Data Visualizations of Mobility rates from 2020 to 2022 in the United States of America

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I. Introduction

The arrival of Covid-19 in the early months of 2020 brought changes in society's habits in a grand variety of levels. The pandemic affected social interactions, mobility trends, economic indicators, household income or unemployment rates among many other domains. This study focuses on mobility indicators to visualize how the population distribution got affected by the lockdown and the different public health measures implemented and how it evolved over time during the following 3 years.

II. Data Description

This research includes two datasets that complement one another: one is a dataset of public health data in the world, and the other is a dataset of population mobility indices during the same time. The first dataset comes from Google COVID-19 Open Data [1]. This dataset contains country-level, daily, time-series data on confirmed COVID-19 cases, deaths, testing rates, mobility, and government action indicators. The size of the dataset is extremely large, and therefore only the USA data was kept. The data used has been reduced to fewer dimensions to find good visualizations with a part of the data. The results can help the reader understand both the scale and intensity of the pandemic and the economic effects it had.

The data for the second dataset was retrieved from the Google COVID-19 Mobility Reports Dataset [2]. Each row contains information of the intensity of the mobility in a certain zone (recreational and retail zones, parks, workplaces, residential areas…) in a certain state and county of the USA. It is available for more countries, but only the USA's data was used for this report. Therefore, the data contains multiple entries on each date, and frequency of recording may vary in each different county. Therefore, using sums of the index in a particular date is not a good idea and averages or other statistical metrics are used throughout the report to correctly interpret the data.

TABLE I. Data Attributes

Attribute	Type	Example Value	Description
Country Region	Categorical	US	Country where the row information is located
Country Region Code	Categorical	US	Country Code where the row information is located
Sub Region 1	Categorical	Illinois	State (in case of the US)
Sub Region 2	Categorical	Will County	County (in case of the US)
Date	Date	12-12-2021	Date of the entry
Grocery and Pharmacy % Change from Baseline	Categorical	20.12	Index to monitor Grocery and Pharmacy % Change from a baseline
Parks % Change from Baseline	Categorical	12.43	Index to monitor Parks % Change from a baseline
Residential % Change from Baseline	Numeric	23.12	Index to monitor Residential % Change from a baseline
Retail and Recreation % Change from Baseline	Ordinal	43.23	Index to monitor Retail and Recreational % Change from a baseline
Workplaces % Change from Baseline	Ordinal	-12.54	Index to monitor Workplaces % Change from a baseline
Transit Stations % Change from Baseline	Ordinal	-41.35	Index to monitor Transit Stations % Change from a baseline

Attribute	Type	Example Value	Description
New Confirmed COVID-19 Cases	Numeric	775,345	Daily number of newly reported Covid-19 infected individuals.

III. Methodology and Results

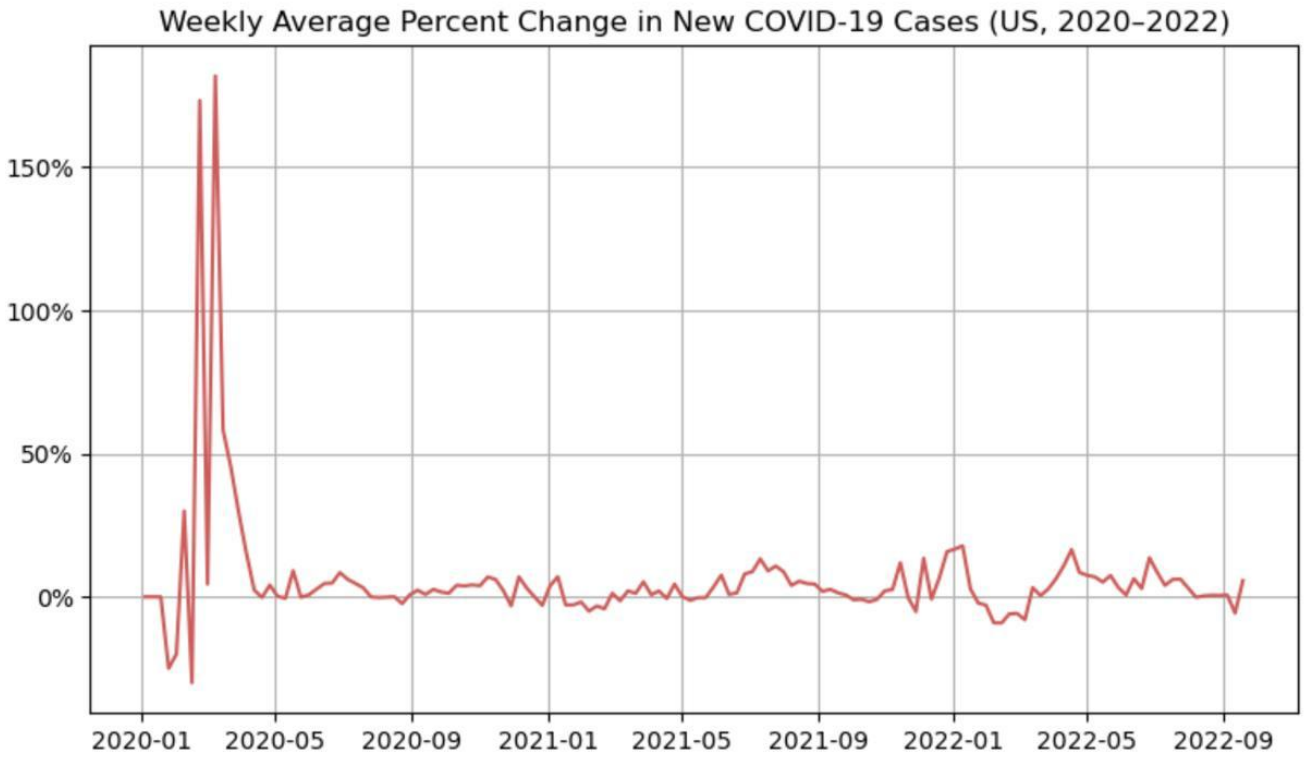

Figure 1 Weekly average percent change in new Covid-19 cases (US, 2020-2022)

First, Fig. 1 has been implemented to help visualize the evolution of the disease across the same timeline in which the mobility indicators will be further studied below and to provide a comparative tool to be able to establish correlation if needed. Fig. 1 shows the weekly average percent change in new COVID-19 cases in the US from 2020 to 2022. Fig.1 perfectly displays the initial spike in cases, where the disease started spreading exponentially and normalized as time went by. The spike displayed in Fig. 1, this sudden exponential increase in cases, was the reason for general panic and worldwide lockdowns, which affected societies in a grand variety of ways. It is key to remember for the rest of the study that the spike in cases for the first time in the USA was around February-March 2025.

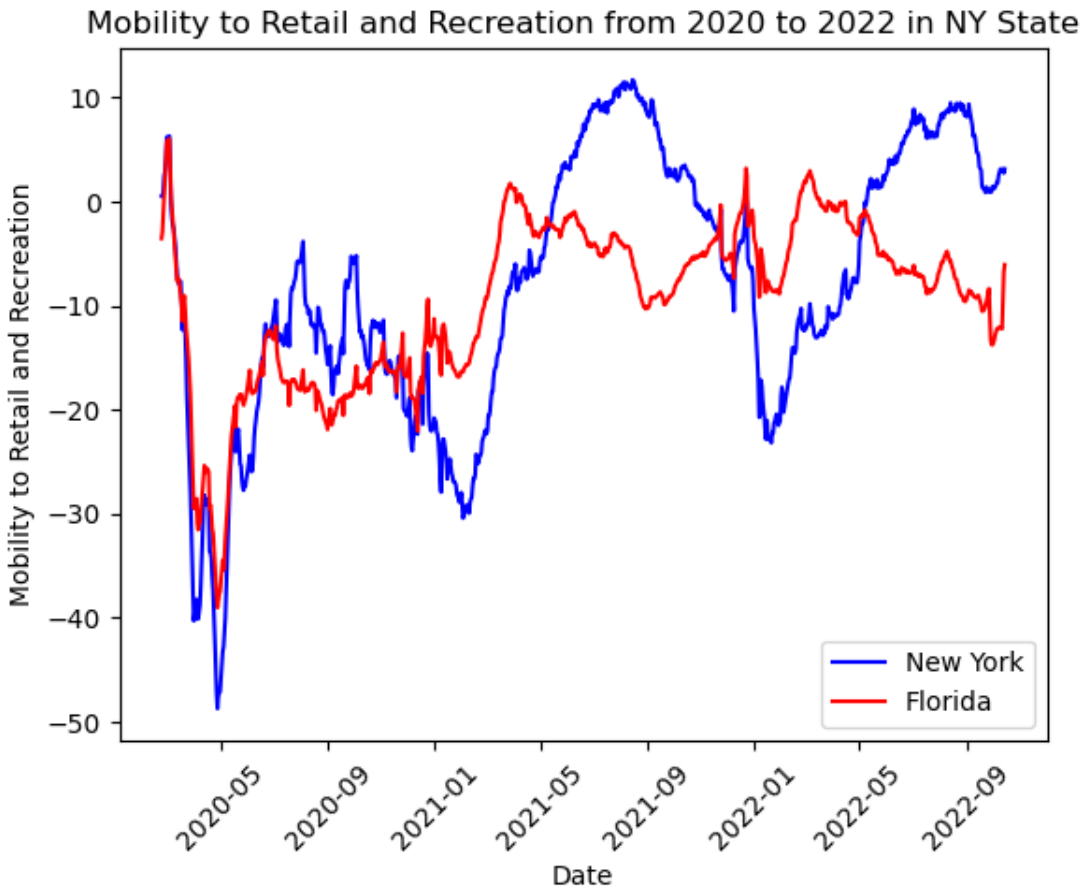

Figure 2: Mobility in Retail and Recreation Areas from 2020 to 2022 (NY and Florida)

Figure 2 shows the average mobility to retail and recreation from 2020 to 2022. The initial data was very noisy, so two transformations were made to make the visualization clearer. The visualization displays the average value for all the entries on a particular date. Additionally, it uses the 15-day rolling average to smoothen the graph and give clear shapes and continuity, to visualize patterns more easily.

The values are percentages from the baseline. The baseline is the median value, for the corresponding day of the week, during the 5-week period Jan 3–Feb 6, 2020, before the spike of COVID-19 cases. Both in Florida and NY, we observe a downfall in the points later in March-May, with most of the values between late March and June being lower than 20% from the baseline. This lower attendance to Retail and Recreation may have been influenced by the lockdowns decreed in Florida and NY in April 3rd and March 20th of 2020 respectively.

The comparison allows us to see that both states were affected by COVID-19. There is a gradual decline from June 2020 in both states, although New York does go back to lower values later in the year. By looking at the graph from 2021 onward, we see a very clear trend. Florida's retail and recreation stay similar all year round with some exception around the Christmas holidays. By contrast, New York's occupancy rate of recreational and retail zones depends a lot more on the time of the year. In winter, retail and recreational zones are occupied far lower in NY than during the summer, probably influenced by harsher weather.

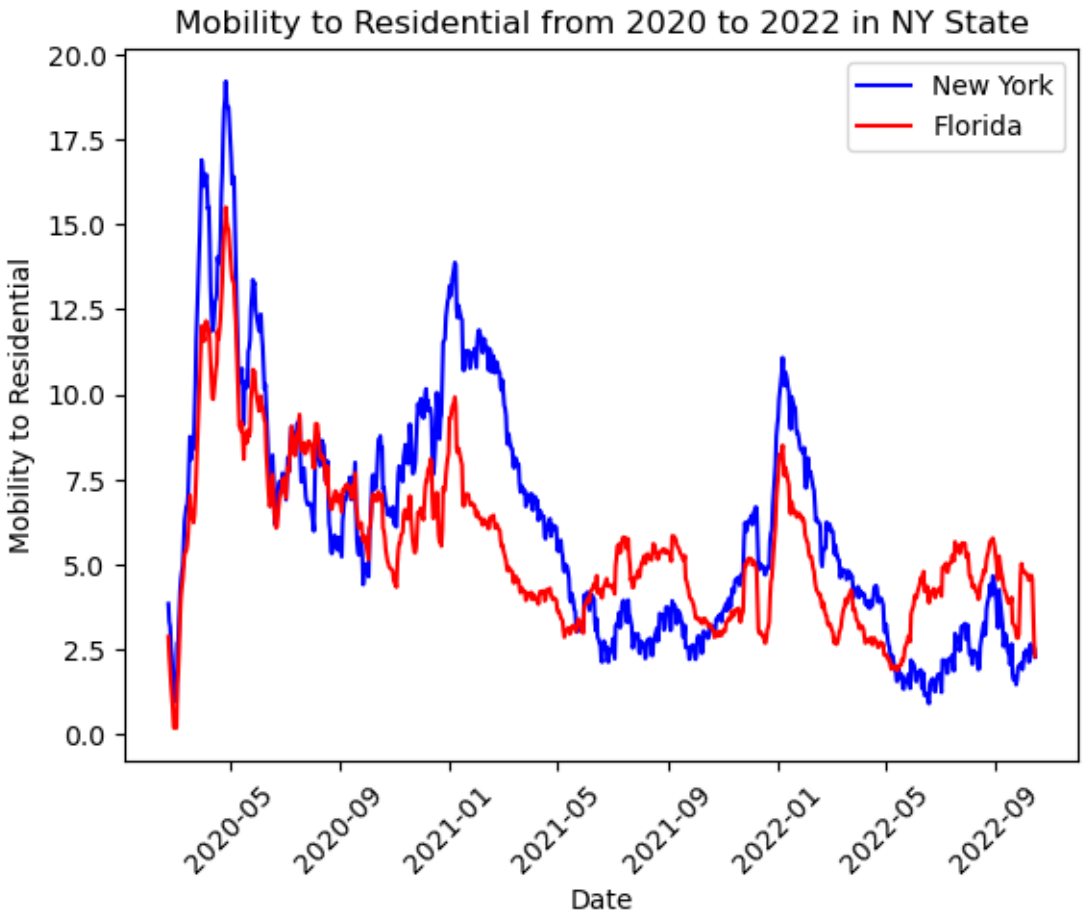

Figure 3: Mobility to Residential from 2020 to 2022 in NY and Florida

Figure 3 looks at the dataset by using the same technique. This time, however, the graph reflects the mobility in residential areas rather than retail and recreation zones.

Contrasting with the previous visualization, the start of lockdown drove up the number of people at residential areas, probably at their own homes. This backs the hypothesis of the lockdown having worked successfully at keeping people at home rather than at recreational zones.

It is also interesting to see how both Florida and NY residents are home a lot for Christmas, but during the rest of the winter, Florida residents seem to spend more time outside their homes compared to NY residents. The roles are reversed in the summertime. Both graphs give information on this and back the hypothesis that weather influences the life of people in NY and Florida, with a similar effect of the COVID-19 pandemic and lockdown at the start of 2020.

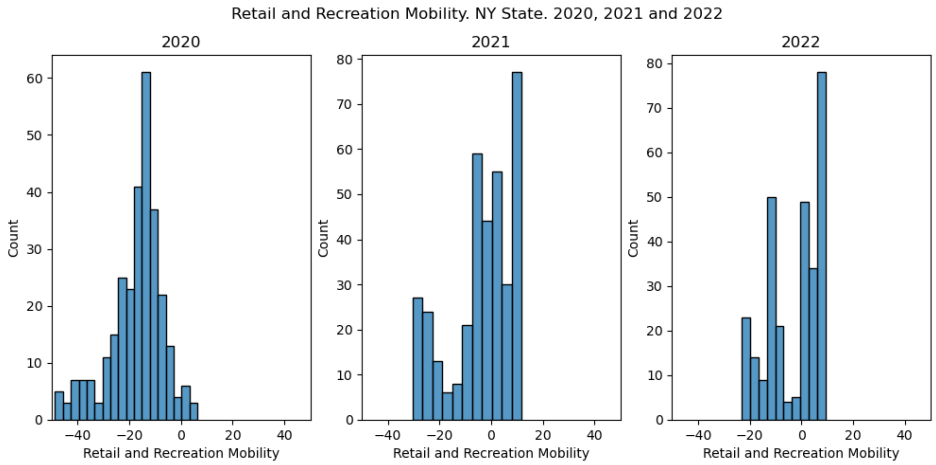

Figure 4: Retail and Recreation Mobility distribution in NY state. 2020, 2021 and 2022

Figure 4 offers a different perspective. This time, only the state of NY is considered. The distributions show the number of days that people have gone to retail and recreation areas at each specified percentage range. This allows us to see how in 2020, very few days were above the median recorded between January and February of that same year (baseline). This may have been influenced by the COVID-19 pandemic and the lockdown it caused.

In 2021, we observe a different trend. Still, many days inside the range were under the baseline, but about 170 days were over it. The histogram shifted right with respects to 2020. The distribution of 2021 was quite similar to 2022, showing how the effects of COVID-19 were not very strong after 2021. However, it still is possible that the first weeks of 2021 had effects related to COVID-19 but that was not very notable in the metric, because during the winter, people visit recreational and retail zones less in the state of New York. Figure 5 seeks to see if the winter is hiding the real effect of COVID-19 during the first weeks of the year 2021 by using Florida as a reference, since Figure 2 shows that its activity in retail and recreational zones is not so affected in the winter.

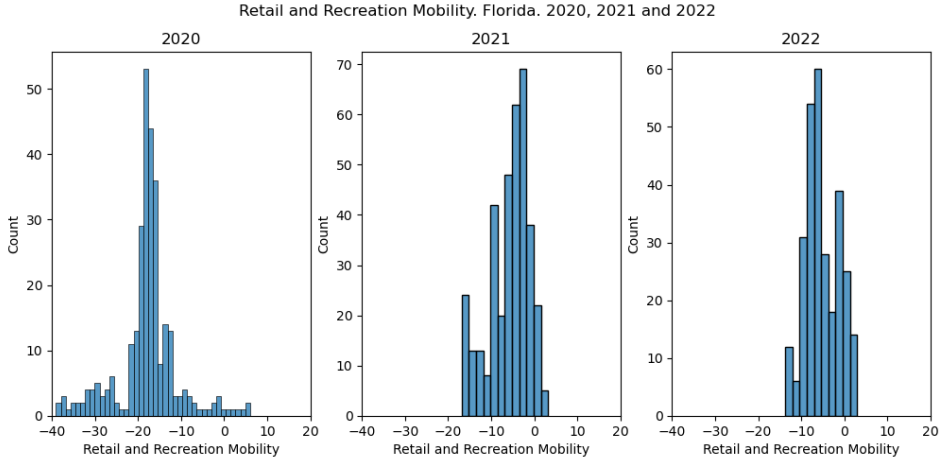

Figure 5: Retail and Recreation Mobility, Florida. 2020, 2021, and 2022

By plotting the same graph in Florida, we are able to see that the graphs are still very similar, but there are 30 days where the indicator went below -15 in 2021 while it did not in 2022. That could indicate that there was still some impact on mobility caused by COVID-19 in early 2021 when the number of vaccinations was growing. However, there could be other sources such as having some days with bad weather or other adverse effects.

It is important that the labels on the graphs are checked appropriately since the Y axes of each of the visualizations are cut so that the distributions can be seen as clear as possible.

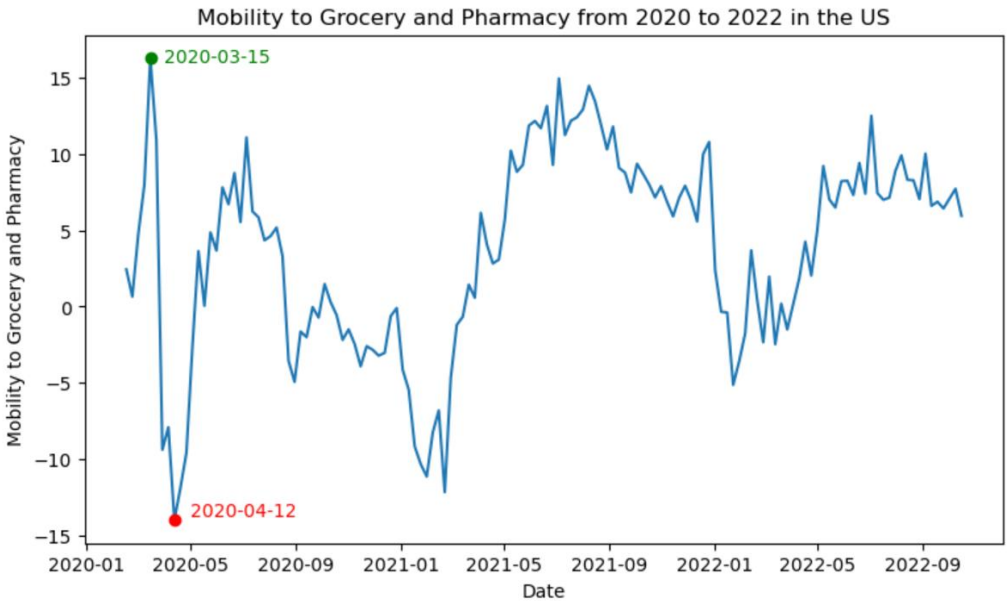

Figure 6 Mobility to Grocery and Pharmacy from 2020 to 2022 in the United States

In Fig. 6 we can observe the mobility rates of the population to grocery shops and pharmacies over the period corresponding to 2020 to 2022. Fig. 6 shows a large amount of information and the clearest observation that wants to be discussed is how the days leading to the global emergency outbreak had the biggest spike in the whole timeline, which could correspond to the masses desire to stock their homes before the rumored worldwide lockdowns. This spike is interestingly directly followed by the biggest drop in mobility during the same set period, with a difference of less than a month between the highest and lowest values in the visualization. This drop can be related to the start of the lockdown which limited mobility in many states and the fear of the disease which may also have had an effect to people's movement habits.

Fig. 7 allows us to visualize how the trends of movement in residential areas changed and compared between the months of lockdown for many states and the same period two years later. In Fig. 7 it can be easily observed how in 2020 the movement of the masses to residential areas increased substantially probably due to the lockdown.

Comparing this period to the same period two years later allows for the visualization of a general countrywide trend of a decrease of mobility to residential areas. This further backs the previously stated hypothesis of the lockdown having worked successfully at keeping people at home rather than at recreational zones.

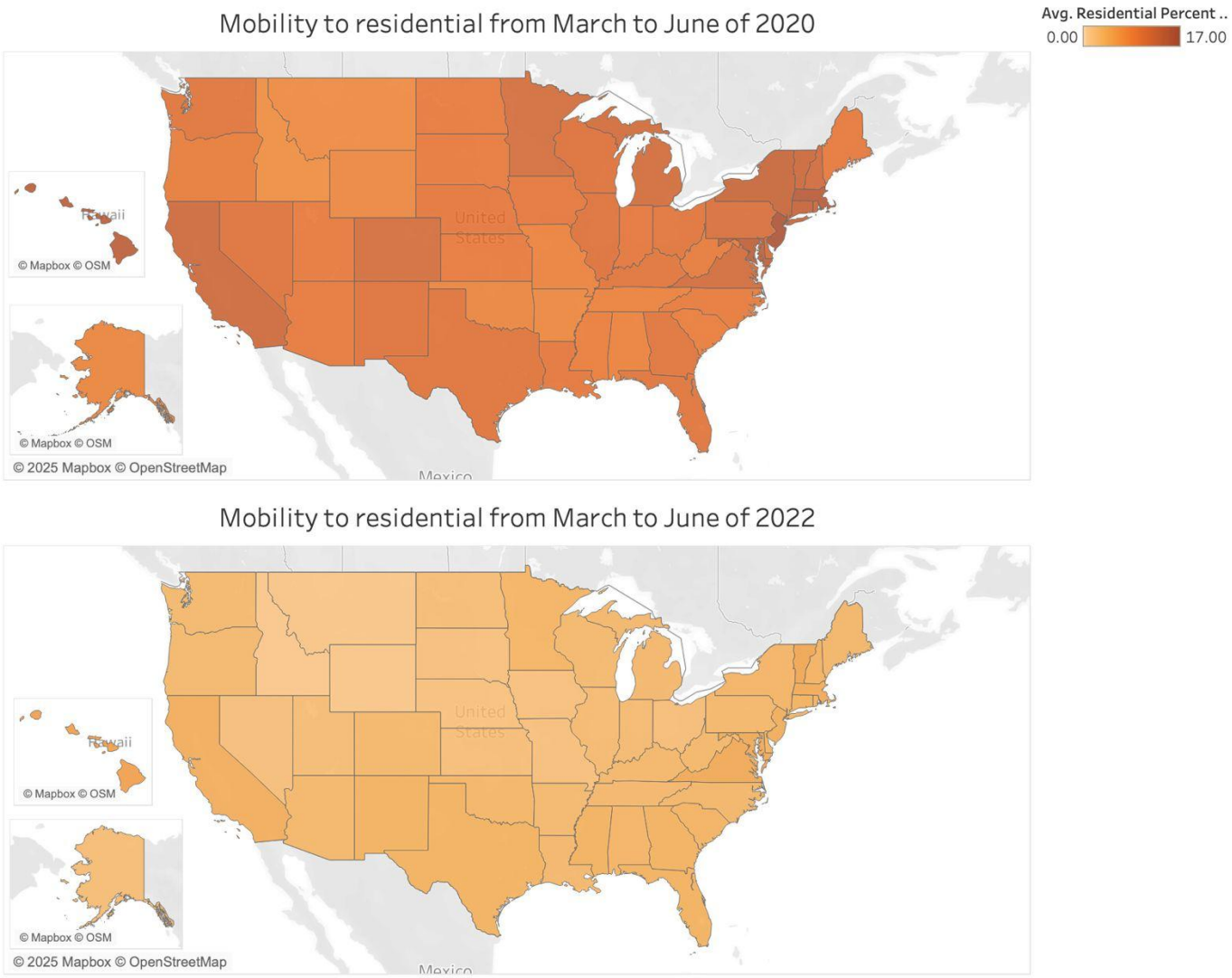

Figure 7 Mobility to residential from March to June of 2020 and 2022

Fig. 8 displays a correlation heatmap visually explaining the relationships between main mobility indicators in the U.S. over the years 2020-2022. The heatmap exposes several significant patterns that agree with the behavioral changes brought about by the COVID-19 pandemic. The mobility-related to retail, grocery, and transit carries strong positive correlations between each other, which means that these types of movement usually went up and down together depending on how restrictions were changed and whether the public activity was resumed or not.

Unlike this, mobility at the workplace has a strong negative correlation with mobility at home. This correlation may indicate that when people stay home to do remote work, the number of people in workplace areas decreases.

In addition, transit mobility negatively correlates with residential activity, which could be a sign that when people are not home, they are at transit areas. Mobility related to parks has moderate correlations with other categories, which could be an indicator that the outdoor spaces played a role as alternatives for recreation during the restrictions imposed, but no firm conclusions can be drawn from that.

The heatmap, in general, is an efficient tool to grasp the interconnection of various mobility types during the pandemic period and to see how people's behavior has changed over the years studied.

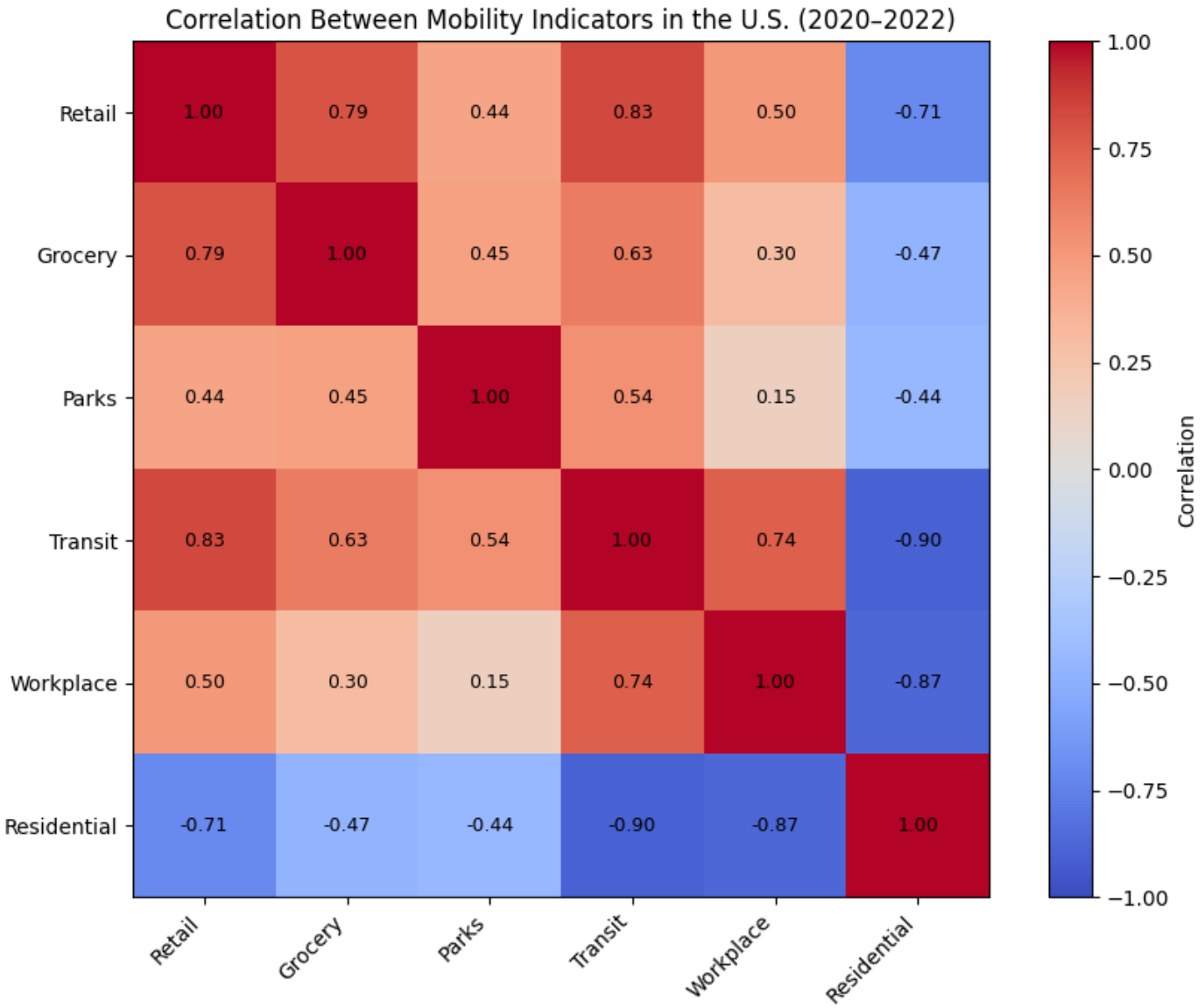

Figure 8 Correlation Heatmap of Mobility Indicators in the U.S (2020 – 2022)

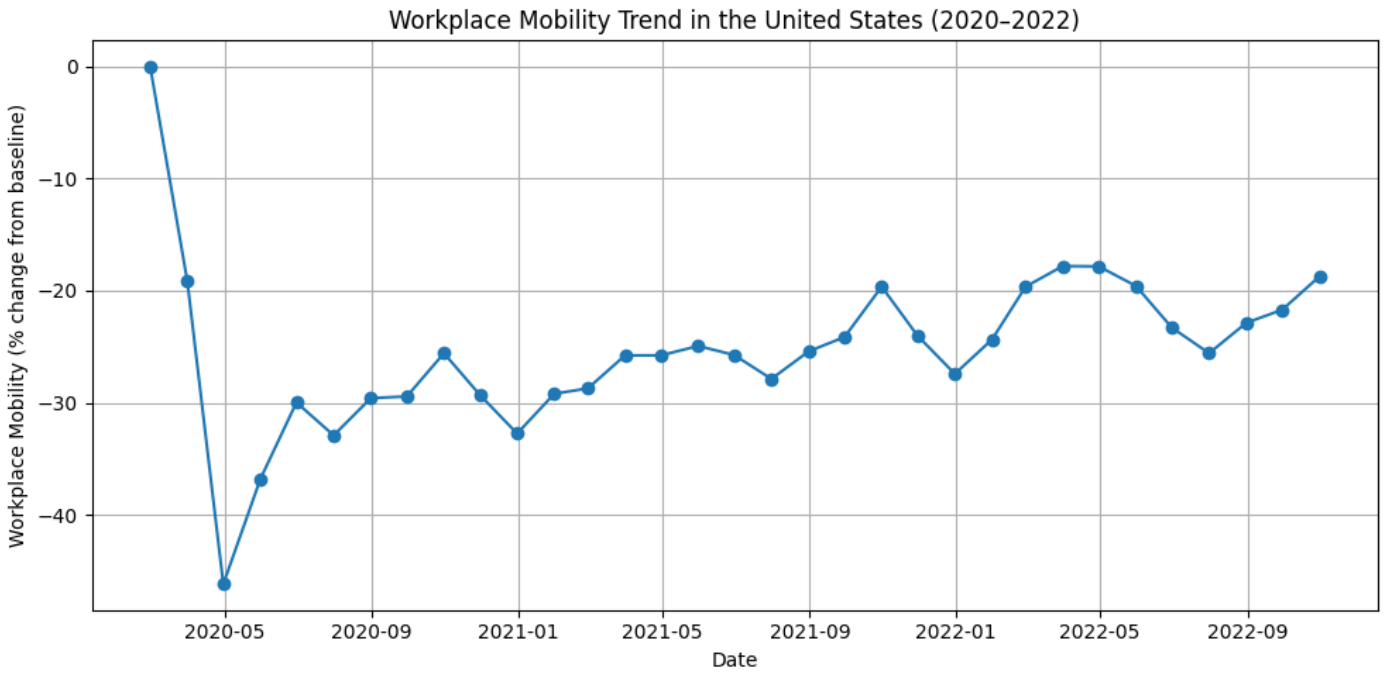

Figure 9 Workplace Mobility Trend in the United States (2020–2022)

Fig. 9 depicts the variation in office mobility in the US from 2020 to 2022 and is informative about the workplace commuting trends during and after the COVID-19 pandemic. The chart discloses a very steep fall in workplace mobility in the first quarter of 2020 that is in line with lockdowns across the country and rapid remote work adoption. The study of 2021 and 2022 recorded an upward trend in workplace mobility despite being below the baseline every month in the chart. This indicates the return to the in-person work was slow and not all employees were physically present in the office even by the end of 2022. There are some minor variations month by month showing how mobility adjusted to these situations: restrictions, seasonality, COVID-19 waves and many other circumstances. In essence, the figure conveys the significant consequences of the pandemic on work-related travel in America that lasted for a long time.

IV. Discussion

The visualizations for this project illustrate the changes and trends in various mobility behaviors in the US from 2020 to 2022. Fig. 1 aims to provide latter visualizations with a basis to be able to establish correlations between mobility trends and the pandemic of COVID -19. To further relate the data to COVID-19, all the data is a level compared to a baseline of that same indicator before the COVID -19 pandemic started. It is interesting to see how most figures perfectly depict a sudden change in trends and social behaviors around the month of March of 2020, correlating with the instauration of the first public health measures (like lockdowns) countrywide.

The correlation heatmap implemented in Fig. 8 provides a basis to establish correlations among the different trends observed in different mobility sectors, by unveiling a variety of strong positive and negative relationships between variables. Nevertheless, these correlations are not enough to establish causation in any way as the trends were influenced by public-health measures as well as social behavior, work practices, and the population's gradual adjustment to pandemic conditions among many reasons.

V. Conclusions

The changes in the mobility patterns over the period of 2020 to 2022 show how the pandemic reshaped daily movement in the USA. Going to work and using public transportation were some of the highly decreased activities, among other trend changes in grocery shopping and residential mobility, which shows that people made major lifestyle changes due to the lockdowns. Afterwards, when limitation measures were lifted, the movement of people got back to standard levels only slowly, still leaving some distance from full recovery. These figures refer to the major shifts in the people's conduct as they adapted to ups and downs of the health crisis.

Interesting conclusions from the visualizations provided can be drawn. The report shows how differences in habits in the states of Florida and New York shaped the impact of COVID-19 in each state, or how COVID-19 cases evolved during the pandemic from 2020 to 2022. Also, how mobility in residential areas tends to indicate lower mobility in other areas such as retail or workplaces, among other correlations found. Another interesting finding is how 2020 and 2022 differed in terms of mobility in different states.

REFERENCES

[1] Google Health. COVID-19 Open Data [Dataset]. https://health.google.com/covid-19/open-data/
[2] Google. COVID-19 Community Mobility Reports [Dataset]. https://www.google.com/covid19/mobility/

TEAM CONTRIBUTION

Pau Casé Barrera: Developed part of the data description, extracted the data from the repositories and merged the different years, developed the text and visualizations for figures 2, 3, 4 and 5.

Pol Monné Parera: Scripted the introduction, part of the data description and the text conclusions associated to visualizations 1, 6 and 7. Used Tableau to develop the geospatial figure 7 and Matplotlib to create visualizations 1 and 6.

Shaubhagya Mahat: Contributed to this project by creating visualizations (among them Figures 8 and 9) and briefly assisted in writing the discussion and conclusion section.