Understanding and Predicting the Socio-Economic Impact of COVID'19 for Tallahassee (Florida)

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ABSTRACT

The COVID-19 epidemic has adversely affected the political, environmental, and economic viability of society. To understand the extent of the impact, we will plot various economic and social factors in this paper, such as unemployment, inflation, and prices. We will also conduct a data-driven analysis on these factors using a variety of machine learning techniques to generate policy recommendations, which will help us survive any future pandemic situation that is as unanticipated as COVID 19. Using large datasets from Kaggle and other web sources by web scrapping to collect the data and train the algorithm will help in achieving the desired output. Examples of machine learning algorithms to apply include multivariant logistic regression, Support Vector Machine, Decision Tree, or K-nearest Neighbor Algorithms. For the sole sake of user readability, we shall also plot a visual depiction of the algorithms. The socalled proposed system's use case is to offer user insights so they may help with better policy recommendations. The study will specifically offer insights on economic aspects based on GDP, earnings, and unemployment. Housing based on newly constructed residences, average home prices, and rent rates; the auto sector based on the registration of new and used vehicles; environmental elements such the air quality index, CO2 emissions, and energy use; Insurance claims, hospital claim costs, hospital bed capacities, mortality rates, suicide rates, tourism characteristics like number of visitors or tourists, semantic analysis to forecast emotion, and constructing models to anticipate some of the above parameters in case of any comparable pandemic event

1 INTRODUCTION

The Greek terms pan, which means "all," and demos, which means "people," are the roots of the English word pandemic. It is the phrase used by disease experts when pandemics are spreading concurrently throughout numerous nations and continents. On March 11, the World Health Organization declared the coronavirus a pandemic. Despite having its roots in the Chinese city of Wuhan in the province of Hubei, COVID19 has grown quickly throughout the world. The COVID-19 virus started to change people's way of life. whereas pandemic-related policies had been successfully implemented by the government. People began adhering to the quarantine and/or stay-at-home orders. Businesses and organizations that offered both essential and optional services started to alter their business strategies, either by going virtual or by ceasing operations. There weren't enough human resources because people had to stay in quarantine. There have been considerable changes in a number of social and economic variables. Due to the fact that there had been a dramatic increase in instances and an unexpected breakout, this was a completely new occurrence

for the world, and it had only happened in recent years Governments and authorities around the world have implemented several containment measures to combat this pandemic until medical technology develops a vaccine or preventable measure for it. These measures include lockdown in cities, closing public spaces like recreation centers, limiting travel, and outright banning public gatherings to prevent the spread of the virus and buy time for the development of a vaccine. Due to the paucity of medical facilities in underdeveloped nations, there was a rapid demand for medical infrastructure during covid. In addition, the hurry to create a vaccine for the virus added to the tension in the medical community. While all of these preventive measures were successful in stopping the spread of the virus, they also had the unintended consequence of crippling the economies of the affected nations. The nation's economy stagnated as the cities began to appear deserted, which led to a host of additional issues that haven't been resolved even after two years of COVID. The demand-supply chain was impacted, exports and imports slowed, share markets crashed, small and medium-sized businesses closed, and large corporations that could only afford it laid off workers, raising the unemployment rate in the countries. We chose the topic of comprehending the impact of COVID'19 on numerous factors and conducted a thorough analysis for the same due to a direct impact on many of the factors in the country that was discussed in a few papers.

In order to estimate the socioeconomic implications of COVID'19 for Tallahassee (Florida) and offer policy recommendations, we are examining how these components behave. For instance, if we could forecast the pandemic's unemployment rate, policymakers might decide how much aid and employment possibilities to offer. We believe that using data from online sources to obtain information could help us analyze socioeconomic behavior.

We attempt to provide our findings from the thorough research we conducted and provide insights for each parameter or dimension we evaluate in this study (discussed in the section Data Description) in order to offer some policy making recommendations. We want to suggest the idea outlined in the above abstract to aid in the fight against this pandemic because COVID is still ongoing and the entire human race is trying to recover from this catastrophe and be ready for anything similar in the future.

2 RELATED WORK/STATE OF THE ART METHODS

There have been several researches right after few months of COVID to predict the impact and out of them – *'Research on the impact of COVID19 on Global Economy'* only focuses on economic impact. The repercussions are said to be unparalleled. The global spread of COVID-19 has disturbed the global economy. The disease's progression and economic consequences are very unknown. Because of its high infectivity, mortality, and incubation time, the primary preventative strategies are to reduce social distance and isolation, which renders many economic activities unfeasible. This research examines the macroeconomic impact of the novel coronavirus on global GDP, merchandise trade, and employment.

The paper *'Getting Through COVID-19: The Pandemic's Impact on the Psychology of Sustainability, Quality of Life, and the Global Economy – A Systematic Review',* primary goal of this research is to assess the influence of COVID-19 on the psychology of sustainability (quality of life), sustainable development, and the global economy. A computerized literature search was conducted, and journal articles from reliable sources such as MEDLINE (PubMed), Google Scholar, Science Direct, ProQuest, and Emerald Insight were retrieved. It was discovered that

there are worldwide connections between health, economic, environmental, and political challenges. The pandemic can be controlled if we implement new policies that affect global economic and public health. A planned, coordinated strategy between the public and private sectors is essential, tailored to each country's health system and economy. We can get out of this problem if we work together and help both rich and poor countries.

In the study '*Explaining the economic impact of COVID-19: Core industries and the Hispanic workforce*', we look at the relationship between a city's primary business, its economic susceptibility to the pandemic, and the recession's racially uneven impact in six different metropolitan regions. We discovered that locations with economies based on the movement of people, such as Las Vegas with tourism, faced far more unemployment at the end of 2020 than those with primary businesses based on the mobility of information. Furthermore, we discover that the hardest-hit locations have bigger Hispanic or Latino communities, reflecting the demographic mix of employees in significantly impacted industries and vulnerable places.

All the studies mentioned above and read focuses on any one single factor either its economically or sustainability. The above papers also don't predict the design of the impact and extract the patterns to be used in the future. Our paper resolves these issues and comes with a comprehensive analysis where all the factors are considered (mentioned in the Data Description), extracts insights from them and also give suggestions in case of any other pandemic in the future.

3 DATA DESCRIPTION

We need a large amount of information to support this research and help us understand the impact in order to achieve the goals outlined in the sections above. We first talk about the dimensions we are taking into account for this study, and then we talk about the data source. We shall divide all of these dimensions into three categories in order to better comprehend this: social factors, economic considerations, and other elements.

3.1 Economic Factors

There has been a major impact on economies of the countries along with the standard of living of the people and drastic changes in the per capita income of the population. We will consider GDP (Gross Domestic Product) of the country/state/county as one of the parameters and along with we will also take unemployment, wages of the people, income of all the classes to understand how COVID impacted people financially. We will also understand how the housing industry got hit by taking the parameters like number of houses sold (pre-covid, present time, and post-covid), median housing price, and the changes in rent prices and other factors. Industries like Auto mobile and Tourism also got majorly hit, factors like new vehicle registration, number of vehicles sold, and increase in used vehicle industry are analyzed. Number of travelers and visitors are plotted to understand the impact on Tourism industry.

3.2 Social Factors

Due to the psychological effects of COVID, social factors like people's mood and emotions are also taken into account. To fully grasp the impact, health/medical parameters like the need for medical infrastructure are assessed along with hospital claim costs, hospital bed capacities, insurance claims, suicides, and mortality rates.

3.3 Miscellaneous Factors

In addition to social and economic aspects, we will also take into account a few more factors that

fall outside of the scope of the social and economic sections. We will also conduct a traffic analysis to assess the number of accidents and other parameters connected to checking on human mobility during COVID in order to make this data-driven analysis complete. To determine how COVID has altered the patterns of energy consumption, environmental indicators including the AQI (Air Quality Index), CO2 emissions, and energy use are plotted and closely examined.

The aforementioned information was gathered from a variety of sources; most of it came from public websites where data was made available online, with some data coming from Kaggle. If available, the data is either taken as csv or excel files, database tables, or json files. When downloading the data into CSV files is not an option, web scraping is used to retrieve the data from various government websites. Python libraries are used for web scraping using a few parameters to scrape the data and then use it for analysis.

Table 1 shows a small part of dataset which we used for our analysis where it represents some economic and social factors combined at a timestamp. These kind of several datasets are used to achieve our goal of analysis.

Using the data we have gathered, we have conducted an analysis.

4 ANALYSIS

Time	Private Employees	Unemployed Persons	Employed	Listing	Median Housing Price	Listing Count Number	Price per sqfeet
2017-10-01	561.40050464990300	24327	603719	61	193400	1626	92
2017-11-01	561.42951382403300	24416	603909	67	189950	1530	92
2017-12-01	562.60279400862000	24280	607759	74	186250	1160	92
2018-01-01	559.86158747186600	24164	609007	83	186750	1264	93
2018-02-01	562.31397881612800	26744	596736	76	184425	1634	94
2018-03-01	564.74791354387900	26808	602746	56	185000	1804	94
2018-04-01	564.36668390489500	25865	604133	57	193450	2022	94
2018-05-01	565.71539826388100	23662	606293	56	199950	2046	95
2018-06-01	566.02929190285200	24490	607636	52	210875	2096	96

Table 1:- A part of dataset which is collected from different sources for our analysis

4.1 Preliminary Analysis

260 new cases were recorded for the Tallahassee metro area (67.4 for every 100,000 residents). All at-home positive tests are not included in reported cases. There are around 37 new confirmed cases per day in the Tallahassee metro region (9.6 for every 100,000 residents as seen in figure 1 and 2).

In the Tallahassee metro region, 107,262 (26.7%) persons have received a booster injection, compared to 257,942 (66.6%) who have received at least one dose, 223,464 (57.7%) who have received at least two doses, and at least two Johnson & Johnson doses. Anyone who has been alive for at least six months is qualified for vaccination. Among those who received a dose, less than 0.001% had a serious adverse response.

The number of COVID-related deaths reported by Tallahassee hospitals in a single month has increased to its highest level since October, when the delta variant was ravaging the neighborhood. The most fatalities were reported in September 2021. Since January 2022, there have been 21 COVID-related fatalities in the first month, with February recording the highest number of fatalities. As people became more careful, they began receiving vaccinations, and the number of fatalities has decreased.

4.2 Unemployment during COVID

Using the information we have gathered, we have conducted an analysis(see figure 3). Job comparisons utilizing data from the COVID time frame are not as significant because to the COVID epidemic. As a result, the Leon County Jobs Report, which is published below, contains employment information from before the epidemic. The unemployment rate was 2.5% lower than the Pre-COVID figure. There were 5,708 more persons working in May 2022 than there were in May 2019. The number of people seeking for work in May 2022 was 157,617, which is 5,165 more than the figure for May 2019. Compared to 3.6% in November, the unemployment rate in December was 3.5%. The unemployment rate in June was 3.1%, up from the 2.5% recorded in May. The unemployment rate in June 2021 was 4.8% a year ago. The unemployment rate was 3.0% in June 2019. In June 2022, there were 6,109 more individuals employed than in June 2021 and 5,840 more than in June 2019. Compared to 3.6% in November, the unemployment rate in December was 3.5%. In the Tallahassee Metropolitan Statistical Area, there were 184,000 non-farm jobs overall in December, up from 178,500 in December 2020.

4.3 Crime rates with Covid

Before the COVID outbreak, the City of Tallahassee stated that violent crime had leveled off at roughly 1,300 incidences per year from 2017 to 2019. But there were more violent crime incidences in 2020 and again in 2021, for a total increase of almost 21%. In 2017, 2018, and 2019, there were 5,500 and 6,500 arrests per year, respectively. The total number of arrests decreased by about 50% to 3,145 in 2020. The number of arrests grew slightly to 3,459 in 2021, but they are still much lower than they were before COVID. Before covid, in the years 2017, 2018, and 2019, there were between 9,500 and 11,500 traffic infractions issued. The total number of traffic offences decreased by around 50% to 5,663 in 2020. Traffic offenses decreased once more in 2021, to 5,352.

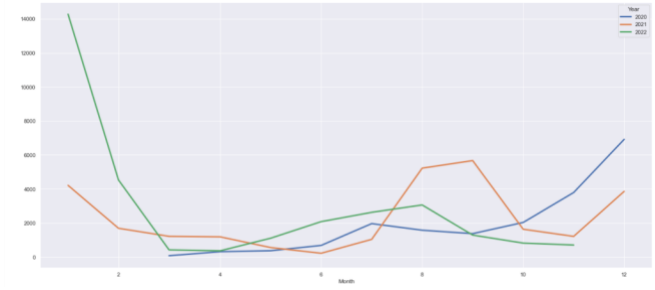
4.4 Effect of insurance during COVID

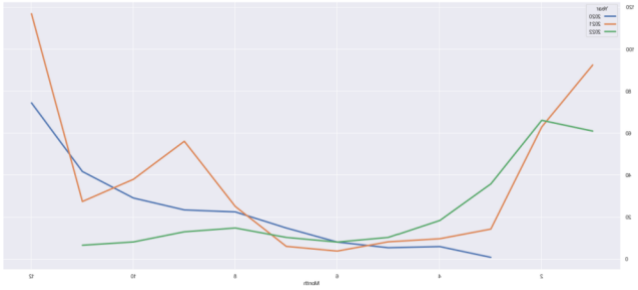
Rising infection rates, mobile field hospitals, and widespread uncertainty in the early stages of the pandemic caused panic. Analysts in the industry anticipated a sudden increase in the purchase of life insurance, but the trend took longer than anticipated (as we can see in figure 5). In Quarter 2, applications barely increased 1%. The U.S. life insurance market gained substantial momentum in the second half of

2020, with a record growth of 14.1% in July alone and a year-over-year increase of 9.2% in Q3. The overall increase in applications was 4%, which was the largest yearly year-over-year growth rate ever. Application activity increased the most among those under 45, by 7.9% year over year, followed by those between 45 and 59, by 3.8%, and those 60 and older, by 1.7%. The overall application momentum persisted in 2021, with an annual year-over-year growth rate of 3.4%—the second-highest growth rate on record, only surpassed by 2020. Comparing 2020 to the prior year In the medium to long term, insurers will encounter a variety of difficulties in addition to a number of fresh chances. Over $90 billion will be paid out by life insurance firms in 2020, an increase of 15.4% over 2019.

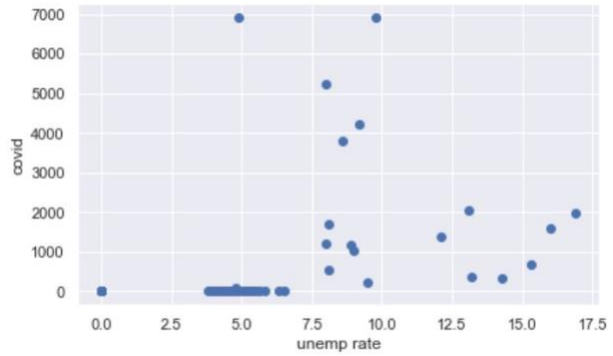
4.5 Housing with COVID

House prices have risen at historic levels in recent months following the brief but severe COVID-19 recession, reaching the peak gain of 19.3 percent in July 2021. For a number of factors, the Covid-19 recession saw a different behavior from previous recessions in terms of housing prices. Large transfer payments made during the pandemic, such as stimulus cheques and extended/expanded unemployment benefits, increased household earnings. As a result, when unemployment rose to a seasonally adjusted 14.8 percent in April 2020 from 4.4 percent a month earlier, household incomes and home demand did not crash. The demand for homes was further increased by extremely low mortgage interest rates, which reflected market dynamics and exceptionally supportive monetary policy(figure 6). Since the Great Recession, single-family home prices in the US have increased, increasing by around 7% over the past year. Additionally, demand for offices for businesses has largely held steady. The median price of a home was about $258,000 in the first quarter of 2020, right before the COVID-19 pandemic took down a large portion of the global economy(figure 7). However, prices have already gone down significantly, reaching medians of $240,800 in the first quarter of 2021 and signigficantly shot up upto $318,700 in 2022. In addition, prices now are about 16 percent higher than they were just a year ago and are well over 30% higher than they were in 2020.

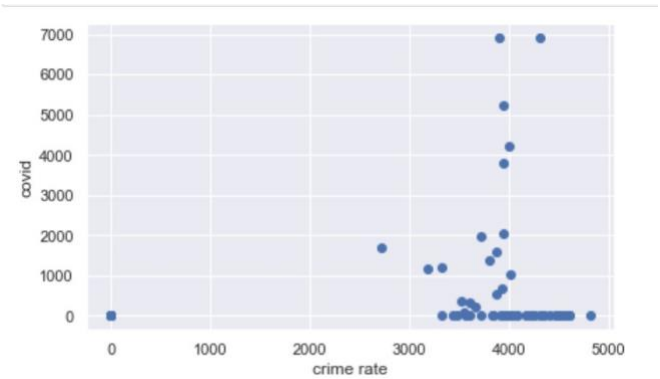




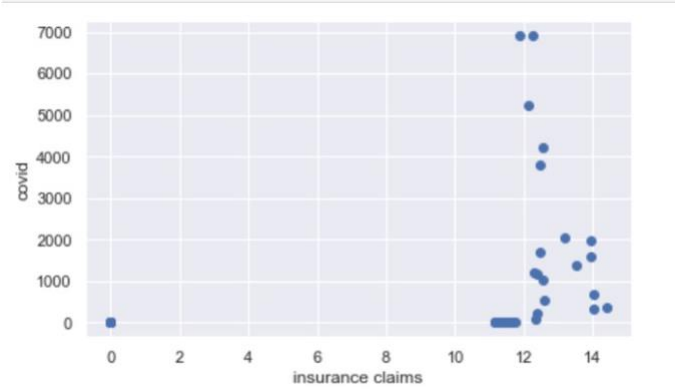
(Figure 1- Preliminary data analysis on the number of covid cases) (Figure 2- preliminary data analysis on the number of deaths due to Covid)



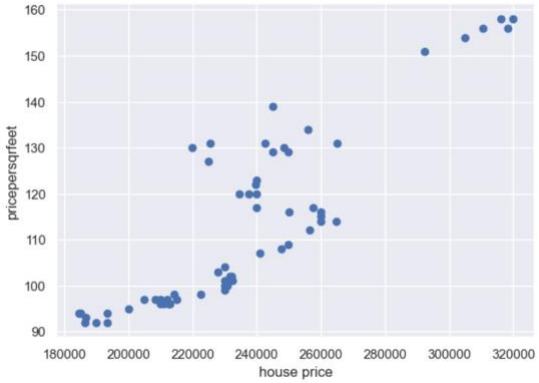
(Figure -3 the unemployment rate due to Covid19)



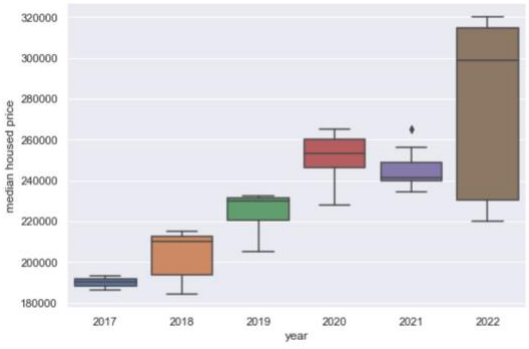
(Figure 4- Crime rate due to Covid 19)



(figure 5- shows the number of insurance claims)

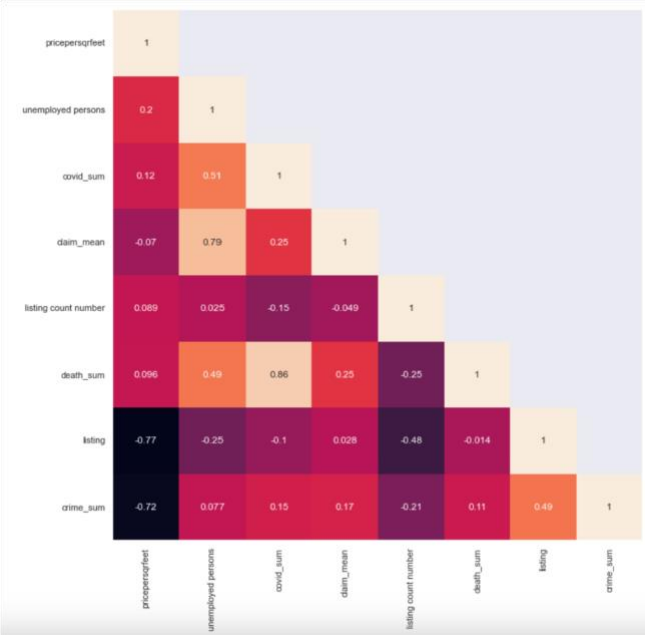


(Figure 6- shows the price per squarefeet)



(Figure 7- this shows us the median house prices)

CORRELATION MAP – VISUALIZING VARIOUS FACTORS



(Figure 8- Corelation matrix)

Price per square feet is positively correlated to median housed price and negatively correlated to crime sum. Price per square feet is negatively correlated to listing that is as price increases number of listing increases. Unemployment is positively correlated with claim_mean. Covid is highly correlated with death sum. Listing is correlated with listing count number that if more houses are there number of days listed decreases as we can see from figure 8.

5 MODEL DESIGN

We shortlist some of the models for the prediction and try to take out the best candidate to use and propose the model for the prediction. We consider Mean Square Error as the primary parameter to differentiate between the models. We consider linear regression, LASSO (tuned with GridSearchCV), RIDGE algorithm and XGBoost. Here is the brief about each algorithm we used and the final results table in the end. We also mention disadvantages of each algorithm as well.

The *Mean Squared Error* is a metric that quantifies how near a regression line is to a set of data points. It represents the expected value of the squared error loss as a risk function. The average, especially the mean, of errors squared from data as it pertains to a function is used to determine mean square error.

5.1 Linear Regression

Linear regression is unquestionably one of the most often utilized statistical modeling techniques. Although the general concept and calculation techniques are same, simple regression (with just one explanatory variable) and multiple regression (with several explanatory factors) are commonly distinguished.

The basic idea behind linear regression is to describe a quantitative dependent variable Y using a linear combination of p quantitative explanatory variables, X_1, X_2,..., X_p. The linear regression equation for observation I is as follows:

$$y_i = a_1x1_i + a_2x_{2i} + ... + a_px_{pi} + e_i$$

where y_i is the dependent variable value seen for observation I x_{ki} is the value taken by variable k for observation I and e_i is the model error.

5.2 LASSO

When discussing regression, the phrases linear regression and logistic regression are widely employed. However, there are other forms of regression that are important. Other forms of regressions include lasso regression, ridge regression, polynomial regression, stepwise regression, and elastic net regression. We shall concentrate on Lasso regression in this blog. Overfitting is caused by the growing polynomials in the regression model equation. Regularization procedures are used to combat overfitting.

The Least Absolute Shrinkage and Selection Operation is the full name of LASSO. LASSO employs the "shrinkage" approach, as the name implies, in which coefficients are calculated and shrunk towards the center point as the mean. In regularization, LASSO regression is based on basic models with fewer parameters. Because of the shrinking process, we receive a better interpretation of the models. The shrinkage procedure also allows for the discovery of variables that are highly related to variables that correspond to the aim.

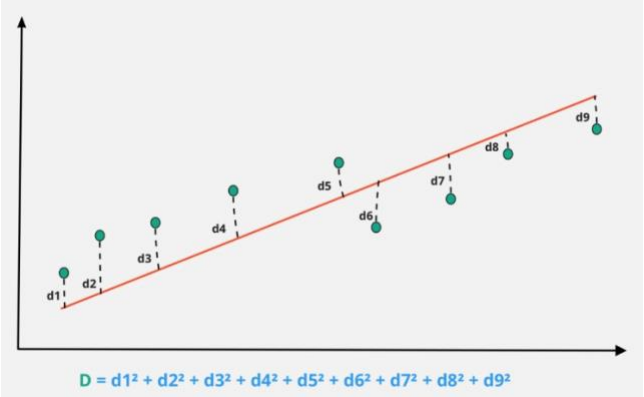


Fig : - Statistics of LASSO Regression

d1, d2, d3, and so on represent the distance between the actual data points and the model line in the preceding graph. Least-squares is the sum of the squares of the distance between the points on the depicted curve. In linear regression, the optimum model is chosen to minimize the leastsquares. When doing lasso regression, we add a penalizing component to the least-squares. That is, the model is designed in such a way that the below loss function is reduced to a minimum value.

GridSearchCV is the process of tweaking hyperparameters to find the best values for a given model. As previously stated, the value of hyperparameters has a substantial impact on the performance of a model. Because there is no way to predict the optimum values for hyperparameters in advance, we must preferably attempt all possible values to determine the optimal values. To avoid wasting time and money, we utilize GridSearchCV to automate hyperparameter tweaking.

Before saturating, LASSO picks no more than n variables. LASSO does not support group selection. If there is a collection of variables with very strong pairwise correlations, the LASSO prefers to choose only one variable from the group.

5.3 LASSO with tuning

In ridge regression and lasso regression, a tuning parameter (), also known as a penalty parameter, affects the severity of the penalty term. It is essentially the amount of shrinkage, which occurs when data values are reduced towards a central point, such as the mean. Shrinkage produces simple, sparse models that are easier to examine than high-dimensional data models with many parameters.

When = 0, no parameters are eliminated. The estimate is the same as that obtained through linear regression. As increases, more and more coefficients are set to zero and eliminated. When = is used, all coefficients are removed. In resultant estimators, there is a trade-off between bias and variance. As rises, bias grows, and as reduces, variation grows. Setting your tuning parameter to a low value, for example, leads in a smaller number of model parameters and lower bias, but at the price of a considerably bigger variation.

5.4 RIDGE

Ridge regression is a kind of linear regression in which ridge coefficients are penalized. This method may be used to mitigate the impacts of multicollinearity in ridge regression, which can be caused by significant correlations between predictors or between predictors and independent variables. Ridge regression works by adding a punishment term to the cost function, with the penalty term equal to the sum of the squares of the coefficients. The punishment term is known as the L2 norm. As a result, the optimization issue becomes easier to solve and the coefficients become lower. This penalty term pushes the model to strike a compromise between fitting the training data well and being simple. As a result, ridge regression can aid in the generalizability of a machine learning model.

However, there are significant drawbacks to ridge regression. First, if the data collection is huge, it might be computationally expensive. Second, because the Ridge term or L2 norm alters the coefficients, ridge regression findings might be difficult to interpret. This is because the cost function has a quadratic term, making optimization more challenging. Furthermore, ridge regression does not give an exact answer but rather a closed-form approximation. This can make it difficult to comprehend the model's results. Finally, ridge regression is susceptible to outliers and might yield unstable results if the data contains outliers.

5.5 XGBOOST

Gradient boosting (GBM) trees do unsupervised learning by learning from data without a predefined model. XGBoost is a well-known gradient-boosting toolkit that may be used for GPU training, distributed computing, and parallelization. It is exact, adapts well to many sorts of data and issues, has great documentation, and is overall quite simple to use.

It is currently the de facto standard approach for obtaining reliable results from predictive modeling using machine learning. It is the most accurate and quickest gradient-boosting package for R, Python, and C++.

However, XGBoost struggles with sparse and unstructured data. Gradient Boosting is particularly sensitive to outliers since each classifier is compelled to rectify the flaws in the previous learners. The entire technique is not scalable.

Linear Regression	LASSO (Tuning with GridSearchCV)	**After tuning LASSO**	RIDGE	XGBoost
0.0723	0.112	**0.0465**	0.4947	0.1208

Table 2:- Mean Square Error Values of all the algorithms used for Mean Housing Price

Linear Regression	LASSO (Tuning with GridSearchCV)	**After tuning LASSO**	RIDGE	XGBoost
4.7869e-13	0.0011	**0.0001**	2.8142e-05	0.5674

Table 3: - Mean Square Error Values of all the algorithms used for Crime Rate

Linear Regression	LASSO (Tuning with GridSearchCV)	**After tuning LASSO**	RIDGE	XGBoost
3.59e-12	0.537	**0.0045**	2.429e-04	0.957

Table 4: - Mean Square Error Values of all the algorithms used for Unemployment

6 EVALUATION/DISCUSSION AND RESULTS

Following are the evaluation results that can be concluded from the above analysis done which needs to addressed individually–

- The preliminary data analysis as the shown in the graphs above shows that the number of covid cases increases during the period of last quarter if every year which tells us that the gathering of people is increasing due to the festive period.
- It shows that number of deaths have been decreasing significantly in the year 2022 due to the start of vaccination programs in several countries which is a good sign.
- The dataset when observed during the pre-covid, and post-covid period tells us that the unemployment rate drastically increased during the covid period and is getting normalized now due to the closure of many small industries.
- The decrease in unemployment lead to increase in crime rate in several parts of the city, this issue needs to be quickly addressed by the governments.
- The onset of new virus made the people very scared and forced the people to take more insurances, which increased the number of premiums paid by the people. Number of claims taken by the people during the period also saw a drastic increase which was a good sign for the insurance industry.
- As the covid locked everything in the world, the housing prices drastically dropped down to a very low in last few years which raised the inflation in the countries. But, when during 2022, the housing prices started to become normal and then started to increase.
- To predict the patterns of covid for a particular factor, we have chosen LASSO (tuned) as the algorithm to be considered for prediction. It can be seen from the above tables that for factors like median housing price, crime rate, unemployment, the algorithm LASSO gives the least mean square error value.

The code and dataset for the above analysis and model design can be found at this link – https://www.dropbox.com/scl/fo/oxm565l3nae2mojjo3r5a/h?dl=0&rlkey=53uw21tlgpeqp0o7lzb154svw

7 CONCLUSION

This project relies heavily on data collecting, which is done through a variety of sources. Following data collecting, there will be data cleansing, aggregation, and combining of various data obtained from various sources. During the data preparation step, exploratory data analysis will be performed on a portion of the data to identify the social and economic aspects present before, during, and following the COVID. In the event of comparable pandemic conditions, we will offer potential recommendations. The impact of COVID-19 or a similar pandemic situation on housing prices, insurance claims, employment, unemployment, and crime incidents is understood and predicted using the EDA analysis with time series data collected from 2017 to 2021 on a monthly basis. In the end, a algorithm is also proposed to predict.

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