Covid 19 Community Mobility Analytic with Graph

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Abstract

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1 Problem Statement

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2 Dataset Description

For Apple mobility data: The CSV file and charts on this site show a relative volume of directions requests per country/region, sub-region or city compared to a baseline volume on January 13th, 2020. We define our day as midnight-to-midnight, Pacific time. Cities are defined as the greater metropolitan area and their geographic boundaries remain constant across the data set. In many countries/regions, sub-regions, and cities, relative volume has increased since January 13th, consistent with normal, seasonal usage of Apple Maps. Day of week effects are important to normalize as you use this data. Data that is sent from users' devices to the Maps service is associated with random, rotating identifiers so Apple doesn't have a profile of individual movements and searches. Apple Maps has no demographic information about our users, so we can't make any statements about the representativeness of usage against the overall population. [1].

3 Feature Preprocessing & Engineering

3.1 Data Cleansing

3.1.1 COVID Case / Death Number

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3.2 Joining Datasets

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4 Data Visualization

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4.1 Information of Mobility

Described by Apple, the "Mobility" is generated by counting the number of direction/routing requests the users made on Apple Maps. Apple would like to make this information helpful to the governments and health authorities to generate insights and hopes to make it useful for reference for the new public policies by showing how the volume of people's walking, driving and taking public transit changes in their communities.

Apple mainly emphasizes that Apple Maps embraces privacy as core from the beginning. Apple declared that the mobility data collected by their map application, Apple Maps, does not relate to any user's Apple ID, and Apple does not store the location history of any user. So, in the mobility data set we downloaded, we can just see mobility per countries/regions, and cannot see any personal identifier columns.

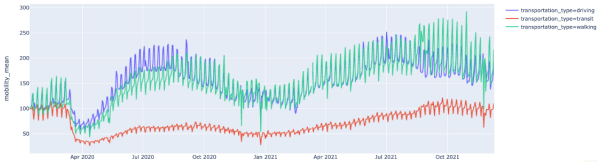
4.2 Filter Out Mobility's Weekly Seasonality

As shown as below, there are many regular periodic changes along the mobility, which makes us difficult to truly see the trend of the mobility data. In this case, the seasonality is by weekly and it is related to people movements which repeat every week. For example, people will go to workplace from Monday to Friday, go home after works but go out for dinning on Friday, and go out for hanging or playing during weekend.

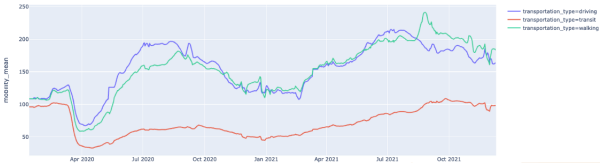
To remove the seasonality, in this case, it is a weekly seasonality, using 7-day moving average can filter out this seasonality. The original and filtered results are shown below. It

is much clear to see the trend of the mobility across time.

Before:



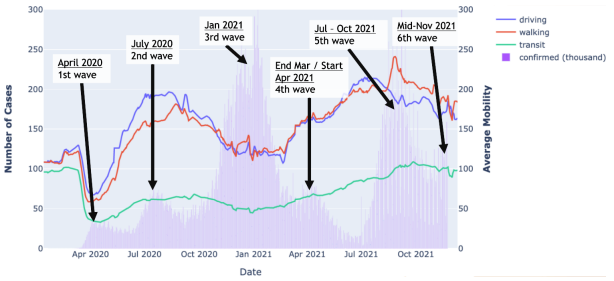
After:



4.3 Mobility and Daily Confirmed Cases

The below plot shows the major waves of confirmed cases in U.S. There are 6 obvious peaks of confirmed cases in COVID-19, where 2 major peaks appear in the period of October 2020 to mid February 2021 and July to November 2021. There is a great drop in mobility of all three types of transportation type at the end of March 2020, because of the public declaration of COVID-19 as pandemic by WHO.

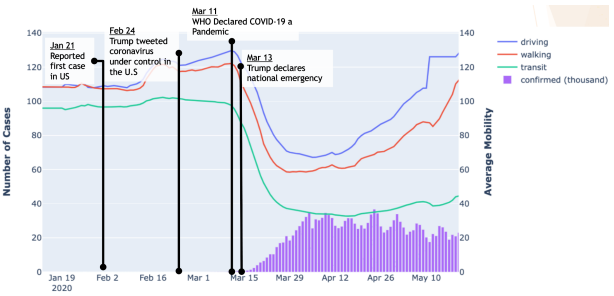
Line chart - Mobility and Daily Confirmed Cases in U.S.:

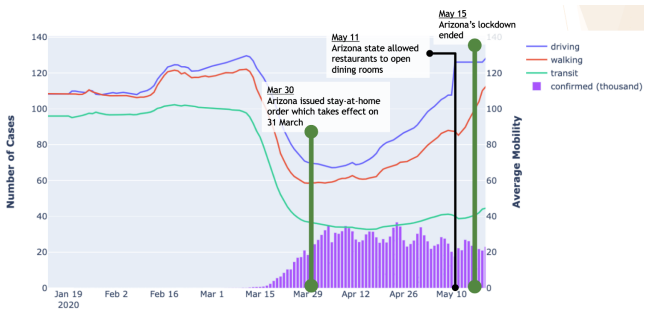


4.4 Timeline of COVID-19 in U.S.

The below plots show the mobility plus the number of confirmed cases in U.S. from 13rd January to 19th May 2020. Several major events are interested to look into.

Significant events related to COVID-19 in U.S.:





On January 21, 2020, Centers for Disease Control and Prevention (CDC) reported a first confirmed case of COVID-19 in the state of Washington. It is travel-related and the patient was returned from Wuhan, China on January 15, 2020. The mobility keeps nearly the same level which indicates U.S. residents did not have a great reaction on it.

On February 24, President at that time, Donald Trump, tweeted that "The Coronavirus is very much under control in the USA", when he was visiting India. The mobility of Apple users greatly soared after the day he made this tweet in Twitter from February 24 to March 11, 2020. But the mobility of taking public transit decreased, which indicates people might still concern about the epidemic and would like to avoid public transportation.

However, on March 11, World Health Organization (WHO) that WHO "made the assessment that COVID-19 can be characterized as a pandemic." User mobility decreased significantly after WHO's declaration. On March 13, Trump also announced a national emergency to deal with coronavirus crisis. The mobility keeps dropping until the end of March while the confirmed cases increases.

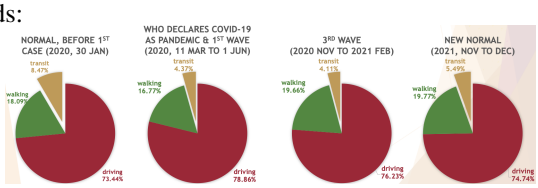
On March 30, Arizona, one of the states in U.S., issued stay-at-home order and it took effect on March 31. The mobility did not decrease so much after that. On May 11, Arizona state allowed restaurants to open dining rooms, the mobility of driving skyrockets on March 11.

4.5 Insight - Change in Behaviors of Taking Transportation

In the normal period (Jan 2020), the portion of taking public transportation is about 8.5%. After WHO declared COVID-19 as pandemic, the portion of taking public transports decreases more than 4% to around 4%. Until nowadays, from November 2021 to now, although portion of public transit increases to 5.5%, it is still lower than before while portion of driving and walking increase. It shows that people avoid to take public transportation, and they are more willing to walk or drive compared to before-epidemic. It makes sense, because the coronavirus is much easier to spread from the infected to

others in a crowded and closed area.

Portion of three transportation types during different periods:



5 Graph Visualization

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5.1 Degree Distribution

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5.2 Path Length

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5.3 Clustering Coefficient

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6 Graph Machine Learning

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6.1 Preprocessing

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6.2 Model Training

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6.3 Result

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6.4 Future Improvement

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6.4.1 Graph Database

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6.4.2 Using Apache Spark

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6.4.3 Selecting Temporal Model

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6.4.4 Other Graph Module

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7 Conclusion

People change their behaviors of transportation during the epidemic, they prefer to walk or drive by themselves rather than taking public transportation, which makes sense for them to reduce person-to-person physical contact to others in public closed area.

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8 Team Contributions

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References

[1] Apple, “Covid-19 mobility trend report,” 2021. link.