

Study of recharging stations placement for electric car sharing systems

First report

July 1, 2017

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1 Introduction

In this document will be reported the first analisys of car sharig users' patterns. In particular, was created a dataframe wich allows to store all the tracked bookings (and parkings) for both Enjoy and Car2go, from the 17th May 2017, to the 17th June 2017, only for the city of Turin.// Moreover in all the plots, the Red is used to represent all data computed from Enjoy, instead the Blue for Car2go.

2 Valid entries

In first analysis was checked in which day are present entries in terms of booking. More in details, the database was quereid for all the bookings in the date interval. Then the bookigns was gropued per day and for each booking belonging to a given day, a counter for those day was incremented. In fig. 1 is possible to see the days where the crawler worked for Car2go while in fig. 2 the same analysis for Enjoy.

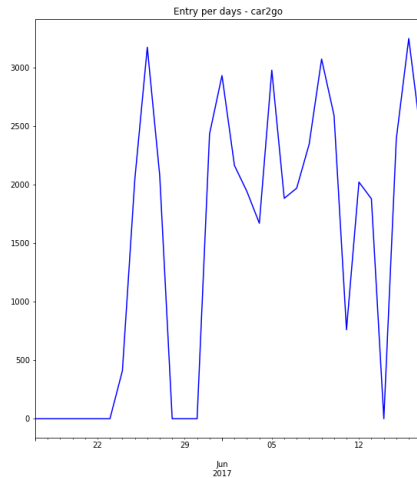


Figure 1: Days in which are present entries for car2go

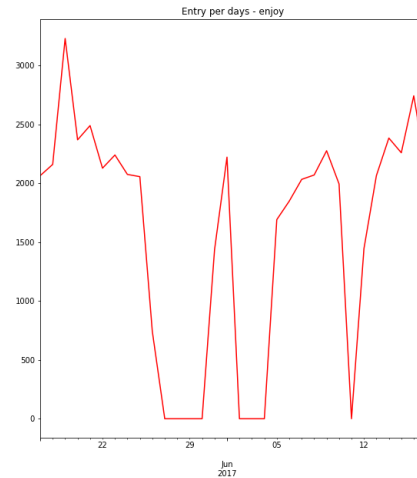


Figure 2: Days in which are present entries for Enjoy

3 Bookings Analysis

Some analysis are performed on both providers, regarding the bookings.

3.1 Total distnaces for each car

First of all, was queired all the permanet bookings in the period, for each provider in Torino. Firstly, was computed the linear distance between the starting and end points cooridnates. Then the car are grouped per plate and finally are summed the total number of kilometers percurred and the numbers of bookings which are ocured for each car. In the following plots, on the x axes are reoprtd the plates, and on the y the kilometers covered by each car. Notice that the car palte are alphabetically sorted.

Total number of cars (fleet size):

- Enjoy 602 cars
- Car2go 395 cars

In fig. 3 is possible to notiche the big amount of outliers for Enjoy(the points on the plot which have zero or few more kilometers).

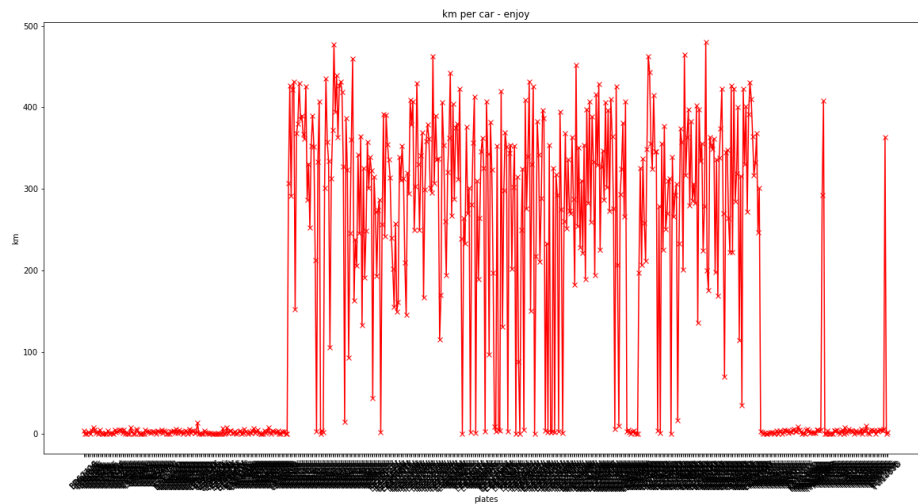


Figure 3: Enjoy, kilometers covered for each car

Instead it is possible to see in fig. 4, the distances for car2go are less affected from the phenomenon of 0km entries.

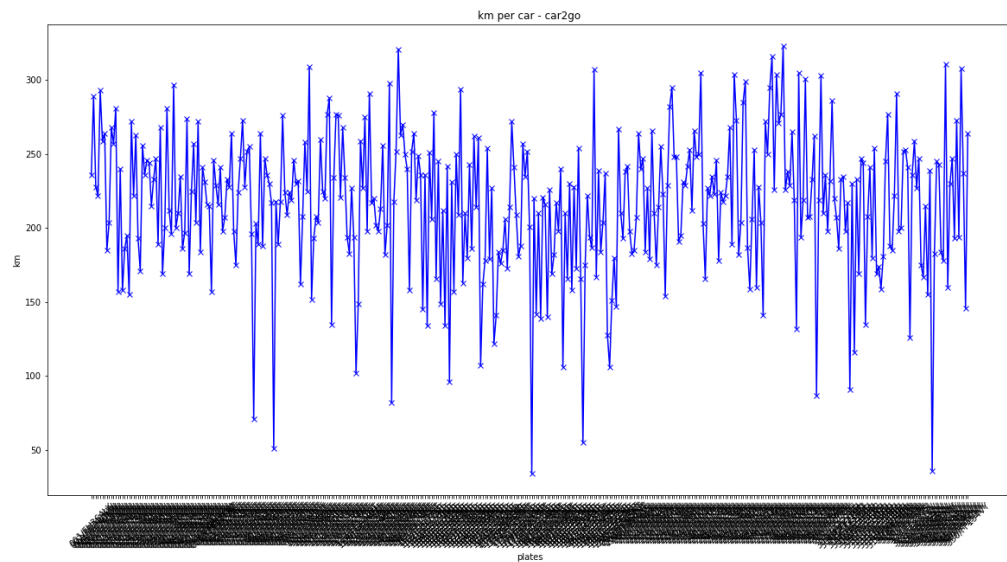


Figure 4: car2go, kilometers covered for each car

3.2 Outliers removing - Enjoy

In order to remove the outliers, the number of bookings for each car is considered.

In the plots on the first row in fig. 5 it is possible to notice how the CDF starts from 42%. This is due to the noise visible in the PDF: there are more than 250 cars which have a total number of covered kilometers around 0km and which correspond to the entries at 0km in the plot in fig. 3. The plots in the second row of fig. 5 are obtained removing from the total entry the cars which are booked more than 1 time and which have covered at least 30km (1 km per day in the considered time interval). By applying this filtering criterion it is possible to notice how the biggest part of noise is removed and a more reasonable CDF and PDF are obtained.

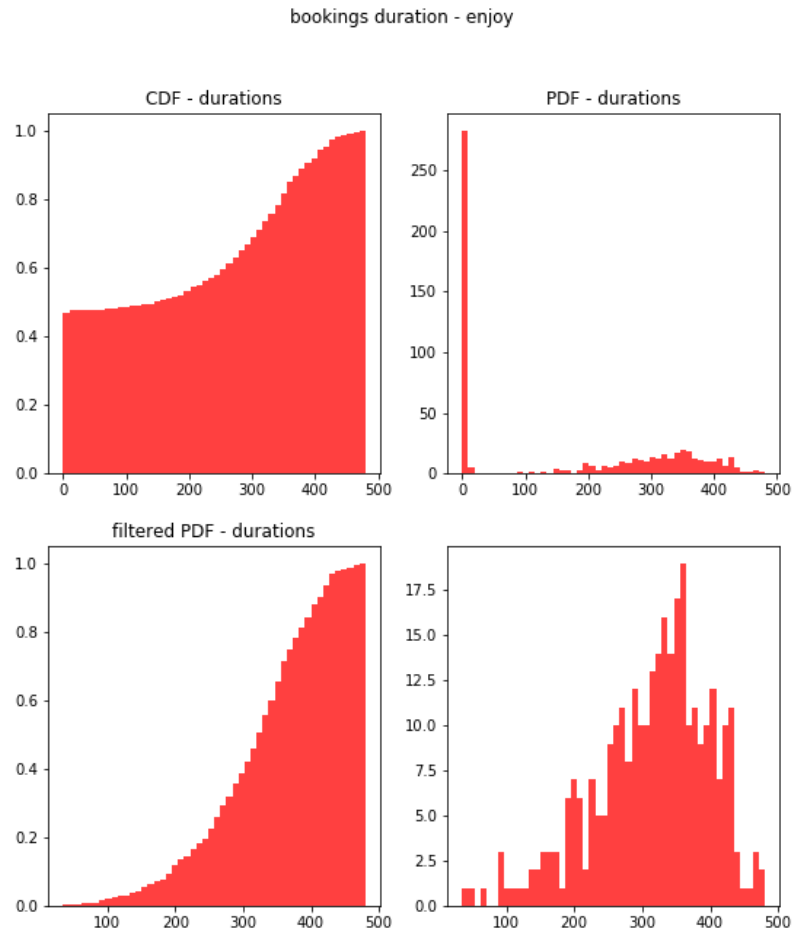


Figure 5: Enjoy, CDF and PDF of distnace

The new enjoy fleet parameters are:

- fleet size: 315 cars
- mean distance: 314 km
- standard deviation: 84 km
- biggest distance: 480 km
- mean bookings per car: 187

3.3 Outliers removing - Car2go

Starting from the plots in fig. 4, through a graphical inspection it is possible to notice that the numbers of outliers in Car2go is lower than Enjoy. It is confirmed also by the plots in fig. 6 where are reported the CDF and PDF for distances in Car2go first filtering (first row) and after filtering (second row): both distributions appear very similar.

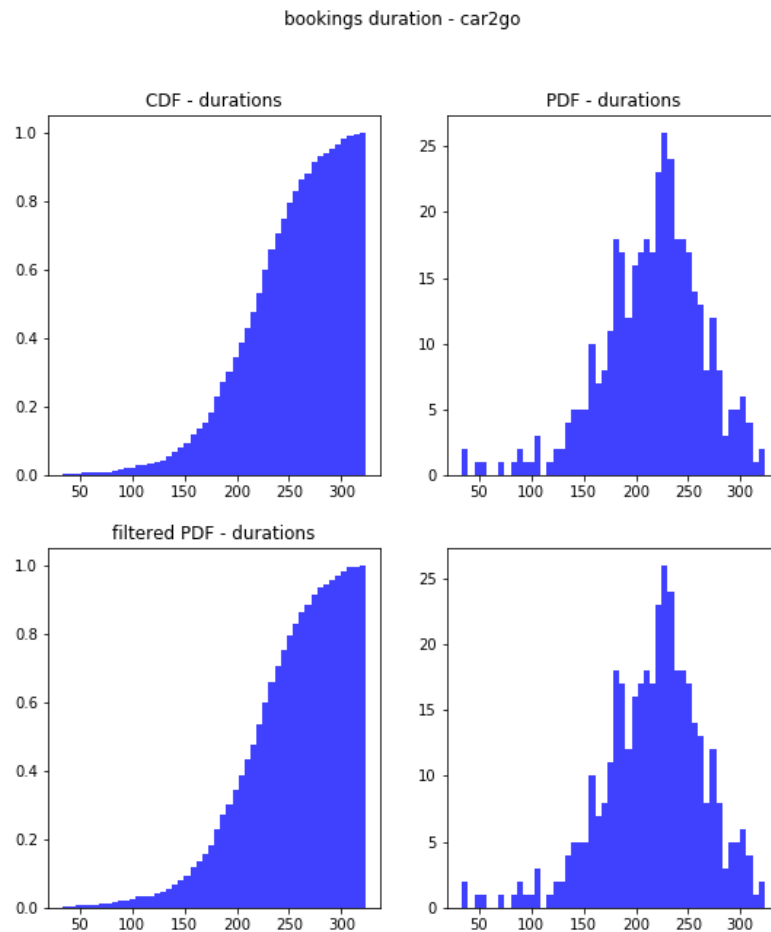


Figure 6: Car2go, CDF and PDF of distance

The new enjoy fleet parameters are:

- fleet size: 395 cars
- mean distance: 216 km
- standard deviation: 48 km
- biggest distance: 323 km
- mean bookings per car: 85

3.4 Fuel consumption

In order to analyse the consumption, to correct dimension both battery and power supply, are analyzed the fuel level of the most booked and most covered distance car for both providers. In general the fuel level is a consistent information, it increases and decreases booking after booking, until it reaches a guard level where the user (or the provider) does the fuel. However, some level steps are apparently inexplicable, but must be kept in mind that the fuel measurement is not so much effective. This is justified by the fact that some consecutive bookings has a fuel level slightly bigger than the end level of previous one.

The following plots present on the x axis a custom booking id generated according to the time stamp, and on the y axes the fuel level.

3.4.1 Enjoy trend

About Enjoy, as showed in the fig. 7, the fuel decreases linearly with the rent id. The big falls which appear are due to very long rents, and in particular the one in the 3rd line is due to a rent last for 10 hours where the car is moved of 2 km, here is possible to think a possible tour.

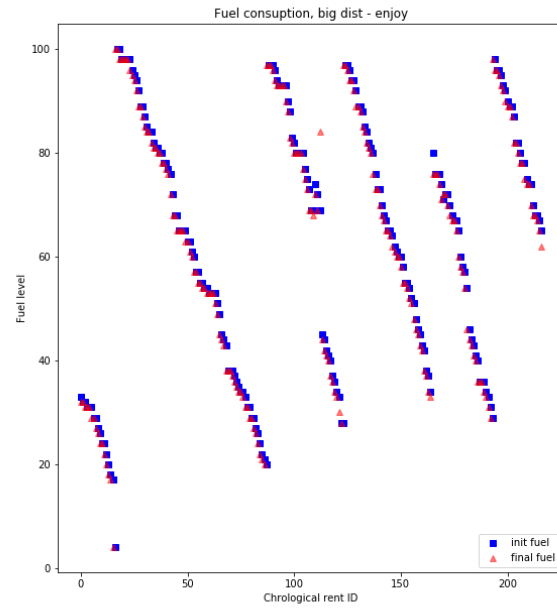


Figure 7: Enjoy, Fuel level of car with more km traveled

In the fig 8, where is persented the fuel trend of the most booked car, there is a similar behavior where even here the big falls are due to long tours.

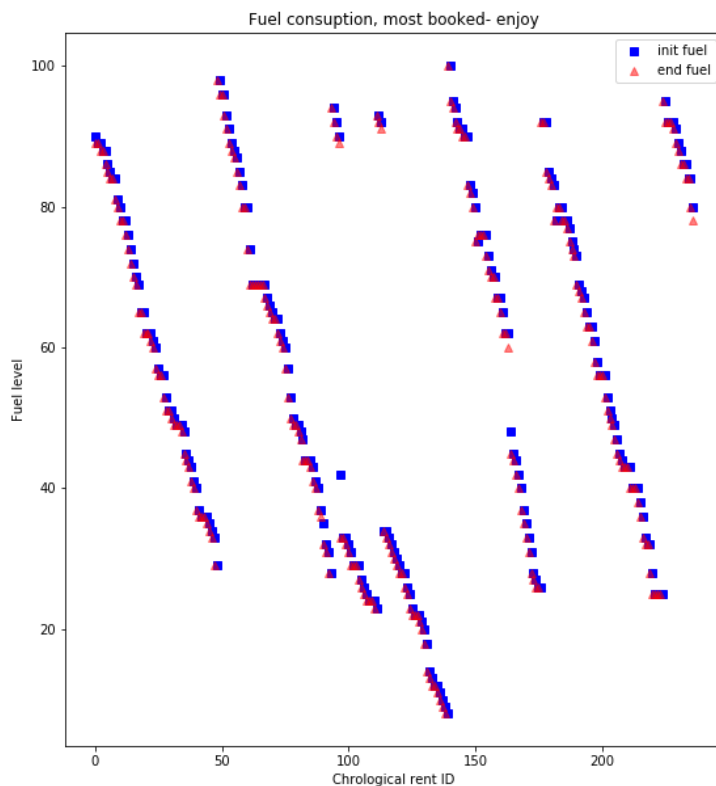


Figure 8: Enjoy, Fuel level of most booked car

3.4.2 Car2go trend

The Car2go most moved car fuel trend, showed in fig. 9 is more regular than Enjoy one. But it is possible to notice another phenomenon: in both graphs there is some points which use same fuel level for more than one bookings id. This is probably due to some GPS failures.

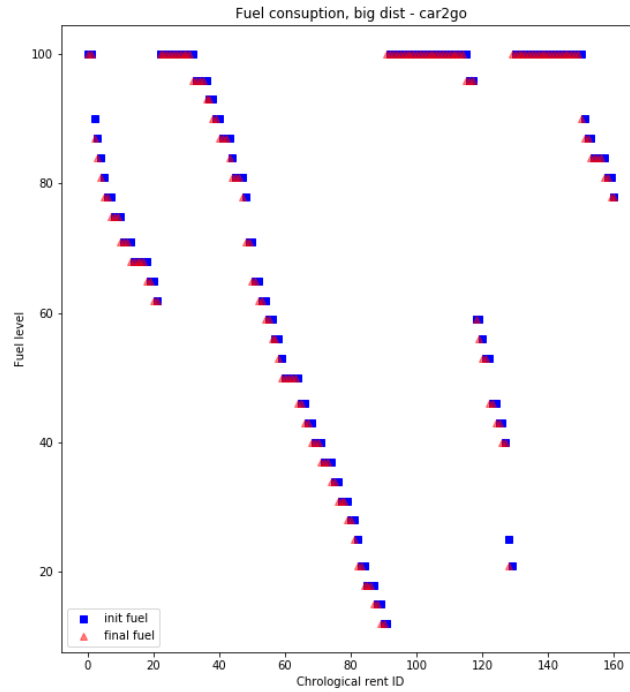


Figure 9: Car2go, Fuel level of car with more km traveled

For the most booked car, in fig. 10 is possible to to do the same considerations.

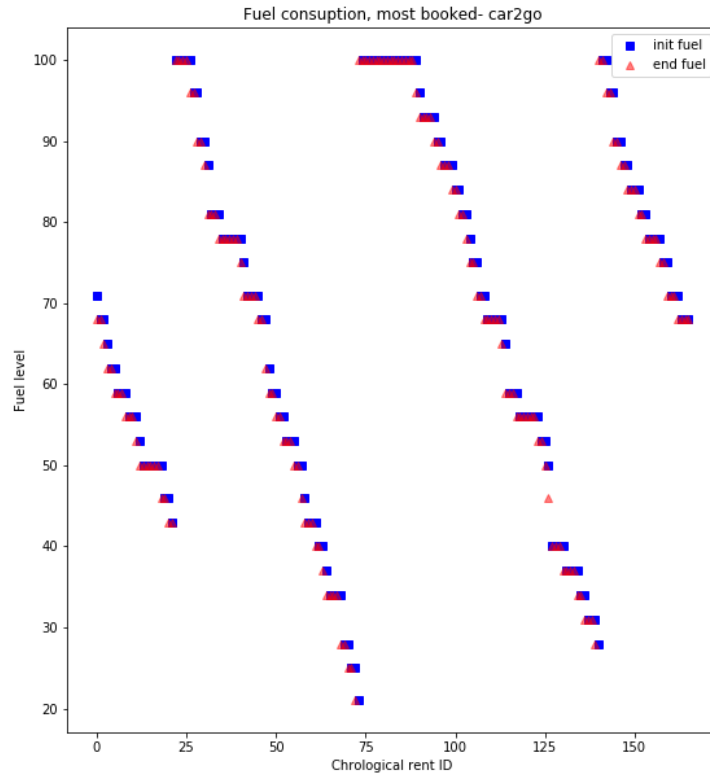


Figure 10: Car2go, Fuel level of most booked car

4 Parkings

To dimension an electric car sharing provider system must be analyzed where the car are will be left by users. Taking the trasnport zonizations, was produced the heatmap of both provider.

The procedure consist in:

- to take all parkings in the period
- to check in which zone the parkings coordinates falls
- to increase the parkings counter for the interested zone

- to plot all the zone which has at least 90 parkings (3 parkings per day considering the whole period)

Please, notice that the Caselle area is not rescaled: all parkings of in the areoport are counted like parkings in all the caselle area, fort this reason in fig. 12 the Caselle area apperas as large as Turin.

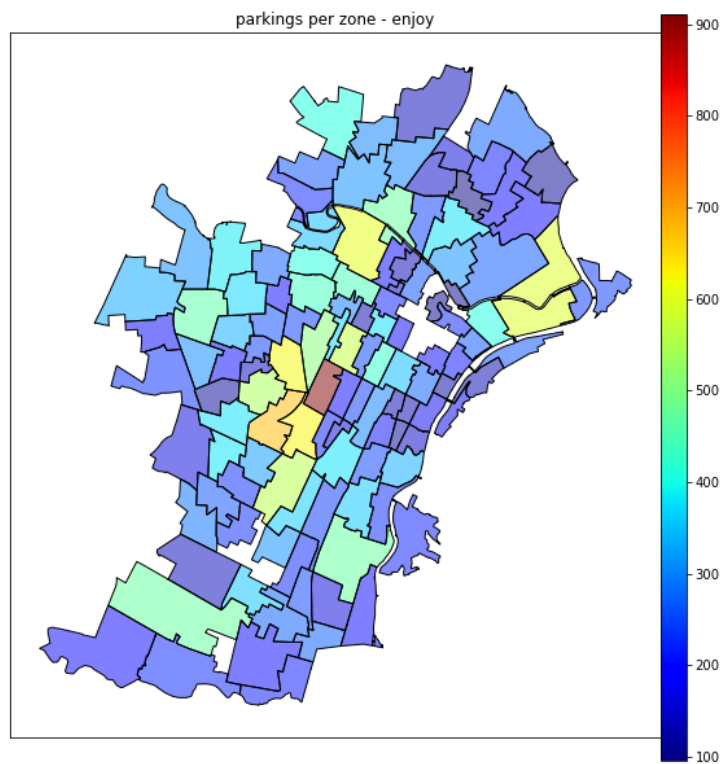


Figure 11: Enjoy, parking heatmap

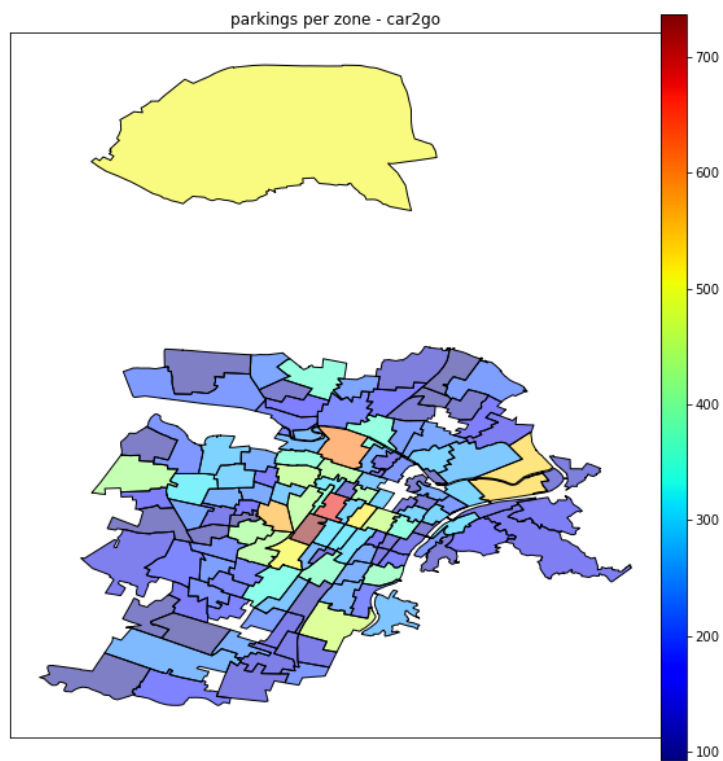


Figure 12: Car2go, Parkings heatmap