Impact of Covid-19 on Mobile Networks

Riccardo Pezzoni

September 20, 2022

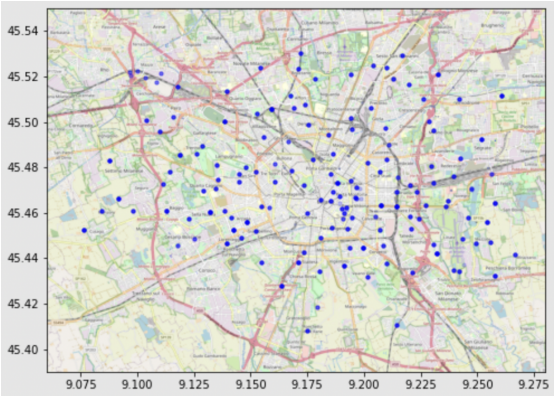
1 Introduction

The severe impact of the COVID-19 pandemic has forced the Italian government to apply restrictive measures to the population in order to contain the spread of the infection. Given the fact that nowadays every person carries a phone all day long and makes use of it both for work and leisure, we can study the impact of the restrictions on the people's habits.

2 Work Description

2.1 Provided Data

Thanks to the locations csv we note that we are provided with data from a lot of eNodeBs across the entire city of Milan. We know that a good way to make an accurate analysis in network traffic is to try to split it in residential and business traffic, to do so we will use clustering.



2.2 Clustering

In order to differentiate and analyse residential and non-residential network areas, eNodeBs can be split with a K-means clustering algorithm imported from

Scikit Learn. To make that possible, the data-set was firstly filtered taking into account a COVID free period, joined with the locations data-frame and grouped by eNodeBID, weekday and time as to obtain, for each eNodeB, the median hourly total traffic (given by the sum of uplink and dowlink traffic) for each day of the week. This is the Median Week Signature (MWS) as shown by Furno et al. in "A Tale of Ten Cities: Characterizing Signatures of Mobile Traffic in Urban Areas". The kmeans algorithms was fed with a matrix having a row for each eNodeB so that every column of represent the median total volume of a certain time and day. With some attempts, the best number of cluster came out to be 3.

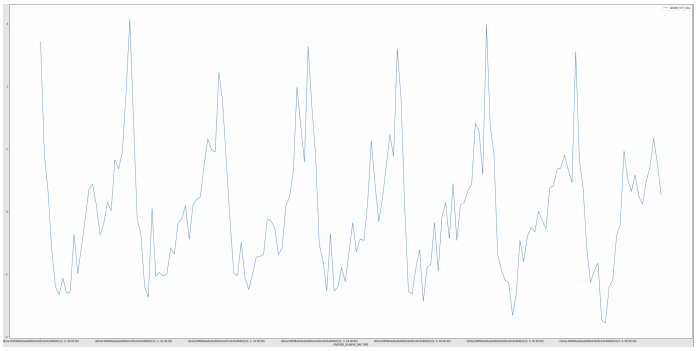


Figure 1: Example of Residential eNodeB

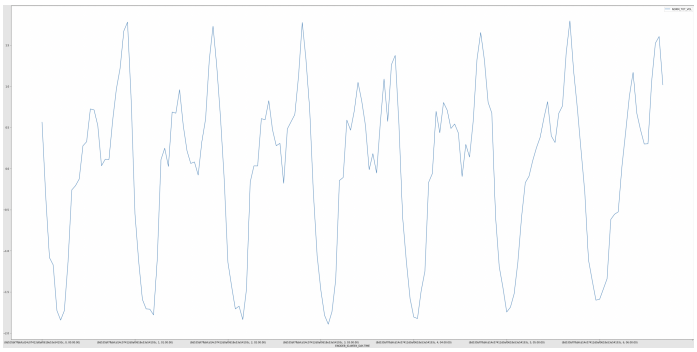


Figure 2: Example of Residential eNodeB

2.3 Total Volume Analysis

For each of the three clusters produces, some analysis was performed to show the daily traffic signature pre-covid, the daily traffic signature post-covid and the

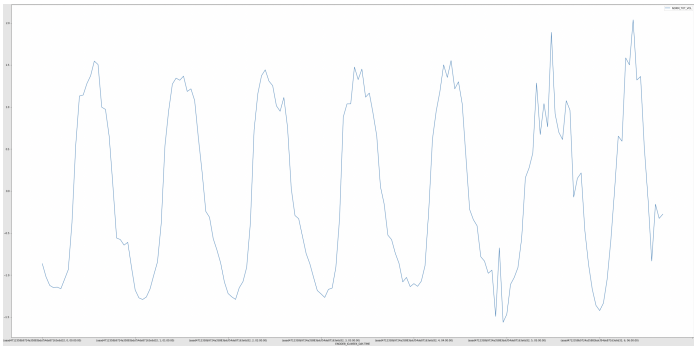


Figure 3: Example of Residential eNodeB

variation of the median daily total traffic for each weekday. The cluster number 0 shows the typical residential traffic signature with, on week days, little traffic in the morning that increases through the day with a spike in the evening, while on Saturdays and Sundays the morning traffic is higher. The cluster number 1 shows a signature with the shape of a plateau through the conventional working hour with some spikes in the morning and in the evening, indicating a transportation cluster. The cluster number 2 shows the typical signature of a business area, with lot of traffic in the morning and in the conventional working hours on week days with a reduction on Saturdays and Sundays. Looking at the the total volume difference we see that:

1. Cluster 0 traffic shows a 25% increase
2. Cluster 1 traffic shows a 18% increase
3. Cluster 2 traffic shows a 27% reduction

2.4 RRC Re-Establishment Success Rate

A similar analysis was performed using as a metric the RRC Re-Establishment Success Rate. It is possible to see a general improving in the whole network showing how the average congestion is diminished. The major difference, however, was seen in business areas. More precisely:

1. Cluster 0 traffic shows a 5.8% increase
2. Cluster 1 traffic shows a 5.0% increase
3. Cluster 2 traffic shows a 9.8% reduction

2.5 Average Number of PRB allocated

Another metric analysed is the average number of PRB allocated by the eNodeB for both the uplink and dowlink traffic. The calculation of the mean shows us

yet again the congestion differences between the two analysed time slots. The results were:

1. Cluster 0 traffic shows a 25% increase
2. Cluster 1 traffic shows a 21% increase
3. Cluster 2 traffic shows a 23% reduction

3 Outliers

With such a large data-set is hard to keep track of outliers values after performing mean or median calculations. Some of them, however should be noted as they help drawing some interesting considerations. That is why thanks to a function that finds the closest eNodeB closest to a given (X,Y), we can highlight differences in some metrics in specific points of interest.

3.1 Linate Airport

The nearest eNodeB to Linate Airport shows a big increase in median daily throughput. This, which might comes as a surprise at first, can be explained by the fact that in the first month of lockdown there was a huge demands for transportation for people to go back to their homes.

3.2 Centrale Station

The eNodeB closest to Centrale train station, on the other end, shows up a reduction of median throughput of about 25%. This is easily explained by the fact that many local trains where cancelled, and due to lockdown far less people travelled in the underground station below.

3.3 Politecnico di Milano

The neared eNodeB to the Politecnico di Milano University shows us the effects of remote teaching that was established as soon as COVID spread. In fact here we see an impressive -60% of median throughput.

4 Final Considerations

The analysed metrics are clearly able to represent the huge behavioural change that every person had accept when facing lockdown. Many phenomenons, such as the rise of remote working or the suspension of sport events are only partially visible, but none the less the picture that comes out, especially thanks to clustering, is clear and precise.