



DATA ANALYSIS FOR
MOBILITY

MATHEMATICAL ENGINEERING
APPLIED STATISTICS 2020/21



GROUP MEMBERS



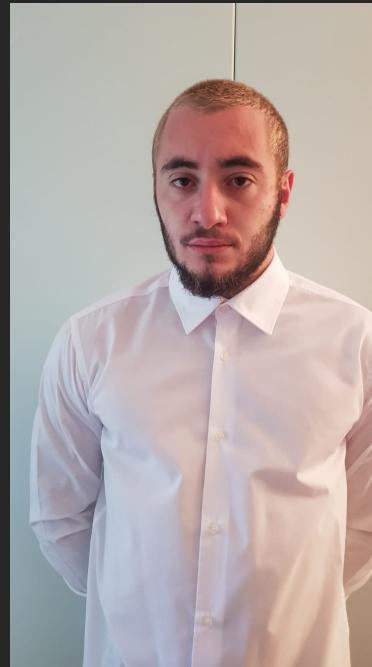
Davide Caffù



Simone Lima



Erica Manfrin



Luca Panzeri



Davide Zaltieri

Tutor: Agostino Torti

DATA COLLECTION: Recap

Athens, Central Business District

10 DRONES

Recording traffic streams over
10 subzones (1.3 km² in total)

MORE THAN 0.5 MILLION TRAJECTORIES

Extracted by means of ML
algorithms

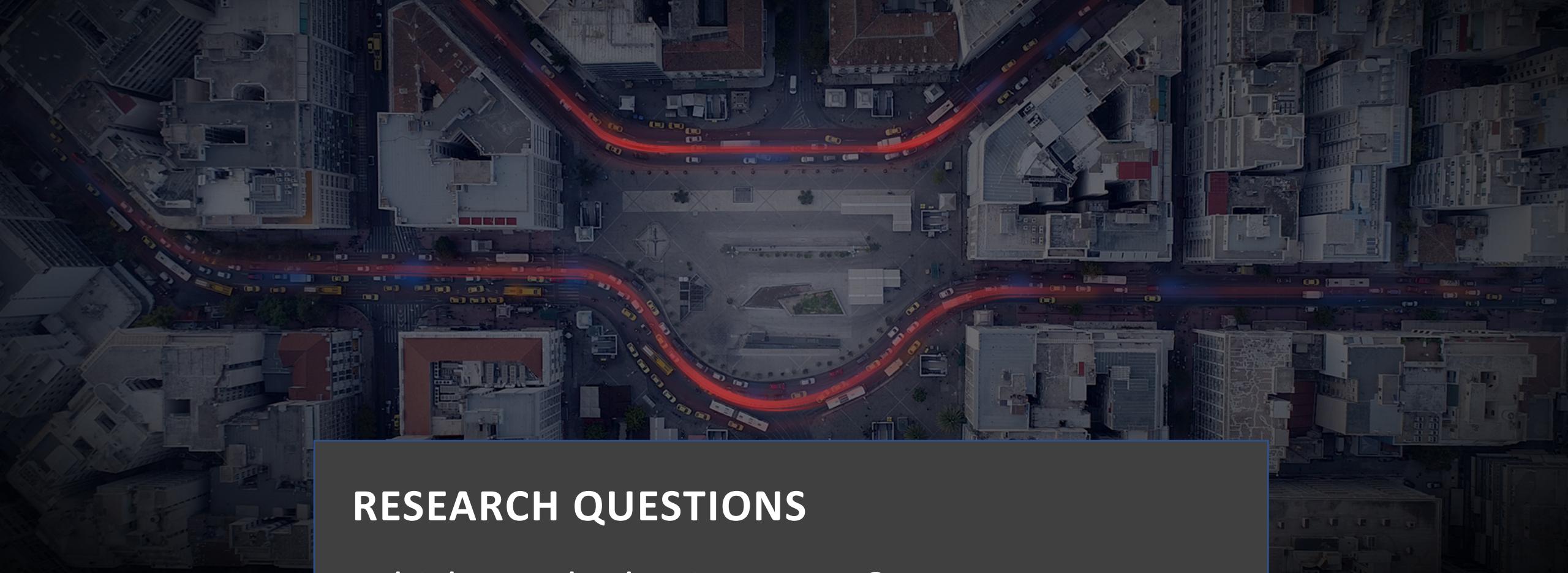
MULTIPLE DAYS

24/10/2018 29/10/2018
30/10/2018 01/11/2018

MULTIPLE TIMES

Slots of 30 minutes:
From 8:30 to 11:00





RESEARCH QUESTIONS

Which are the busiest areas?

Which is the best way to move around the city?

How does the soil conformation affect traffic congestion?

ORIGINAL DATASET STRUCTURE: Recap

Statistical unit:

4 UNIQUE VARIABLES IDENTIFYING A VEHICLE:

'track_id', 'type', 'traveled_d' [m], 'avg_speed' [km/h]

6 REPEATED VARIABLES CORRESPONDING TO AN OBSERVATION FOR THE GIVEN VEHICLE:

'lat', 'lon', 'speed [km/h]', 'lon_acc [m/s²]' ,
'lat_acc [m/s²]', 'time [s]'

6 types of vehicle: Car, Taxi, Bus, Medium Vehicle, Heavy Vehicle, Motorcycle.



track_id	type	traveled_d	avg_speed	lat	lon	speed	lon_acc	lat_acc	time	V11	V12	V13	V14	V15	V16
1	Car	48.85	9.770344	37.97739	23.73769	4.9178	0.0518	-0.0299	0	37.97739	23.73769	4.9207	-0.0124	-0.0354	0.04
2	Motorcycle	98.09	19.839417	37.97764	23.73740	16.9759	-0.0361	-0.0228	0	37.97764	23.73740	16.9739	0.0087	-0.0262	0.04
3	Motorcycle	63.80	18.228752	37.97800	23.73726	20.1906	-0.0795	-0.3395	0	37.97799	23.73727	20.1862	0.0191	-0.3887	0.04
4	Motorcycle	145.72	26.229014	37.97814	23.73707	2.7555	-0.0302	0.0948	0	37.97814	23.73707	2.7538	0.0072	0.1052	0.04
5	Motorcycle	138.01	24.841425	37.97813	23.73710	0.0000	0.0000	0.0000	0	37.97813	23.73710	0.0000	0.0000	0.0000	0.04

DATA PREPARATION: From Trajectories to Graph



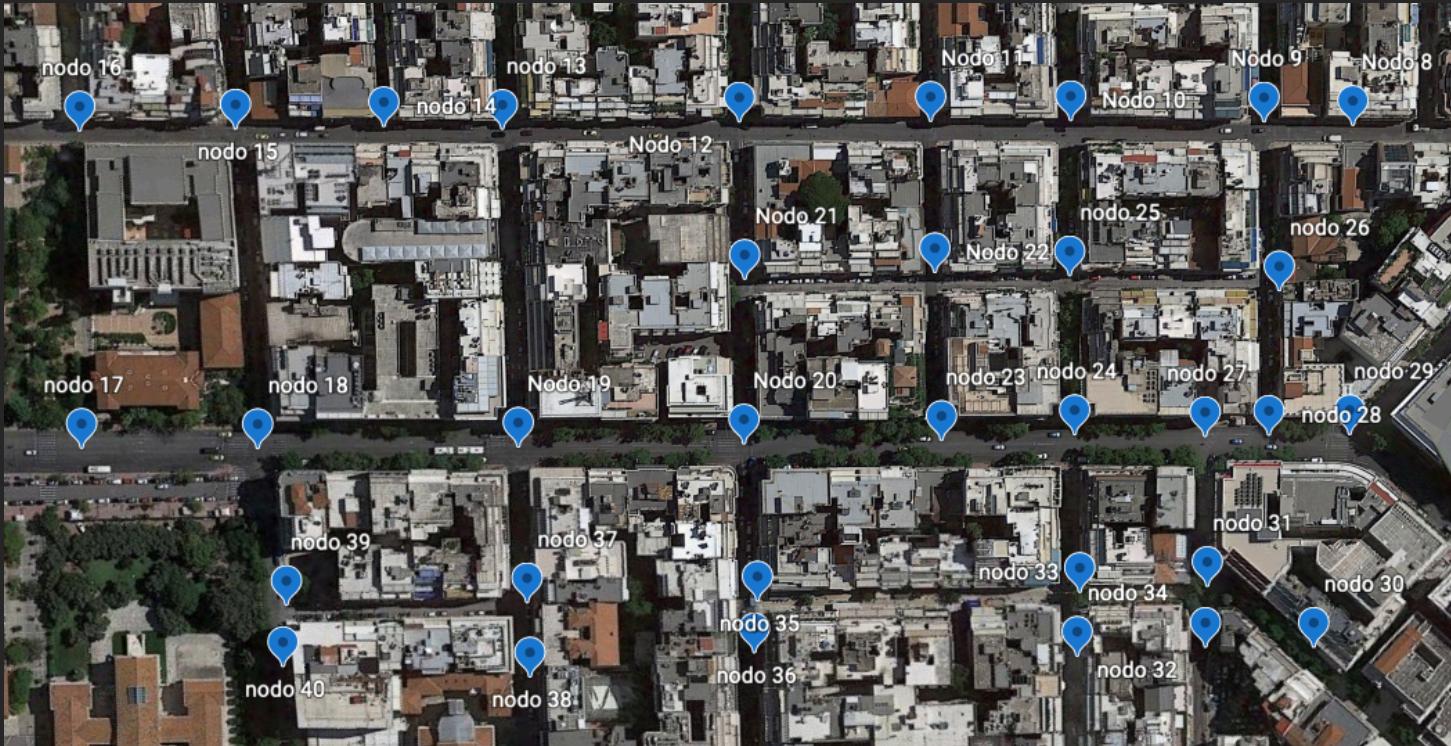
maps.stamen.com via ggmap library

DATA PREPARATION: From Trajectories to Graph



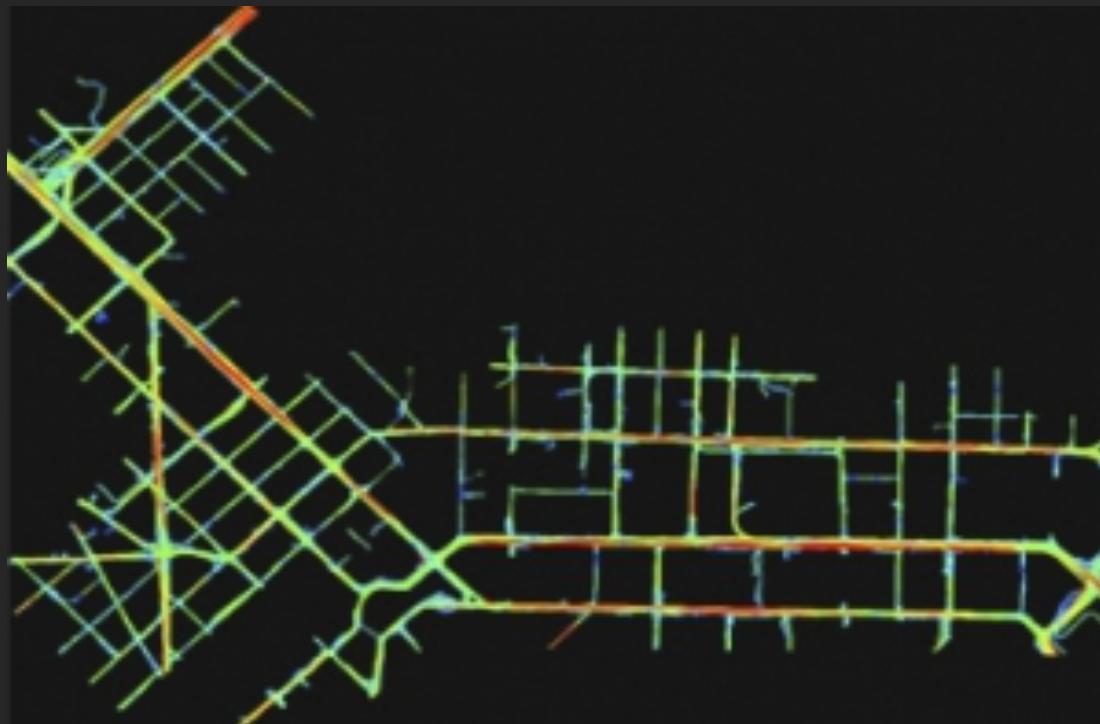
Google Earth - From roads to polygons
Polygons design and coordinates
extraction via KML files, handled by
libraries *sp* and *sf* on R

DATA PREPARATION: From Trajectories to Graph



Library *igraph* - Graph construction
Intersections as uniquely numerated nodes;
Each road identified by means of the nodes
at the end

DATA PREPARATION: From Trajectories to Graph



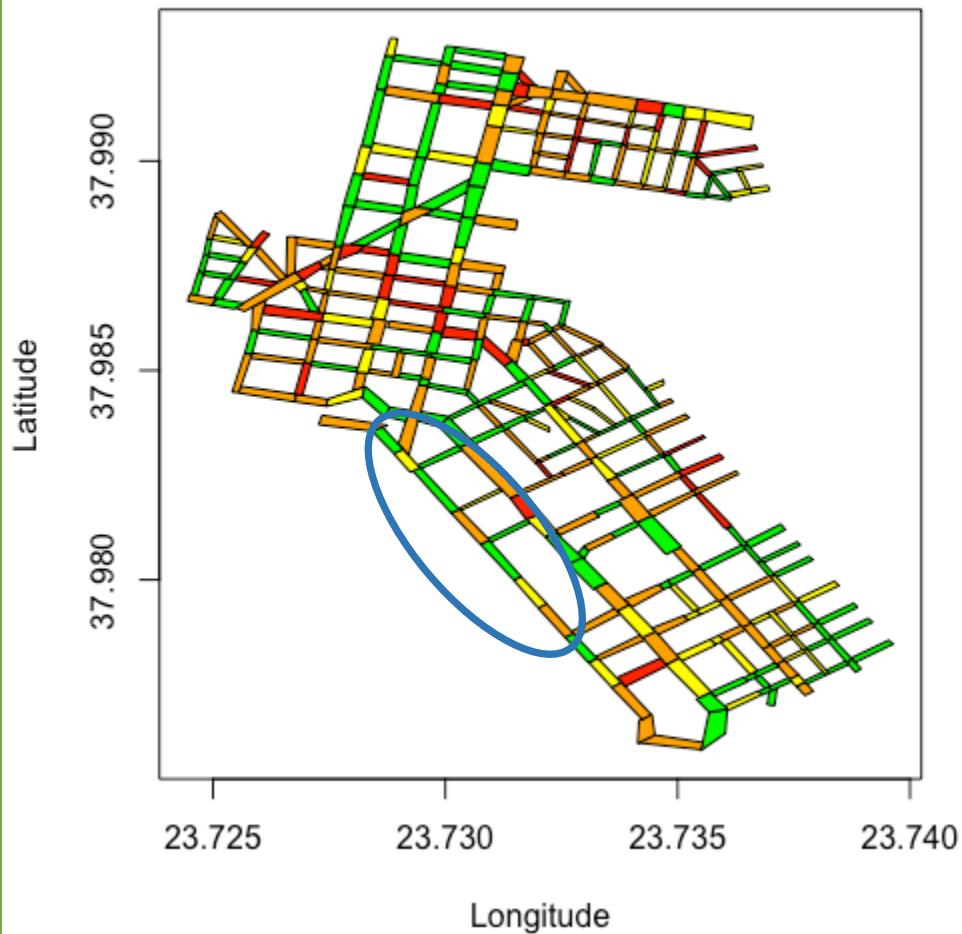
Weights assignment

$$w = \frac{\text{number of vehicles observations}}{\text{vehicles mean speed over the road}}$$

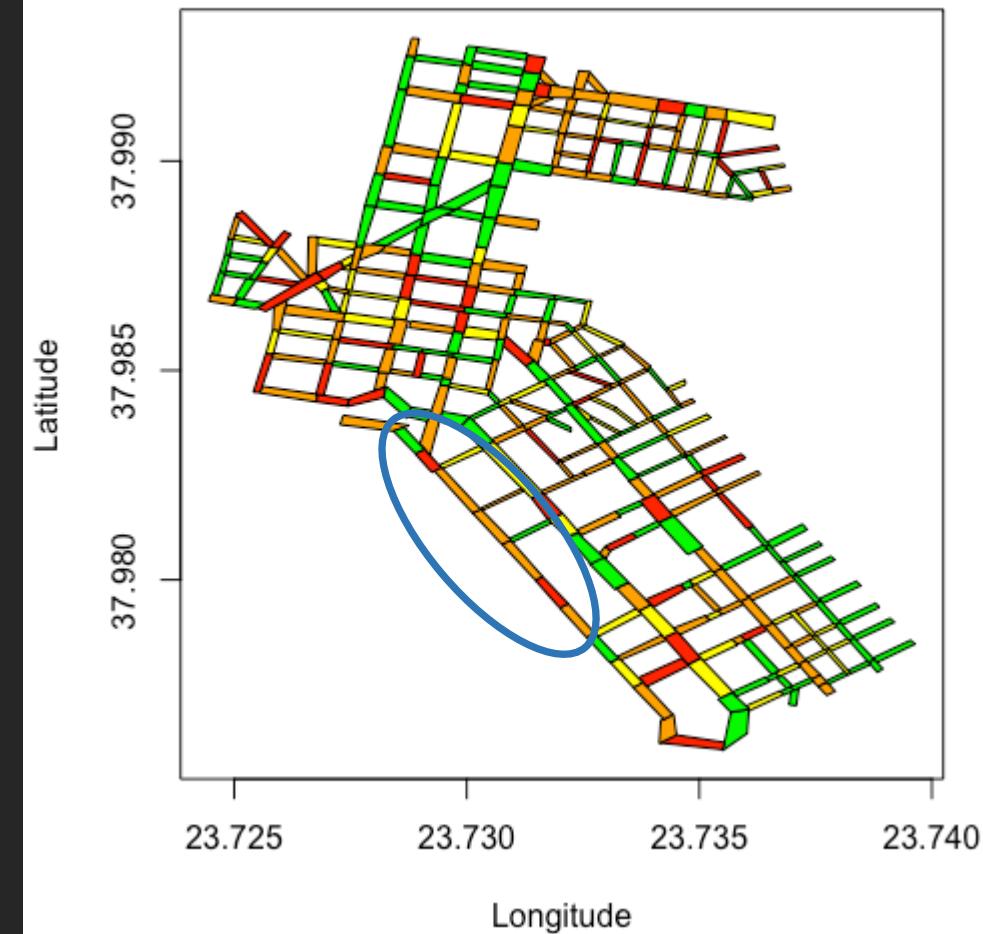
$$\text{color} = \begin{cases} \text{red,} & w \geq 1000 \\ \text{orange,} & 100 \leq w < 1000 \\ \text{yellow,} & 10 \leq w < 100 \\ \text{green,} & 0 \leq w < 10 \end{cases}$$

TRAFFIC MAPS

Day 24/10/18 - Time 08:30-09:00

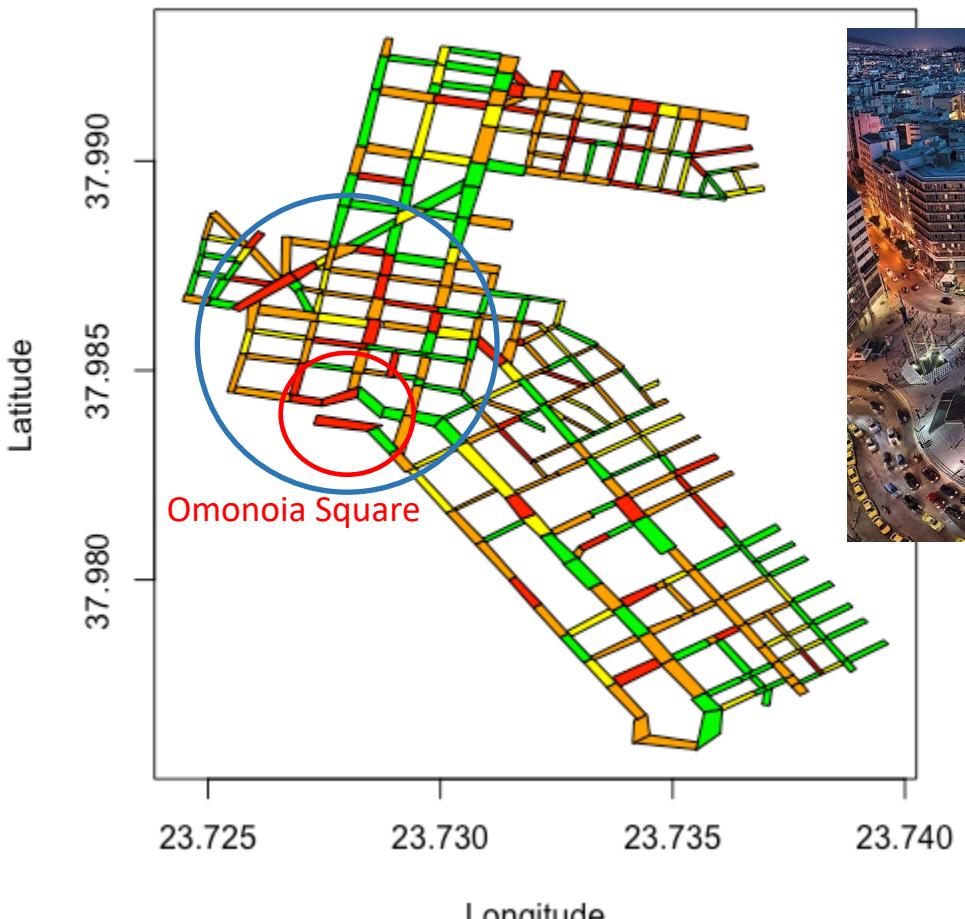


Day 24/10/18 - Time 09:00-09:30

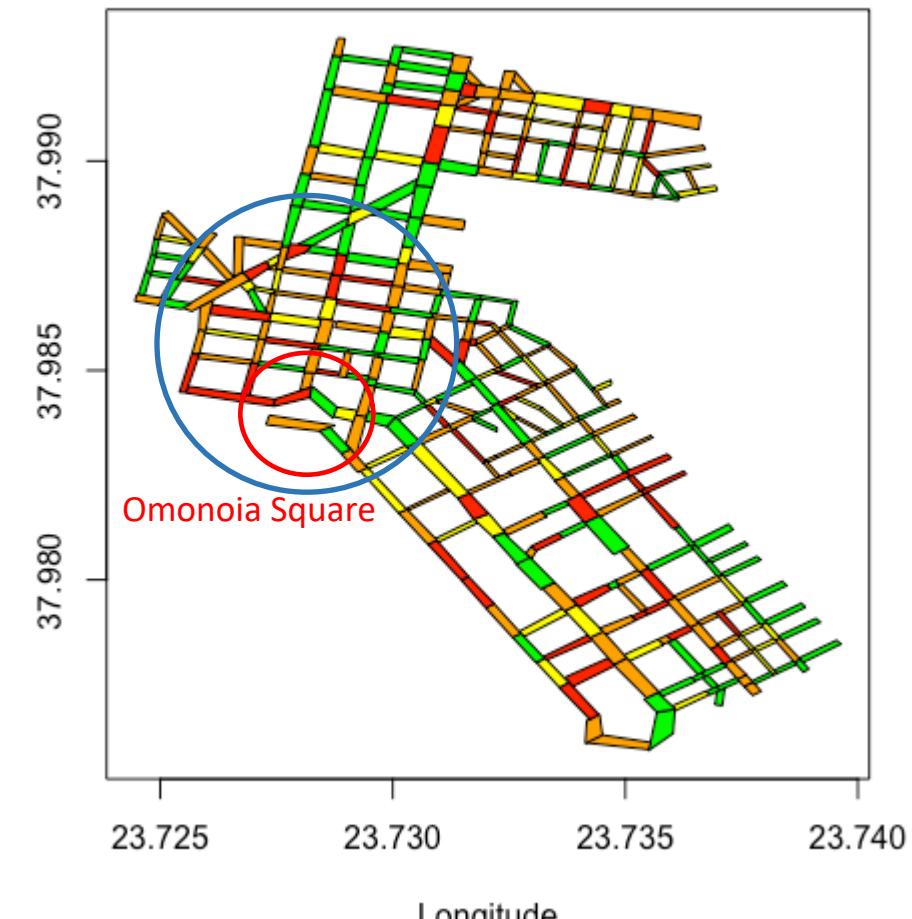


TRAFFIC MAPS

Day 24/10/18 - Time 09:30-10:00

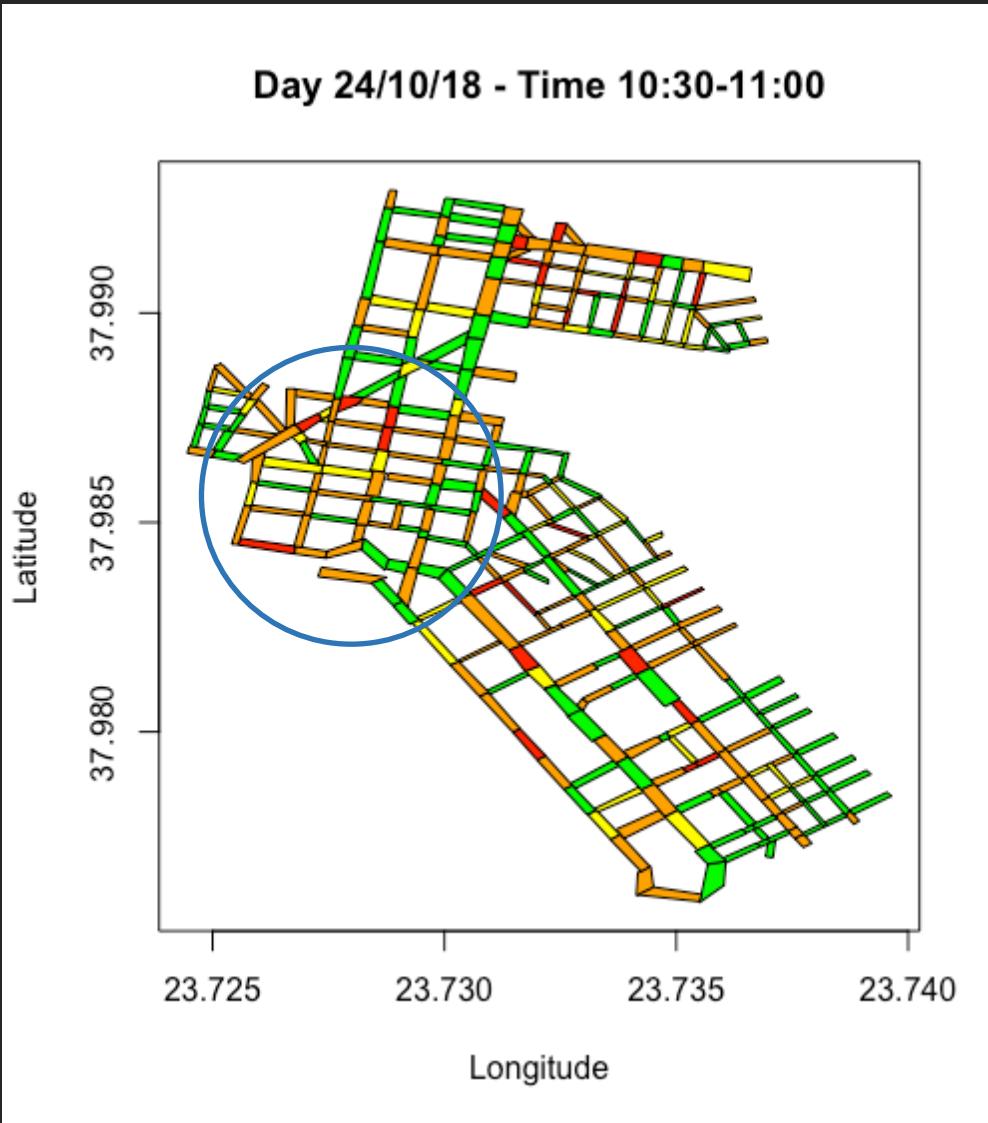


Day 24/10/18 - Time 10:00-10:30



TRAFFIC MAPS

Day 24/10/18 - Time 10:30-11:00

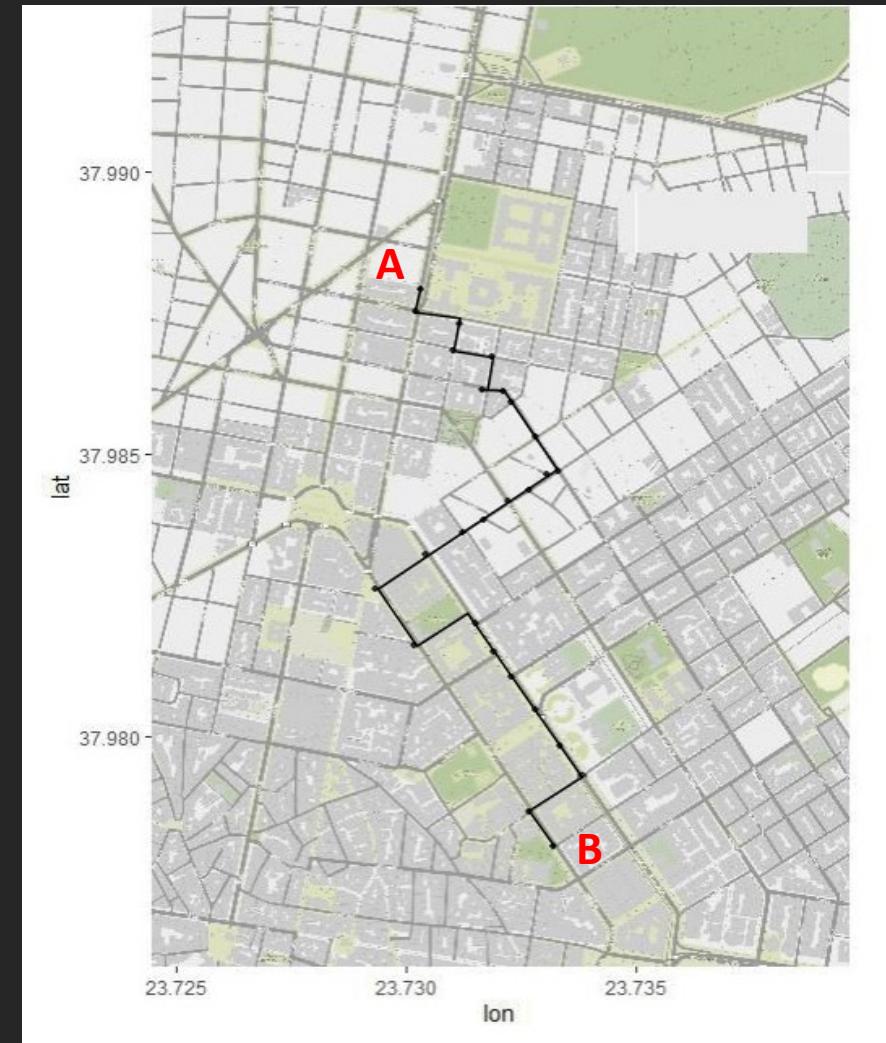
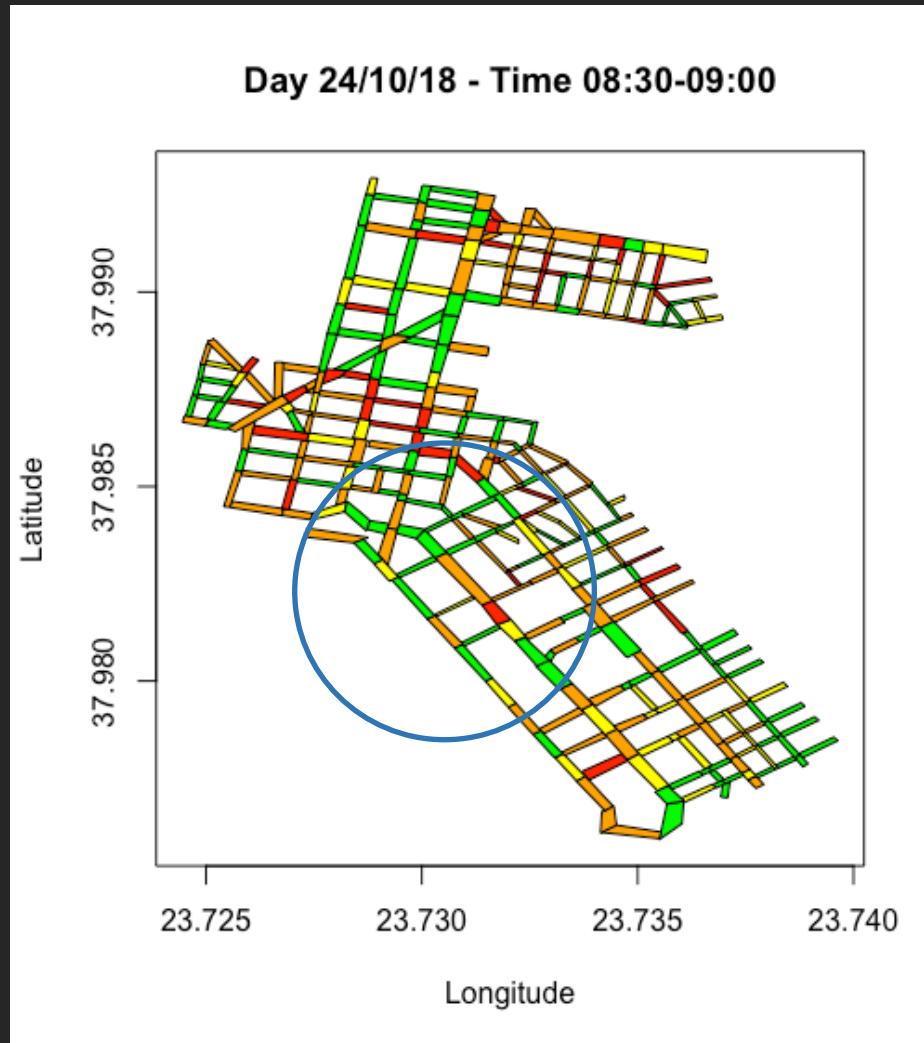


Percentages of road colours

	GREEN	YELLOW	ORANGE	RED
8:30 – 9:00	35.71%	17.14%	35.42%	11.71%
9:00 – 9:30	32.57%	17.14%	35.71%	14.57%
9:30 – 10:00	31.71%	15.71%	37.14%	15.43%
10:00 – 10:30	31.43%	16.28%	36.28%	16.29%
10:30 – 11:00	37.14%	15.43%	40.00%	7.43%

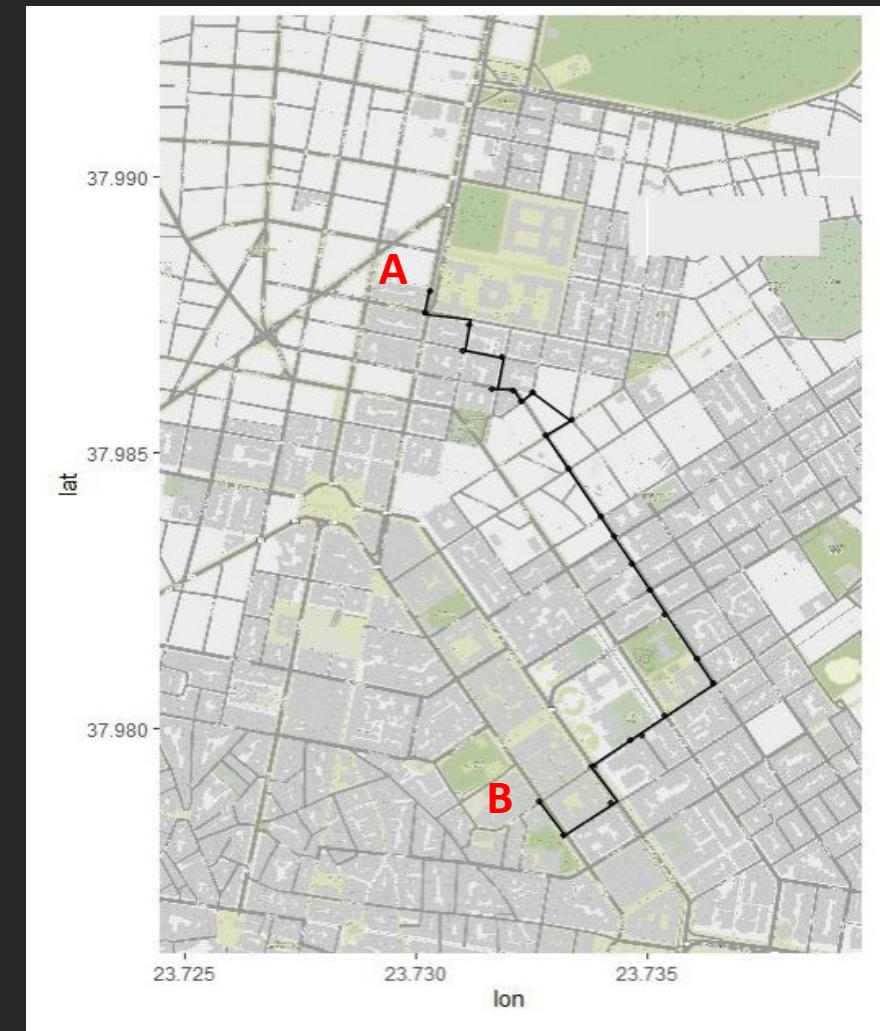
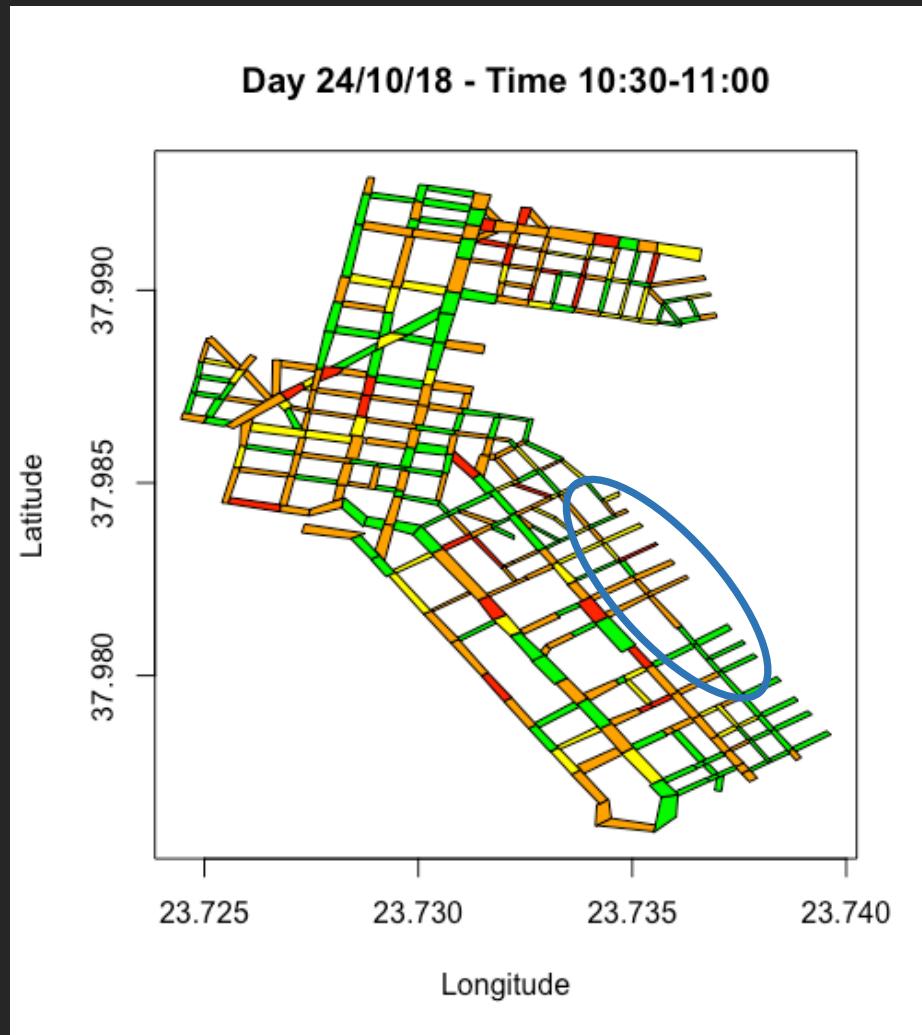
SHORTEST PATH: An Example

A: National Technical University of Athens -> B: National Library of Athens

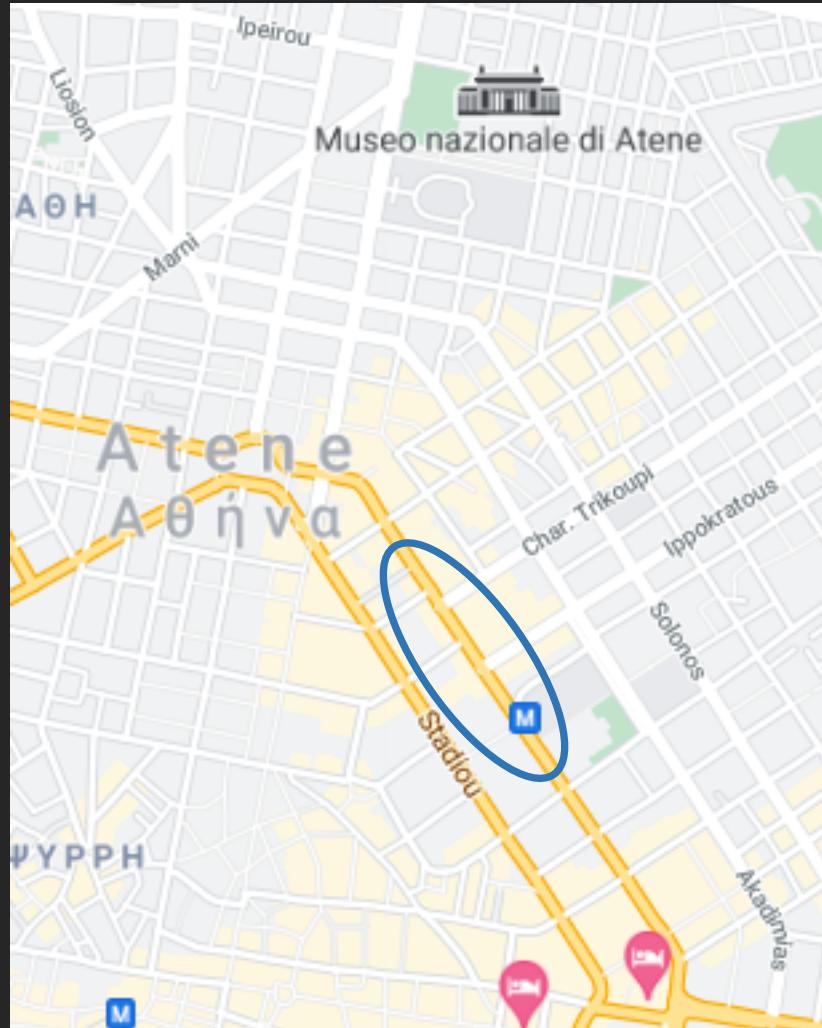


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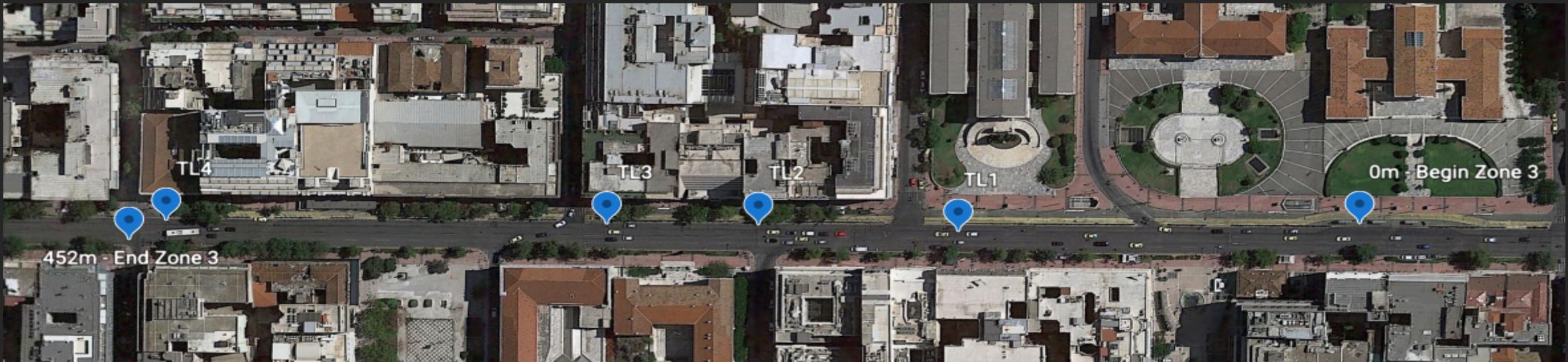
FDA – Speed Trends and Traffic Lights locations



Zone 3: 5 lanes road controlled by several traffic lights

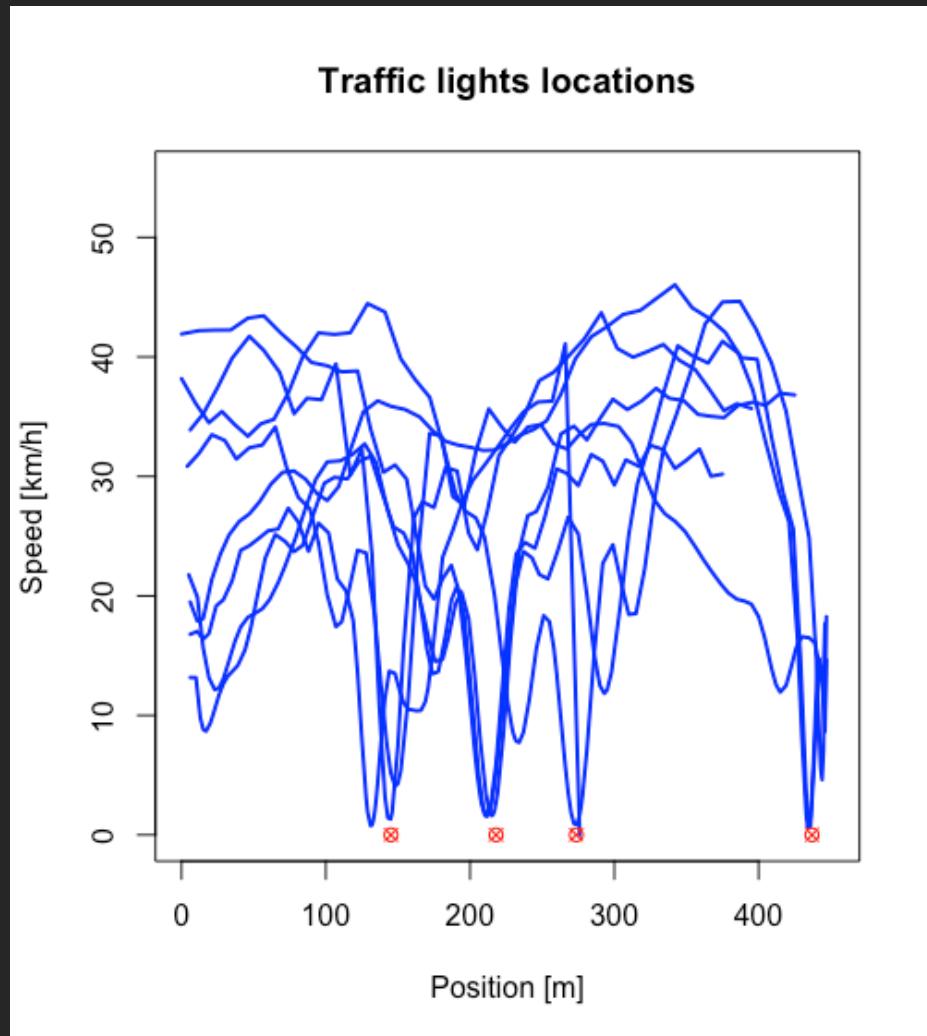


FDA – Speed Trends and Traffic Lights locations



Coordinates of traffic lights located on the considered road extracted via Google Earth and exported via KML file

FDA – Speed Trends and Traffic Lights locations



Function domain

An arbitrary zero is set at the beginning of the part of the road contained in our zone 3 and the other extreme is located 452 meters far from it
(Haversine distance for lat-lon coordinates has been used)

Bspline Smoothing

Traffic Lights locations

Extracted coordinates fall where some vehicles speed goes to zero

Conclusion

It is possible to identify road features from trajectory data

CONCLUSIONS



From trajectories to networks

- More general view with traffic maps
- Easy optimal paths

Trajectory functional data

- Traffic elements identification

RESOURCES

pNEUMA | open-traffic – An open data initiative

<https://open-traffic.epfl.ch>

Google Earth

<https://www.google.it/earth>

ggmap: Spatial Visualization with ggplot2

<https://cran.r-project.org/web/packages/ggmap>

igraph: Network Analysis and Visualization

<https://cran.r-project.org/web/packages/igraph>

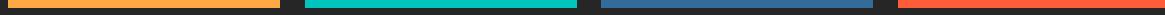
sp: Classes and Methods for Spatial Data

<https://cran.r-project.org/web/packages/sp>

sf: Simple Features for R

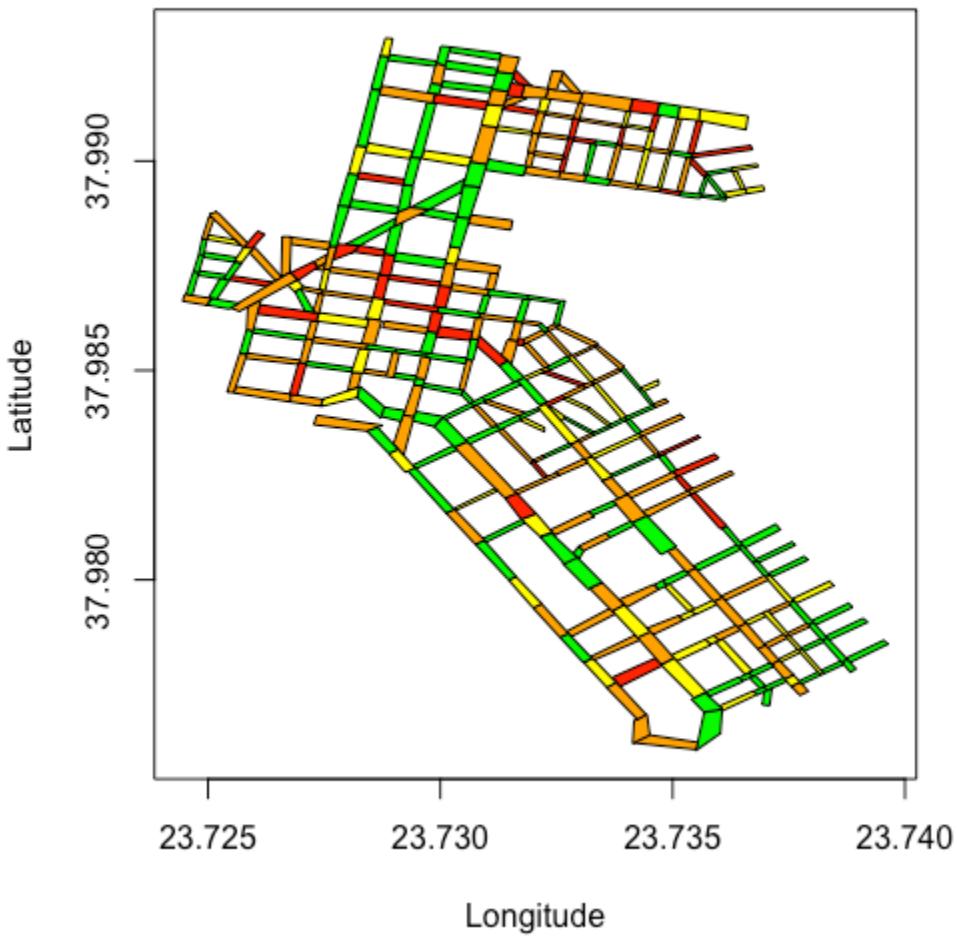
<https://cran.r-project.org/web/packages/sf>

APPENDIX



TRAFFIC MAPS: Different Days (Wednesday - Thursday)

Day 24/10/18 - Time 08:30-09:00



Day 01/11/18 - Time 08:30-09:00

