately restricted economic activity, suffocating both supply and demand [21]. Automobile, aviation, construction, hospitality, travel agencies, restaurants, and hotels were among the industries worst affected by the lockdown. Indians were forced to stay at home, and these industries either laid off or placed their employees on 'leave without pay. [20].

Manufacturing (28 million), retail, hotel and restaurant (32 million), construction (15 million), shipping, storage, and communications (11 million), and banking, enterprise, and real estate (11 million) are the five major sectors impacted in urban areas (7 million).

The Naukri Jobspeak index is a monthly index that analyses and records hiring activity based on job postings on the Naukri website. In Table 1, it indicates how covid -19 affects the recruiting process across various sectors from March to May 2020.

Table 1: Hiring Index across sectors in India

Industry	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
IT-Software/Software Services	3,133	3,353	3,525	3089	1803	1472	1755	1749	1986	2375	2533	2779	3081
BPO/ITES/CRM/Transcription	2120	2279	2259	2140	929	839	1244	1315	1527	1971	1878	1791	1819
Construction/Engineering/Cement	862	952	906	633	216	282	374	475	490	583	583	555	663
Auto/Auto Ancillary	1151	1276	1330	915	265	327	580	661	771	994	985	820	1088
Banking/Financial Services/Broking	2701	3062	2946	2465	993	858	1192	1378	1437	1910	1832	1772	2088
Oil & Gas/Power/Infrastructure	712	820	830	543	334	249	300	347	313	408	386	332	431
Telecom/ISP	586	611	558	451	277	300	285	322	507	470	349	350	439
Insurance	1147	1552	1306	936	633	476	637	659	795	1017	910	759	1100
Indus Products/Heavy Machinery	1127	1133	1099	772	272	351	546	695	773	1041	965	837	1036
Pharma/Biotech/Clinical Research	1905	1845	1875	1448	1026	1125	1426	1316	1243	1794	1494	1477	1885
Hotels/Restaurents/Airlines/Travel	2060	2185	2087	1047	221	207	430	407	417	616	818	738	826
FMCG/Foods/Beverages	1832	2001	2118	1446	654	700	1103	1209	1227	1754	1591	1404	1701
Chemicals/Petrochemical/Plastic	1116	1252	1366	964	574	487	815	939	937	1439	1246	1018	1356
Education/Teaching/Training	3945	4630	4608	3797	1785	1582	2711	2118	2312	3258	3234	2697	3279
IT Hardware & Networking	1125	1179	1231	1052	557	558	764	835	829	1354	1055	949	1050
Retailing	1556	1643	1797	1135	399	308	545	532	813	935	1051	981	1084
Media/Dotcom/Entertainment	1027	1109	1050	698	299	438	420	572	589	816	758	637	596
Media/Healthcare/Hospital	5186	5448	5938	4706	2133	4060	4499	4612	5279	5091	4866	5044	5736
Real Estate/Property	2194	2452	2501	1640	420	594	947	1021	1364	1963	1983	1939	2068

Source: Naukri Jobspeak Index December 2020.

In 2020, India's unemployment rate reached its highest level since 1991, when the country's economy came to a halt due to the coronavirus outbreak. As the pandemic took many lives in March of last year, the country experienced one of the hardest lockdowns in the world, with strict limitations on transportation and economic activities across the board [22].

COVID-19 has a wide range of effects on people's lives, and here we'll focus on unemployment because it's the most critical concern. Many people have lost their jobs as a result of the lockdown, and they are unable to feed their families. As illustrated in Fig. 1 [24] [25], lockdown is inversely related to mobility. Three machine learning models with unemployment as a reference have been described here. This information may be useful in determining the future impact of the lockdown.

Figure 1: Change in mobility and Unemployment rate

1.1 IMPACT OF UNEMPLOYMENT ACROSS INDIAN STATES

According to the Center for Monitoring the Indian Economy (CMIE report). This indicates that 119 million workers have lost their employment during the two-week lockdown. If we assume that half of India's households (60 million homes or 300 million individuals) are family members with an average family size of five households (based on the 2011 census), the country may face a major survival dilemma, with around 227 million families adversely effected. According to the CMIE research, employment has decreased substantially, while unemployment has increased significantly in March 2020. The unemployment rate was 8.7% in early March 2020, just over the projected state unemployment rate of 6.1 percent for 2017-18, which was at a 45-year high. This is the highest unemployment rate since September 2016. During the same time period, the number of unemployed persons increased from 32 million to 38 million. As we entered the lockdown period in the last week of March, the situation worsened further, and the jobless rate rose to 23.8 percent.

Table 2: Unemployment rate of India July, 2019- June 2020

Months	Unemployment Rate %		
	India	Urban	Rural
Aug-19	8.19	9.71	7.48
Sep-19	7.14	9.58	5.99
Oct-19	8.1	8.27	8.02
Nov-19	7.23	8.88	6.45
Dec-19	7.6	9.02	6.93
Jan-20	7.22	9.7	6.06
Feb-20	7.76	8.65	7.34
Mar-20	8.75	9.41	8.44
Apr-20	23.52	24.95	22.89
May-20	23.48	25.79	22.48
Jun-20	10.99	12.02	10.52
Jul-20	7.43	9.15	6.66

Source: Centre for Monitoring Indian Economy Pvt. Ltd.

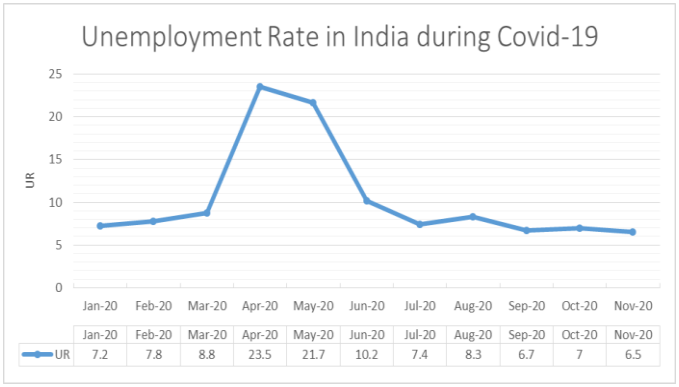

Figure 2: Unemployment Rate in India during Covid-19
Source: Centre for Monitoring Indian Economy Pvt. Ltd.

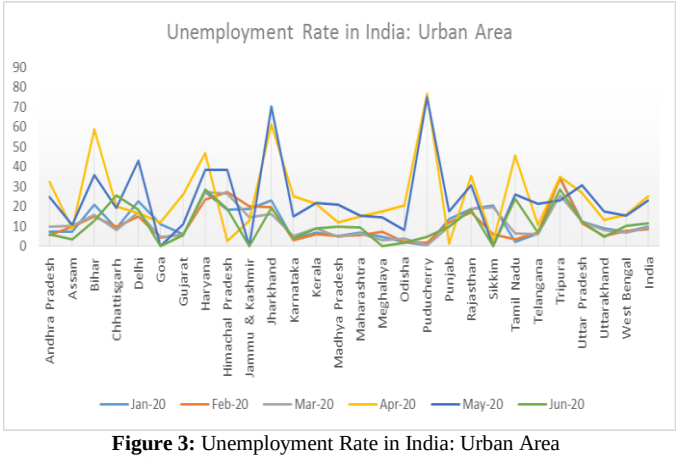

Figure 3: Unemployment Rate in India: Urban Area
Source: Centre for Monitoring Indian Economy Pvt. Ltd.

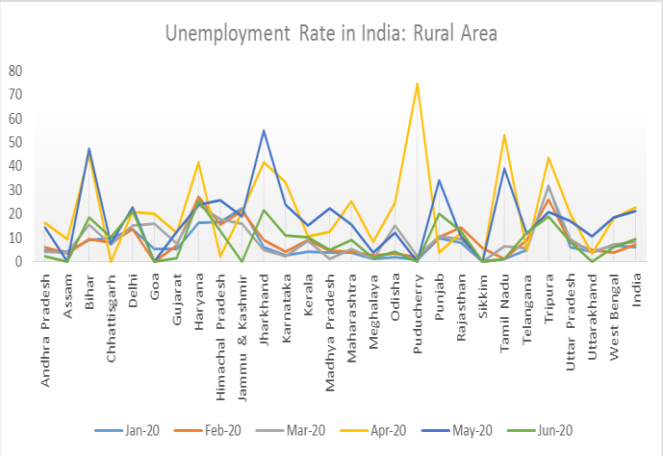

Figure 4: Unemployment Rate in India: Rural Area
Source: Centre for Monitoring Indian Economy Pvt. Ltd.

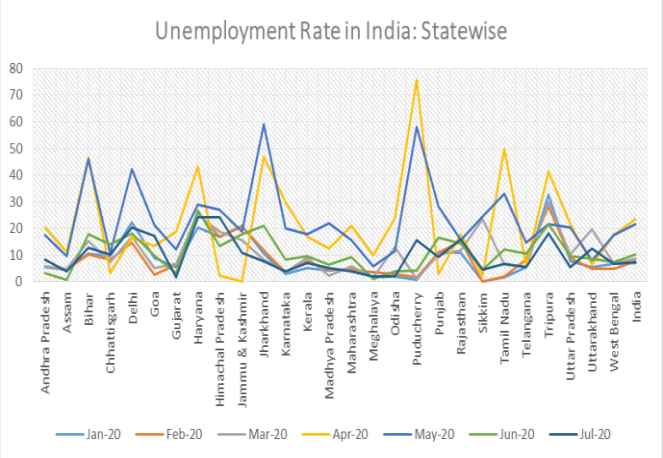

Figure 5: Unemployment Rate in India: State wise
Source: Centre for Monitoring Indian Economy Pvt. Ltd.

When some industries resumed operations following weeks of corona virus pandemic closure, India's unemployment rate fell to 11% in June 2020, down from a record high of 23.5 percent in the preceding two months. Urban India has a higher unemployment rate of 24.95 percent compared to rural India's 22.89 percent (Table 2). The unemployment rate hovered around 23.48 -23.52 percent during the last week of April and the first two weeks of May. (Table 2).

When we compare the variations in unemployment rates between April-May 2020 and the average rate that occurred between April-May 2016-19, we can see from Figure 5 that a substantial number of states had a figure in the double digits. Second, some states, such as Jharkhand and Bihar, appear to be on the high end of the scale. These are some of the states from which people migrate to other parts of the Nation. It's understood that the lockdown led in a resurgence of migration and a gradual increase in unemployment. Similarly, several of the more developed states, such as Tamil Nadu and Delhi, as well as its neighbouring state Haryana, are near the top of the list. In April-May 2020, several other states, including Karnataka, Telangana, Madhya Pradesh, Andhra Pradesh, and Maharashtra, had their unemployment rates increase [24].

2. Related Work

Katris et al, mentioned that time series and machine learning models for unemployment prediction in several countries (Mediterranean, Baltic, Balkan, Nordic, and Benelux) are explored and analysed for a range of forecasting horizons. The FARIMA model has been successfully used to predict unemployment when a time series contains long memory [26]. Viljanen et al, offer a machine learning model to predict a person's labour market situation using data from a sizable administrative unemployment registry. According to the model, people are represented as Markov chains with unique transition rates. We test the model on three scenarios, trying to determine who is most likely to avoid unemployment, find employment, and remain jobless at any given time [27]. Curbelo Montañez et al, compares machine learning models for predicting unemployment among residents of single-person households using features taken from smart metre electricity readings. The effectiveness of various nonlinear classifiers is assessed by benchmarking them against a generalised linear model and presenting the results [28]. Xitao Liu et al, uses the Chinese National Bureau of Statistics' unemployment data as a statistical sample in their paper. The neural network model and time series model are combined to create a labour unemployment prediction model [29]. Periklis Gogas_et al, suggest that_Public finances are directly impacted by unemployment, which also has significant sociopolitical ramifications. The objective of this study is to forecast the direction of unemployment in the European area. Variables are fed into the decision trees (DT), random forests (RF), and support vector machines (SVM) machine learning algorithms, and an elastic-net logistic regression (logit) model from the field of econometrics is also used [30]. Mehmet Güney Celbiş, suggest that by identifying the primary individual-level factors related to unemployment in those areas through the use of a variety of machine learning techniques, and seeks to provide findings that are relevant to policy and can enhance the resilience of rural regions. Using tree-based classification models, such as classification trees, bootstrap aggregation, random forests, gradient boosting, and stochastic gradient boosting, unemployment status is predicted [31].

3. Methodology

To define the direction of the analysis, the understanding of labour market theory is first reviewed. There are factors that affect unemployment, which can be divided into three categories: supply-side factors, demand-side factors, and real-wage unemployment factors.

Figure 6 is the ML model methodology which shows the forecast of statistical and ML model

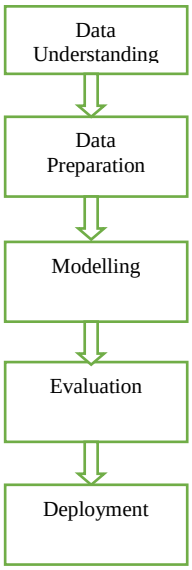

Figure 6: ML Model Methodology

MACHINE LEARNING MODELS

Many recent research works shows the exponential growth of COVID-19 spread. Similar growth is observed in the unemployment rate change. Three models have been selected as follows and compared the result of those parameters.

Inverse Weibull Models:

Probability density function

The flexibility of the Inverse weibull distribution that approaches to different distributions. The Inverse Weibull probability distribution has three parameters ηβ, and. It can be used to represent the failure probability density function (PDF) and is defined as

$$f_{inw}(t) = \frac{\beta}{\eta}\frac{1}{t-t_0}^{\beta+1} e^{-\frac{1}{\eta}(\frac{1}{t-t_0})^{\beta}} \quad Eq(1)$$

$$\beta > 0, \eta > 0, t_0 > 0, -\infty < t_0 < t$$

The Inverse Weibull models is a mathematical process of a real system and then conducting computer-based experiments with these Inverse weibull models to describe, explain and predicting the patterns of the real system over extended periods of real time. [1]

Inverse Weibull Function:

$$f(x) = \kappa.\gamma.\beta.\alpha^{\beta}.x^{-1-\beta}.e^{-\gamma\,(\alpha/x)^{\beta}} \quad Eq(2)$$

Here, $f(x)$ denotes the unemployment rate with, where $x > 0$ is the time in number of days from the date considered as day 1, and $\kappa, \gamma, \beta, \alpha \in \mathbb{R}$ are parameters of the model.

Extreme Function:

$$f(x) = f_0 + A.e^{(-e^{-((x-x_c)/w)} - ((x-x_c)/w) + 1)} \quad Eq(3)$$

Here, $f(x)$ denotes the unemployment rate with, where $x > 0$ is the time in number of days from the date considered as day 1, f_0 is offset and $A, w, x_c \in \mathbb{R}$ are parameters of the model.

Bigaussian Function:

$$f(x) = f_0 + H.e^{(-0.5((x-x_c)/w)^2)} \quad Eq(4)$$

Here, $f(x)$ denotes the unemployment rate with, where $x > 0$ is the time in number of days from the date considered as day 1, f_0 is offset and$w, x_c \in \mathbb{R}$ are parameters of the model.

MSE (Mean Squared Error):

$$\boldsymbol{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

where n = number of data points , y_i = observed values , $\hat{y}_i$ = predicted values

Coefficient of Determination:

$$\boldsymbol{R^2} = \mathbf{1} - \frac{\boldsymbol{RSS}}{\boldsymbol{TSS}}$$

$$RSS = sum\ of\ squares\ of\ residuals$$
$$TSS = Total\ sum\ of\ squares$$

3. Result and Discussion

MODEL COMPARISON:

Model mentioned in equation 2, 3 & 4 have been implemented using python and fitted to the model. After various iteration following results were obtained. Table 3 comparing the performance of machine learning models and traditional statistical models for forecasting the unemployment rate in India.

The time-series data of the unemployment rate in India from January 2020 to October 2020 was used to train and test the models. This data was divided into training and testing, with training data comprising 80% and testing data 20%. The mean squared error (MSE) and R-squared (R2), which are common performance indicators in time-series analysis, were used.

Table 3: Statistics of different model

	Function	Mean Squared Error (MSE)	Coefficient R2
1	Bigaussian	2.311548	0.955028
2	Extreme	1.094473	0.978707
3	Inverse Weibull	0.926550	0.981974

Table 3 is shows the MSE and R2 for three different models and Table 3 also reveals that Inverse Weibull has the highest R2, indicating that the model was successful in capturing the characteristics of the unemployment rate in India. it suggests Inverse Weibull is better model for unemployment prediction. Machine learning models therefore have the added benefit of being able to capture the underlying characteristics of the unemployment rate in India. As a result, machine learning models are more appropriate for modelling and predicting the unemployment rate in India.

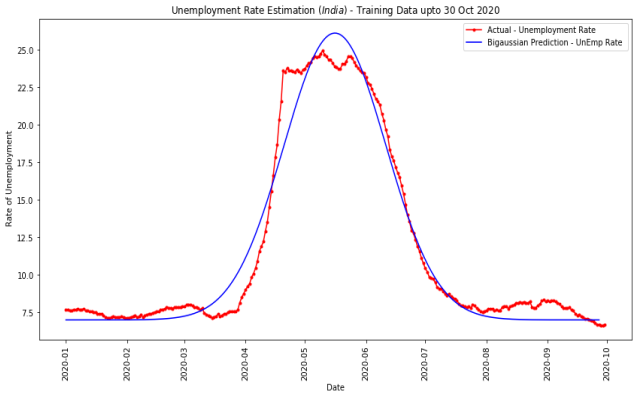

Figure 7: Bigaussian Model Prediction

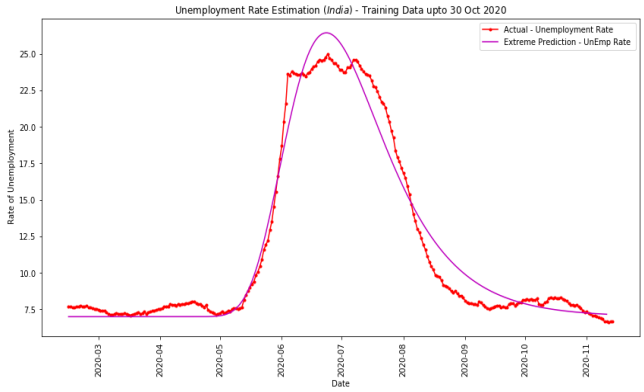

Figure 8: Extreme Model Prediction

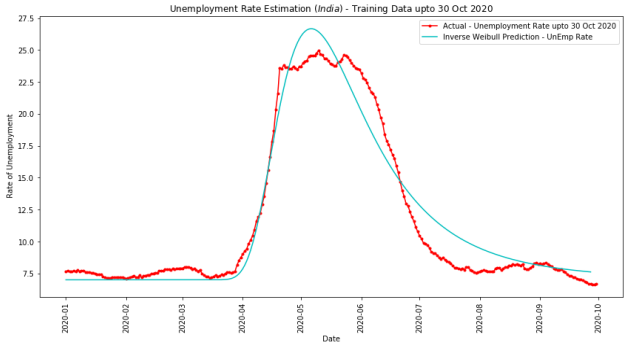

Figure 9: Inverse Weibull Model Prediction

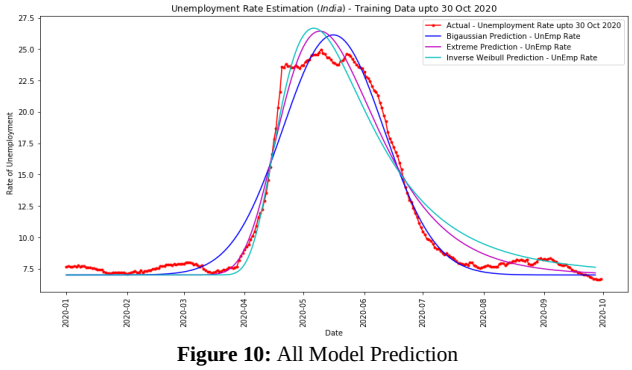

Figure 10: All Model Prediction

By observing Fig 6, Fig. 7 and Fig. 8 it can be observed that almost all models are closely fit to the data. For better understanding combined fitting is shown in Fig 9. In the first half, Inverse Weibull is the best fit and in the second half, Bigaussian is the best fit.

4. Conclusion and Future Scope

Predicting the growth and trend of COVID-19 pandemic using machine learning Table 3 is showing the MSE and coefficient R2. Which reflects the best model is Inverse Weibull and by looking at Fig 8 and 9 it seems Bigaussian is providing very close prediction in the second half after the peak. This shows that these models are mathematical predictor and depends upon various other things also like mobility, etc. So, such a prediction will help our government to decide when necessary to put lockdown, what will be the change in the unemployment status. So, the duration can be chosen wisely and will help to fight with COVID-19 as well as unemployment.

Here only unemployment rate has been considered. Other parameter like mobility, risk of infection etc. can be considered to improve the prediction.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

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