International Workshop on Challenges and Visions in the Social Sciences

Models and tools for the analysis of human behaviour in third generation metropolis

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Abstract

The continuous modern metropolis increase makes the problem of governance a crucial task for the sustainability and the life quality. Recent empirical observations, have shown that the city pace scales with population size differently than in biological systems. **Only continuous innovation can sustain the growth.** Under this point of view, urban mobility is a crucial and paradigmatic problem due to the intrinsic limitation in the transportation networks offer. A mobility governance based on the individual demand, is needed both to optimize the use of the existent mobility networks and to plan for future transportation facilities.

To face the problem

- we consider the spatial **network** obtaining a urban dynamic **space-time**;
- we model the urban systems in terms of **chronotopoi**, i.e. the prime agents of temporal dynamics;
- we examine the **citizens as** free will elementary **components**, endowed with individual propensities and social characteristics, perception properties, e.g. vision, and **able to process information**.

This is our virtual city on which we develop a mobility model and an e-governance system.

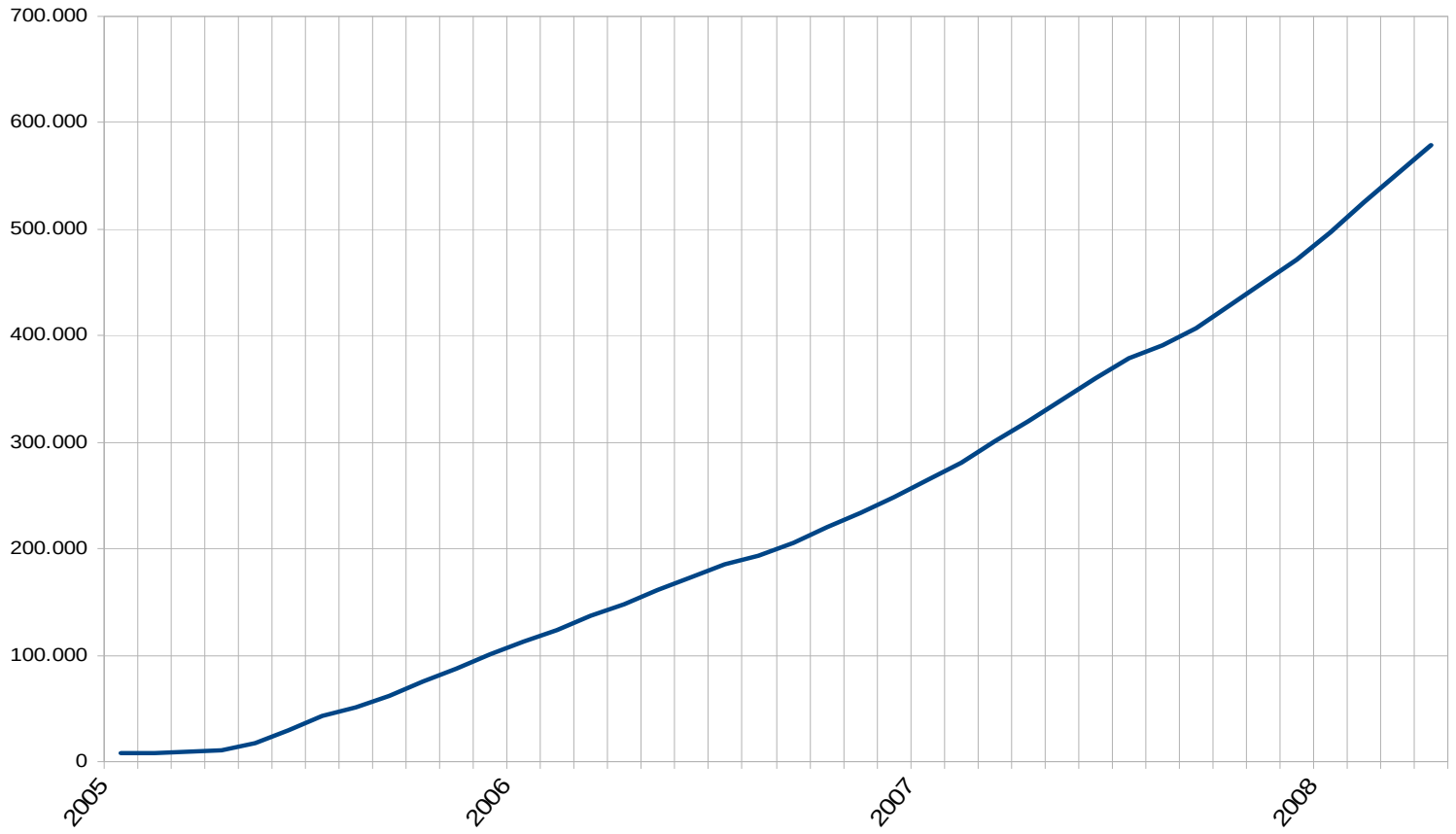
Why now

The new information technologies allow direct measures of individual behaviour in the city, opening the possibility of building this new class of models for simulating urban mobility. In Italy 2% of vehicles population has a GPS system, mounted for insurance reasons, that gives information on position and velocity with a frequency rate sufficient to reconstruct the individual trajectories. This means a direct time-dependent measure of the individual mobility demand on a significant population sample.

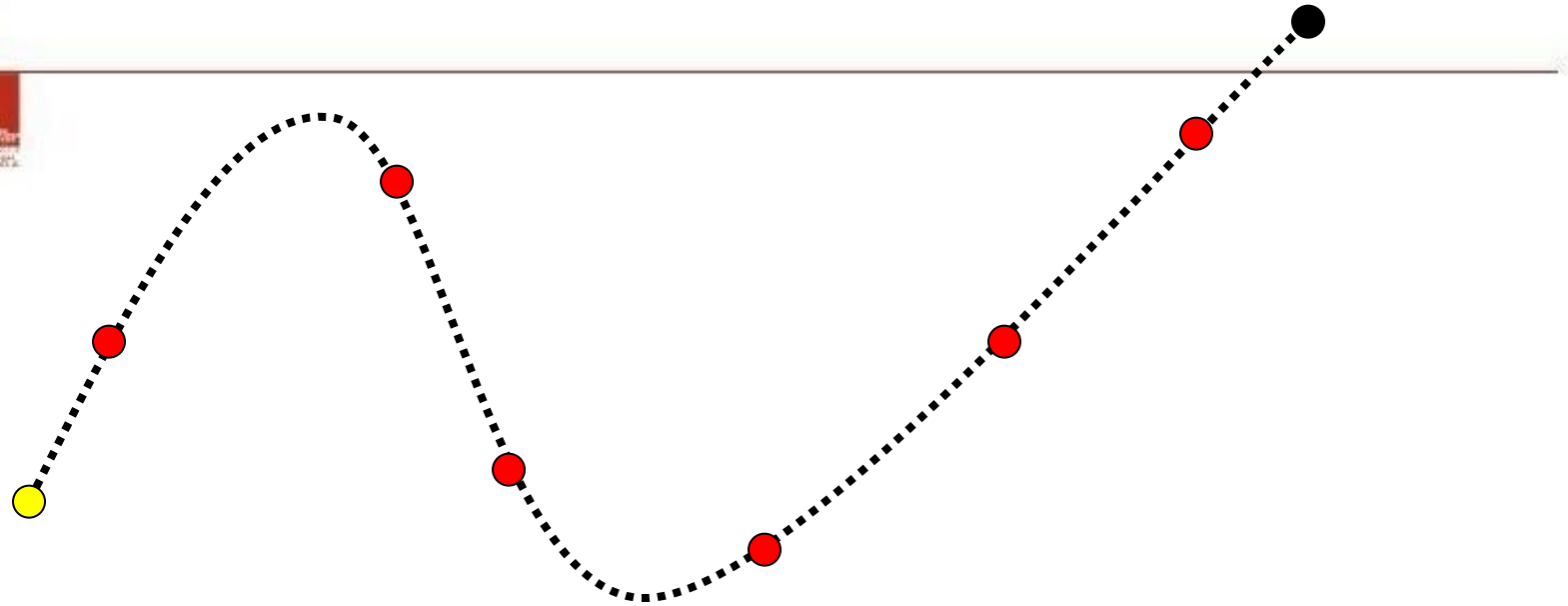
We have analyzed these data for different Italian cities (Bologna, Roma, Torino and Genova) both looking for statistical laws and for a theory for the individual mobility behaviour.

In this context our aim is to define a complex mobility model, where the self-organized and critical states can be described in a cognitive intentional dynamics framework.

Number of OCTOTelematics mobile terminals

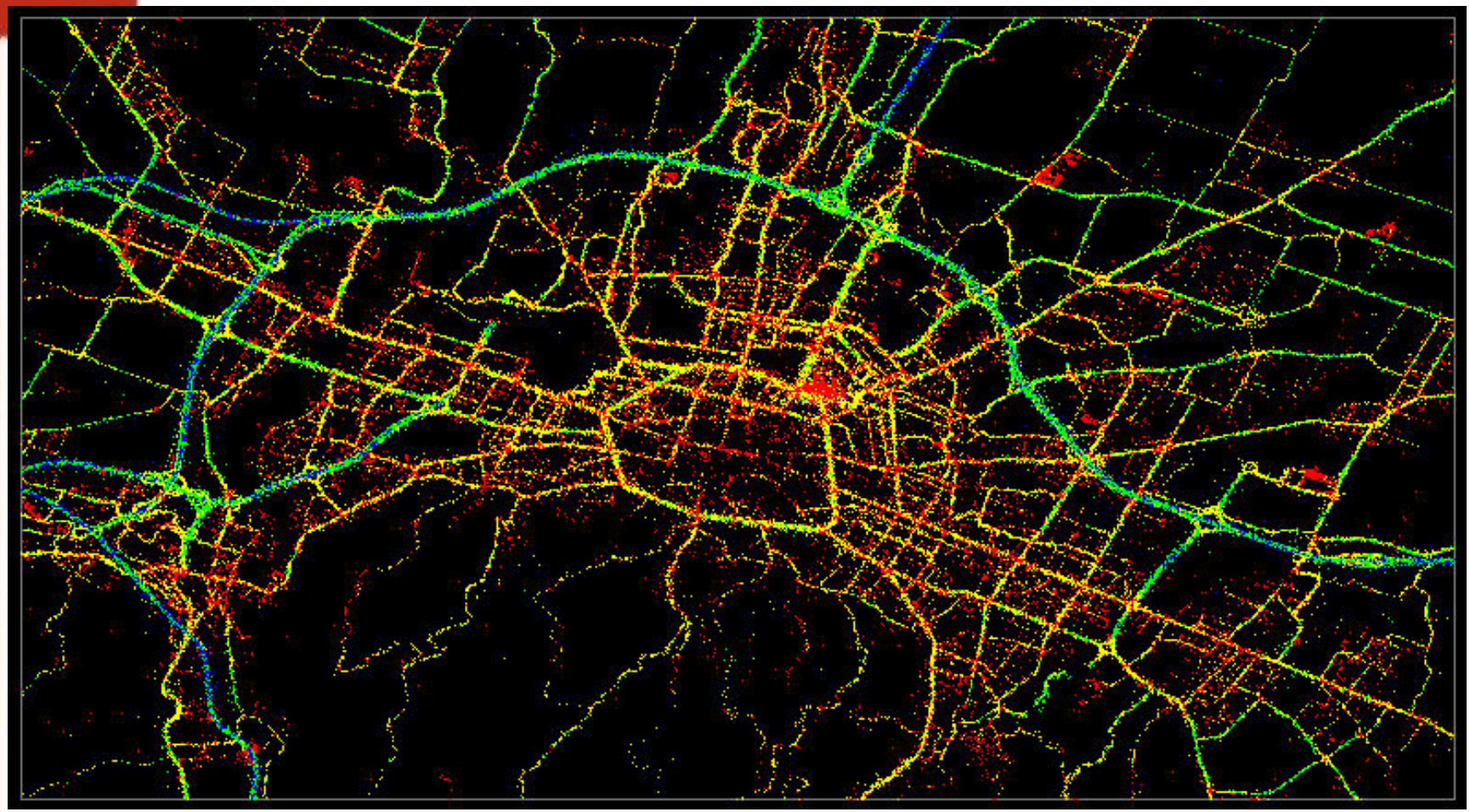


GPS data

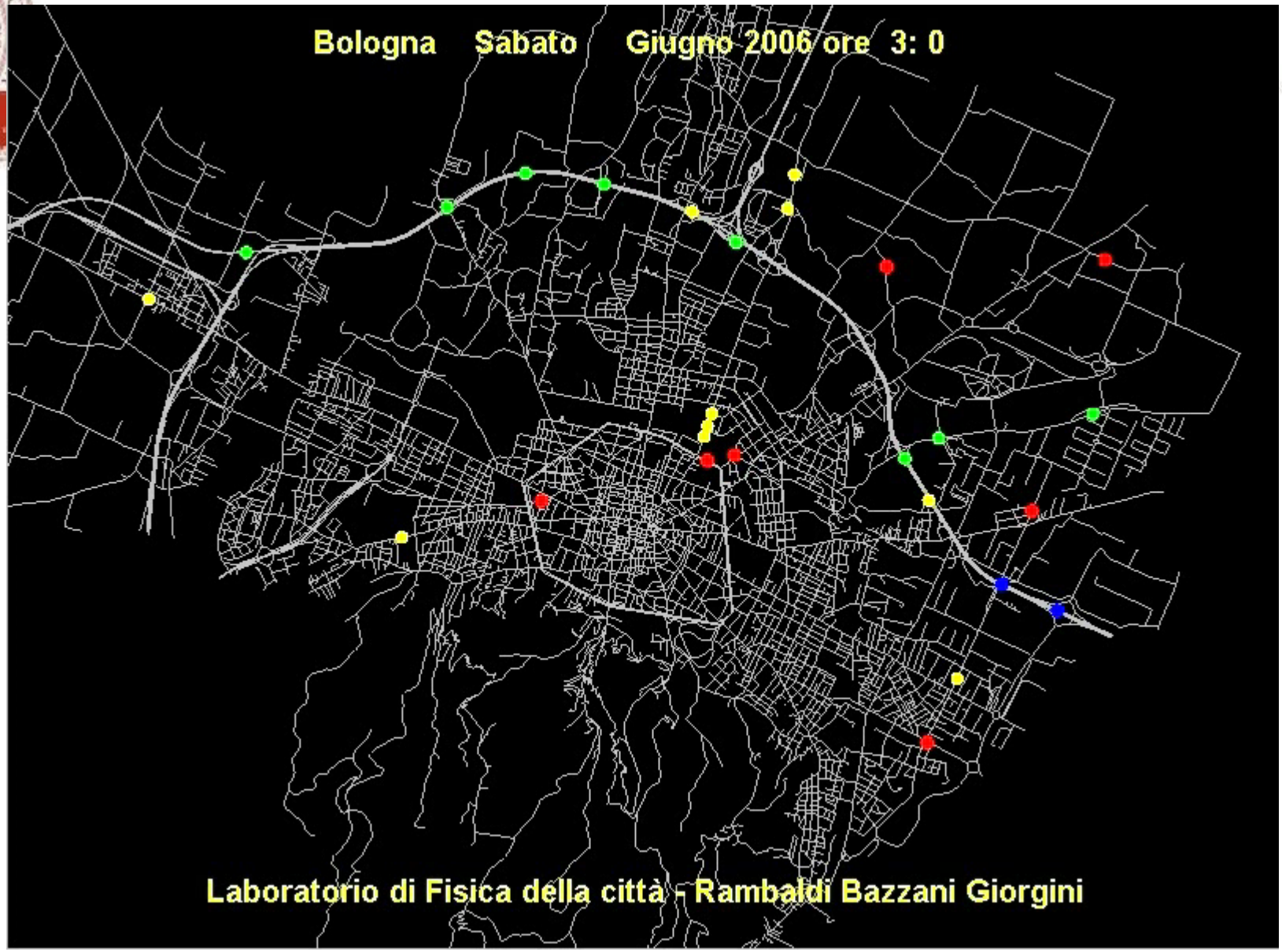


	latitude	longitude	speed	direction	distance	quality	engine
●	last	last	0	no	no	low	on
●	yes	yes	yes	yes	yes	high	run
●	yes	yes	0	no	yes	high	off

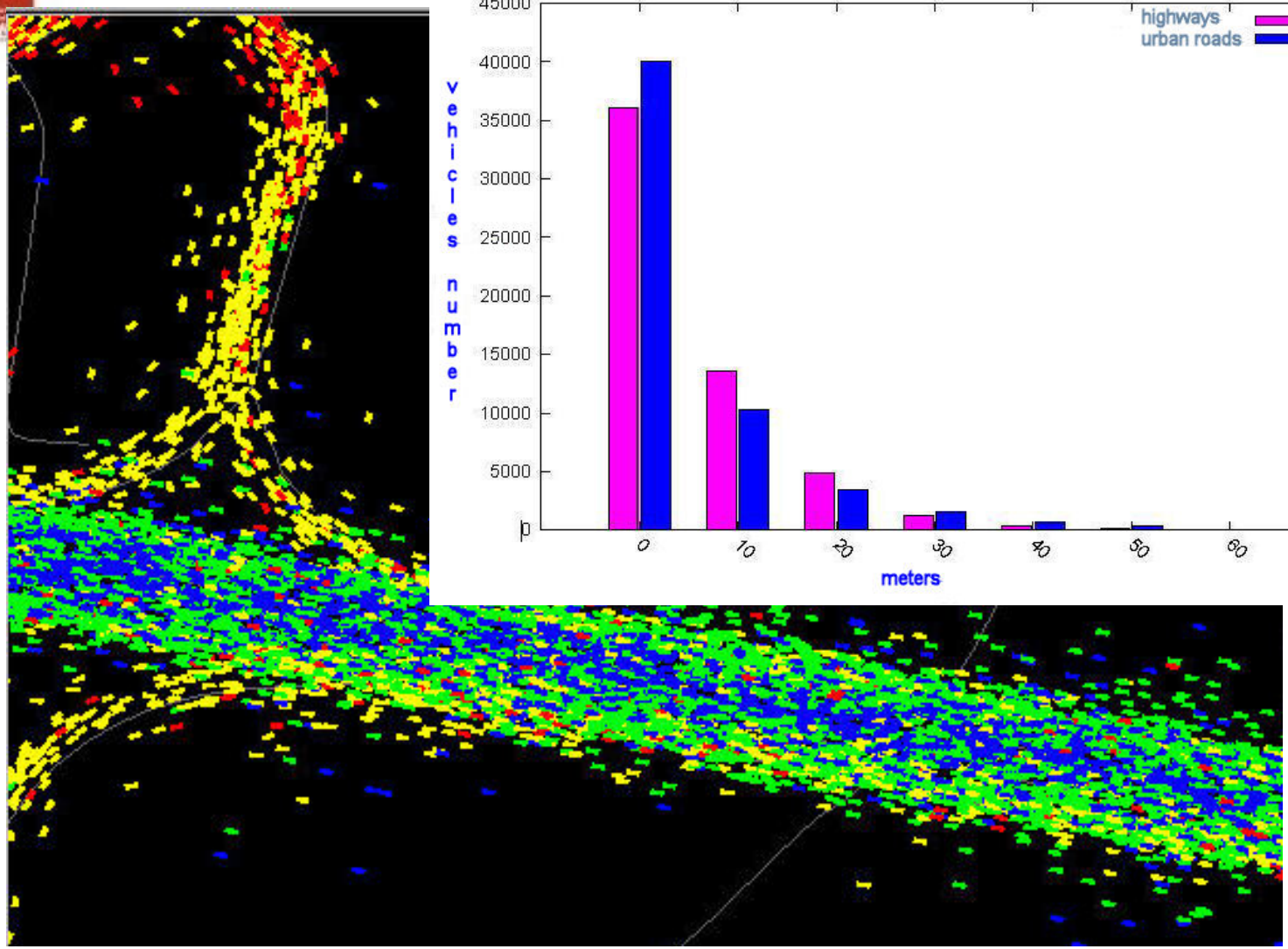
June 2006 Bologna Gps data



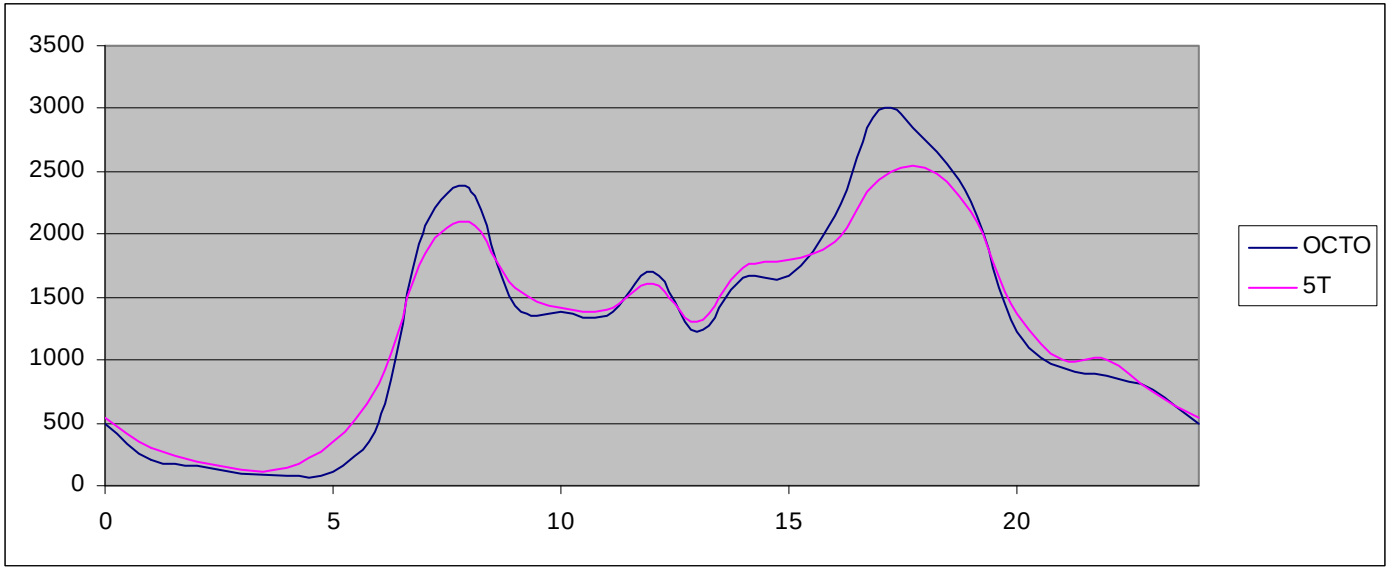
Data by OctoTelematics srl


Bologna Sabato Giugno 2006 ore 3: 0
Laboratorio di Fisica della città - Rambaldi Bazzani Giorgini

Space error -> 10 meters Time error -> none



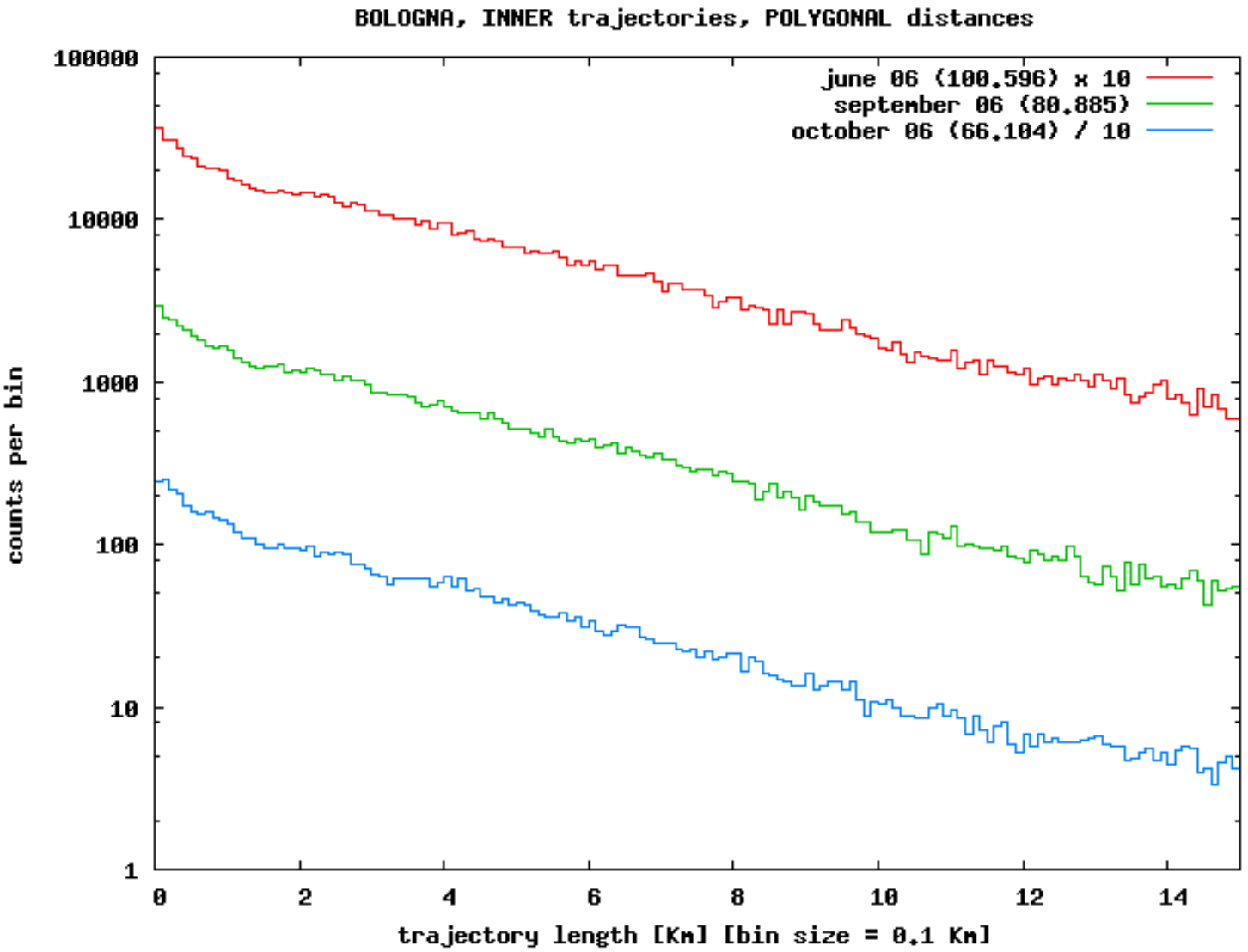
sampling error

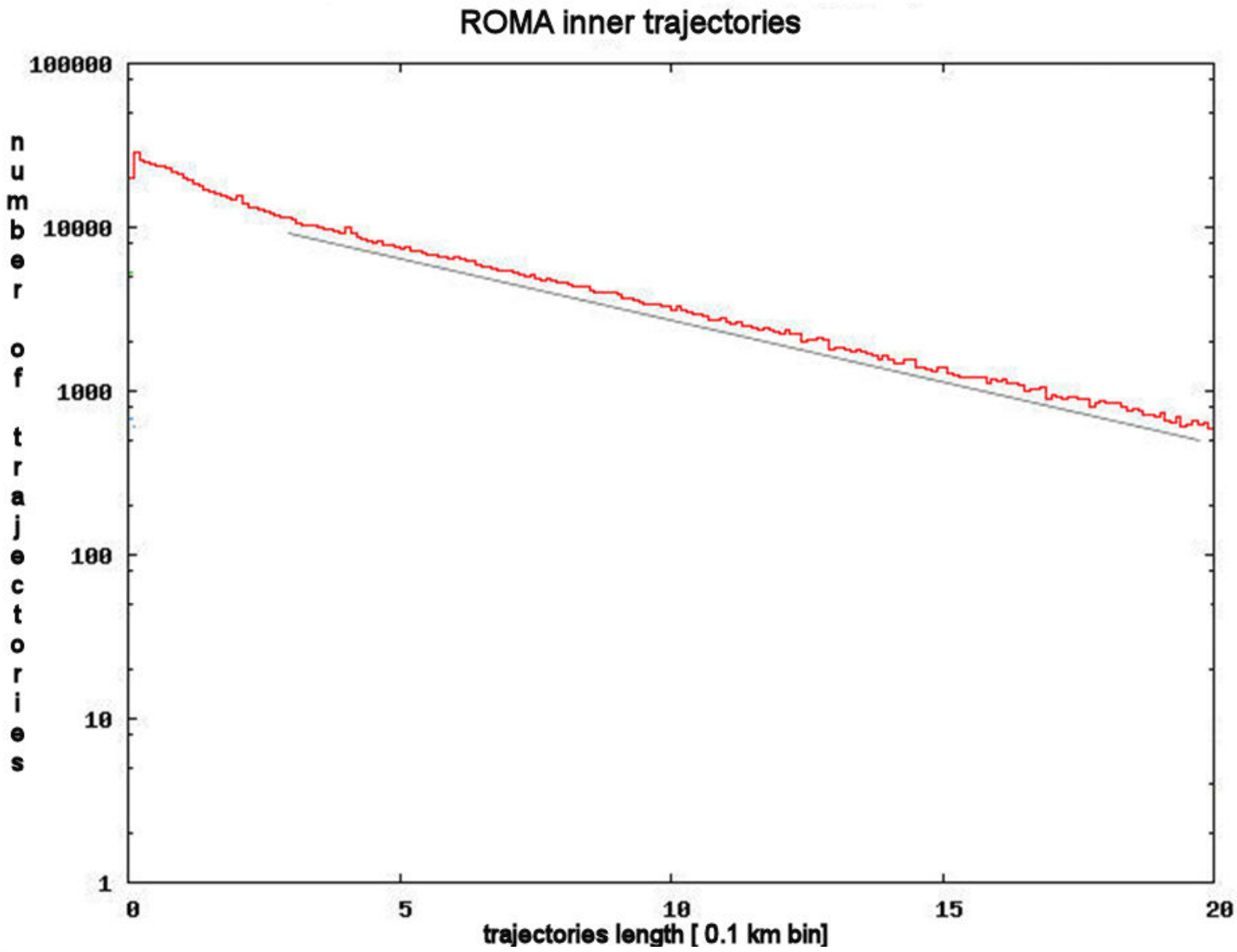


With a terminal percentage between 1 and 4%
20 vehicles give an error of 20%,
80 vehicles give an error of 10%
320 vehicles give an error of 5%

- We show empirical evidences for “universal” laws.
- These laws govern the behaviour of people driving in the urban context.

Bologna inner trajectories




ROMA inner trajectories
number of trajectories
100000
10000
1000
100
10
1
0
5
10
15
20
trajectories length [0.1 km bin]

Exponential decay law

Traffic is a local phenomenon with a 5 km strictly exponential decaying scale.

Moreover:

1. The traffic we live in is dominated by short distance paths.
2. It exists a characteristic lenght of the system (about 5 km).
3. The mean distance travelled by the single car is 5 km.
4. The car number present on the street network is dominated by the automobilis which travel the mean distance.

GPS Data Set Reliability

1. At present 2% of the italian cars are monitored and this number is rapidly growing.
2. Time resolution is “perfect”.
3. Spatial resolution is “adequate”.

As traffic density increases more monitored cars are present and they become more representative. We are in presence of a spontaneous self-adaptive system. In congestion they are very representative as they cannot use free will.

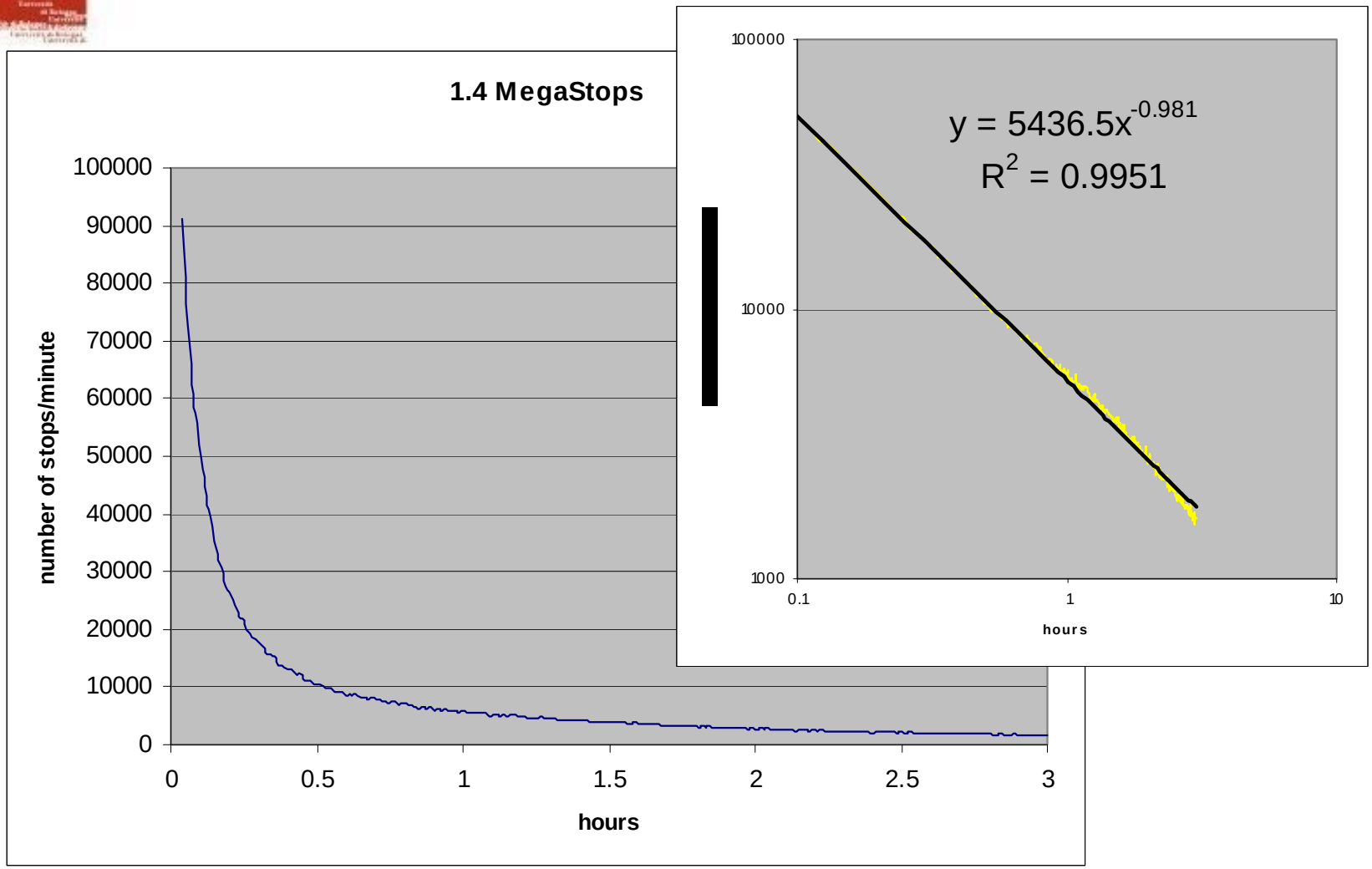
Open problem. At present we are investigating if our sample is generic or specific, studying the social characteristics of the people included in the data set.

This exponential empirical law seems independent from:

1. Urban topology
2. Number of inhabitants - vehicles
3. Traffic conditions

This suggest we are in presence of a cognitive behavioral law for the mobility system elementary components.

Florence stop-time

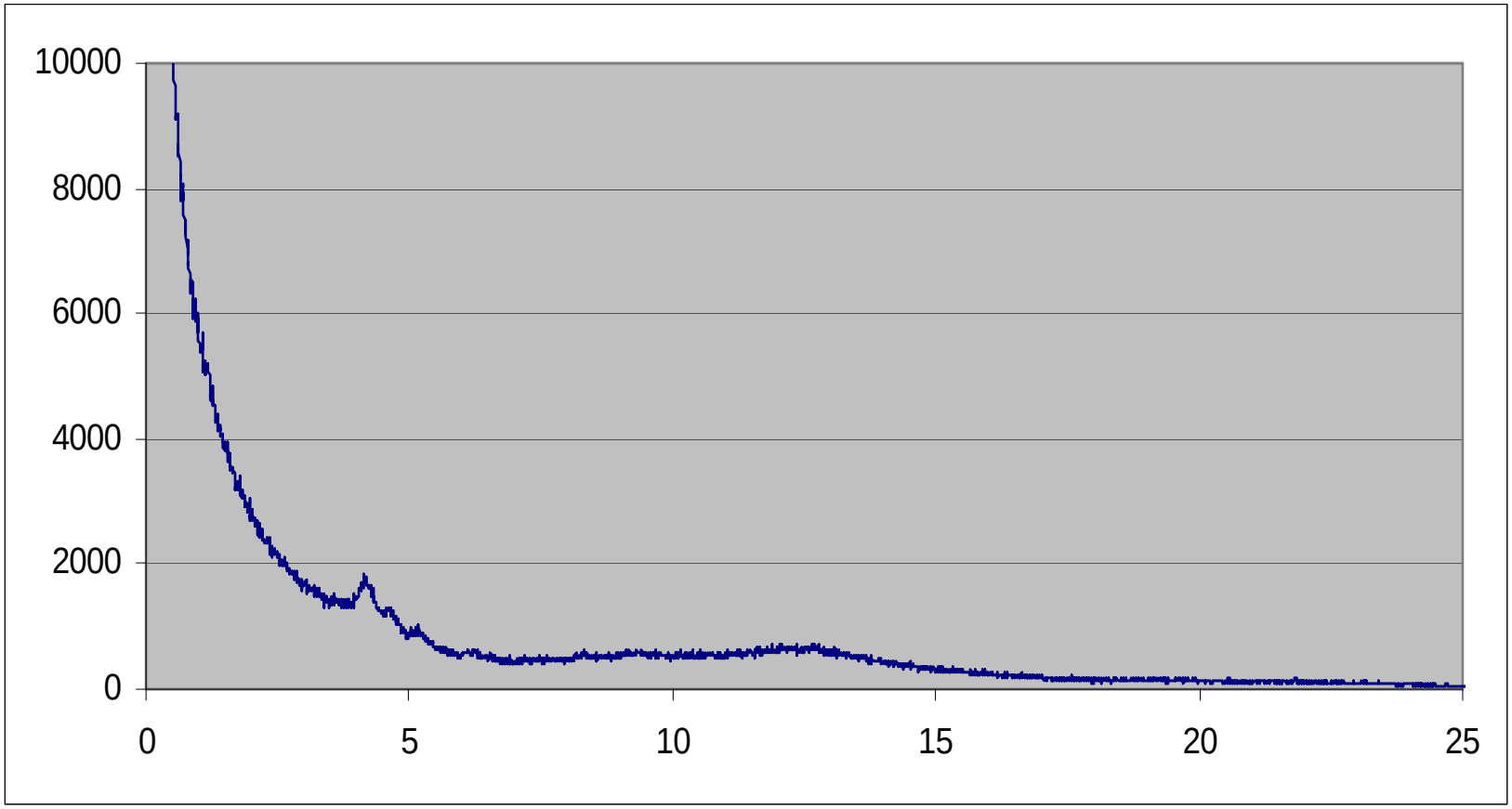


Zipf's stop-law

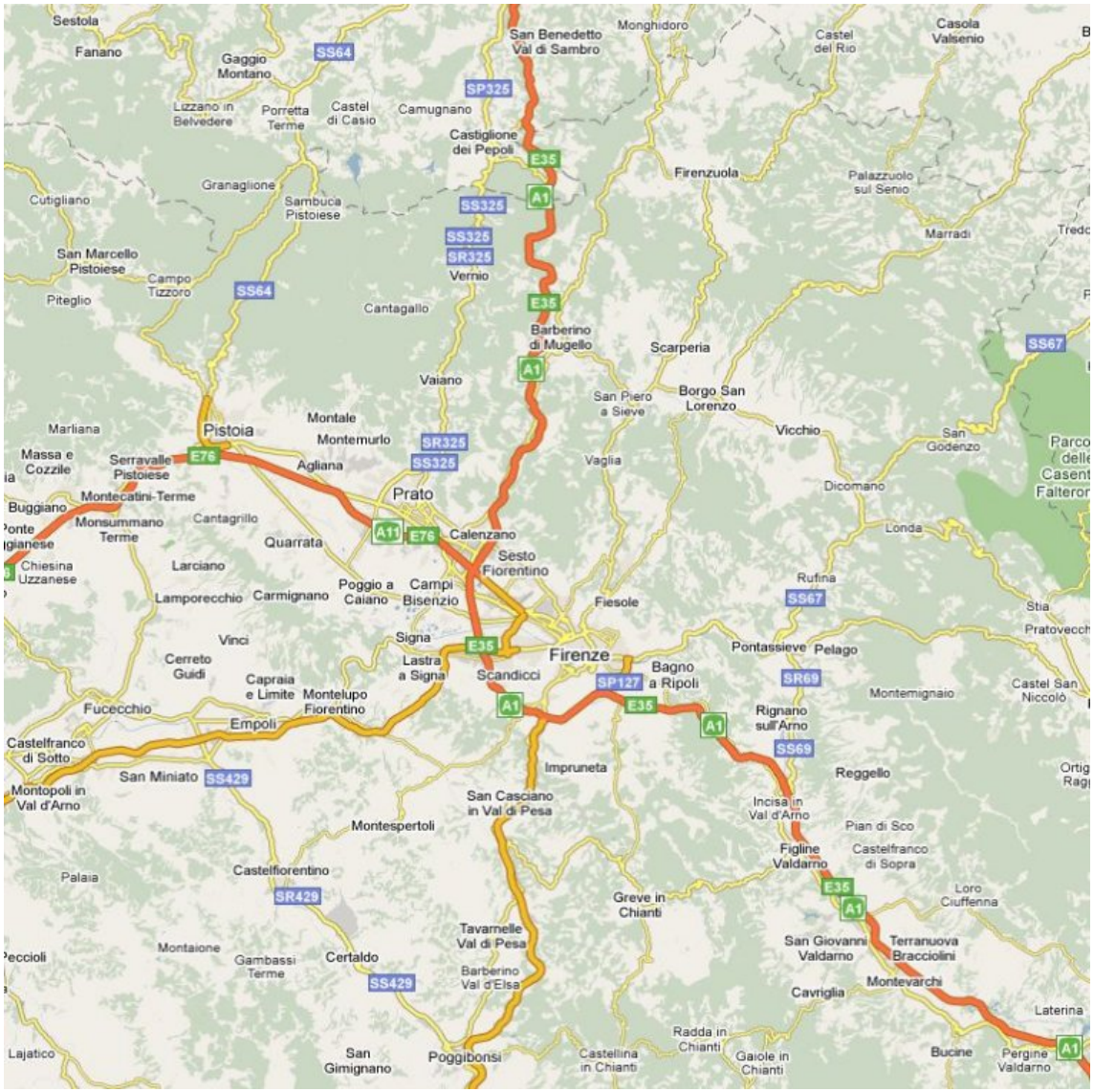
We can justify the exponential 5 km law Fixing the value of the mean distance travelled and assuming all independent Behaviours.

We did not expect the Zipf's stop-law

The signal is hidden by “Zipf’s noise”



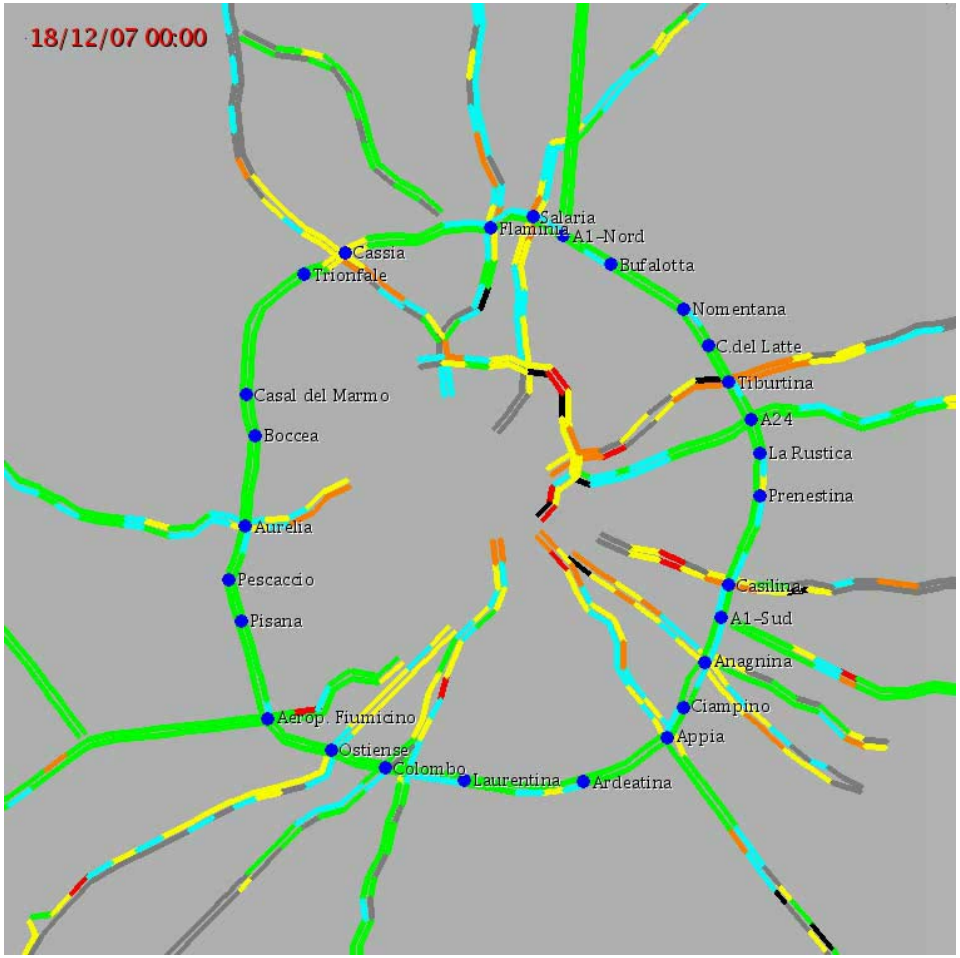
80 km x 80 km model



Traffic Model

- **We have no real problem with the physical model**. The dynamic of the vehicles and of their interactions are well understood and easy to implement in a model. The level of details needed depends on the problem and is only a matter of computer power. We can run a microscopic model to simulate in real time a metropolitan area on a normal pc. If we need fast model we can run a simpler mesoscopic model.
- **Some problem with the behavior.** From our study on the real trajectories we see a robust best path approach with a weak dependence on the traffic conditions.

Some problem with the physical initial conditions (location and speed)



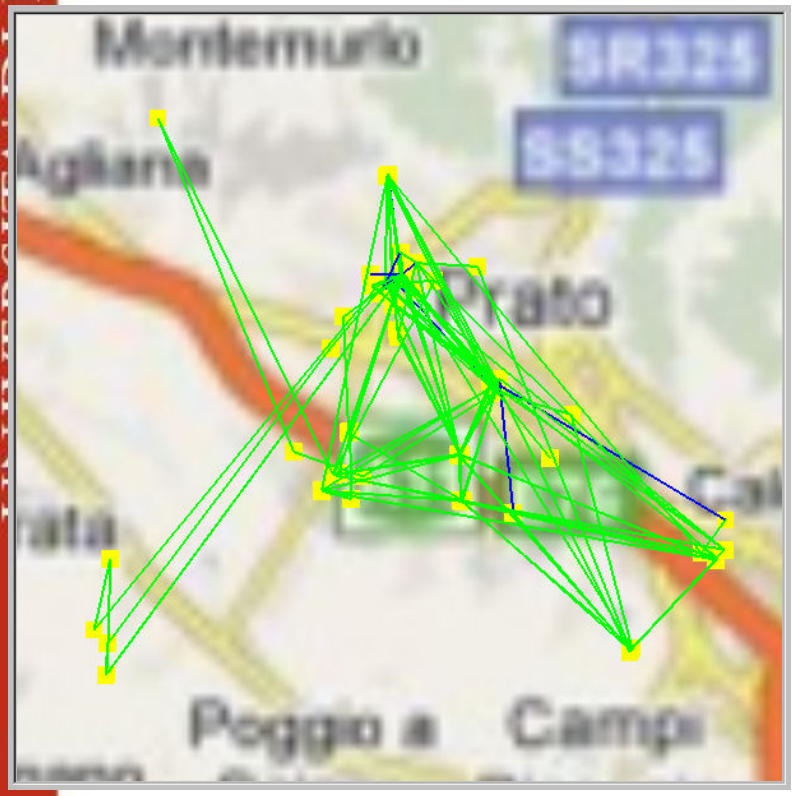
The real problem is to know the intentions

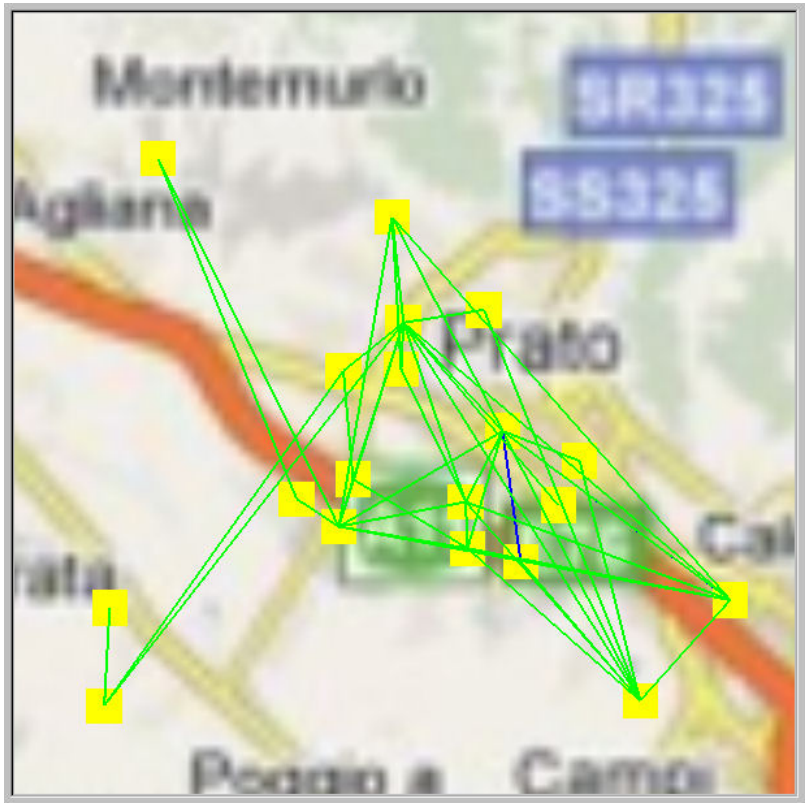
(where people wants to go)..

For the Provincia di Firenze during March 2008 OCTOTelematics data base contains 34839 vehicles and 2127395 trajectories.

After a cluster analysis with a radius of 400 (600) meters 353687 (520130) short trajectories has been neglected and we get:

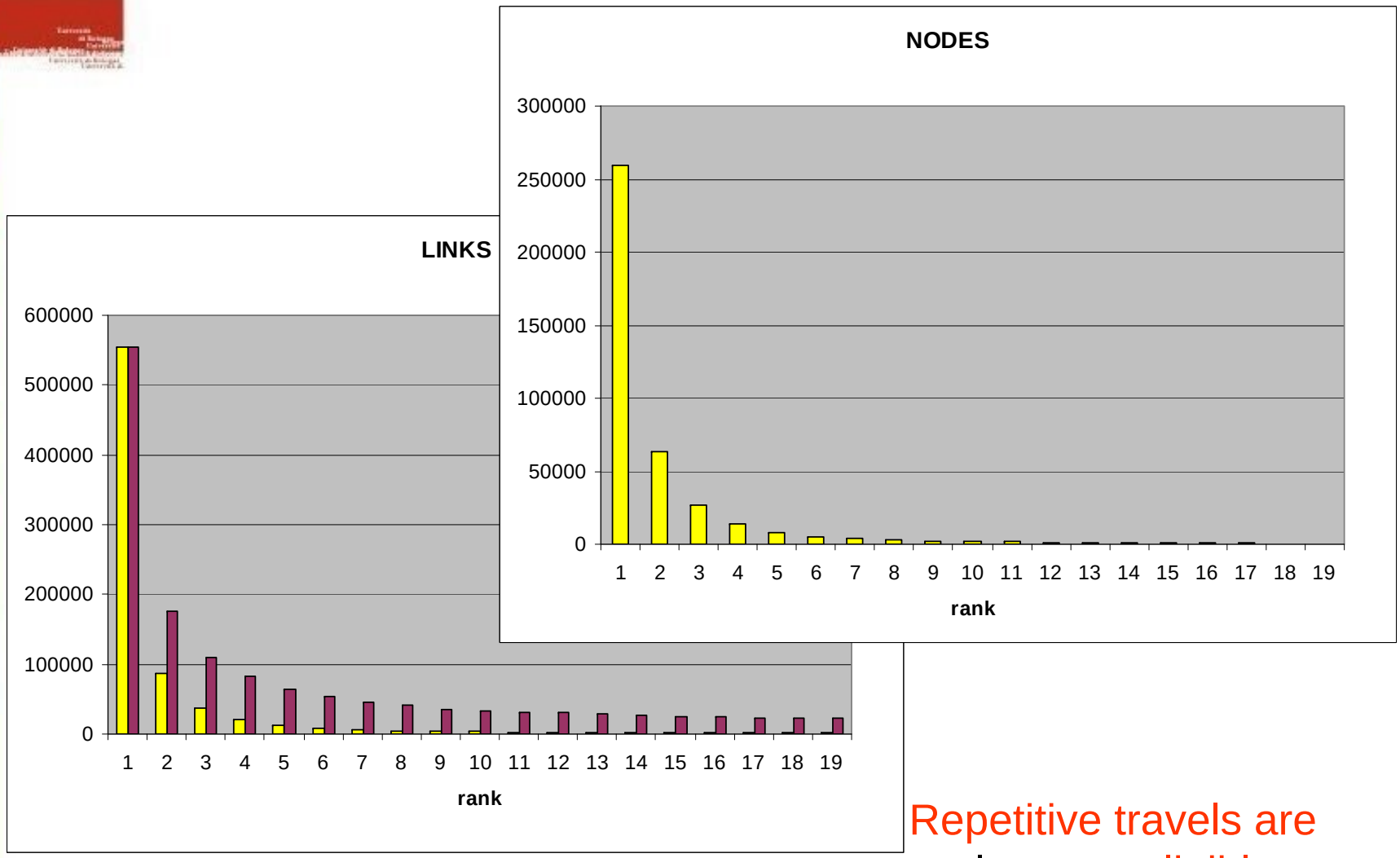
- 471550 (396733) nodes
- 873037 (733309) different trajectories.





Interview and real life

Nodes and Links distribution



Repetitive travels are almost negligible

Plethora of measures