ANALYSING COVID-19 and ITS IMPACT

By: Utpal Mishra (20207425)

Under the supervision of

Dr. Aine Bryne

DATA AND COMPUTATION SCIENCE

UNIVERSITY COLLEGE DUBLIN

BELFIELD, DUBLIN 4, IRELAND

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Submitted to the Department of Mathematics and Statistics in partial fulfilment of the requirements for the degree of Master's in Data and Computation Science.

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CERTIFICATE

This is to certify that Project Report entitled **"Analysing COVID-19 and its Impact"** which is submitted by **Utpal Mishra,** in partial fulfilment of the requirements for the award of master's degree in Data and Computational Science at University College Dublin, is a record of the candidate's own work carried out by him under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

Supervisor: Dr. Aine Bryne

Date: 23rd December 2020

ACKNOWLEDGEMENT

It gives us a great sense of pleasure to present the report of the master's python final project undertaken during the Autumn Trimester. I owe a special debt of gratitude towards ***Dr. Aine Bryne*** *School of Mathematics and Statistics, University College Dublin, Dublin, Ireland for his constant support and guidance throughout the course of our work. His sincerity, thoroughness and perseverance have been a constant source of inspiration for us. It is only his cognizant effort that our endeavours have seen the light of the day.*

I also do not like to miss the opportunity to acknowledge the contribution of all faculty members of the department for their kind assistance and cooperation during the development of our project.

Name: Utpal Mishra
Student Number: 20207425
Date: 23rd December 2020

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LIST OF ABBREVIATIONS

1. **COVID-19 Coronavirus Disease 2019**
2. **PM1 Particulate Matter 1**
3. **PM2.5 Particulate Matter 2.5**
4. **PM10 Particulate Matter 10**

ABSTRACT

The pandemic has been breaking down the health sector and has made us rejuvenate ourselves for a much healthier and better chores. Over the years, it has been proven the air quality has been degrading, especially with numerous forest fires and pollution thus, it has resulted in arising the respiration problem over time and being one of the easiest mediums to spread, the effect of the coronavirus has been intensified with the air we intake. With such a low-quality air to breathe, it has resulted in increasing the percentage of the patient being tested positive, as studied by professors in Harvard University.

Within months, the globe had witnessed the impact of this virus, causing millions of lives and within the snap of a few months, a massive population has died and is still counting. Different countries have shown their actions and measure to safeguard their citizens with the assistance from shutdowns, wearing face masks and hand-sanitizing, as being quite effective. Lockdown has been an important measure to regulate and limit the spread, but it has made a massive impact on unemployment and currency exchange rate (as discussed in the project) all over globe.

This project encapsulates the complete dynamics of the virus, with inception from the influencing air pollutants in this pandemic, about the statistics on the new cases raised over time from January to September 2020 along with the medical analysis and testing performed at local and hospital labs on people of different age groups. And lastly, covering the impact on the coronavirus complement to a time series forecasting on the new cases of Ireland to be prepared and take required measures within time.

CHAPTER 1
INTRODUCTION

In this project, we will be taking an excursion on one of the widely impacted diseases i.e., COVID-19. **Coronavirus disease 2019** (**COVID-19**) is caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2). It was recognized in December 2019 by Wuhan, China being an infectious disease and eating up the world population (Figure 1).

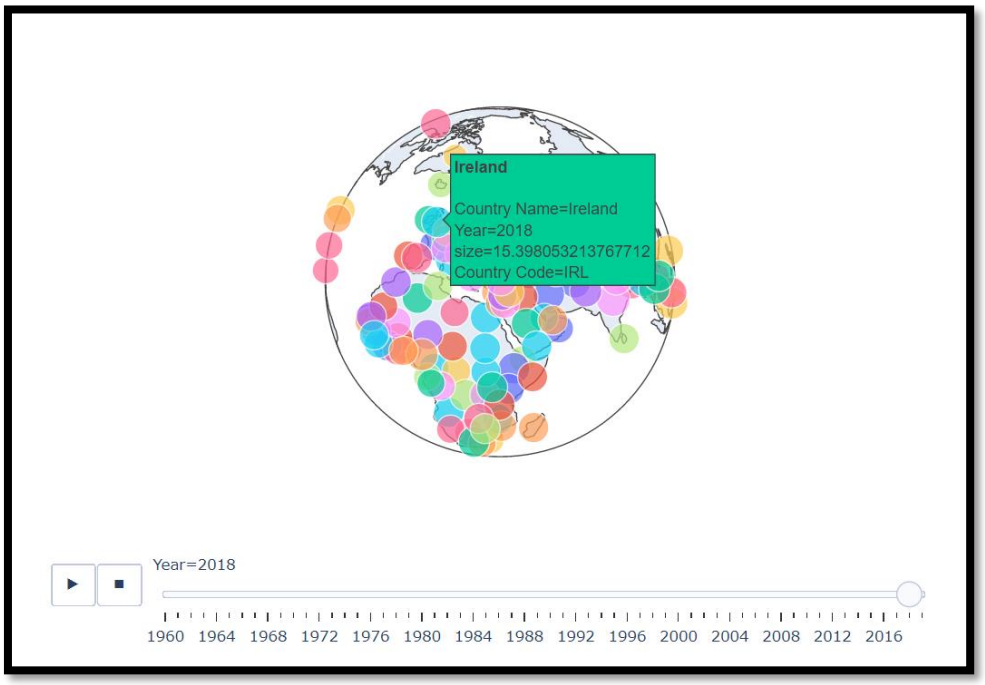


Figure 1: Dynamic scattered orthographic plot of world population (logarithmic of population) from 1960 to 2020

With acute respiratory distress syndrome (ARDS) with cold, fever, and loss of senses (taste and smell) are known to be the more profound symptoms of COVID-19 include fever, cough, fatigue, breathing difficulties, and loss of smell and taste. It was also been observed that in a longer span doctors have also witnessed damage to the heart and lungs as well as infection in body/ body parts. All of this can be comprised of an impact on the cognitive system, fatigue, and respiration.

Coming to the symptoms so, several means of spread has been observed namely, Close/ Direct contact (involving saliva and other bodily fluids and excretions). The exact route of transmission is rarely proven, but infection mainly happens when people are near each other for long enough, which is known as "close contact". It can spread as early as two days before infected persons show symptoms and from asymptomatic individuals. People remain infectious for up to ten days in moderate cases, and two weeks in severe cases. Preventive measures include social distancing, quarantining, ventilation of indoor spaces, covering coughs and sneezes, hand washing, and keeping unwashed hands away from the face.

The use of face masks or coverings has been recommended in public settings to minimize the risk of transmissions.

From studies, it has been found that a sharp inclination death due to virus has been due to pollutant particles known as PM2.5, which has been consumed over years through the air. Researchers have analysed the data of deaths from the virus and on the tiny pollutant PM2.5 levels, and it was investigated that the pollutant was found in 98% of the U.S. population. Statistically, one microgram per m^3 more concentration of PM2.5 in the air has resulted in a 15% higher rate of COVID-19 deaths.

The reason to all this is because these tiny pollutants penetrates deep into the human body which results in increasing complications of the COVID-19 patients with breathing problem, heart diseases, hypertension, and diabetes. It in turn weaken the immune system and causes inflammation in the lungs and respiratory tract and ultimately, makes the condition worst.

So, the idea is to visualize and decipher the influence of toxic air pollutant particles, ups and down in COVID-19 cases, the medical analysis and favourable treatment done in majorly in Ireland. Furthermore, bring out the impact of COVID-19 on the economies and in unemployment.

CHAPTER 2
ANALYSIS

For testing, a standard method known as real-time reverse transcription-polymerase chain reaction has been into use. Results of respiratory samples through nasal swabs can reach from a couple of hours to two days. Moreover, blood tests can also be used with an immediate result. As of 4th April 2020, antibody tests are more accurate, but results take a couple of weeks to showcase any presence of the infecting virus.

Patients have even been tested COVID positive without the presence of any affecting symptoms of the virus in their body. A faster and risk-free alternative way has also been by collecting saliva samples using a sterile container when coughed. Along with testing in labs, a chest CT scan is another alternative for highly infected patients but not in chores.

ABOUT THE DATA

Air Pollution Dataset:

To behold and decipher the metamorphosis of air pollution before the inception of the pandemic as well as to make a prediction (after few years), a WORLDWIDE COVID-19 Dataset (2020) was extracted from Air Quality Open Data Platform of size 8, 23,002.

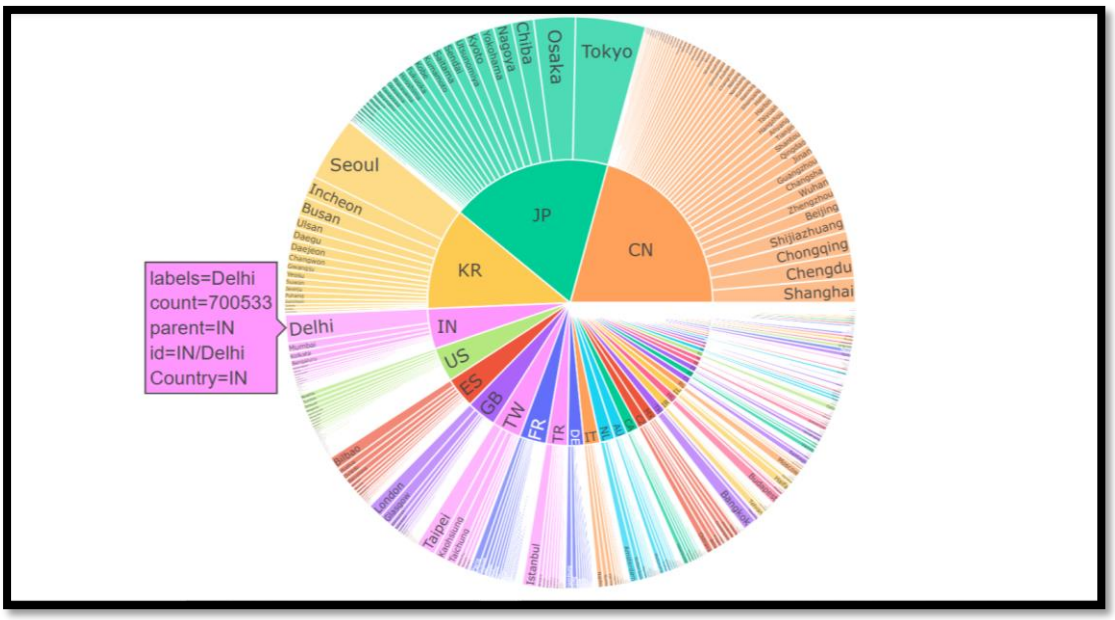


Figure 2: Total count of pollutants (CO, NO_2, O_3, PM1, PM10, PM2.5, SO_2) in the Countries and in their Cities

Covid-19 Datasets:

To understand the inception, spread, and analysis of the pandemic, multiple COVID-19 datasets was extracted from the Government of Ireland data portal i.e., https://data.gov.ie/dataset?theme=Health.

DATA BASED ON	DATASET	DIMENSIONS
Air Pollution	waqi-covid19-airqualitydata-2020.csv	823001 x 9
COVID-19	population_by_country_by_year.csv	264 x 64
	cases_by_country_ireland.csv	595 x 10
	ICUBIHistoricTimelinePublicView.csv	217 x 4
	COVIDStatisticsProfileHPSCIrelandOpenData.csv	252 x 38
	LaboratoryLocalTimeSeriesHistoricView.csv	227 x 11
	Weekly_testing_data_europe.csv	1011 x 9
	unemployment_by_country_by_year.csv	264 x 65
	Euro_exchange_rates.csv	205 x 37
	Covid19AcuteHospitalHistoricSummaryOpenData	239 x 2

Table 1: List of details of datasets used in the project

This project will majorly focus on the statistics and the impact of COVID-19 on Ireland. So, understanding the dynamic of COVID-19 is paramount and thus, to decipher a plausible virtuoso this section is bifurcated into four sub-sections concerning the data provided. These sections are namely,

- Effect of Air Pollutants
- Cases Investigation
- Medical Strategies
- Testing Interpretations

EFFECT OF AIR POLLUTANTS

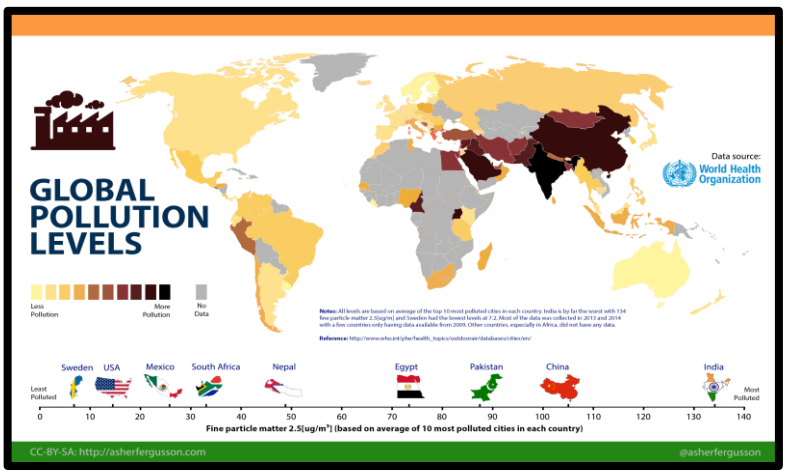


Figure 3 and 4: Statistical Interpretations on Air Pollution

As the novel coronavirus tears around the world, it is exploiting our biggest weaknesses from creaking health care systems to extreme social inequality. Its relationship with one pervasive and neglected problem, however, is more tangled as the air pollution has intensified the pandemic (Figure 3 and 4).

The fine particles penetrate deep into the body, promoting hypertension, heart disease, breathing trouble, and diabetes, all of which increase complications in coronavirus patients.

The particles also weaken the immune system and fuel inflammation in the lungs and respiratory tract, adding to the risk both of getting COVID-19 and of having severe symptoms. From the air pollution data extracted to apprehend the behaviour of pollutants (Figure 5) namely, $S0_2$, NO_2, CO, PM10, PM2.5, O3 and PM1.

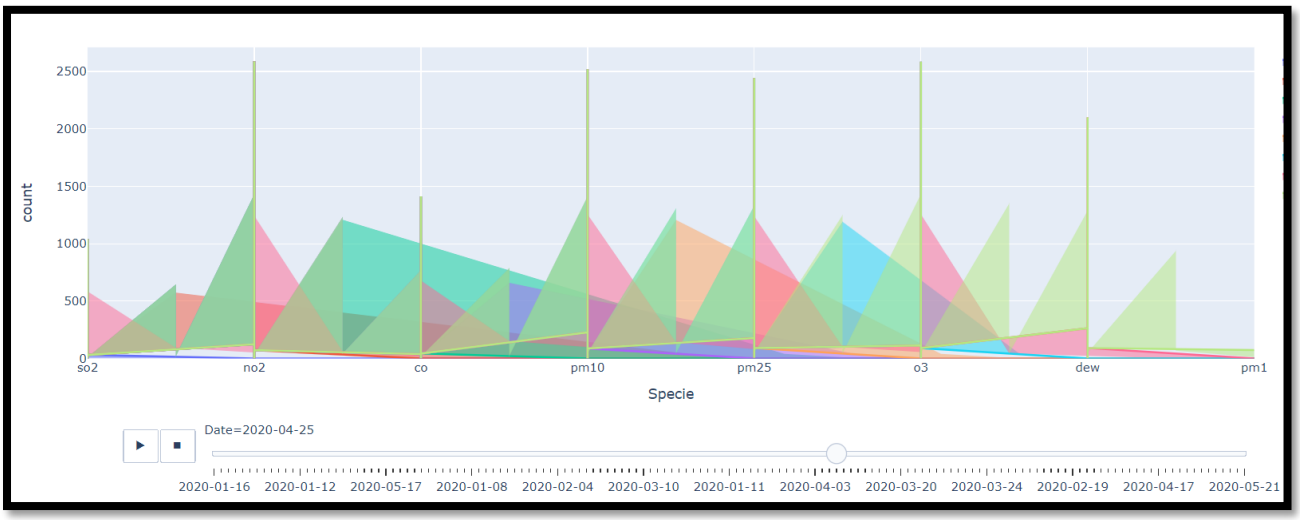


Figure 5: Dynamic plot representing the metamorphosis on the amount of air pollutants from January 2020 to May 2020

CASES INVESTIGATION

It has been complication to collect the actual numbers of affected people but from the data obtained it has been found that the total confirmed cases in Ireland have jumped from 68 cases in March 2020 to the peak of 140 (approx.) in April and with gradual declination to as low as only 7 total confirmed cases by September end (Figure 6). With effective treatments and procedures, admitted cases and discharged cases are moved on simultaneously to witness a gradual decrease in cases in April 2020.

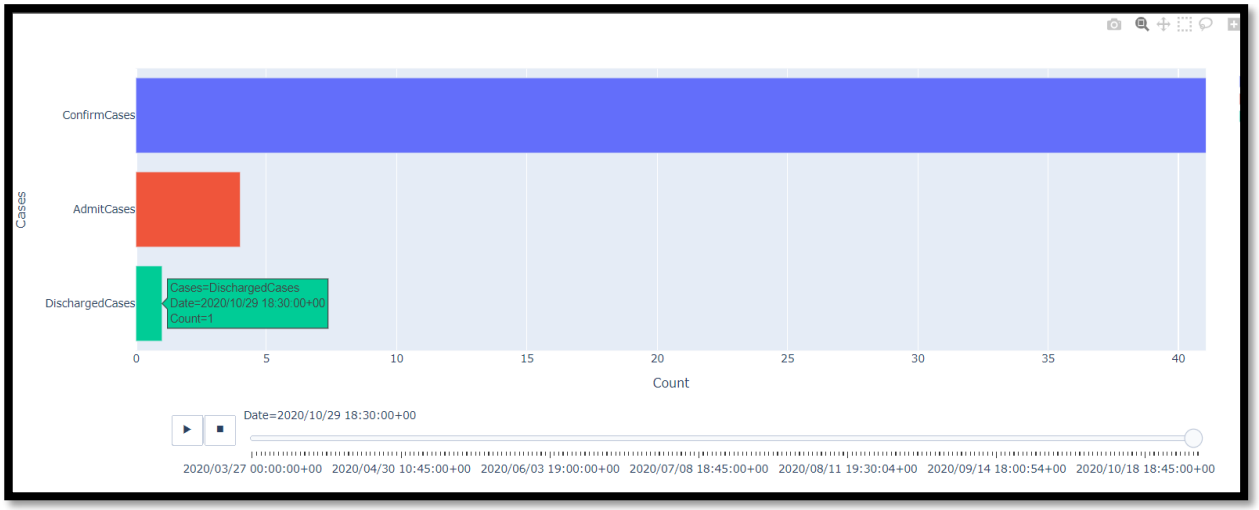


Figure 6: Bar-plot for different cases (i.e., Confirm Cases, Admit Cases and Discharged Cases) in Ireland from last March 2020 to mid-September 2020

The following map (Figure 7) shows the number of cases in different plotted regions of Ireland using the Foursquare API and Folium. All the different Counties of Ireland are represented in the map below with a number of cases and the label in their respective region.

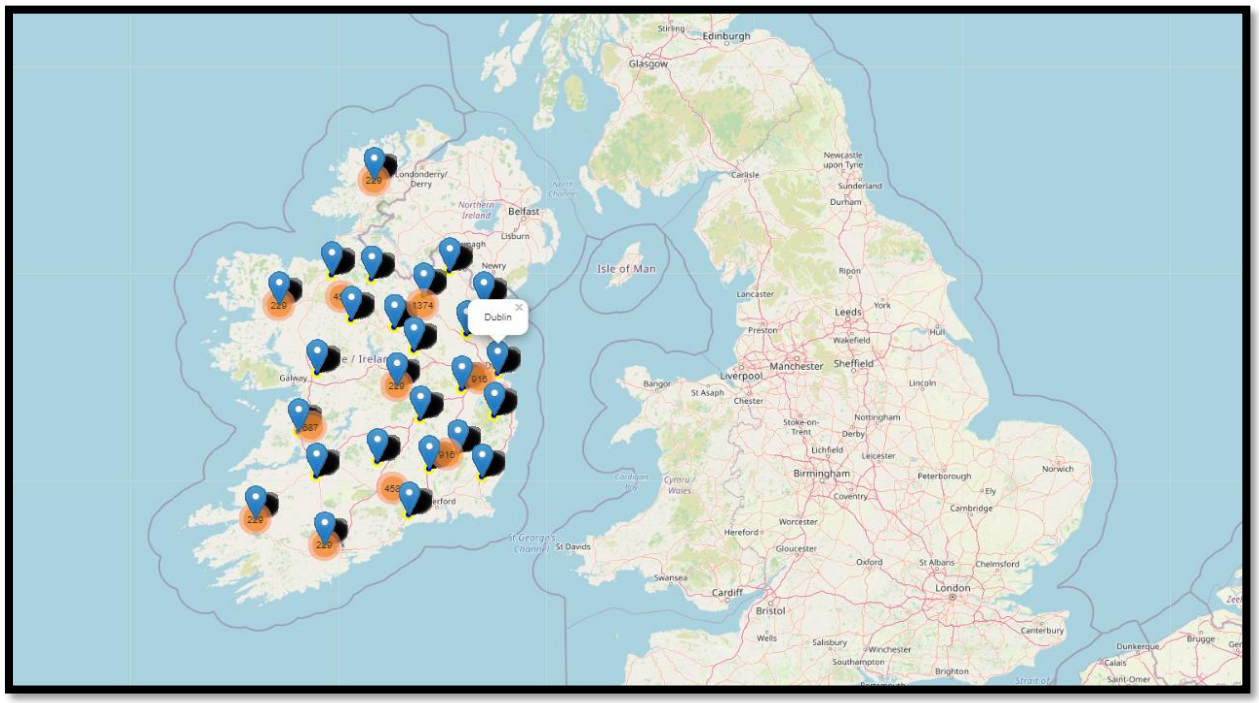


Figure 7: Folium map for COVID cases in Ireland over 7 months

A more detailed analysis of the transition of the case over the course of 7 months on daily basis can be investigated from the below bar-plot (Figure 8). The plot shows the until 3rd April, not so prominent cases were witnessed but just a day after they have inclined all over Ireland and especially in Dublin. Within a span of just a month, the cases have massively increased from ~470 to 10,000+. Though after a couple of months rise slowly,

September has been the most affected for Dublin, as cases moved from 14,000 to over 20,000 by the month-end. Apart from Dublin having exceptionally high cases followed by Cork, counties like Leitrim, Sligo, and Carlow have been the least affected ones.

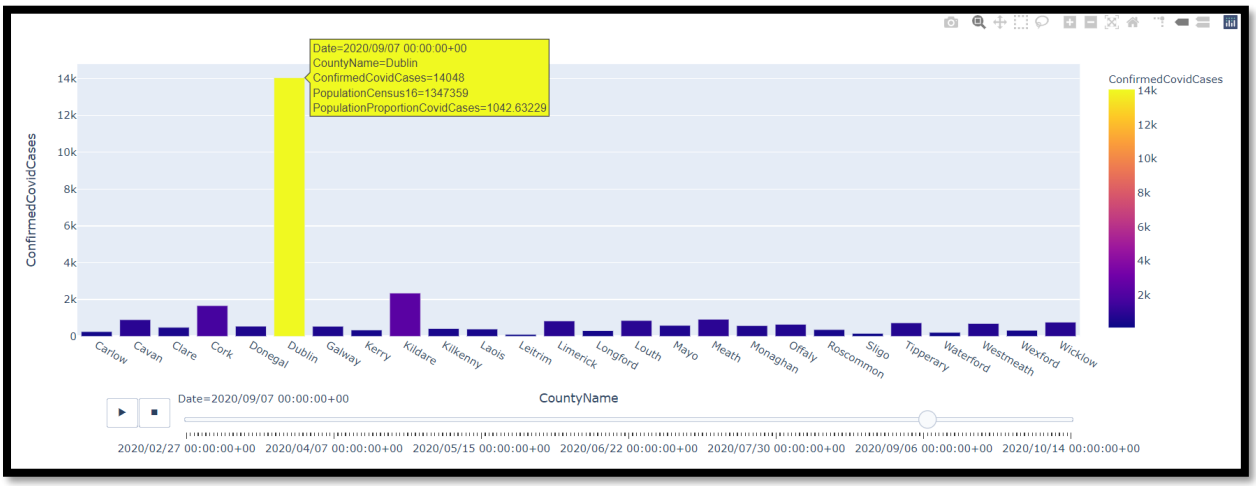


Figure 8: Confirm COVID cases in different county in Ireland from end January 2020 to early September 2020

The plot above gave another picture of the confirmed cases where all the Counties did not seem much affected by COVID. But here is another picture to decipher to propel the proportion of each County affected by the virus from March to September.

Unlike the above plot, the below plot (Figure 9) clearly shows a clear COVID-19 influenced scenario in different regions of Ireland. Though the rate of increase has been unexpectedly higher for Cavan and Westmeath the most affected counties in Ireland are Cavan, Dublin, Kildare, and Monaghan while Waterford, Wexford, and Galway are the least.

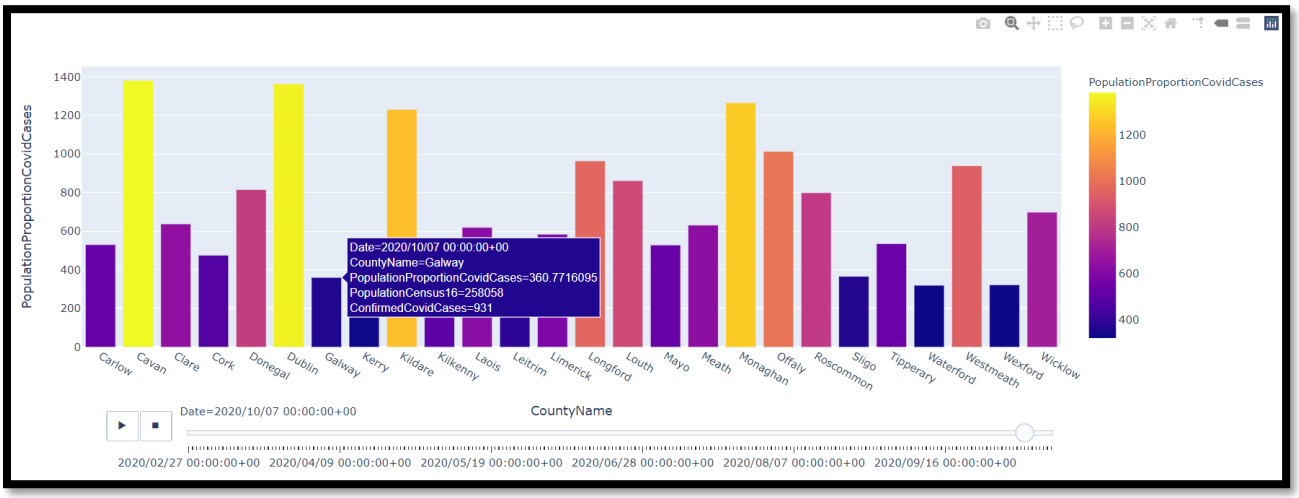


Figure 9: Proportion of population affected with COVID in different Ireland County from end January 2020 to early September 2020

MEDICAL STRATEGIES

Without effective treatment measures, alternatives are required to slow or decline the impact of the pandemic apex and flattening the curve of infection.

The impact of the virus has been witnessed in stages i.e., close contact, traveling abroad, and community transfer. Preventive measures are found to be sanitizing, homestay, wearing masks, maintaining social distancing, and avoid gathering. Maintaining a healthy lifestyle and hygiene, use of handkerchief or tissue while sneezing or coughing are the prominent measures that can be taken into notice.

Figure 10: An important aspect of COVID is the pattern of spread of disease in different phases i.e., Travel Abroad, Close Contact and Community Transmission.

From the data and the above plot (Figure 10) the people living in Ireland have been least affected by traveling abroad while from June to September the most cases of this pandemic were witnessed due to close contact.

Coming on to the influence in different age-groups so, the impact of the virus propelled with the influence within the age-group of 25-54. But with slower and lower immunity towards fitting the virus in adults, people aged 65+ have been the most affected ones while lowest cases were observed for kids and teenagers. As a counteraction towards the virus, antibodies started to build in some people naturally, while in some they were given externally to strengthen the immune system and dominate over the virus. By now, many people without any signs of the pandemic virus has been producing antibodies within their body. A more detailed impact on different age criteria can be analysed from the below plot (Figure 11).

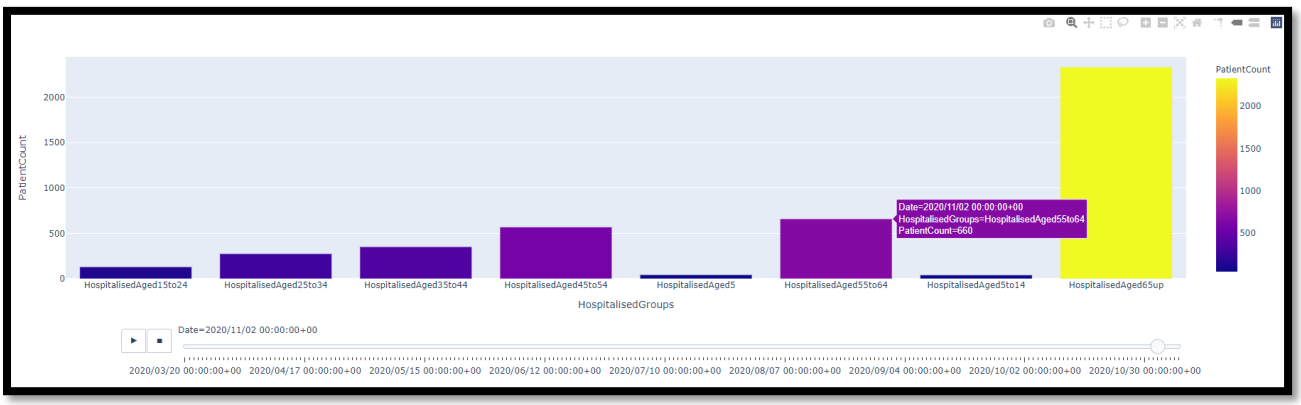


Figure 11: Different age group of total citizens affected from COVID from March 2020 to September 2020

TESTING INTERPRETATIONS

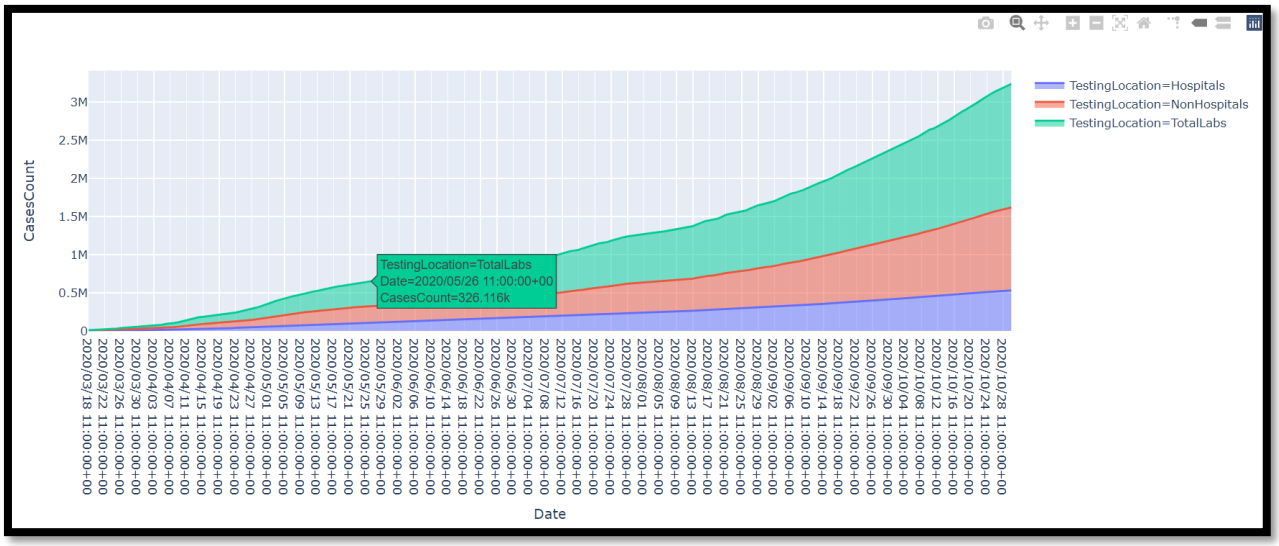


Figure 12: Total number of testing performed in different labs i.e., in Hospital Labs and in Non-Hospital Labs from January 2020 to September 2020.

With the increase in cases and harm on the people with diverse symptoms - even some without any symptoms - it has been paramount to find a hold on the radical besiegement of the impact. Thus, the relevant testing and experiments were performed in numerous labs, some in Hospitals while more Non-Hospitals Labs (Figure 12). And the related statistics can be seen from the above plot for the course of March to September 2020.

The rising cases in countries have been unexpected but the testing was held strong. Even after and intensive impact, many countries have show praise-worthy efforts with testing in manifolds (Figure 13). Ireland has been a low impacted country, with requisite amount of testing done and negligible COVID-19 positive cases, comparatively.

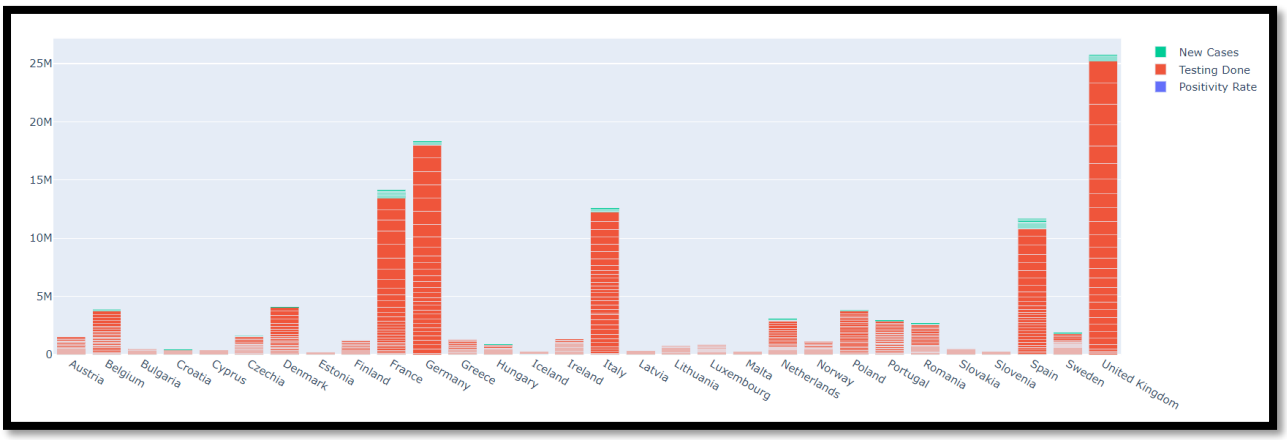


Figure 13: Response of the countries to the new cases and the tests performed.

CHAPTER 3
RESULTS AND CONCLUSION

IMPACT ON CURRENCY EXCHANGE RATE

With the countries in lockdown, a major impact was seen in the currency exchange rate of different countries w.r.t Euros, as can been seen from below plot (Figure 14). It can be witnessed through the span from March 2020 to September 2020, the value of Indonesian Rupiah rises by the value of ~177.44 followed by the shift of figure of ~43 of South Korean won, while other countries have observed a much lower exchange rate.

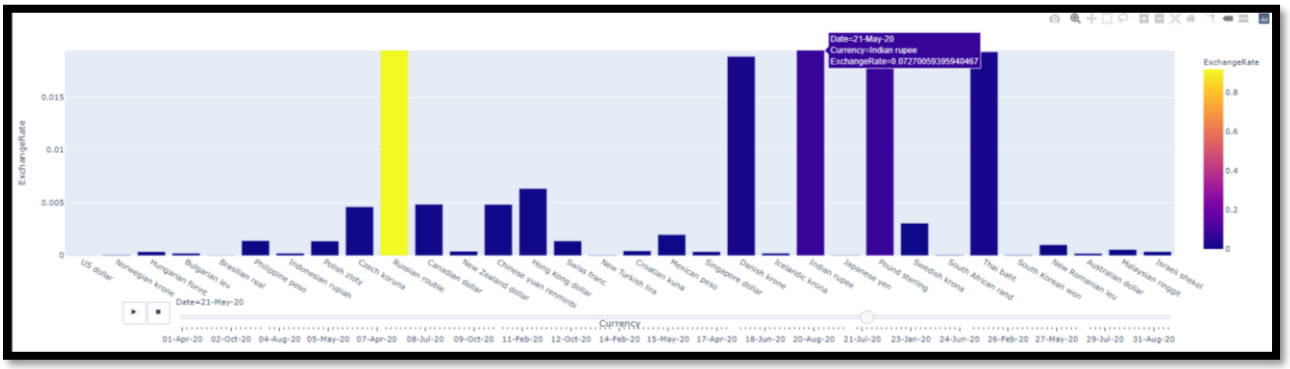


Figure 14: Value of Euros VS other currencies from Jan 2020 to mid-October 2020

IMPACT ON UNEMPLOYMENT

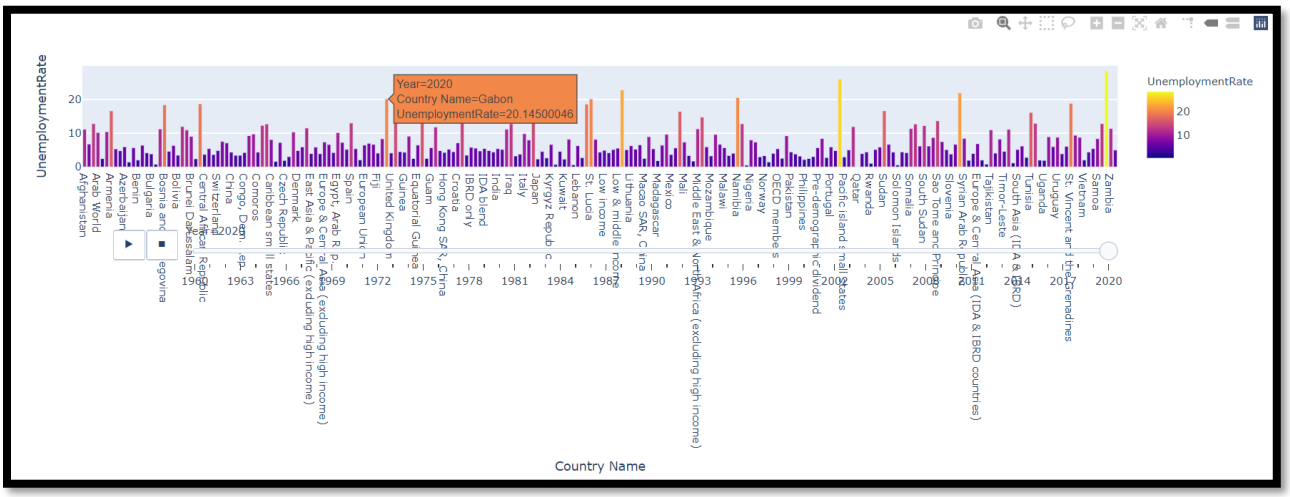


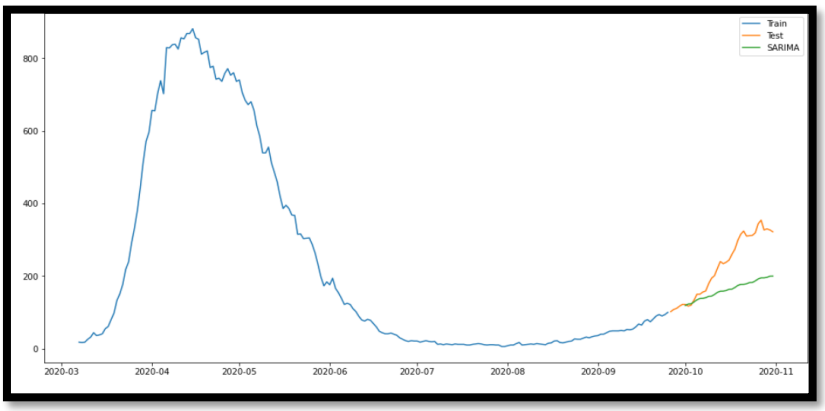
Figure 15: Unemployment in the world from 1960 to 2020

With people getting tested positive and economy on contraction, the companies had to eventually remove employees to a massive scale as can be seen above (Figure 15). It was observed that South Africa (28.47%) had highest unemployment rate while Qatar with the

lowest unemployment rate of 0.082% followed by Niger, Solomon Islands, Lao PDR and Cambodia with rate between ~0.40-0.70%, respectively.

TIME SERIES FORECASTING

With the ongoing cases, it is imperative to predict the number of cases that might arise in the coming month based on previous statistics so, that requisite safety and healthcare measure can be taken into consideration by the Government and the citizens. Thus, forecasting on cases (Figure 16) and multiple time series forecasting models (Figure 17) were used to make the prediction. It was found that on an average, approximately 120 cases might arise in coming months (October to December) based on the stats from January to September.



	RMS Values
Naive Approach	152.248335
Simple Average Method	85.161422
Moving Average Method	207.979349
Simple Exponential Smoothing	154.743079
Holt's Linear Trend	92.022976
Holt-Winters Method	49.037418
ARIMA	97.714634

Figure 16 and 17: Cases prediction (green line) using ARIMA model, RMS Values for number of cases in coming month using time series forecasting.

In conclusion, it can be said that based on factual statistics from October-December, the model made a precise prediction on new cases. And apart from the rise in cases, a downfall over the positive cases is also been observed as a percentage of the people have already started to get immune from the virus with the development of anti-bodies, with use of facemasks, following social distancing, using immunity boosters, and in time, from the vaccines, as expected.

Though the world is slowly stabilizing with uncertain future, this pandemic is going to leave a deep impact on the health care section (uncertain), fluctuating international relations of the countries and technological advancement (a quicker inclination). It has also been observed that many countries are planning for a closed economy to build a stronger economy again with more employments by stepping towards self-sustaining. But since the virus is a biological specie which tends to mutate for its survival, the level of mutating and ultimately, the contamination and % spread will be unpredictable (as UK is witnessing, recently).

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