I Want to Ride my Bicycle: Leveraging Mobike Data to Study Mobility in Padova, Italy

Pietro Rampazzo[*]
Katherine Hoffmann Pham[†]
Francesco Rampazzo[‡]
Francesco Silvestri[§]

Introduction

With the rise of the sharing economy, more and more people are using shared services and goods rather than owning them [Schor, 2016]. In particular, there has been an increase in the sharing of mobility, including shared car services, e-scooter platforms, and bike share systems [Cohen and Kietzmann, 2014]. In this paper, we leverage data from Mobike[1], which is one of the most popular free floating bike sharing (FFBS) systems all over the world. Researchers have already started leveraging car sharing [Boyacı et al., 2015, Ciociola et al., 2017] and FFBS [Weikl and Bogenberger, 2013, Pal and Zhang, 2017] data, but there are still many remaining opportunities to repurpose FFBS data to inform cities in the implementation of bike routes, and identify the types of people who use the service. Focusing on Padova, a mid-size city in northeastern Italy, we present some preliminary results from descriptive analysis of the Mobike data. In addition, we aim to use cluster analysis to study the area in which most of the movements happen, in order to give general information on the characteristics of users.

Mobike and its data

Bike sharing systems can be divided into two categories: docked bike sharing (DBS) and free floating bike sharing (FFBS). In a DBS system, all the bikes offered are located inside a station, while in a FFBS bikes can be parked anywhere since docks are not required. In this study, we use data from Mobike, a Chinese FFBS company operating in over 200 cities in 19 countries [Mobike, 2018]. In Europe, Mobike is used widely in the UK, France, Spain, Germany, and the Netherlands. Mobike is not, however, the only company operating in this field of bikesharing; competitors include: Motivate by Lyft, Jump by Uber, LimeBike and oBike.

Mobike launched its service in Italy in 2017 and it now covers several cities, including Florence, Milan, Turin and, since May 2019, Padova. At this moment Mobike is the most widespread FFBS all over Italy, although some cities like Padova or Milan still have their own public DBS. The data collected from DBS services can only provide the availability of bikes in each dock and bike flows among docks. On the other hand, Mobike can provide more precise data. Mobike rentals are carried out via a mobile phone application, which allows users to lock and unlock a desired bike at an arbitrary location. Therefore, Mobike uses the GPS of users' mobile phones to track the origin, destination, and route of each of its bikes.

Through Padova's Municipality, we have access to a rich Mobike's dataset for the city of Padova. The dataset includes trip-level information on: (1) anonymized user id and rental plan, (2) bike id, (3) origin (latitude, longitude), (4) destination (latitude, longitude), (5) start date and time (timestamp), (6) end date and time

[*]Ca' Foscari University of Venice, Italy
[†]Stern School of Business, New York University, USA
[‡]University of Southampton, UK, and Max Planck Institute for Demographic Research, Germany
[§]University of Padova, Italy
[1]http://www.mobike.com/global/

(timestamp), (7) travel time (minutes), and (8) rounded kilometers traveled. At time of writing, the available data covers all days from May 1st, 2019 to September 30th, 2019.

Padova: our case example

Padova is a city of around 210,000 people[2]. Its morphology makes cycling around the city easy. Moreover, the City Council is investing considerably in public and zero carbon emission transportation. It is home of the *Università degli Studi di Padova*, which enrolls 58,000 students. The presence of tourists is consistent and growing, with more than 1.6 million tourists in 2018.

Objective

The goal of this research is to better understand the mobility of urban cyclists in Padova by leveraging the available Mobike data. Our first objective is to extract patterns that capture cyclists' behavior (e.g., how the number of rentals changes during the day or during a year), and traffic flow (e.g., how bikes move during the day). A second and more challenging objective is to analyze how cycling habits of Paduans change over time. We are indeed in a favorable position since, in the long term, we have access to all rentals starting from the introduction of the FFBS service in Padova. Furthermore, these data will allow us to investigate if the increasing attention of the society on environmental issues will be reflected by increasing bike usage. Population-wise, these data offer an opportunity for demographers as well [Alburez-Gutierrez et al., 2019] to study small area estimation of the population, mobility within a city, and night and day patterns of the population within a city.

Preliminary Analysis

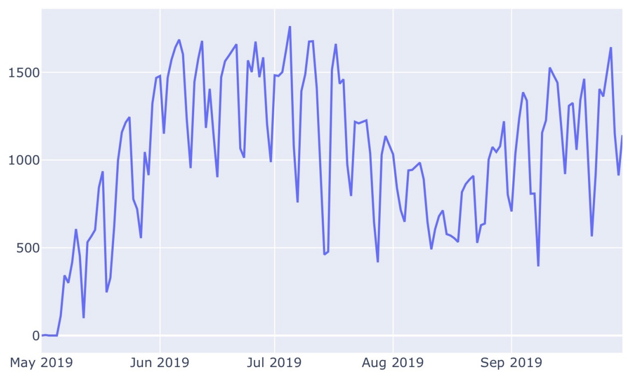
In this section, we present some descriptive findings from the first five months of data. Figure 1a shows a time series of the number of trips from early May to the end of September. From this figure, we can notice the rapid growth in rides at the beginning of May, and the decline in travels in August, when Italians typically go on holidays. The box plot in Figure 1b shows the amount of trips made by day of the week during September 2019, and it includes the median and interquartile ranges. Most of the travels are made during the weekdays (Monday to Friday), and there is a drop during the weekend. On Fridays there is a large amount of variability, but at the same time Friday is the day of the week with the most trips (as opposed to Sunday, which has the least trips). This is an interesting result since the opposite result has been found (in terms of trips on weekdays relative to weekends) in bigger cities than Padova, such as Shanghai and Washington, D.C. [Zhang and Liu, 2018, McKenzie, 2019].

The two heat maps in Figure 2 show the origin and the destination of the travels. They illustrate that most of the travels are to and from the train station and the university areas. This result is even more evident if we plot the data on a circular plot (Figure 3), in which we highlighted the *Train Station* (orange), the *Santo - Portello* - university area (red), and the *Piazze* - city center (green); all other areas of the city are shown in blue. Much of the flows are across the orange, red, and green area, where commuters, university students and employers gravitate.

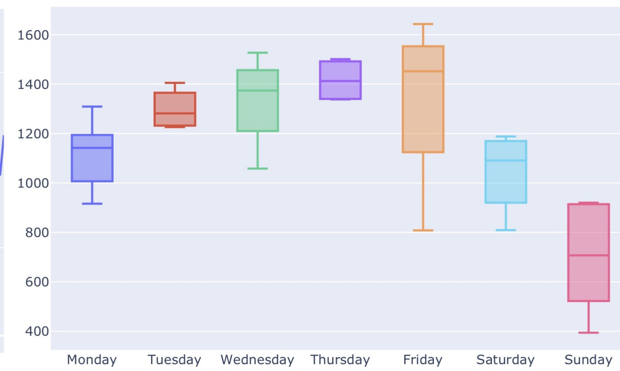
Discussion and next steps

In this abstract, we have presented our preliminary descriptive findings from Mobike data. In future work, we will analyze the data through cluster analysis, which will provide information on the different types of users and their travels around Padova. We aim to identify user types (e.g., commuters, students, tourists) by clustering users according to their most frequent pick-up or drop-off areas. Moreover, heatmaps show bike density in a given time interval in each urban unit: by clustering heatmaps generated every hour or day, we will be able to study bike distribution and infer social dynamics (e.g., university areas, commuting

[2] http://www.padovanet.it/informazione/padova-cifre

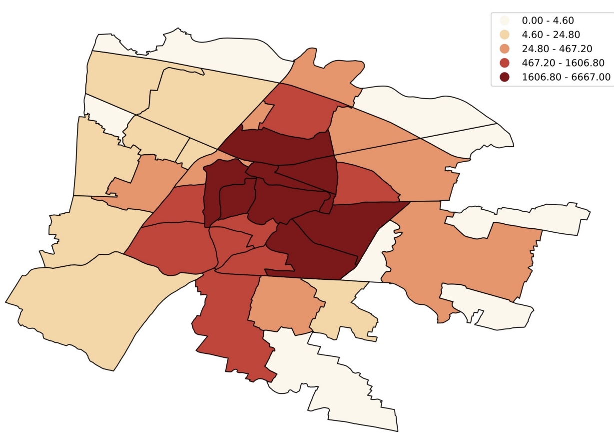


(a) Time Series

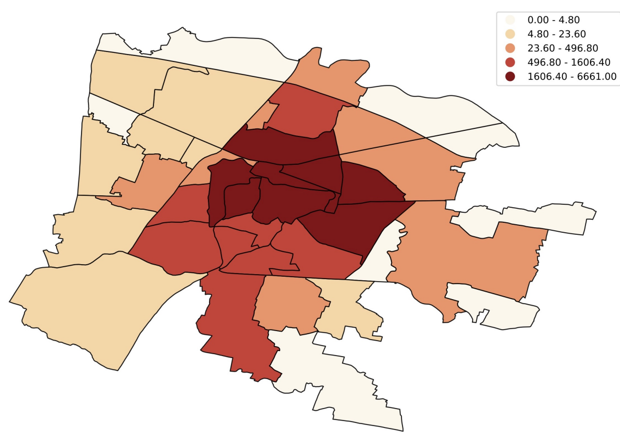


(b) Weekly Box Plot

Figure 1: The two figures show temporal patterns of: (a) trips from the 6th May 2019 to 30th September 2019; (b) trips by day of week during September 2019.



(a) Map Origin



(b) Map Destination

Figure 2: Heatmaps showing the amount of trips started and finished in an urban unit during September 2019.

behaviors,...). Another interesting direction is to analyze how the use of the FFBS service changes over time, for instance by analyzing how clusters evolve. Finally, we remark that our analysis can scale up by using Mobike data from other cities, in order to highlight cultural and social differences in the use of shared mobility.

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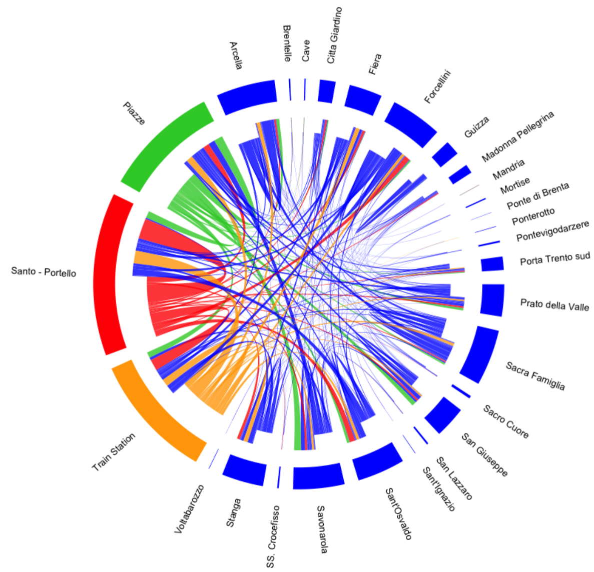

Figure 3: Circular plot of the origin and destination areas of Mobike flows during September 2019.

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