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A Study of before and after Lockdown Situation of 10 Countries through Visualization of Data along With Entropy Analysis of Top Three Countries

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Abstract

Since Dec 2019 the world is facing anepidemic caused by a new coronavirus termedas severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The disease related with this virus is familiar as COVID-19. The COVID-19 virulent virus was position reportable in City, China and so far exhausted on to move to many than 50 countries across the orb. WHO declared COVID-19 as a pandemic on 11th Genre 2020 and there has been travel cases of contagion of the virus. This paper emphases on COVID-19 based on freelyaccessible datasets including the ones in Kaggle repository. In thisstudy visualization of the confirmed, active and recoveredcases of 10 countries is taken in consideration along with before and after lockdown period upto 12 August, 2020.Finally,Shannon's entropy is used for analyzing the confirmed cases of top 3 countries through visualization of data upto the period of consideration of data.

Mathematics Subject Classification (2010): 94A15 and 93C57.

Keywords: COVID-19;Data analytics;Visualization; SIR; Coronavirus; SARS-COV-2; Information Visualization; Pandemic; Shannon's Entropy

1. INTRODUCTION

Encase, exclusive stranded positive-sense ribonucleic dissolver (RNA) viruses titled coronaviruses contain one of the largest viral genomes which are around 32 kbp in length.Humans as well as a wide range of animals can be infected by this deadly virus

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(Randhawa et al. 2020). The 2019 new coronavirus termed as SARS-CoV-2 caused pneumonia outbreak in City, China resulting in the 2019-2020 coronavirus epidemicdeclared by world health Organisation (WHO). It is definite from Midriff Orient respiratory syndrome (MERS) and plain perceptive respiratory syndrome glowing virus(SARS-CoV)(Dey et al. 2020). In Wuhan's Huanan, wholesale activity related to seafood trades a show of unfilmed carnal species which includes fish, poultry, marmots, snakes and bats which linked the irruption (Lu et al. 2020; Sohrabi et al. 2020; Xu et al. 2020). Great genome similarity was identified between SARS-CoV-2 and bat coronavirus by the researchers(Bai et al. 2020; Chen et al. 2020). The infected patients showed clinicalmanifestations of dry expiration, febricity, confusedness, unhealthy throat, rhinorrhea, dresser somatesthesia, symptom, symmetrical lung infiltrates on tomography, symptom, regurgitation and diarrhoea (Chen et al. 2020; Sohrabi et al. 2020). The disease caused by SARS-CoV-2 identified as COVID-19 can be deathly. This happens when the strictness of thedisease onset results in monolithic alveolar harm with progressive respiratory nonstarter with a 2% instance death order (Xu et al. 2020). According to the WHO, an infected patient can hold the virus during uncommunicative representative and via respiratory dropletscold, speaking or sneezing. Though the virus can be transmitted by the virulent carrier (Bai et al. 2020), it is the most contagious when grouping are symptomatic. Arecent examination (Santarpia et al. 2020)reports that for the someone of SARS-CoV-2, aerosol transmission may beexecutable in tight places when there isindividual exposure to the virus. Generally, symptoms may develop in patients between two to fourteen days,with an figure of finite days(Velavan and Meyer 2020). According to the Centers for Disease Contain and Prevention, the regular identification method for the identification of the virus in the enduring is by verso transcription polymerase distributor response (rRTPCR) from nasopharyngeal swab((Centers for Disease Control and Prevention and Division of Viral Diseases 2020). A compounding of symptoms, attempt factors and a CT see showing features of pneumonia can examine the contagion (Jin et al. 2020). In magnitude to foreclose the move of this infection, the WHO recommends frequent washing/cleaning of hands with soap/ alcohol-based sanitizer, maintaining good respiratory hygiene, social distancing, and cover coughs and sneezes with a tissue or flexed elbow. Most of the national welfare regime urge masks for the suspects and respective caretakers. In order to end this pandemic, the way of transmission of the virusto humans many more factors need to be identified. As of 09September 2020, COVID-19 has impressed more than 27,764,017 patients in 213 countries and territories

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around the humans (2020a)and hastransform a starring world wellbeing occupy. This paper is divided into 5 sections. Section 2 describes the review of literature of COVID-19 using tabular information. Section 3 provides analysis of confirmed, active and recovered cases before and after lock down of 10 countries through visualization of data up to 12 August, 2020.Section 4 provides entropy analysis through visualization of data for only confirmed cases of top three countries. Section 5 provides conclusion.

2. REVIEW OF LITERATURE

All over the world there were curfews, lockdowns, stay-at-home and similar restrictions imposed related to the COVID-19 pandemic to prevent the further spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19(Randhawa et al. 2020).Few author's in past have analyzed COVID-19 based on the data [12,20].Analysis has been done on basis ofrecognition of characteristics of COVID-19 including the symptoms: cough, the outcome of temperature etc.. Moreover, accumulation image is provided on the likeness of infections on male/females, and the pattern in the amount of confirmed cases and the someone amount of inveterate/recovered/death cases in disparate countries.

Countries and territories around the world have imposed lockdowns and other restrictions. Few of them include complete control on movement while others have imposed manysimilar restrictions based on time. Mostly, only essential businesses are allowed to remain open. Schools, universities and colleges have closed either on a nationwide or local basis in 161 countries, affecting approximately 98.6 per cent of the world's student population(Dey et al. 2020). Almost all types of entertaining and recreationalmeans have been affected due to COVID-19. It has affected a large number of activities in most of the public places.

Most of the schools and kindergartens have been closed. Majority of non-essential shops (shops and stores apart from content, doctors and treatment stores) have been shut down.Curfews,Stay-at-home orders and unit front know.These measures are thoughtful to eff caused the coronavirus concavity in 2020(2020b).

The pandemic has resulted in the largest assort of shutdowns/lockdowns worldwide at the corresponding instant in history. By 26 March, 2020, 1.7 billion group worldwide were low

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several become of lockdown(2020c),which enhanced to 3.9 billion people by the first week of April, 2020., more than half of the world's population ((Fages 2020),(2020d))

Initially, restrictions began in China ((2020d))with few more countries in East Asia like Vietnam soon following it in implementing distributed containment measures.Most of Europe, North America and Africa took much longer to bring in tough measures. Lockdowns between and within nations are of varying stringency ((Hirsch 2020)).

By mid April, nearly 300 million people, or about 90 per cent of the population, were under some form of lockdown in the United States, ((2020e)) around 100 million in the Philippines,((Jones, S., & Kassam 2020)) about 59 million in South Africa, ((2020f)) , and largest of all 1.3 billion in India.To curb the position of COVID-19 hotspots or containment Zones were formed in India. ((Kaplan, J., Frias, L., & Mcfall-Johnsen 2020),(Langton 2020)) By the end of April, lockdown in various countries of Europe, including Italy, Spain, France, and the United Kingdom and many others impacted around 300 million people; while around 200 million people were impacted due to lockdown in Latin America ((Jones, S., & Kassam 2020)).

As the scientific dominion grapples with the examine for solutions to the COVID-19 pandemic, it also needs to quicken the gait of creativity. Globally, organisations which are funded for research are search to further journeying an quickening in explore with more curtal time calls, schemes to re-purpose existing funding and porta search resources. With this status for faster-paced research comes a require for timely processing, assimilation and discrimination of the continually healthy and evolving embody of research literature that is originating speedily from the orbicular research endeavour. Past studies hold examined the development literature on COVID-19 and working various methods and techniques to psychoanalyse it. Haghani et al. (Haghani et al. 2020)use bibliometric analysis with emotionalism maps, pie charts, and bar graphs to expound COVID-19 explore areas and their soul importance. Others combine bibliometrics with matter defence. Hossain (Hossain 2020)does this, using bibliometrics composed with text defense for word co-occurrence and factorial reasoning of the top keywords visualised in system diagrams and dendrograms. Similarly (to Hossain) Aguado-Cortés & Castaño (Aguado-Cortés and Castaño 2020)use bibliometrics and conjunction of keywords with

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textile diagrams to view the reasoning. Fister et al. (Fister Jr et al. 2020)use memory label schoolbook mining (Agrawal et al. 1993), then examine phrase relationships and employ bar represent and evince cloud visualisations. Wang et al. (Wang et al. 2020) make an application which uses distantly supervised named entity recognition (Wang et al. 2019) and facilitates schoolbook queries. It visualises query results with a friedcake interpret. One ponder by Domingo-Fernandez et al. (Domingo-Fernandez et al. 2020)took a subset of the literature concentration on have targets, generated a meshwork graph by manually expansion evidence book from the capital with Life Reflection Communication (BEL) and explored the web interpret with web applications shapely for the chore. Finally, Ahamed & Samad (Ahamed and Samad 2020)use a method of topic analysis where topics are identified using betweenness centrality measure (Freeman 1977).

2 METHODOLOGY

Here, we have used python libraries matplotlib, seaborn and plotly libraries for visualization of confirmed cases, active cases and recovered cases for the data upto 12 August, 2020 and before and after lockdown period is also shown in this graph. For entropy analysis Microsoft excel library is used for visualization of data.

2.1 Datasets

Our methods and visualisations are automatically generated update data upto 12 August, 2020 from search Kaggle.com ((2020g)). This automatic coming is peculiarly suited for rapidly evolving knowledge datasets as it requires minuscule omission, manipulation, and can avoid unwashed delays oftentimes encountered in drill classifications and processes.

3. RESULTS AND DISSCUSION

Pandemic lockdowns are settled as the shutdown of parts of the scheme, ((2020h))due to non-pharmaceutical anti-pandemic measures. 10 countries along with their before and after lockdown period have been taken as consideration for this study as shown in Table 1. However, some provinces of few countries has also considered and confirmed cases, active cases and recovered cases for all countries have been analysed through visualization.Before and after lockdown has been studied for following countries:

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Table 1:List of countries for which the before and after lockdown situation has been analyzed

India	US	Belgium
Czech Republic	Portugal	Austria
Poland	Bolivia	Morocco
Brazil		

We gear expound, in this study, the epistemology we use to create is our visualisation for analysing the COVID-19 with the help of python . Then with the mutual visualisations of data, we describe digit explore trends which lucubrate the benefits that our techniques carry to the apprehension of COVID-19 along with before and after lockdown period. Eventually, we think by summarising the benefits of our techniques and our new COVID-19 research.

Figure 1 uptoFigure 36 gives a visualisation of the confirmed, active and recovered cases of 10 countries(along with the provinces of few countries) with before and after lockdown period and Figure 37 upto Figure 39 gives the entropy analysis through visualisation of the onlyconfirmed cases of three countries namely USA, Brazil and India .

Before and After Lockdown In India

On 24 March 2020, the Government of India under Prime Minister Narendra Modi ordered a nationwide lockdown.

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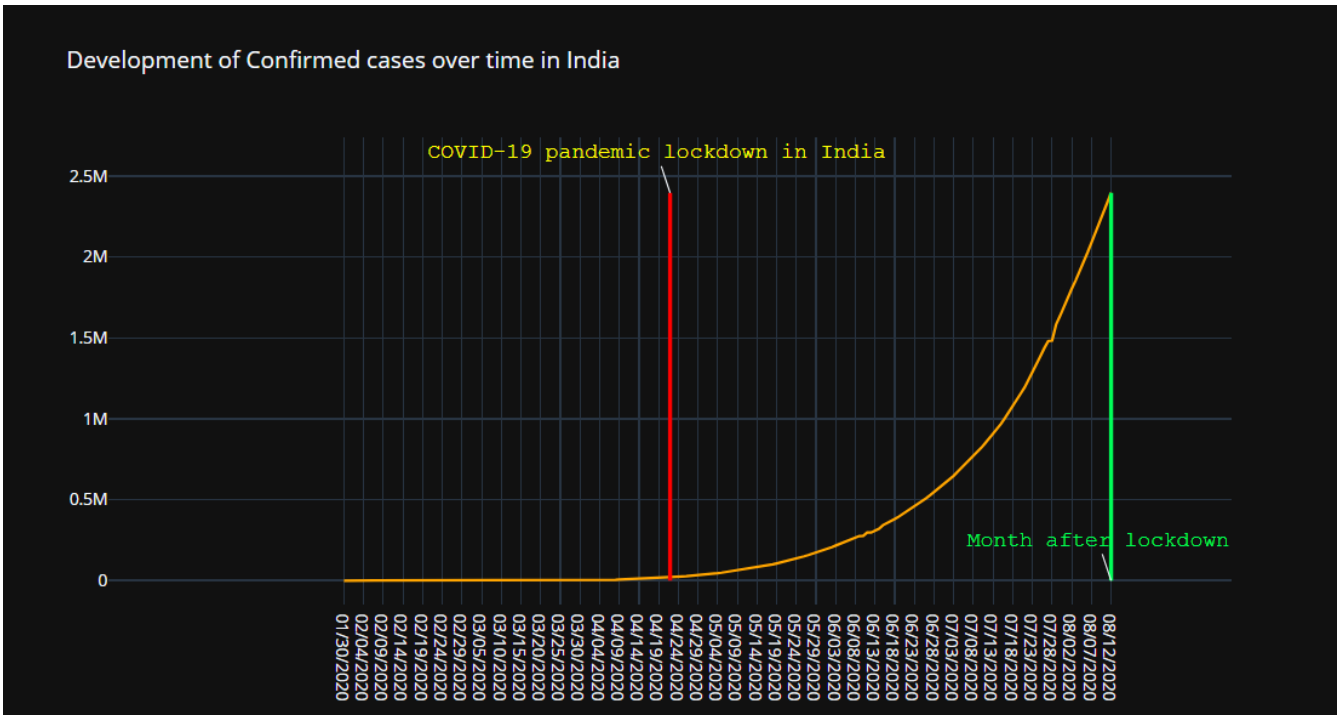

Figure 1:Development of confirmed cases over time in India

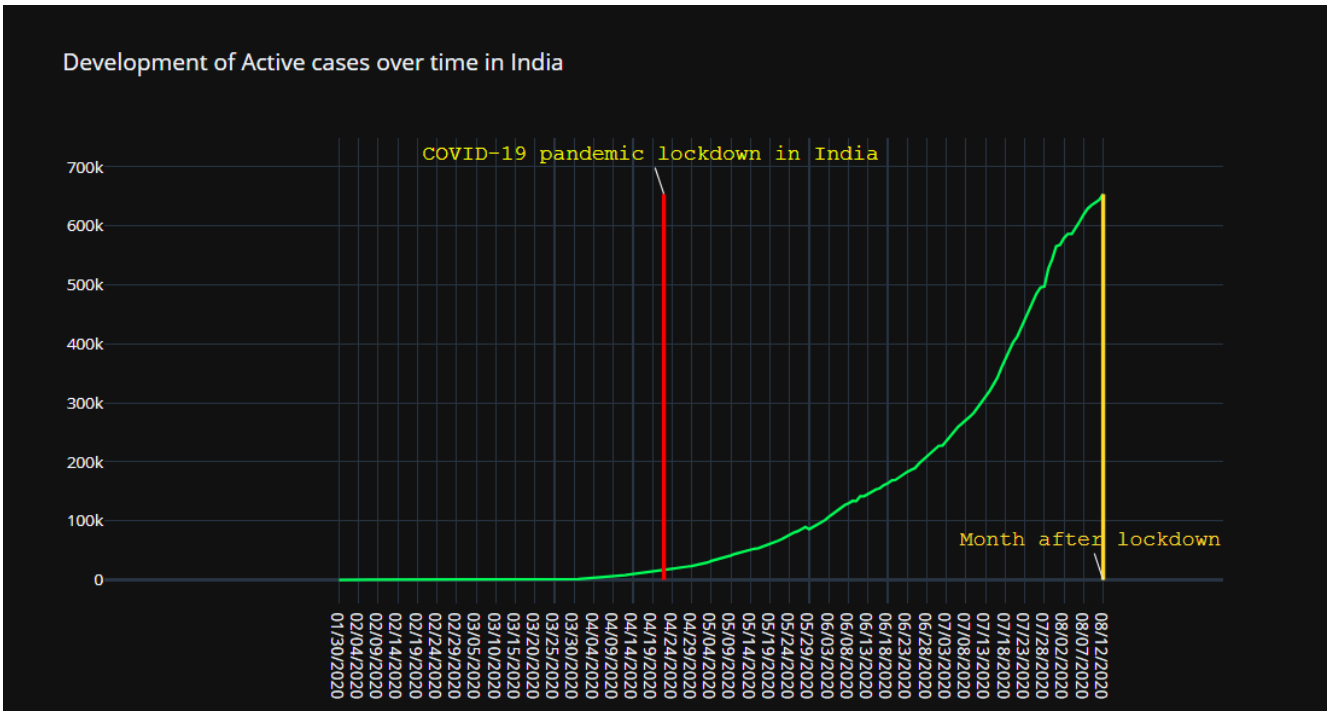

Figure 2:Development of active cases over time in India

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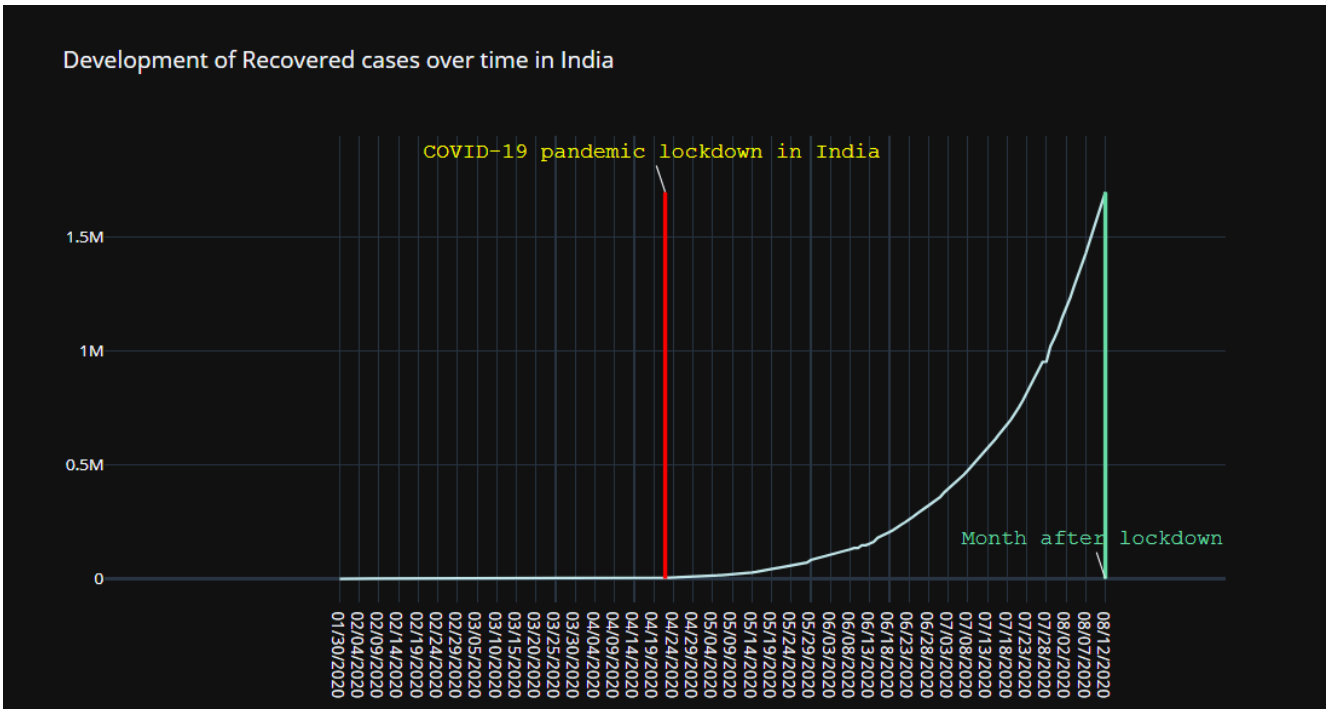

Figure 3:Development of recovered cases over time in India

Before and After Lockdown In US

To encourage residents to remain at their homes in order to suppress spread of the virus, most U.S. states (either state-wide, or phased in on a county-by-county basis) began to impose "stay-at-home orders" from mid-March onward.

California 2020-03-19

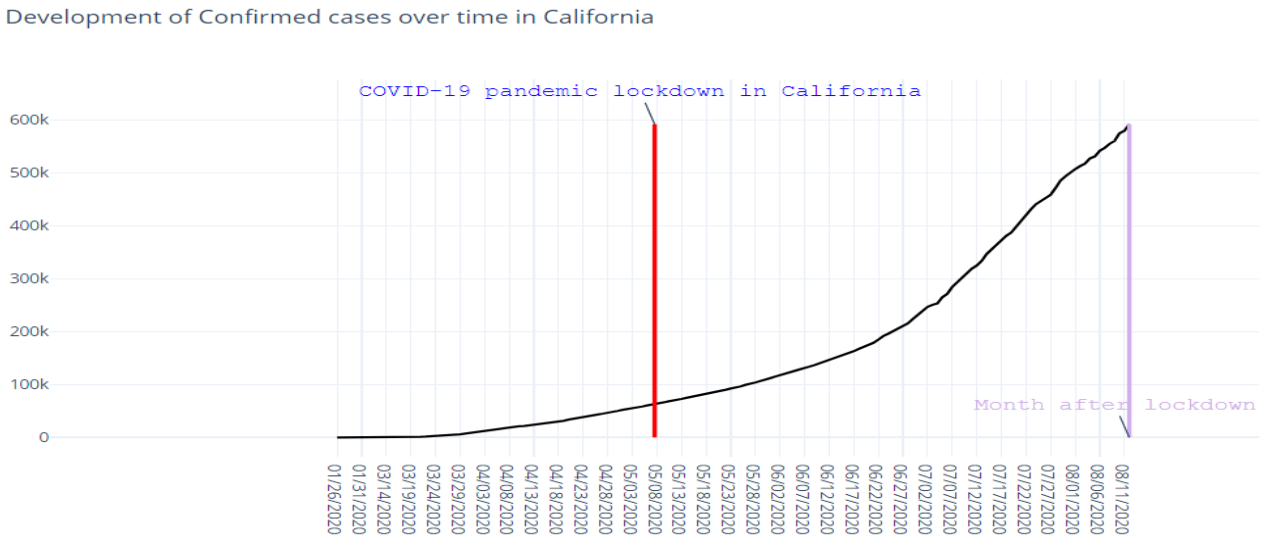

Figure 4:Development of confirmed cases over time in California

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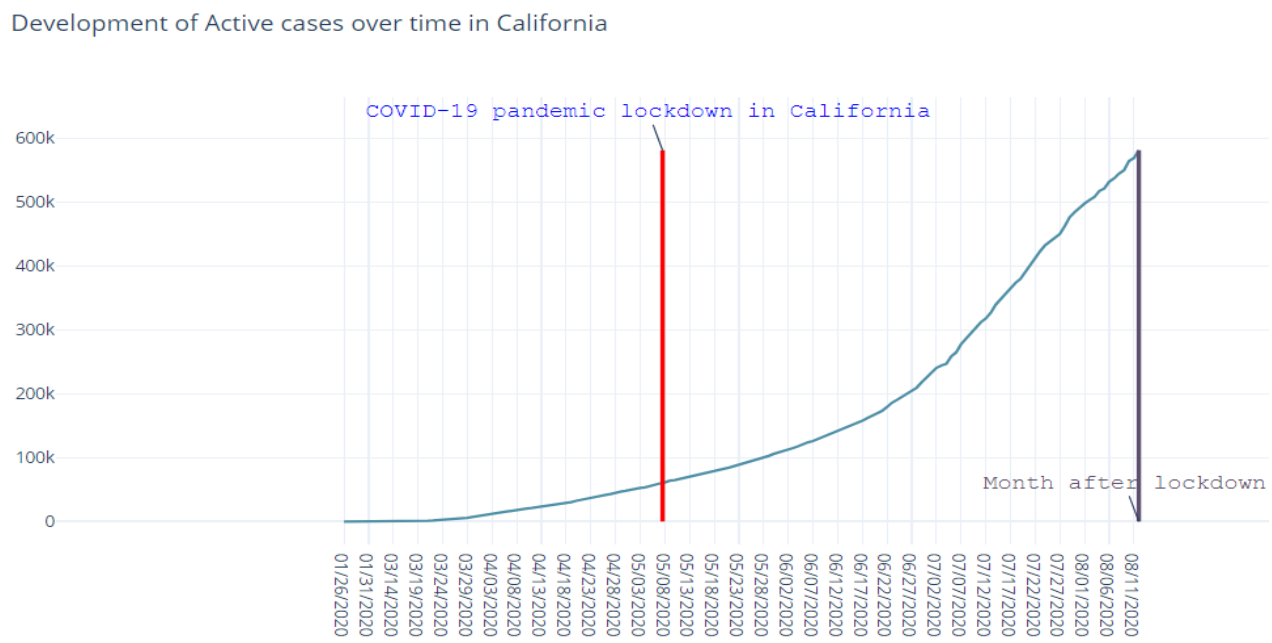

Figure 5::Development of active cases over time in California

New York 2020-03-22

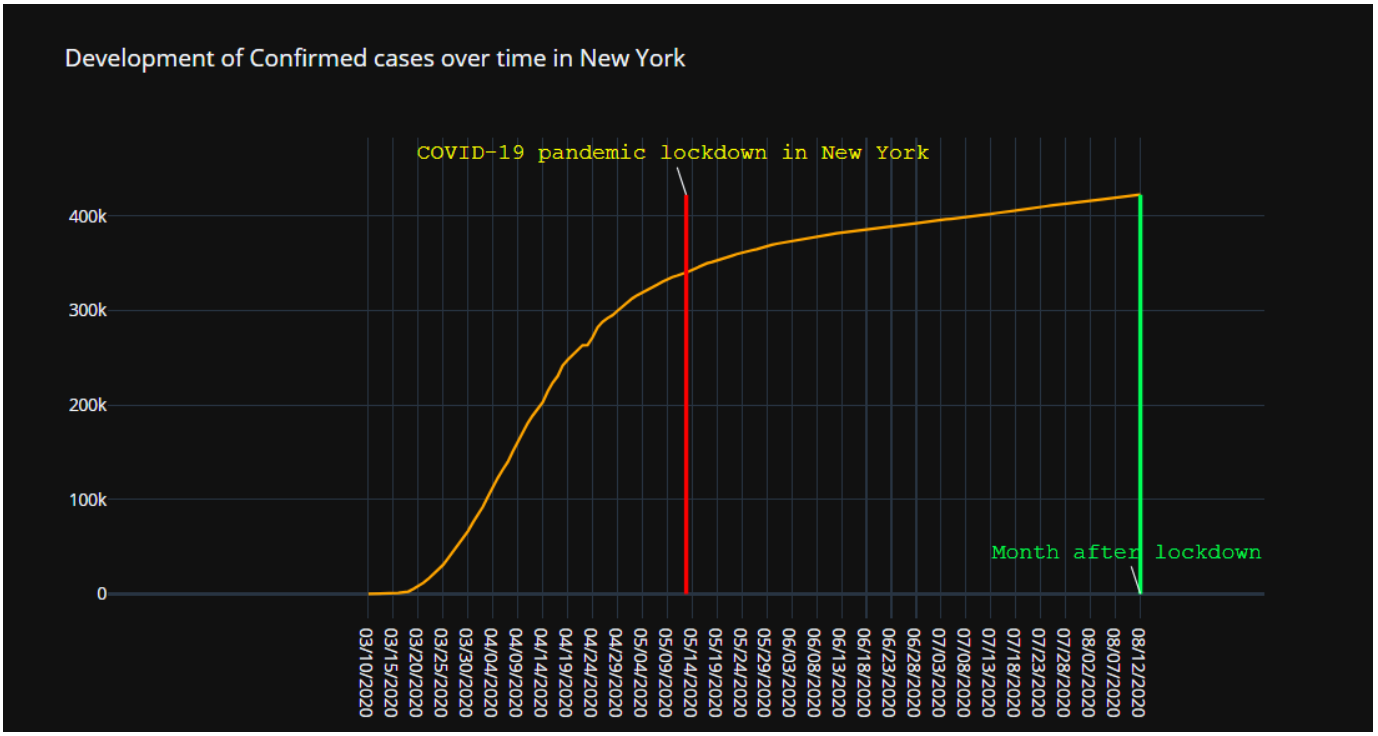

Figure 6:Development of confirmed cases over time in New York

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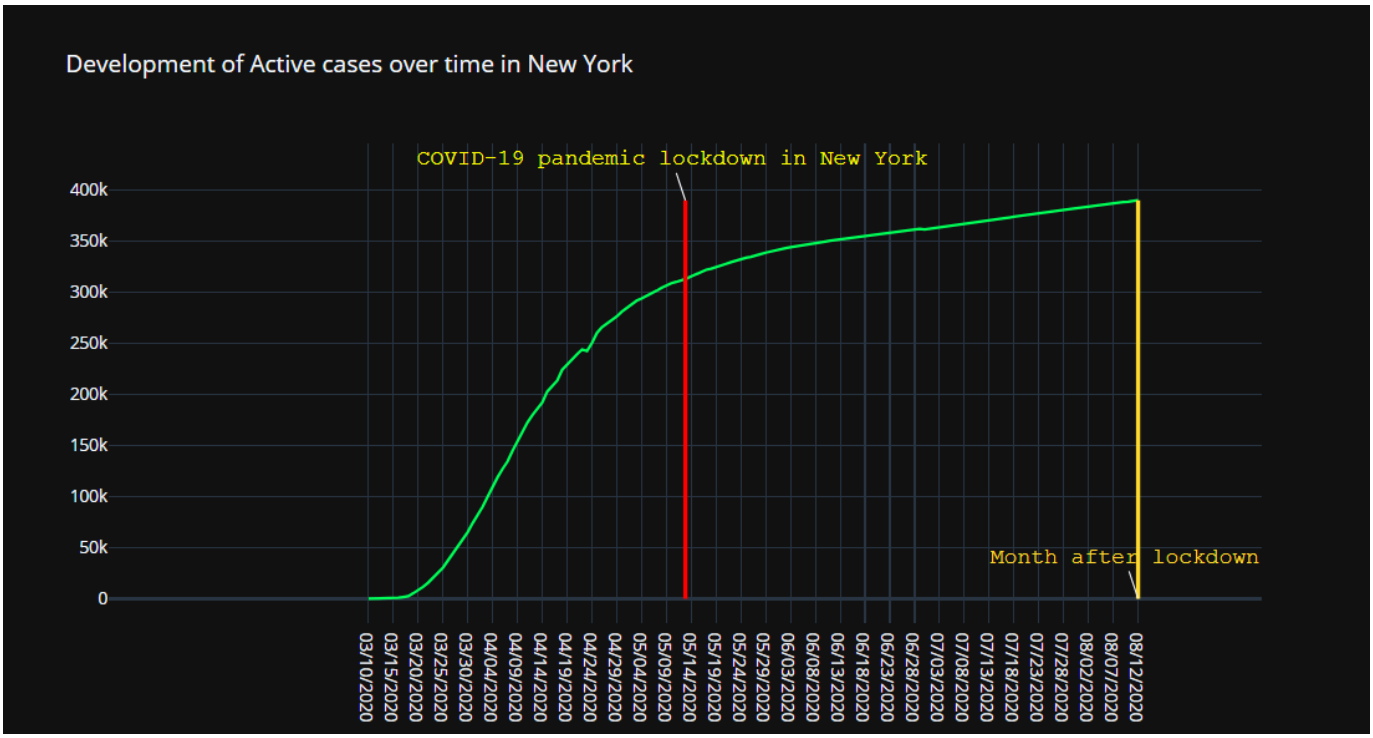

Figure 7:Development of active cases over time in New York

Michigan 2020-03-24

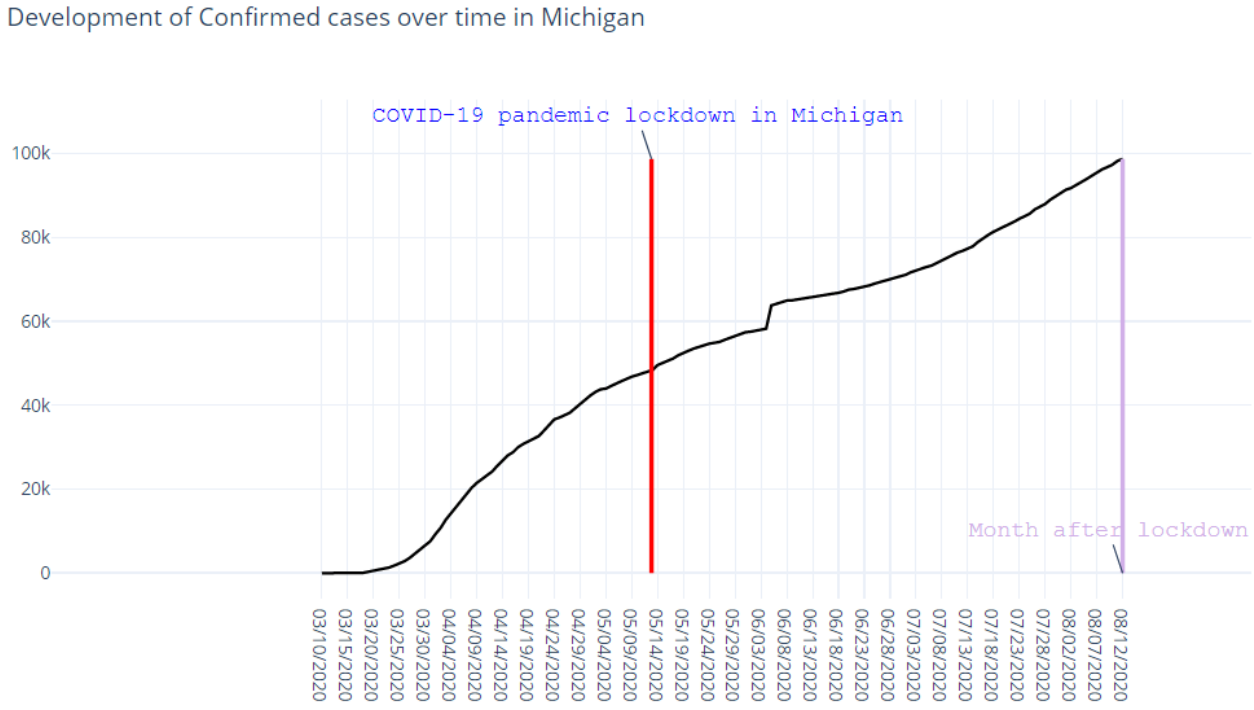

Figure 8:Development of confirmed cases over time in Michigan

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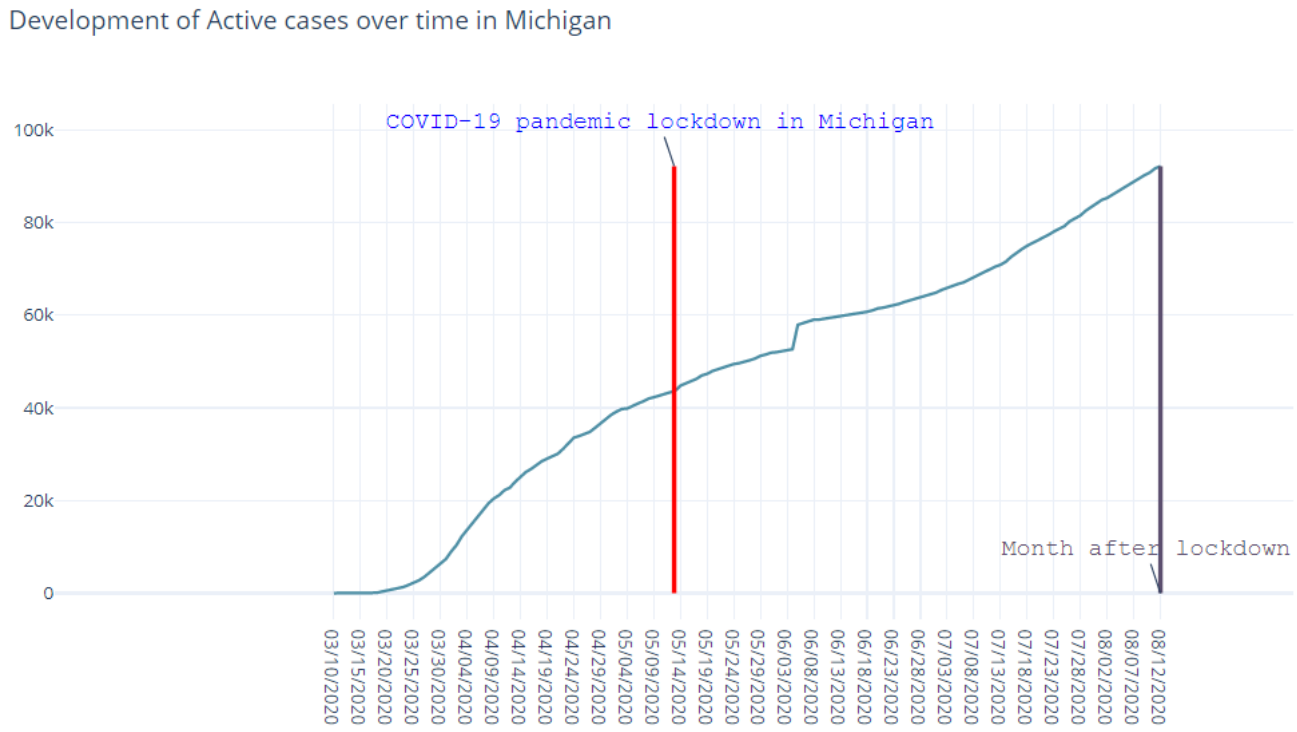

Figure 9::Development of active cases over time in Michigan

Oregon 2020-03-24

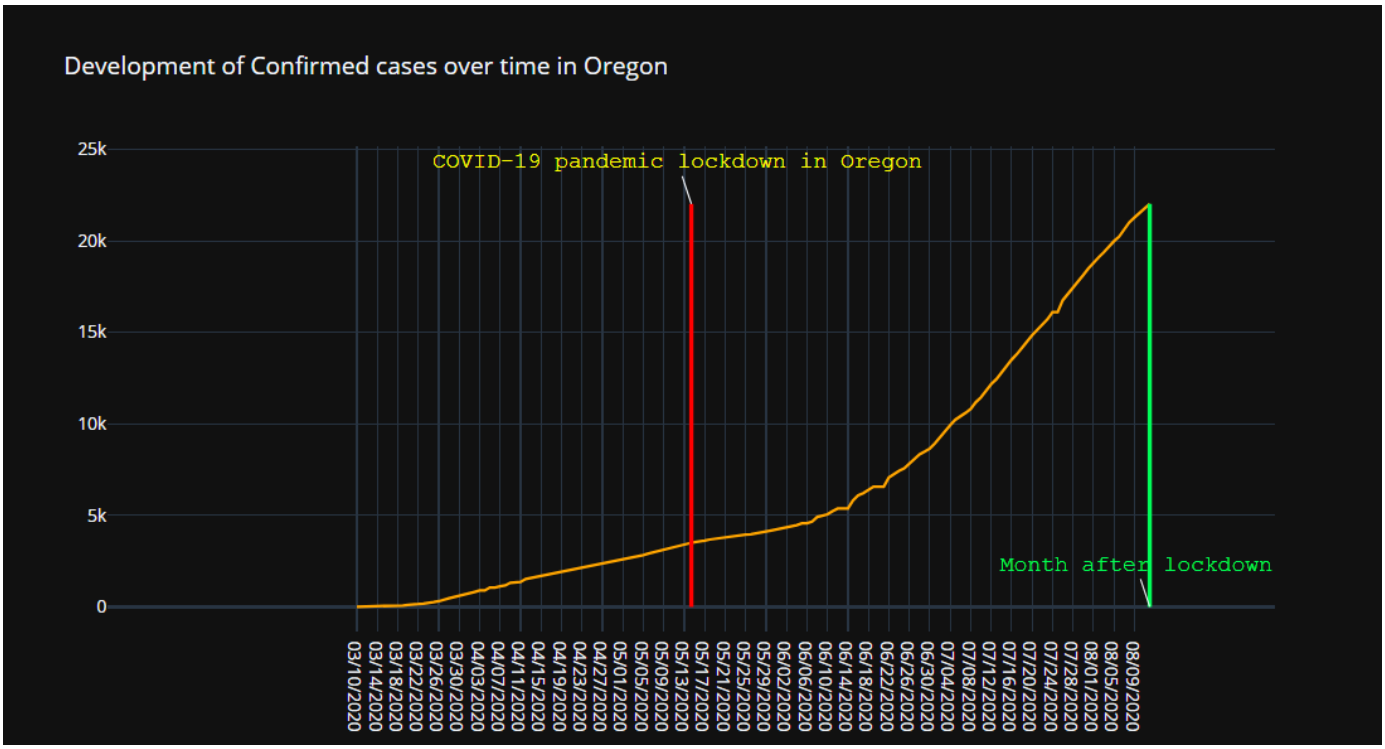

Figure 10:Development of confirmed cases over time in Oregon

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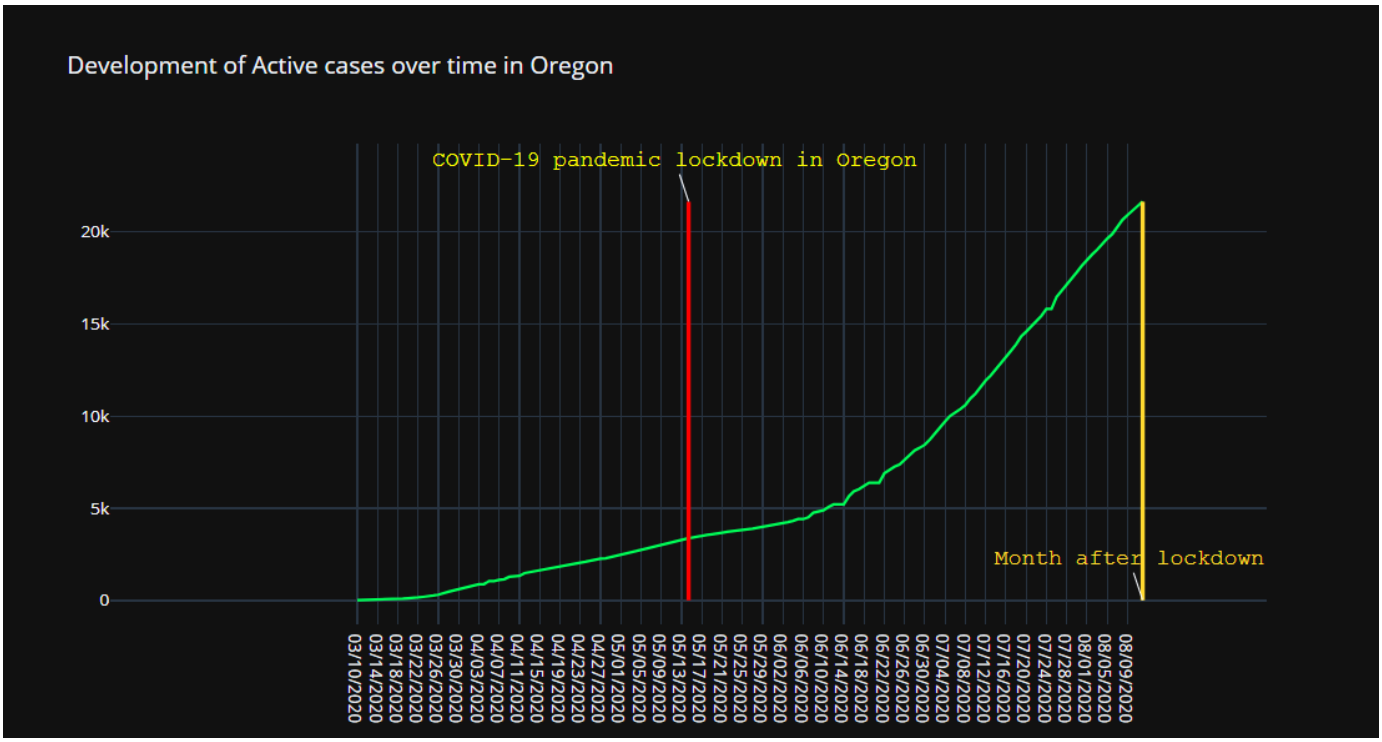

Figure 11:Development of active cases over time in Oregon

Before and After Lockdown In Belgium

Belgium : 03/18/2020

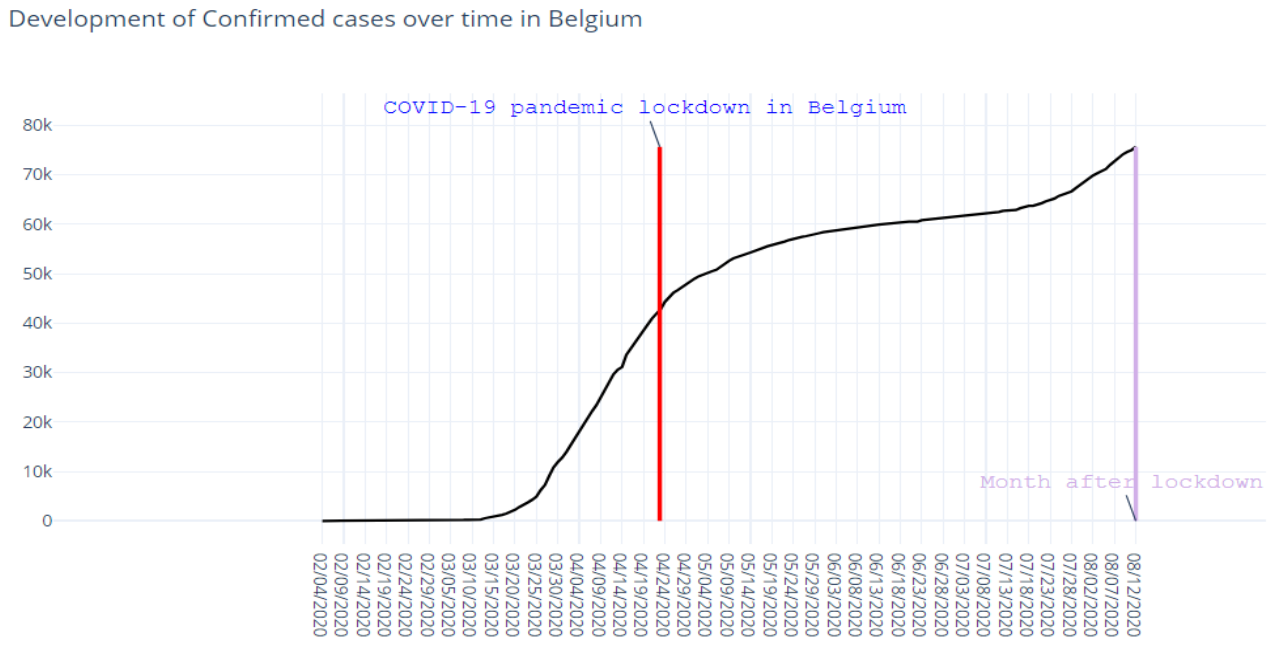

Figure 12:Development of confirmed cases over time in Belgium

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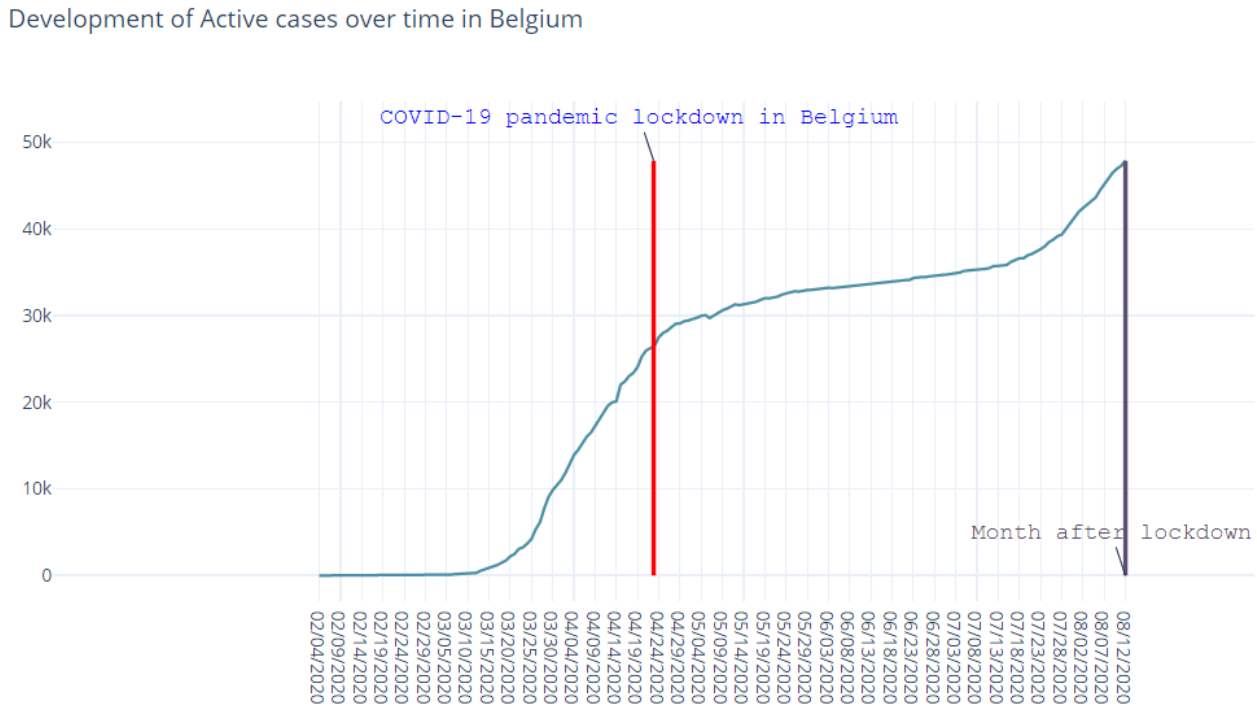

Figure 13:Development of active cases over time in Belgium

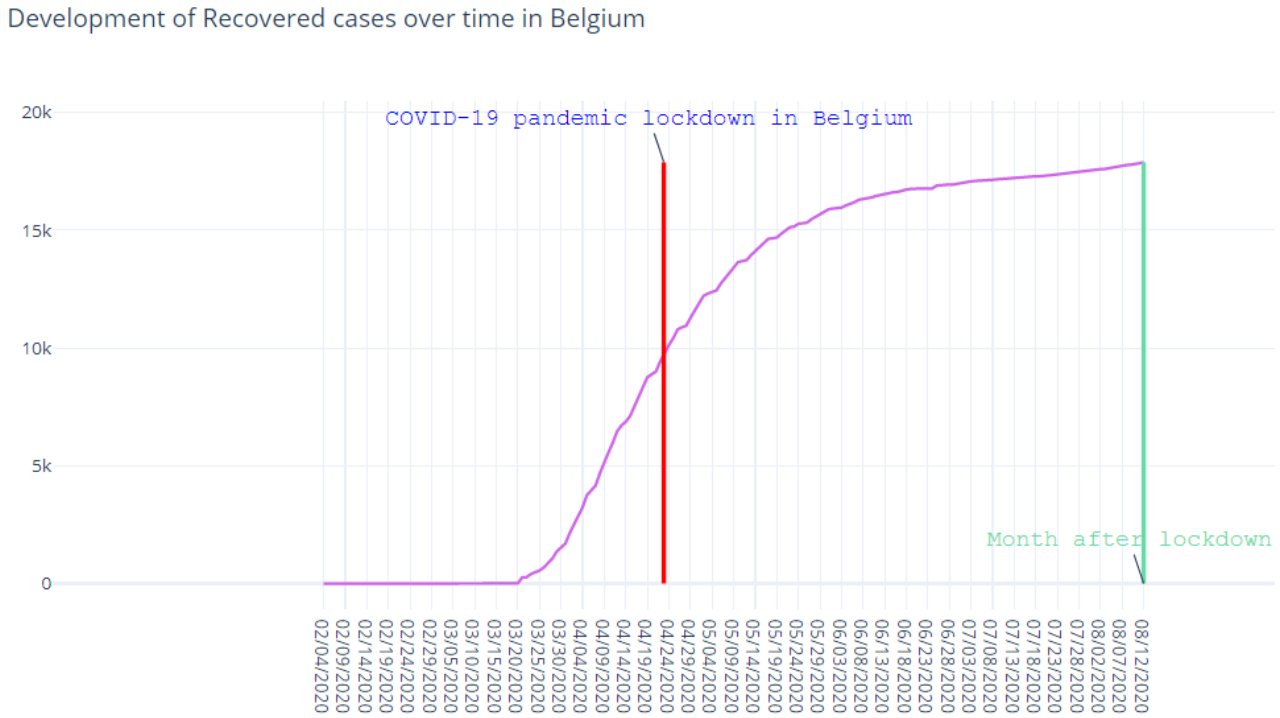

Figure 14:Development of recovered cases over time in Belgium

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Before and After Lockdown In Czech Republic

Czech Republic 2020-03-16

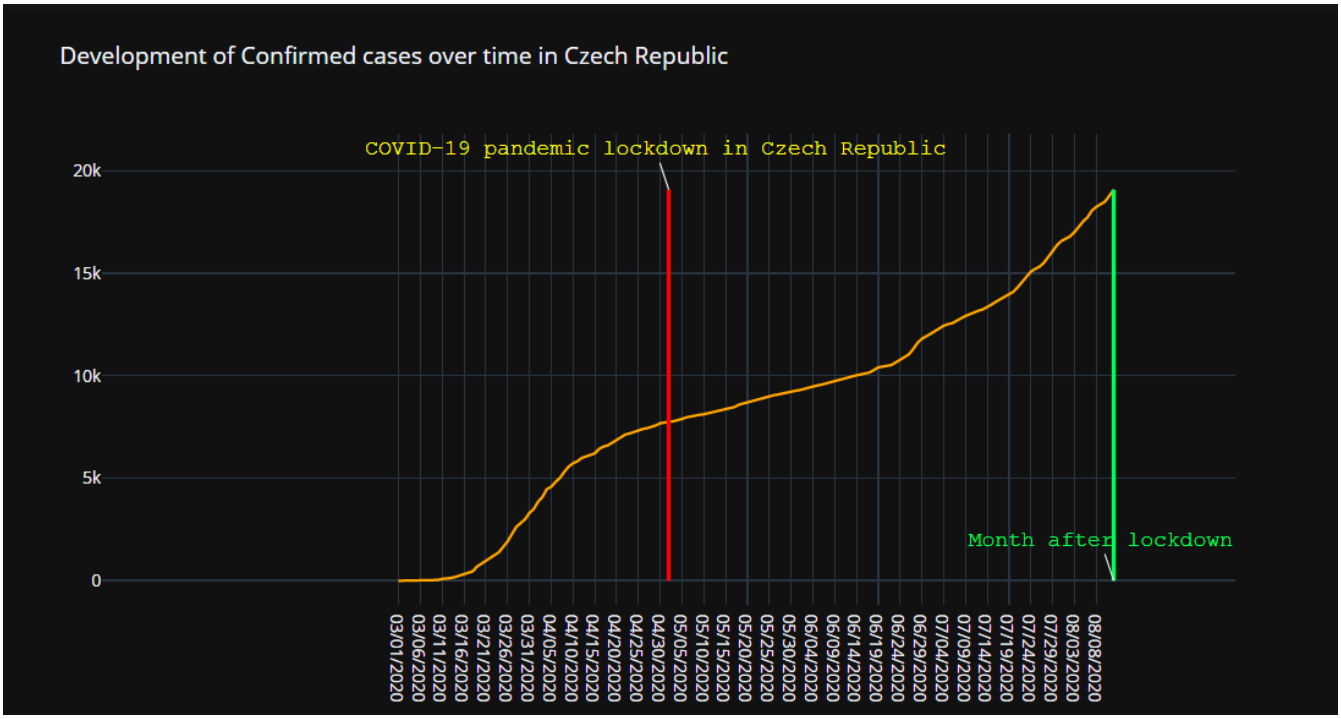

Figure 15:Development of confirmed cases over time in Czech Republic

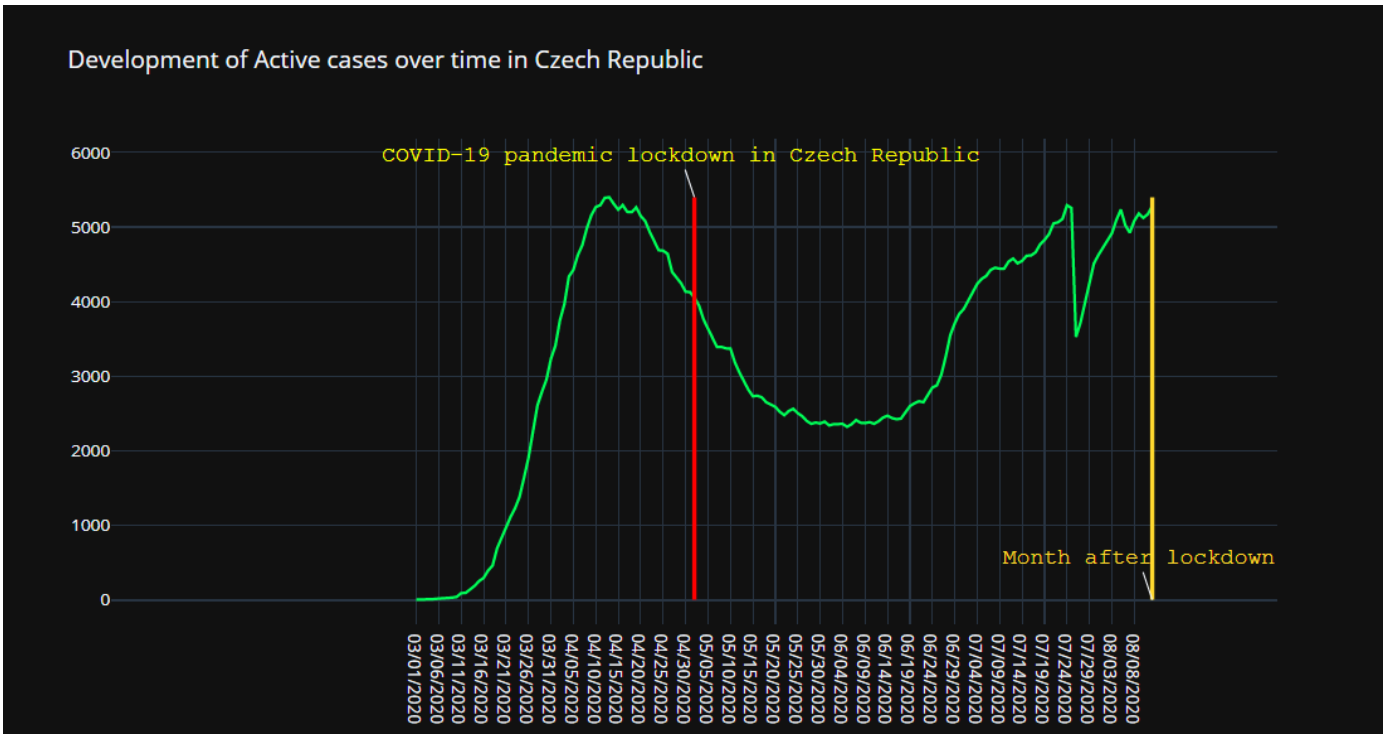

Figure 16:Development of active cases over time in Czech Republic

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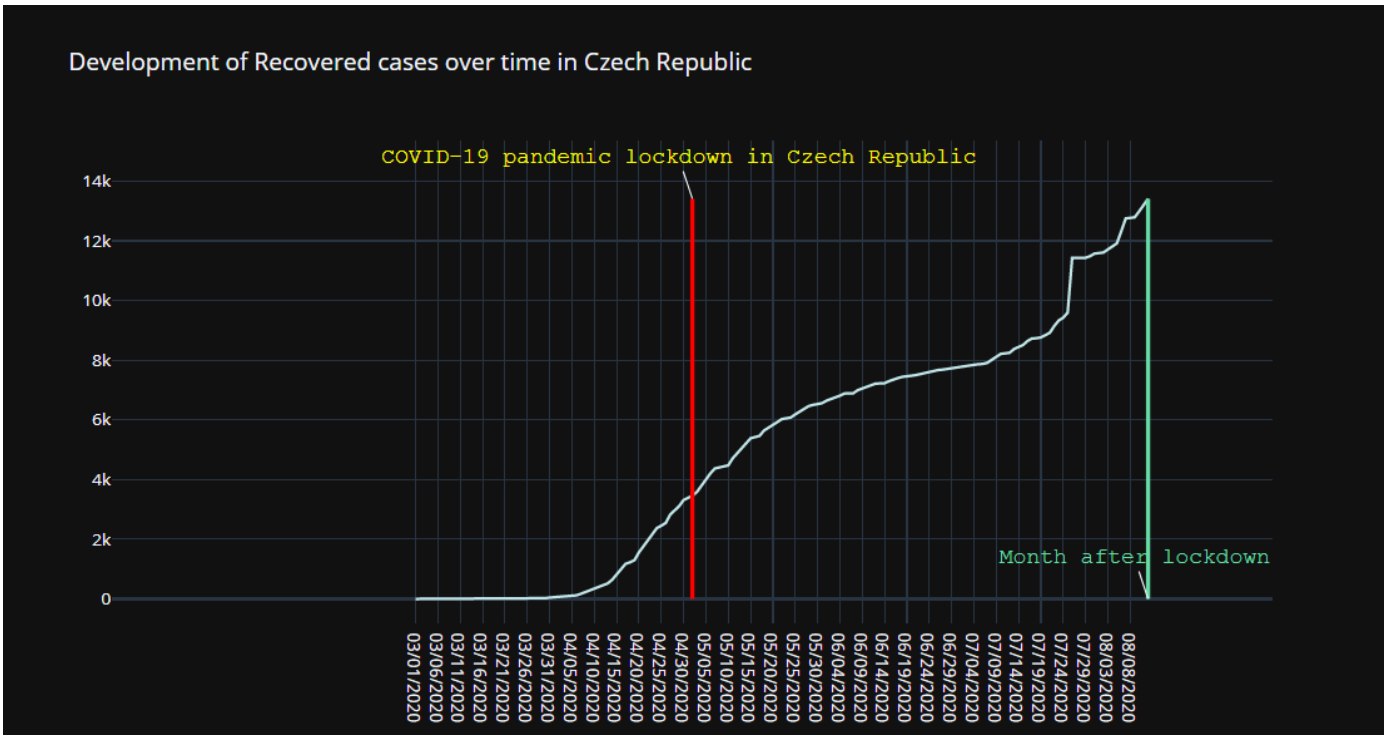

Figure 17:Development of recovered cases over time in Czech Republic

Before and After Lockdown In Portugal

Portugal 2020-03-19

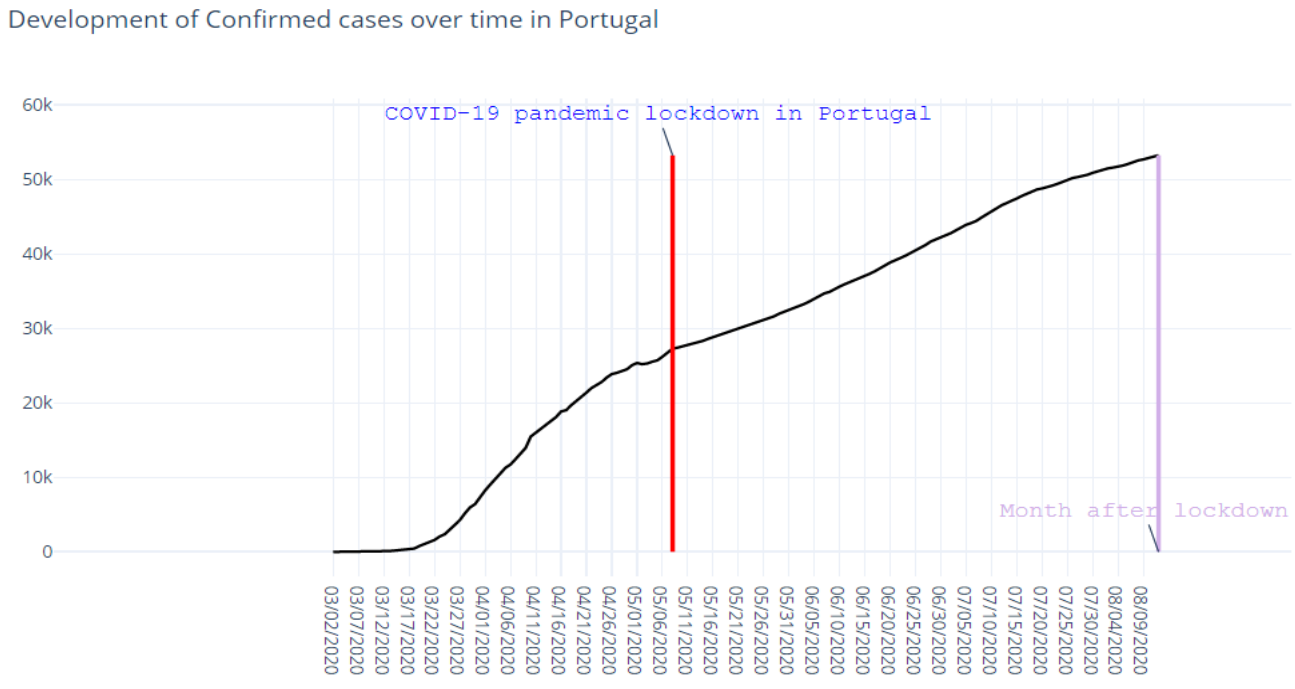

Figure18:Development of confirmed cases over time in Portugal

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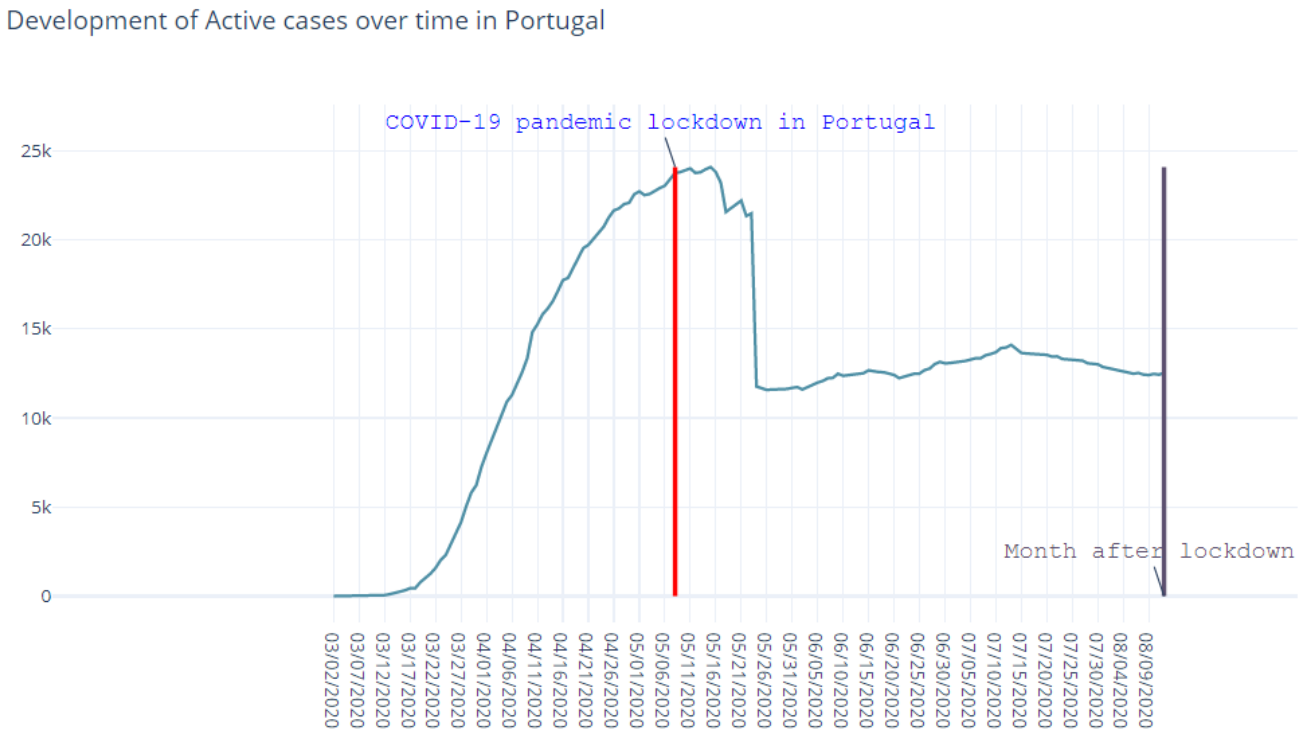

Figure 19:Development of active cases over time in Portugal

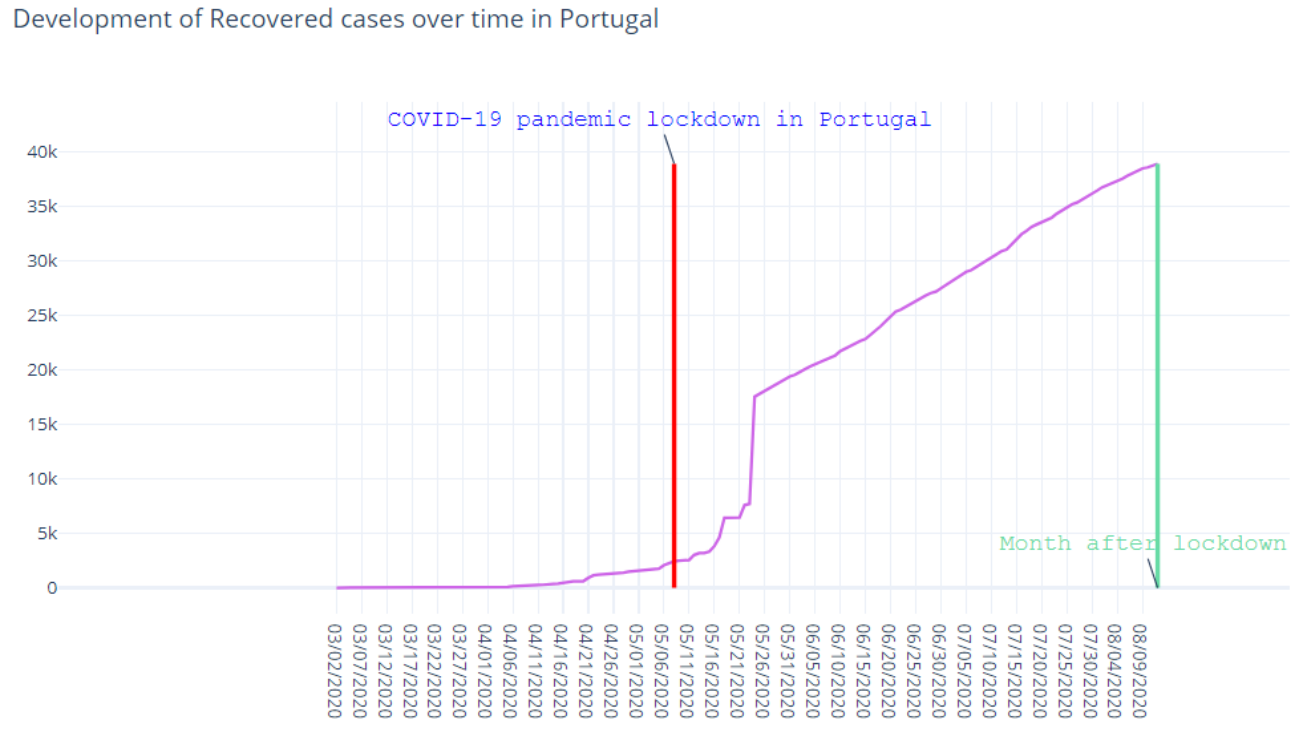

Figure 20:Development of recovered cases over time in Portugal

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Before and After Lockdown In Austria

Austria 2020-03-16

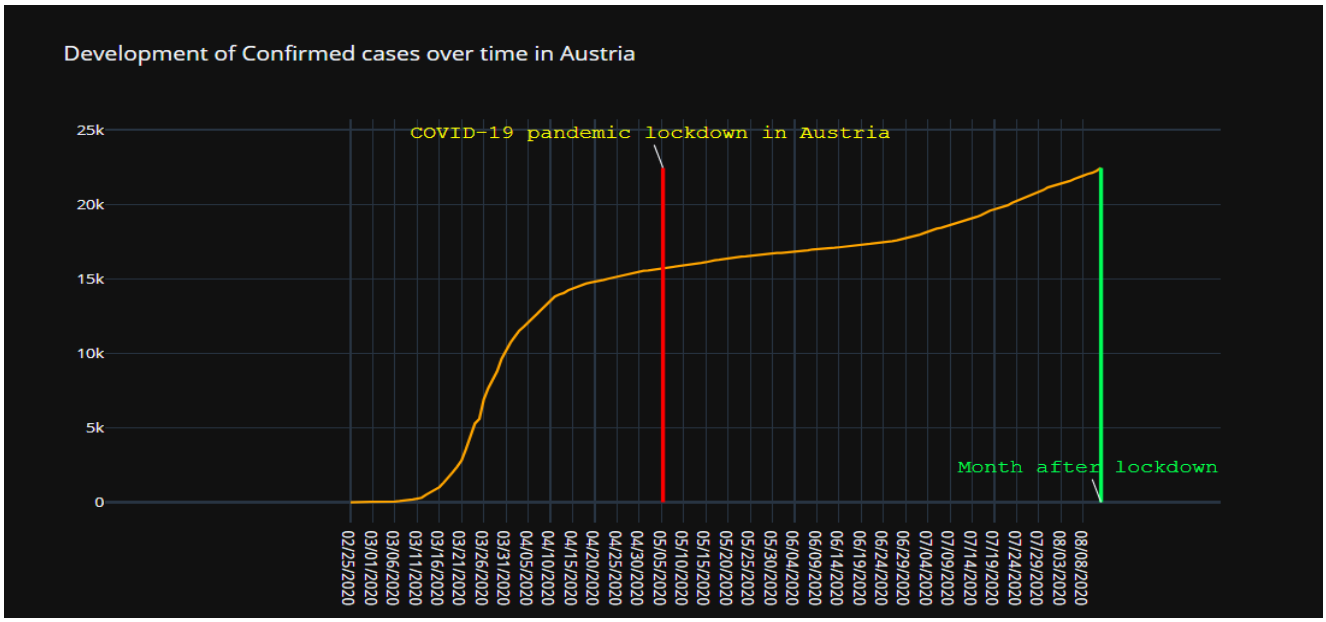

Figure 21:Development of confirmed cases over time in Austria

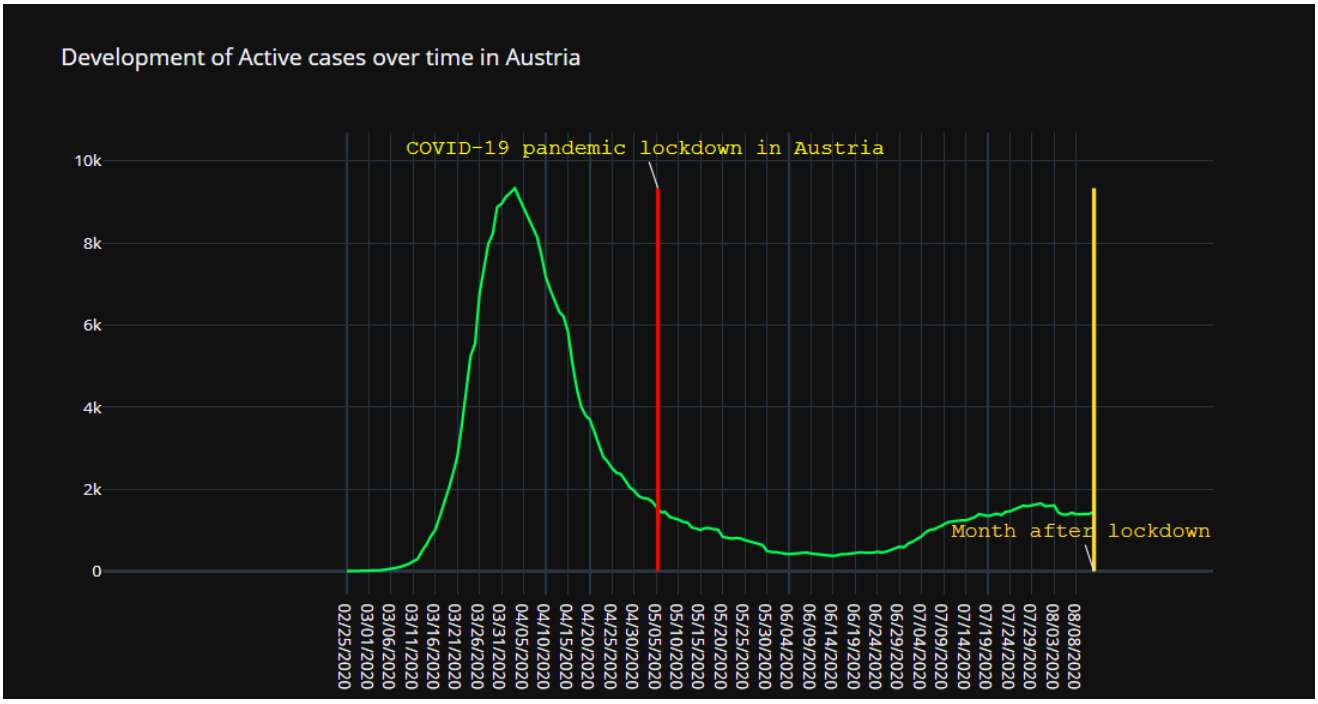

Figure 22:Development of active cases over time in Austria

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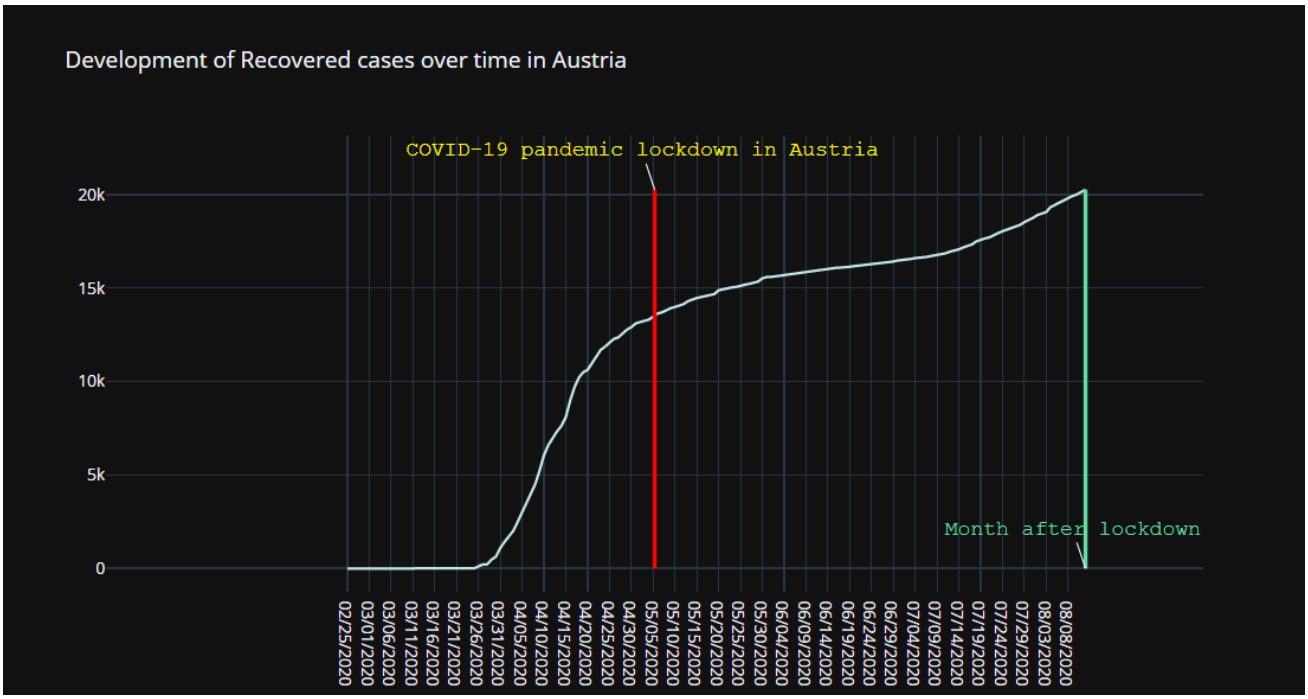

Figure 23:Development of recovered cases over time in Austria

Before and After Lockdown In Poland

Poland: 2020-03-13

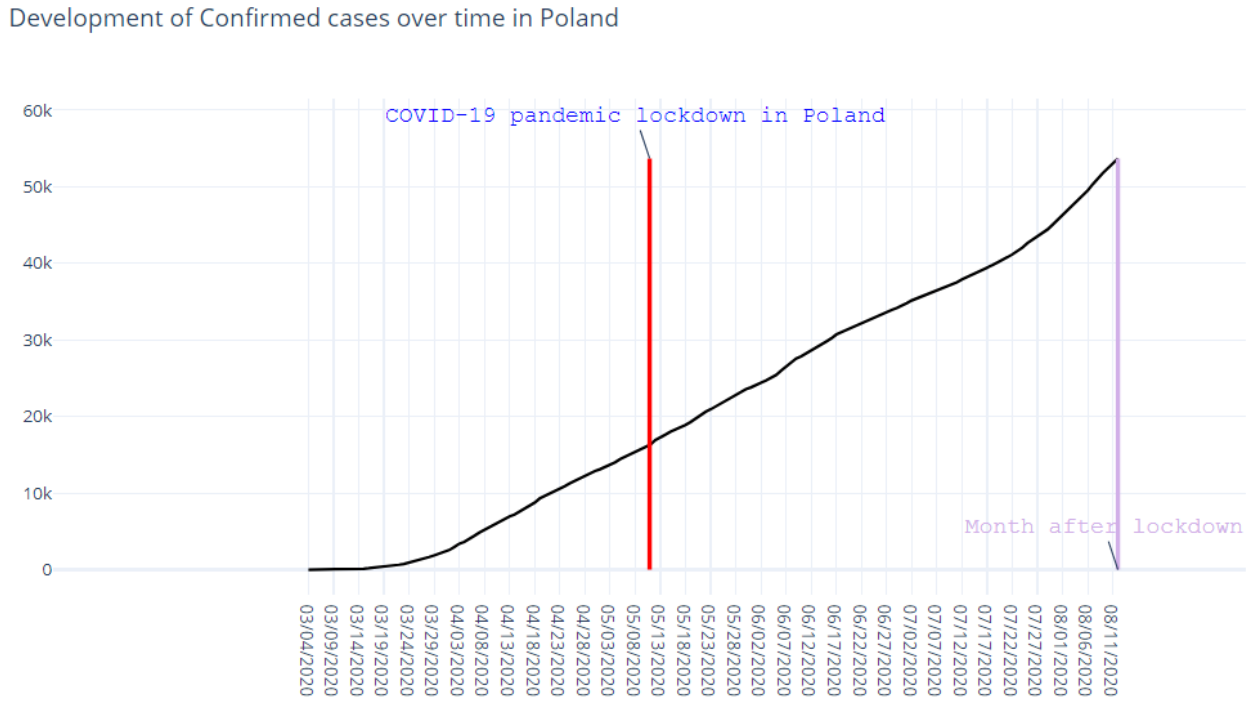

Figure 24:Development of confirmed cases over time in Poland

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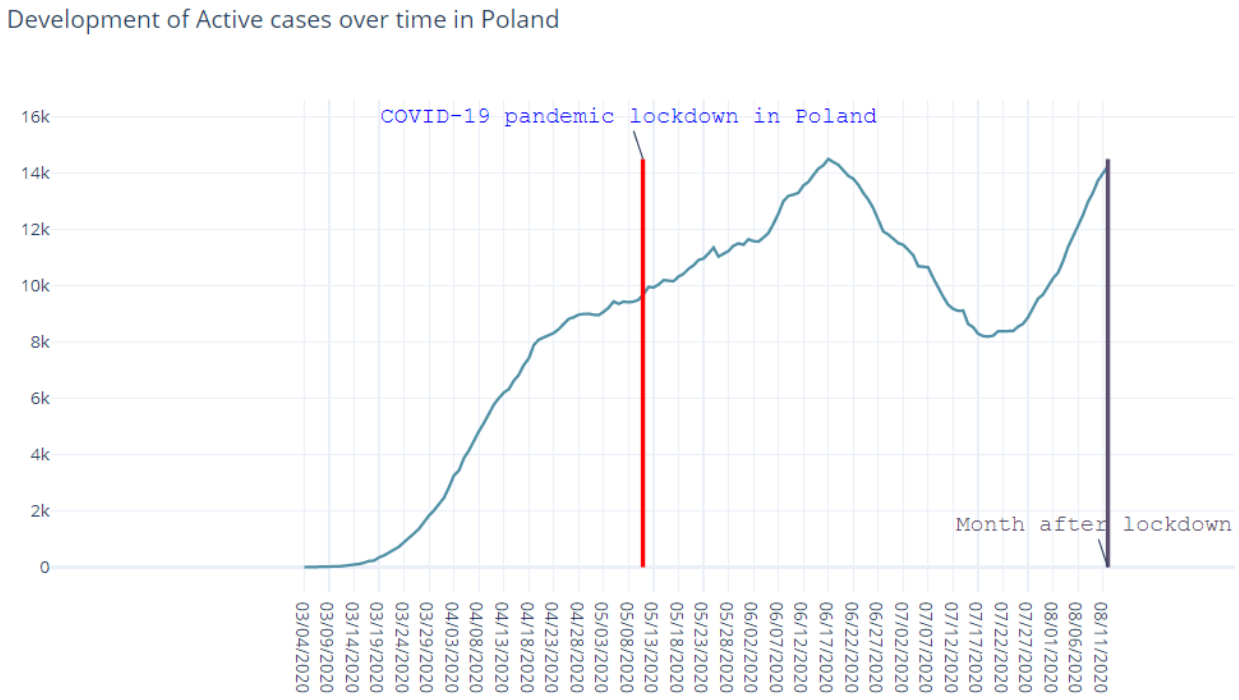

Figure 25:Development of active cases over time in Poland

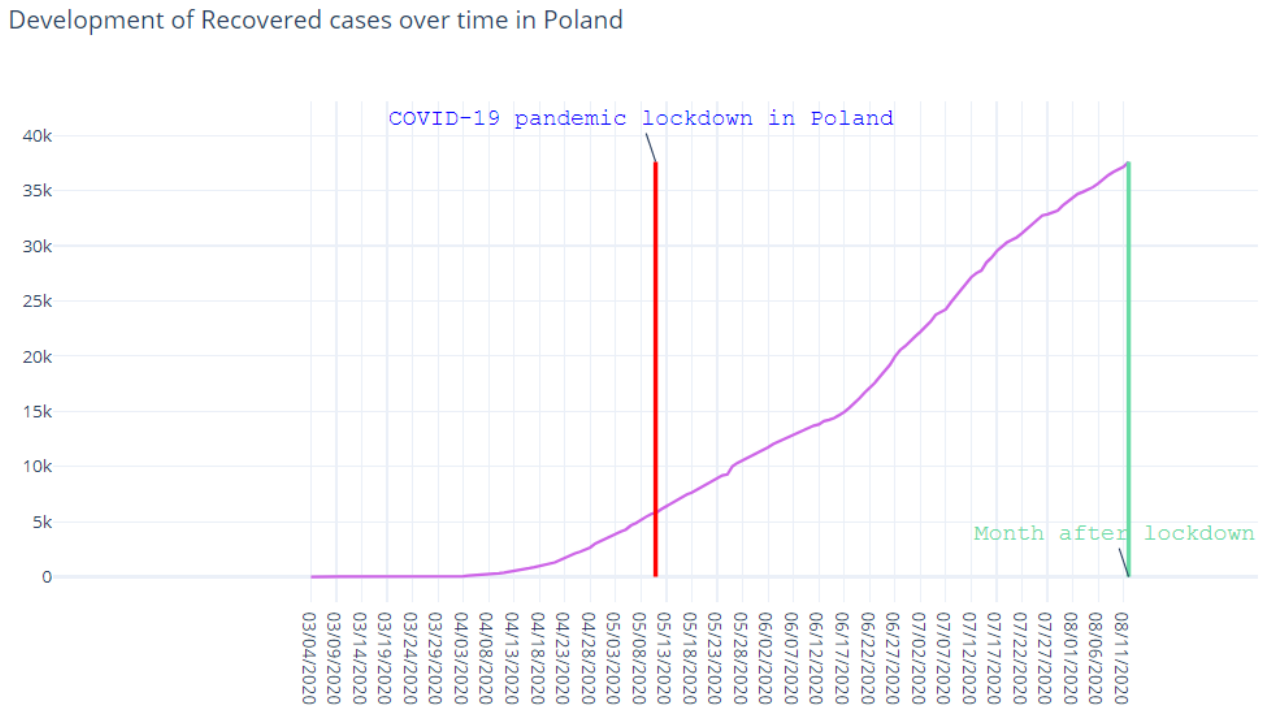

Figure 26:Development of recovered cases over time in Poland

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Before and After Lockdown In Bolivia

Bolivia 2020-03-22

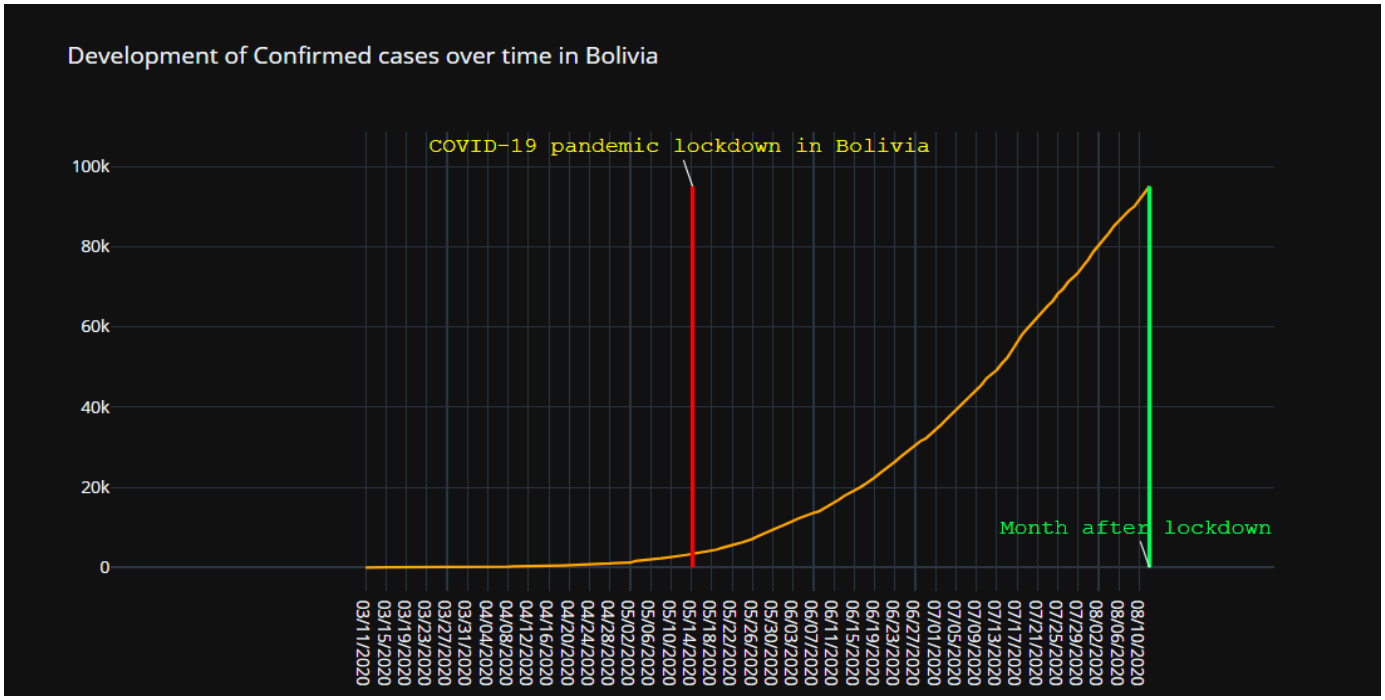

Figure 27:Development of confirmed cases over time in Bolivia

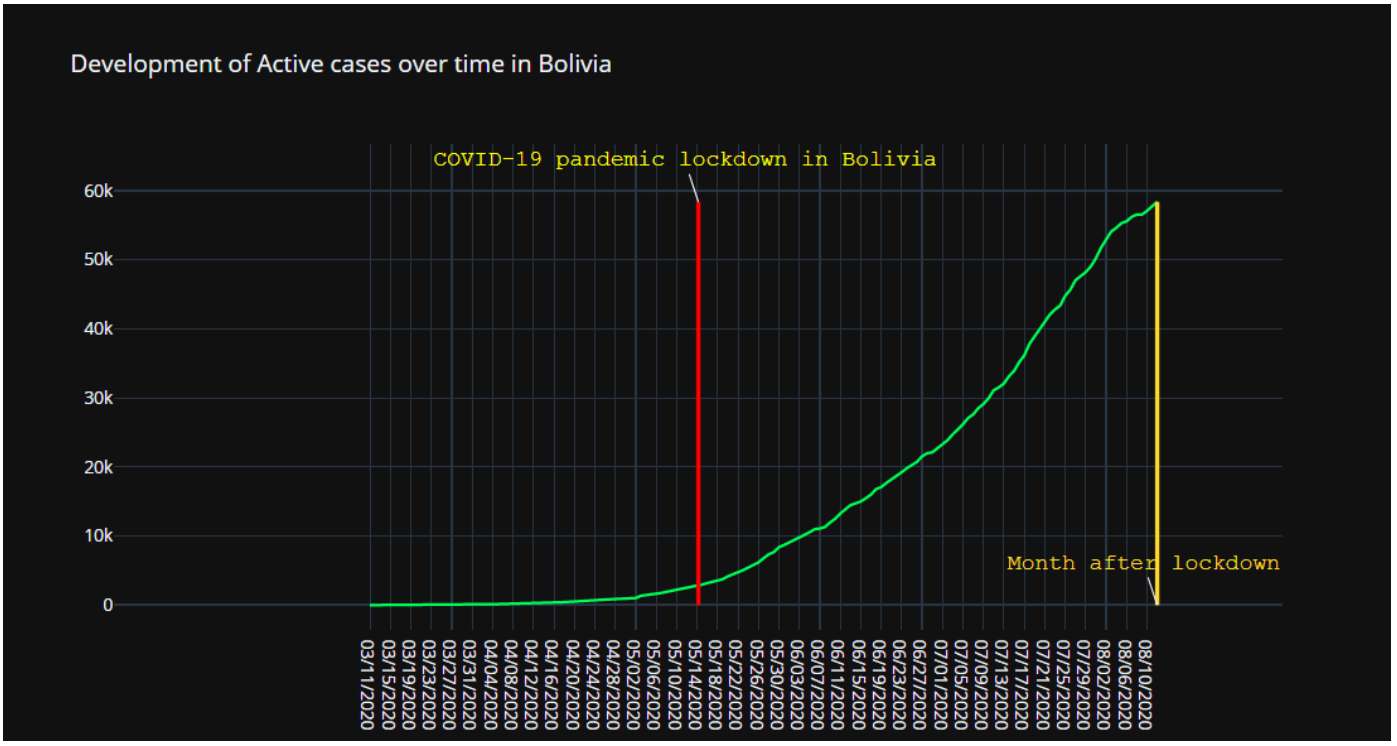

Figure 28:Development of active cases over time in Bolivia

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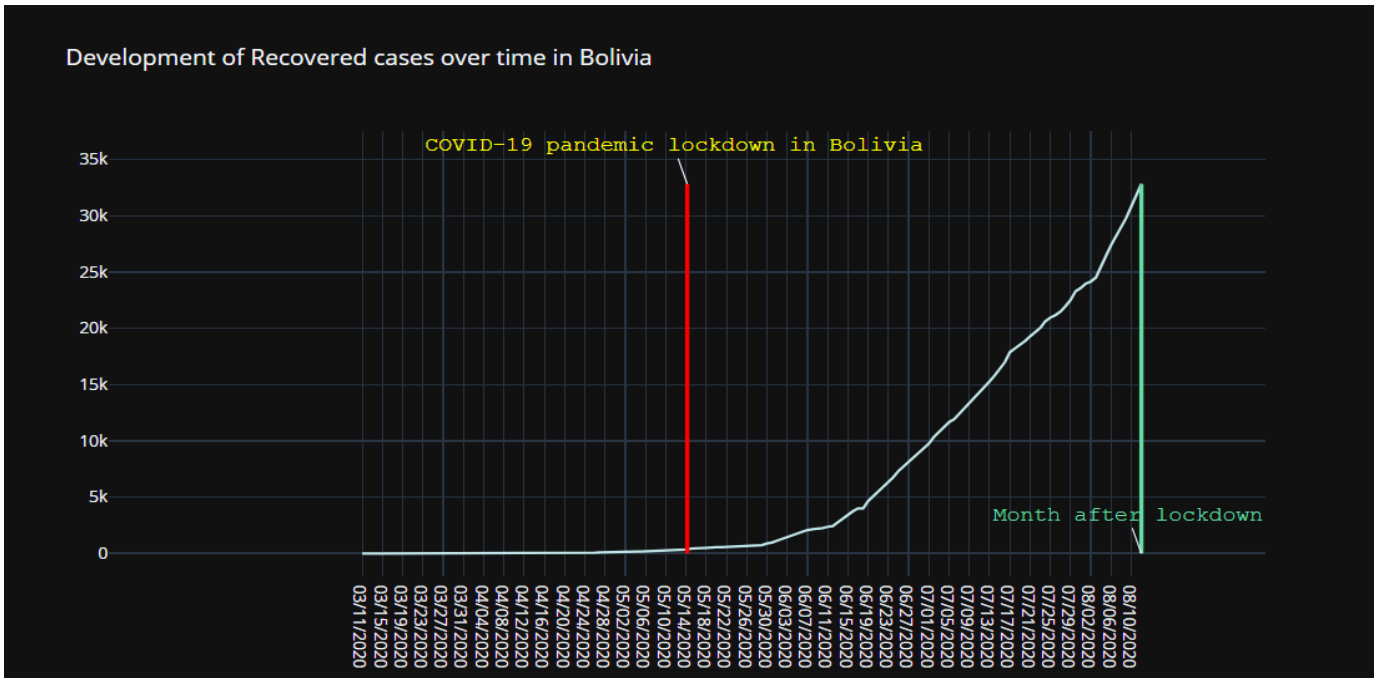

Figure 29:Development of recovered cases over time in Bolivia

Before and After Lockdown In Morrocco

Morocco 2020-03-19

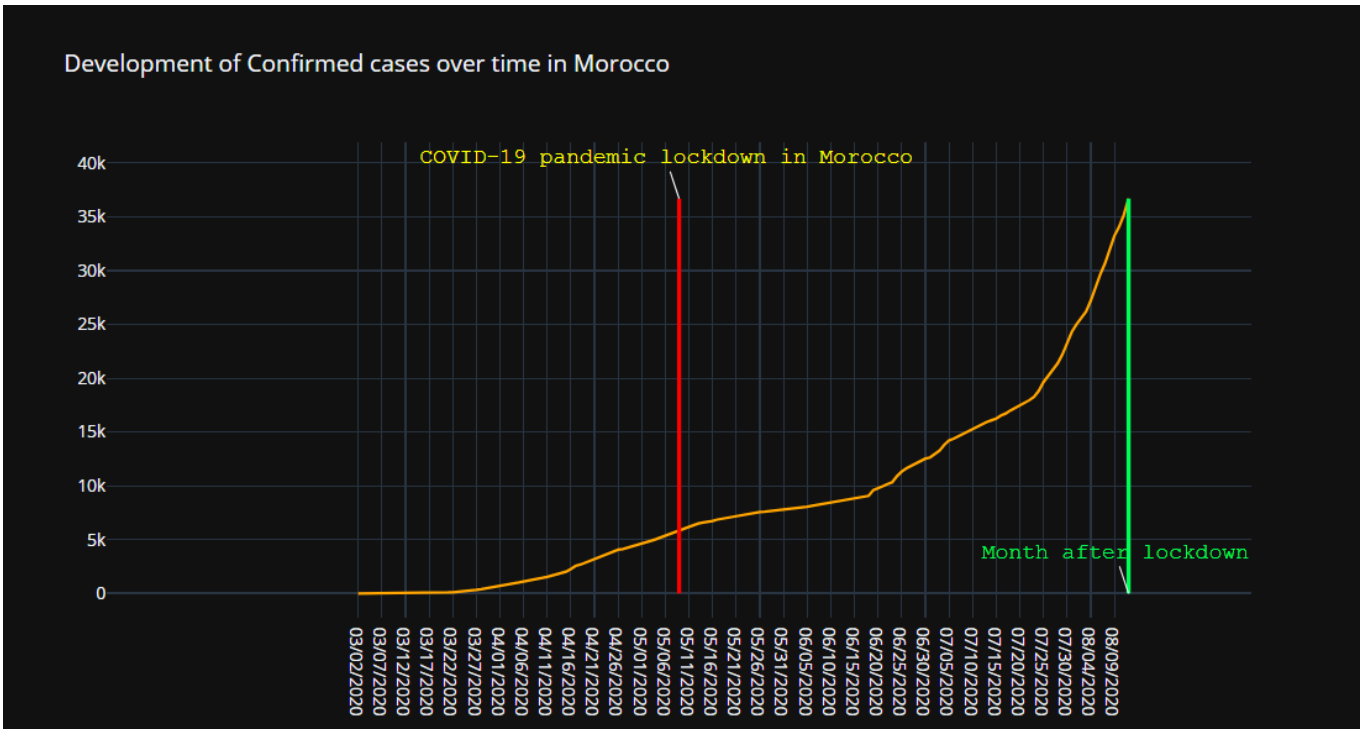

Figure 30:Development of confirmed cases over time in Morocco

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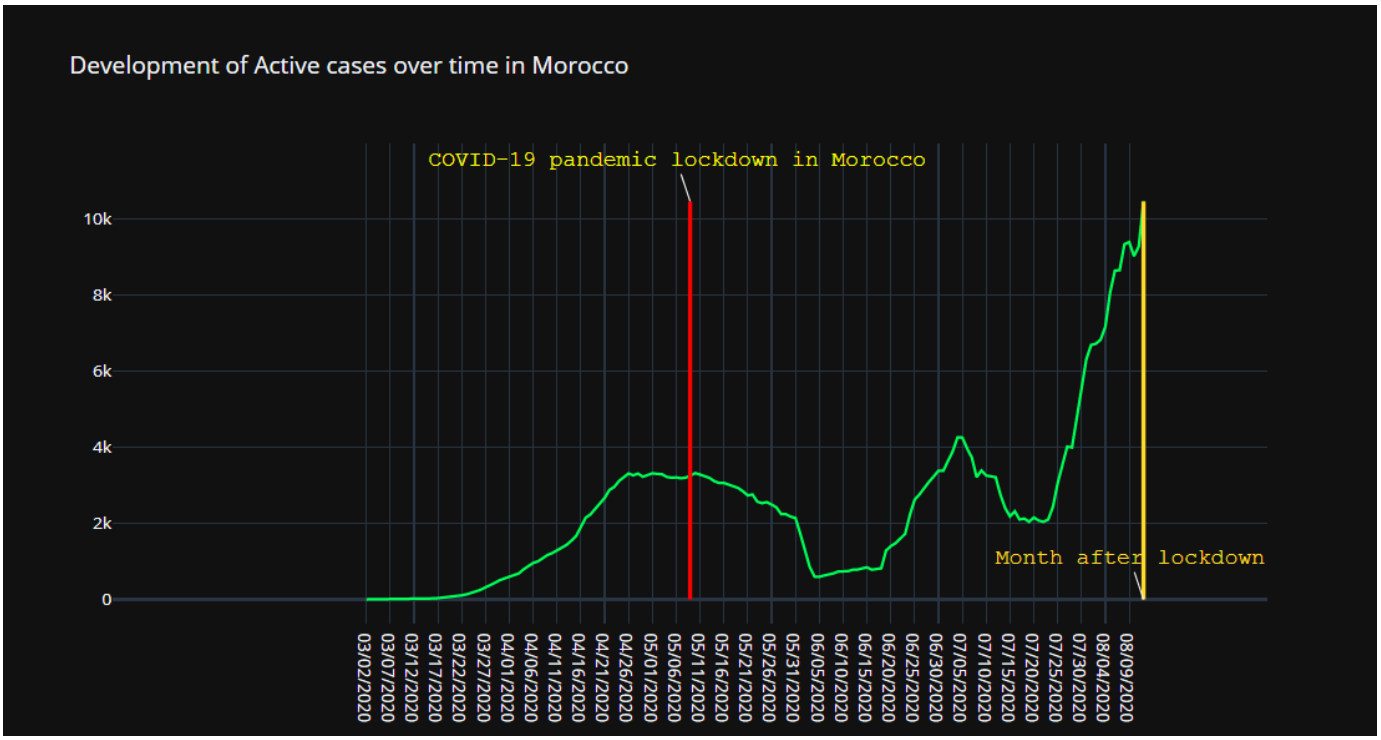

Figure 31:Development of active cases over time in Morocco

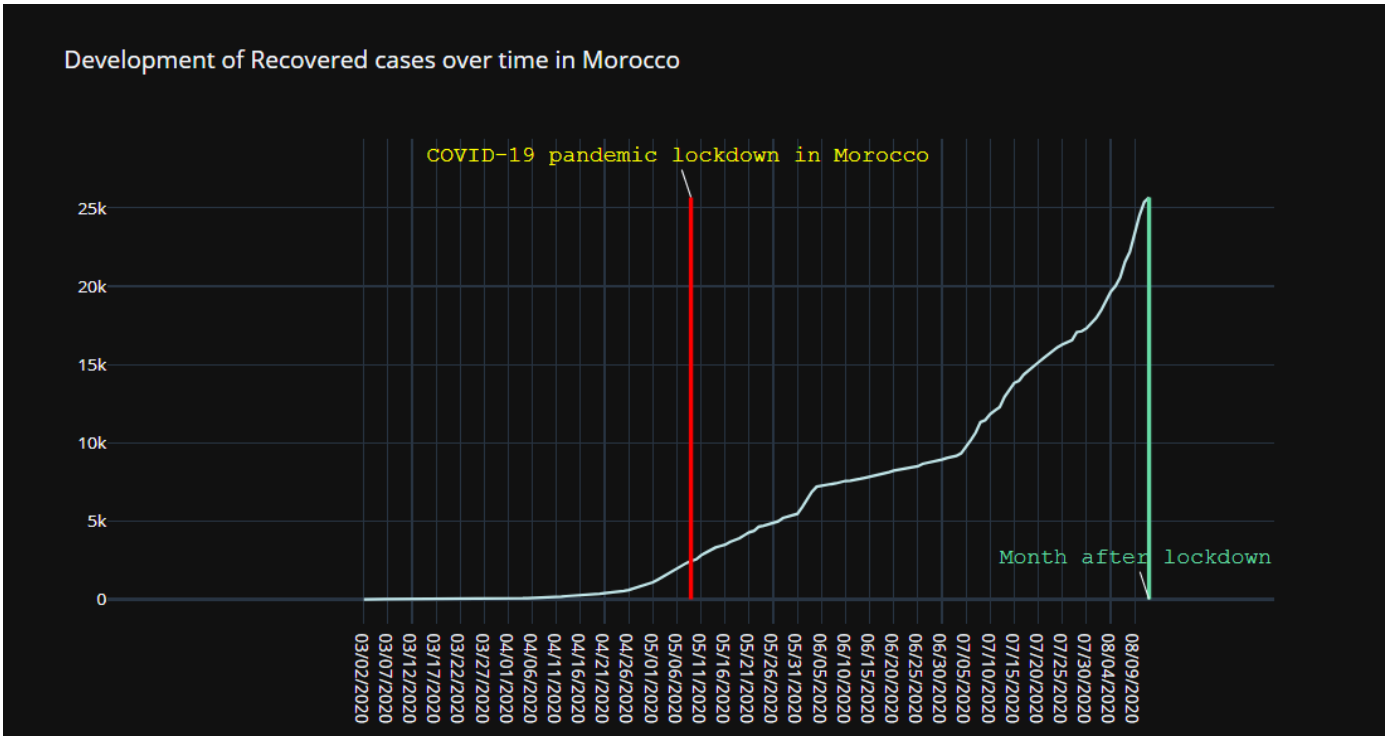

Figure 32:Development of recovered cases over time in Morocco

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Before and After Lockdown In Brazil

Santa Catarina: 2020-03-17

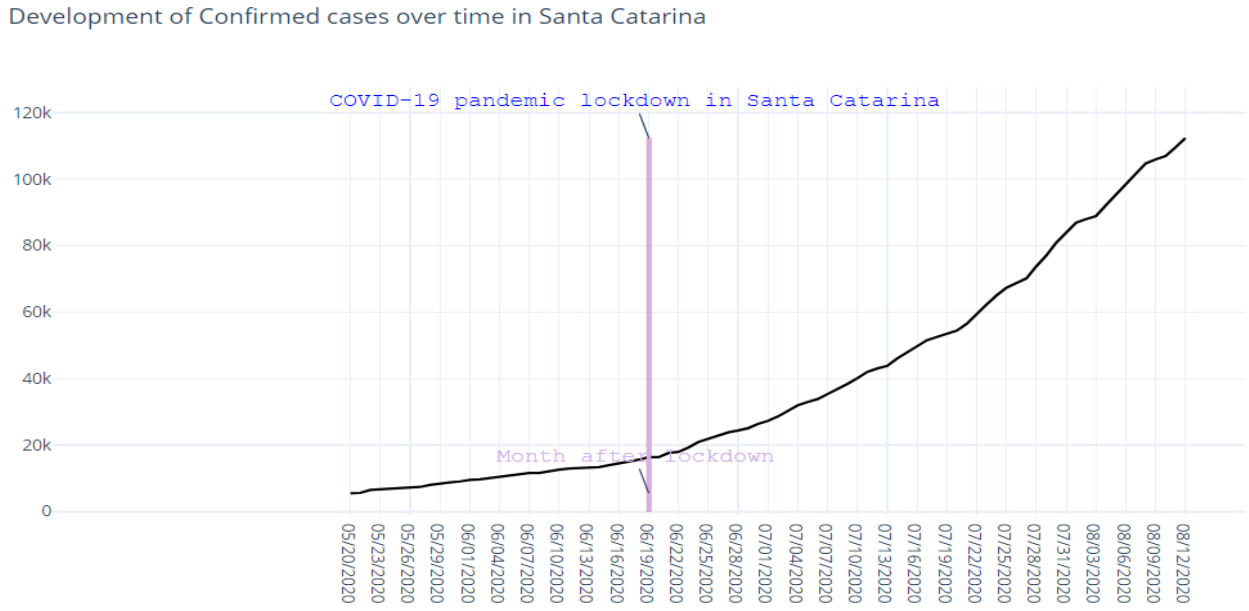

Figure 33:Development of confirmed cases over time in Santa Catarina

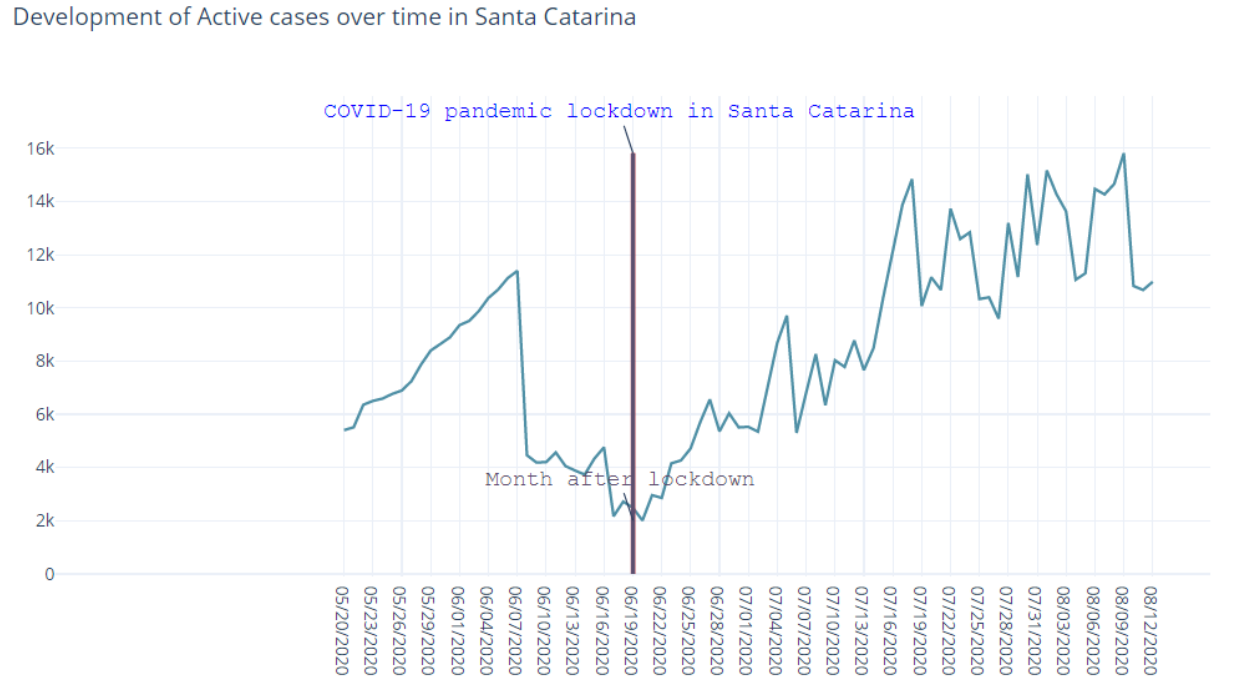

Figure 34:Development of active cases over time in Santa Catarina

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Sao Paulo 2020-03-24

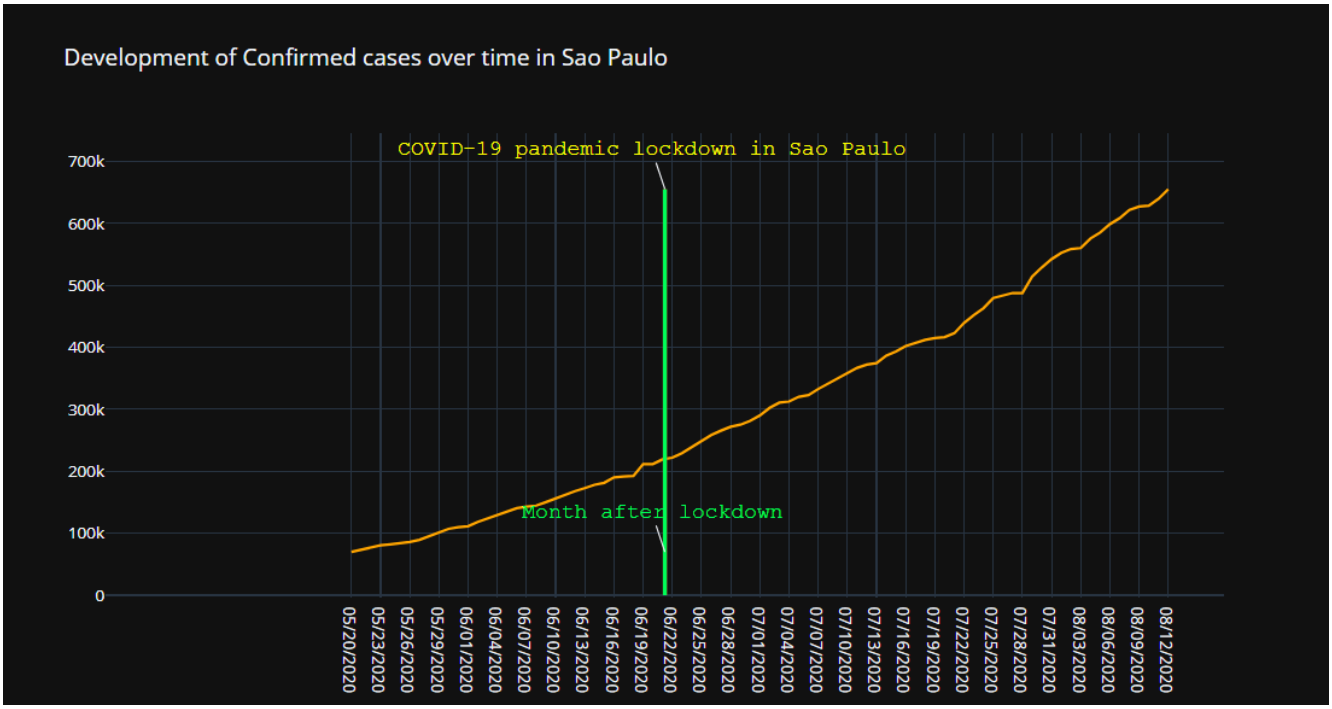

Figure 35:Development of confirmed cases over time in Sao Paulo

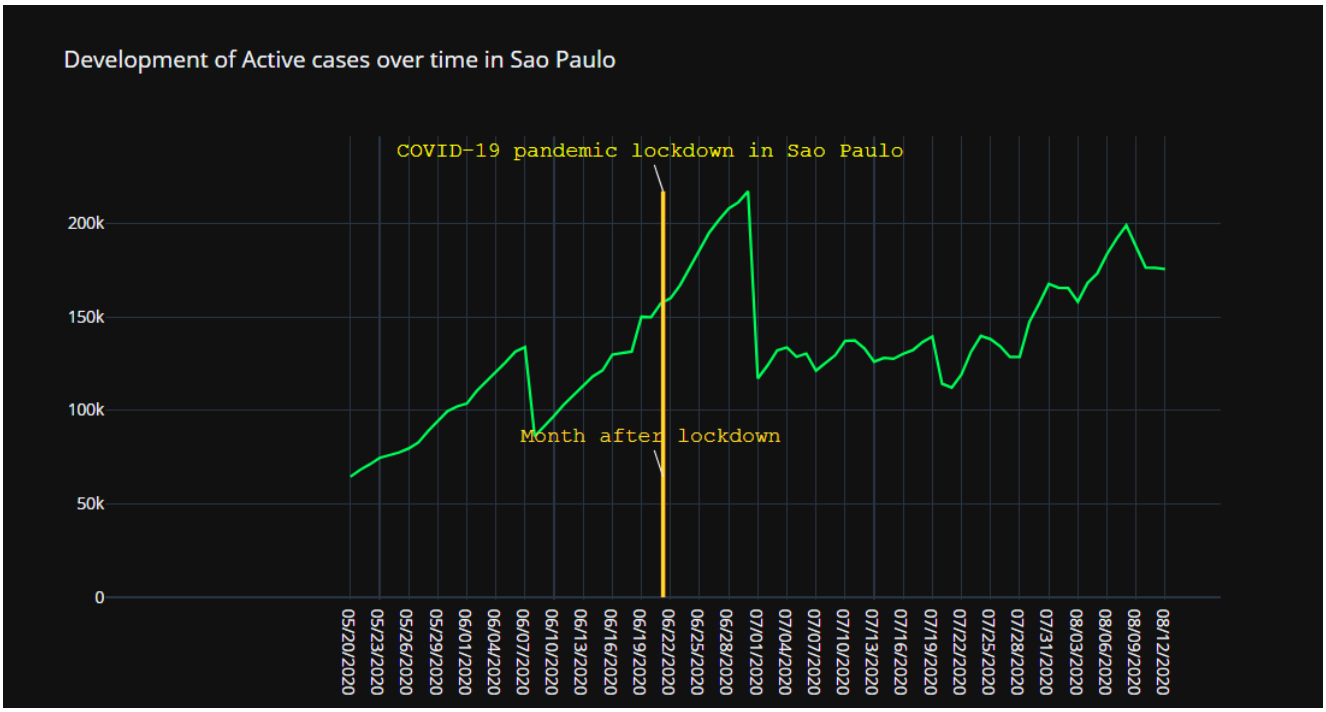

Figure 36:Development of active cases over time in Sao Paulo

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It is observed from above visualizations that after lock down in many countries cases are increasing at a rapid rate.

4. ENTROPY ANALYSIS

Entropy is a term used to quantify randomness. The concept of entropy originated from thermodynamics. This concept was extended to information systems by Claude Shannon(Shannon 1948) in 1948. In information theory, the entropy of a random variable represents the mean information inherent in the variable's possible outcomes. In other words, entropy indicates the average value of uncertaintyassociated with the possible outcomes. Let X be a discrete random variable with possible values $\{x_1, x_2, \dots x_n\}$ and probability mass function $P(X) = \{p_1, p_2, \dots, p_n\}$, then the Shannon's entropy(Shannon 1948) is defined as

$$S_S(P) = -\sum_{i=1}^{N} p_i \log p_i \qquad (2)$$

In this section we have endeavoured to analyse the Covid-19 data using the concept of entropy. We have calculated the Shannon's entropy for confirmed cases in the three most-affected countries with the highest number of COVID-19 cases namely: India, Brazil and United States of America (US) based on the data fetched from (link reference) till Aug 11,2020. To better understand the uncertainty associated with confirmed cases, we have evaluated the entropy value based on

a) probability distribution of confirmed cases each week (further referred as 'Weekly entropy').
b) probability distribution of confirmed cases from beginning till end of each week (further referred as 'Entropy till current week').

The results obtained for Brazil, India and US are as shown in figure 76, figure 77and figure 78 respectively.

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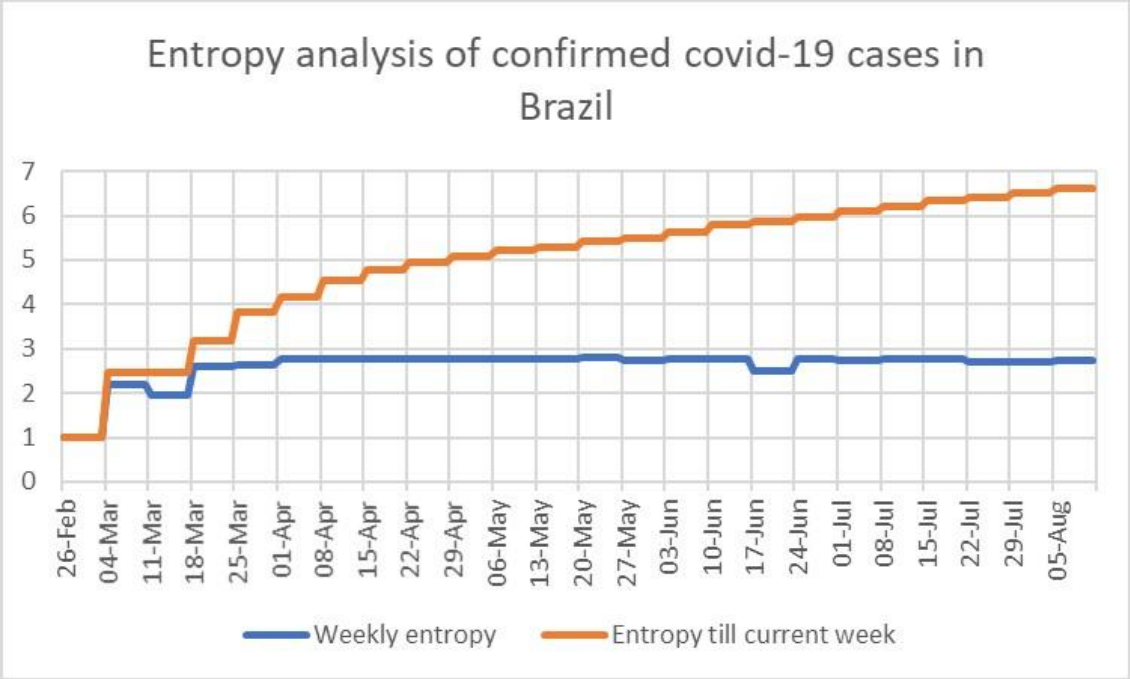

Figure 37:Entropy analysis of confirmed covid-19 cases in Brazil

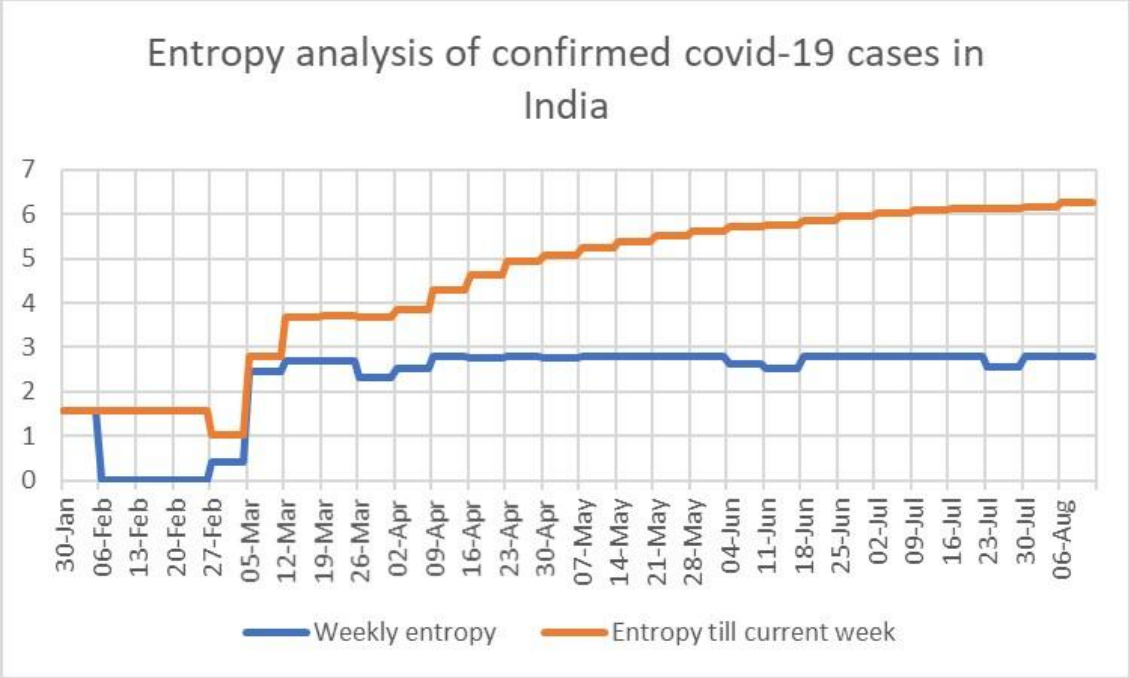

Figure 38:Entropy analysis of confirmed covid-19 cases in India

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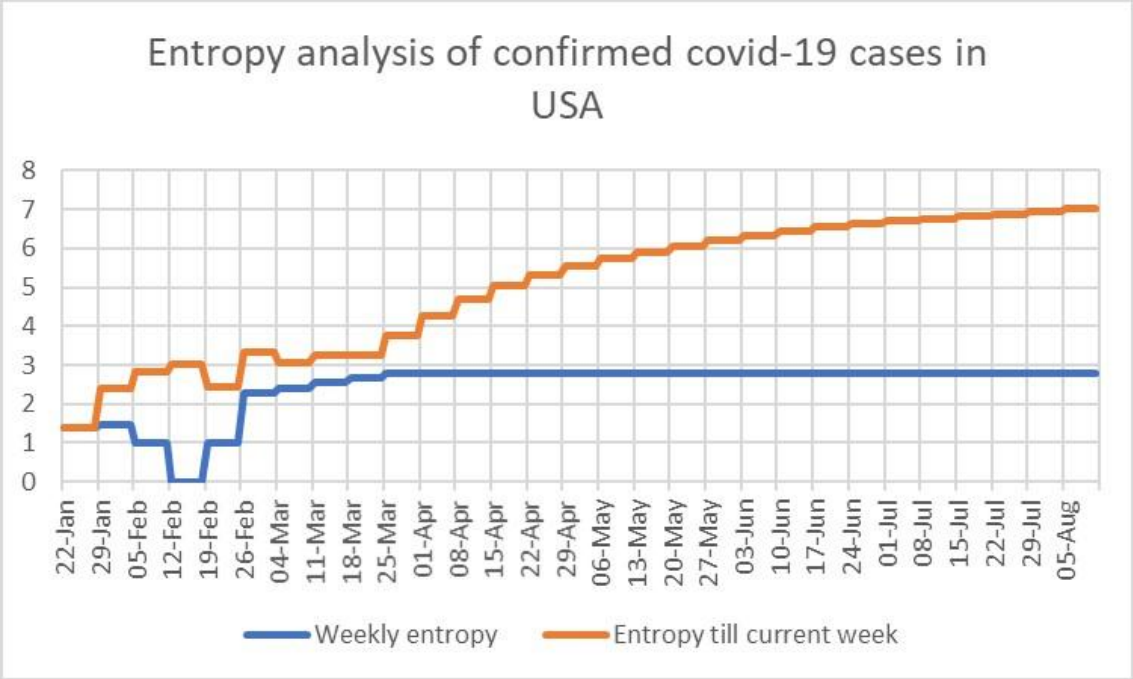

Figure 39:Entropy analysis of confirmed covid-19 cases in US

It can be observed that Entropy till current week increases with time. This is because as the outcomes increase,theuncertainty increases and hence the entropy. The maximum value of weekly entropy is given by $\log_2 7 = 2.8074$.For all the three countries it can be observed that weekly entropy has approached its maximum value in initial one/two months and since then no major variations have been observed in weekly entropy. For India, imposition of lockdown ((2020i))(week following March 25,2020) is accompanied by reduction in weekly entropy. This indicates that announcement resulted in decreasing the uncertainty associated with confirmed covid-16 cases arising in the following week. Another reduction in weekly entropy was observed in the week following May 30,2020, the day when Unlock1 ((2020j)) was announced.

5. CONCLUSION

The study provided data analysis and visualization summary of covid-19 cases in 10 countries basedon thenumber of confirmed,recovered and active cases. The study presented differentplots to showcomparison among the attributes and global cases. Python softwarealong with its important libraries used to plot diagrams for exploring theresults. Finally, Shannon's entropy is used to compare the confirmed cases of top three countries and it is found that confirmed cases are rapidly increasing inthese three countries upto 12 August, 2020. It is believed that this analysis andvisualizations will help researchers for knowing the steps to taketo curtail the spread ofthe virus.

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