Individual mobility profiles: methods and application on vehicle sharing

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People are boring…

People follow the same behaviors almost every day… can we extract this information?

In literature there are works saying that the mobility of an user can be theoretically predicted up to 93% (http://www.sciencemag.org/content/327/5968/1018.abstract)

Let's see what we can do!

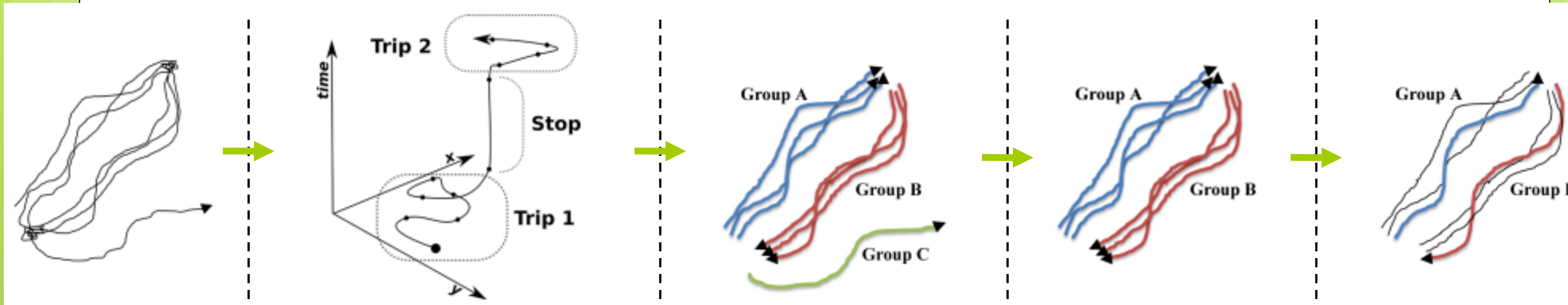
User's Mobility Profile

Given the user history as an ordered sequence of spatio-temporal points, we want to extract a set of *routines* in order to create the his\her *mobility profile*.

Where:

- A *Routine* is a typical local behavior of the user.
- A *Mobility profile* is the set of user's routines

The proposed method



User history

An ordered sequence of spatio-temporal points.

Trips construction

Cutting the user hisroty when a **stop** is detected

Stops Spaital Threshold
Stops Temporal Threshold

Grouping

Performing a density based **clustering** equipped with a **spatio temporal** distance function

Spatial Tollerance
Temporal Tollerance
Spatio temporal distance

Pruning

Groups with a small Number of trips are Pruned

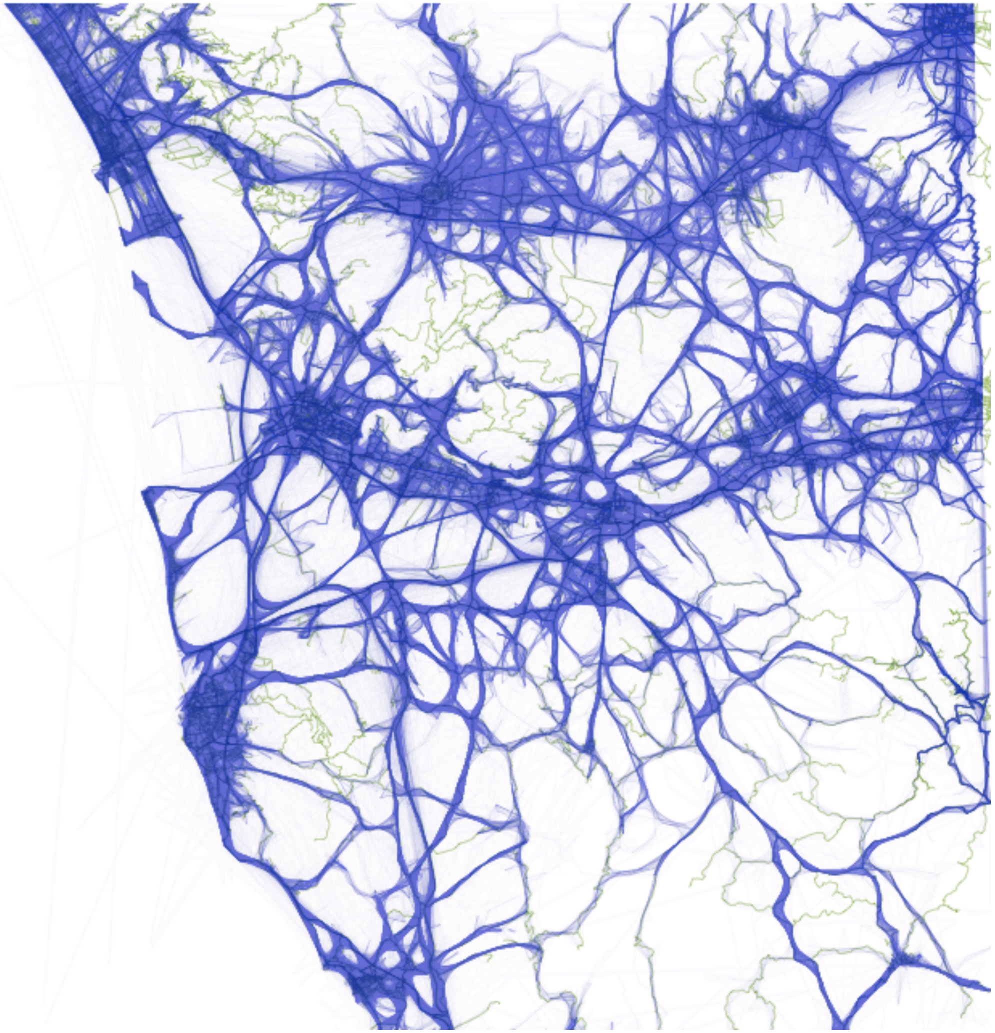
Support Threshold

Profile extraction

The **medoid** of each group becomes user's **routines** and the all set become the user's **mobility profile**

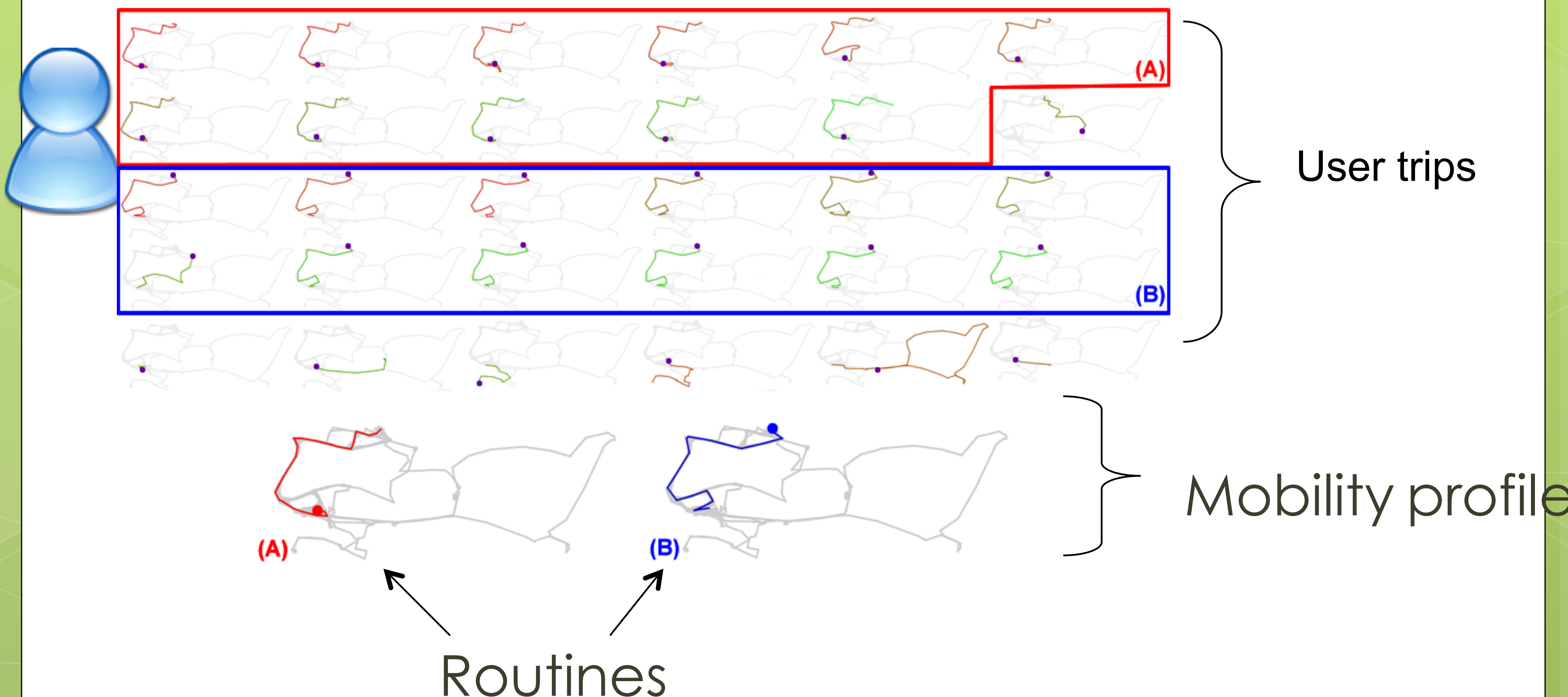
GPS traces

- 38416 vehicles
- 1,449,258 trips
- 35 days monitoring
- 16,426,768 km covered (410 times equator length)
- 1,926,213,632 seconds of travel time
  - 535,060 hours
  - 22,294 days
  - 61 years



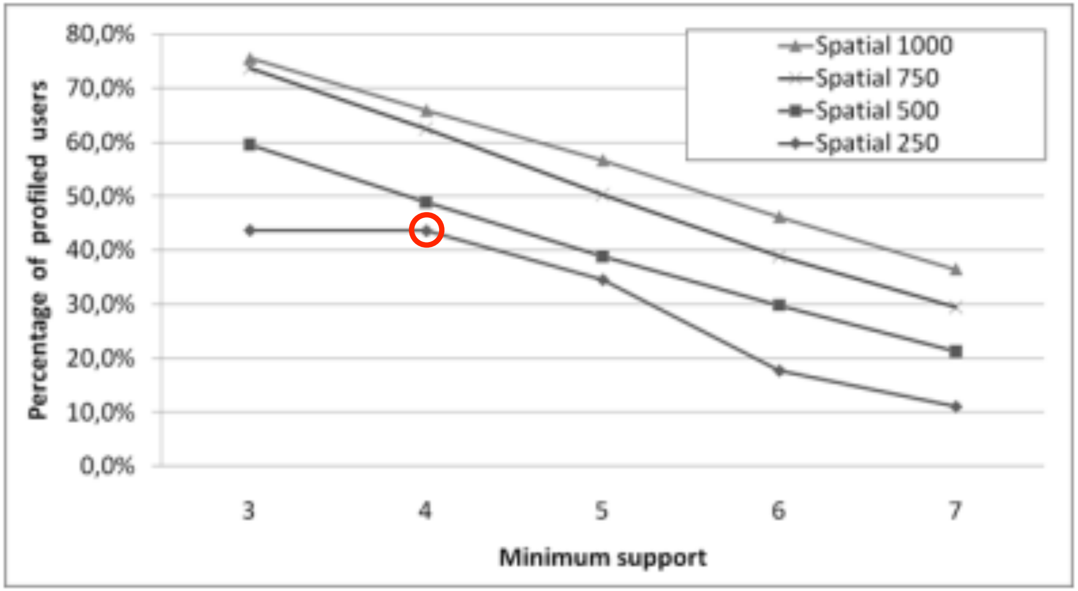
Extracting travellers profiles

- Analysis focused on the single individual
- Find his/her systematic mobility



Experiments on real data

Selecting 2017 users in a period of 12 days we generated 46,163 trips and extracted 1,504 routines over 919 mobility profiles (43.6%)

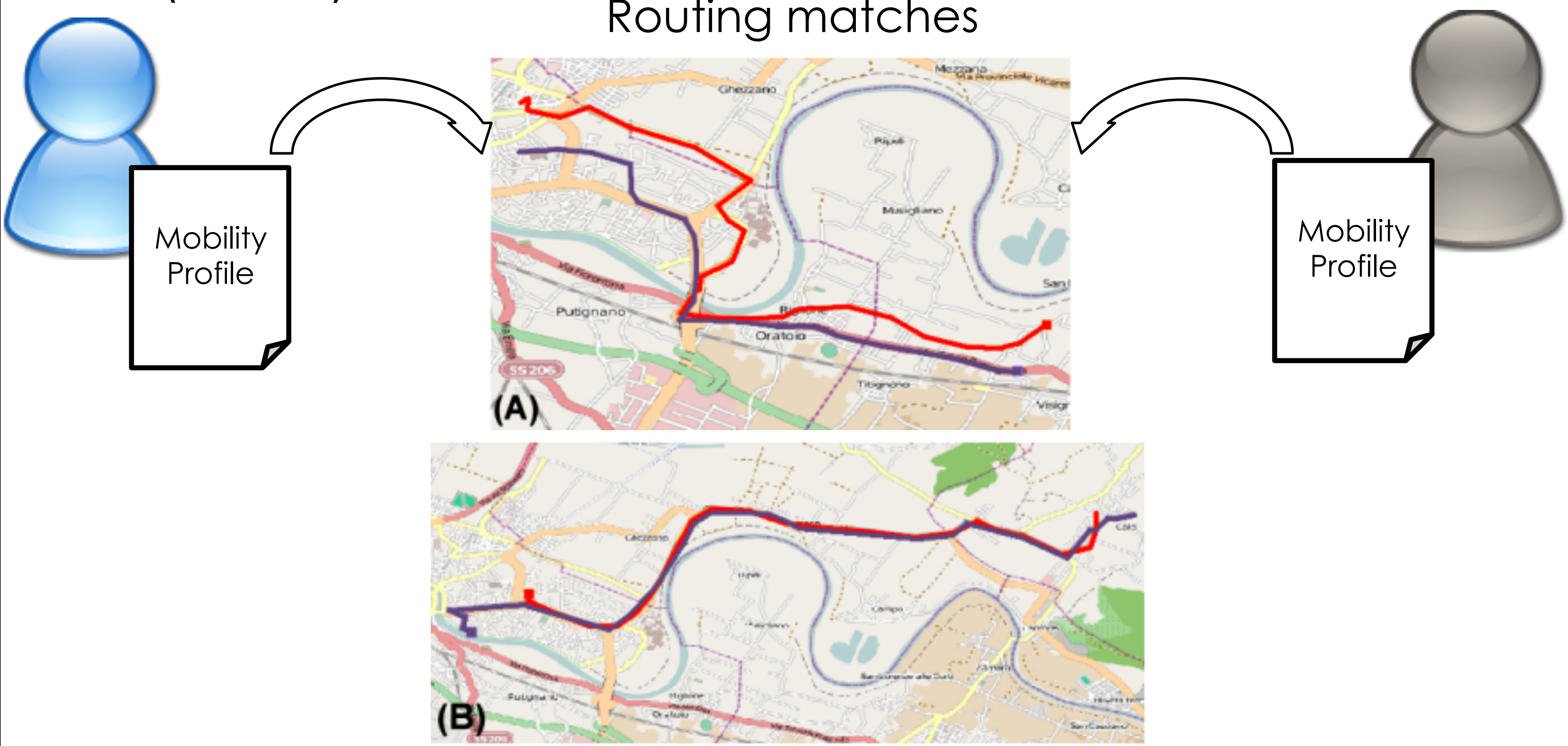


Suggesting a mobility profile match

User A (as host)

Spatio Temporal Routing matches

User B (as guest)



The user **A** can serve a good percentage of the routines of the use **B** so the match is suggested.

Car pooling application

The user profiling might be deployed in a car pooling service which provides a pro-active suggestions without the need for the user to explicitly describe (and update) the trips of interest

Matching of two routines:

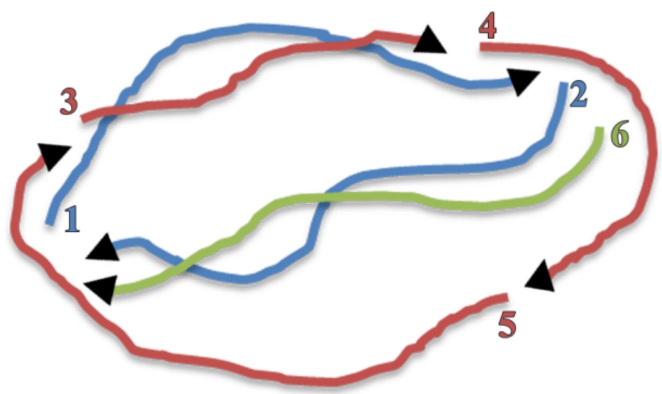
$$T_1 = \langle p^1_1 \ldots p^1_n \rangle \text{ and } T_2 = \langle p^2_1 \ldots p^2_m \rangle$$

$$\begin{aligned} contained(T_1, T_2, th^{walking}_{distance}, th^{wasting}_{time}) \equiv\ & \exists i, j \in \mathcal{N} \mid \\ & 0 < i \leq j \leq m \wedge \\ & Dist(p^1_1, p^2_i) + Dist(p^1_n, p^2_j) \leq th^{walking}_{distance} \wedge \\ & Dur(p^1_1, p^2_i) + Dur(p^1_n, p^2_j) \leq th^{wasting}_{time} \end{aligned}$$

Mobility profile share-ability:

$$\text{mobility profiles } \tilde{T}_1 \text{ and } \tilde{T}_2$$

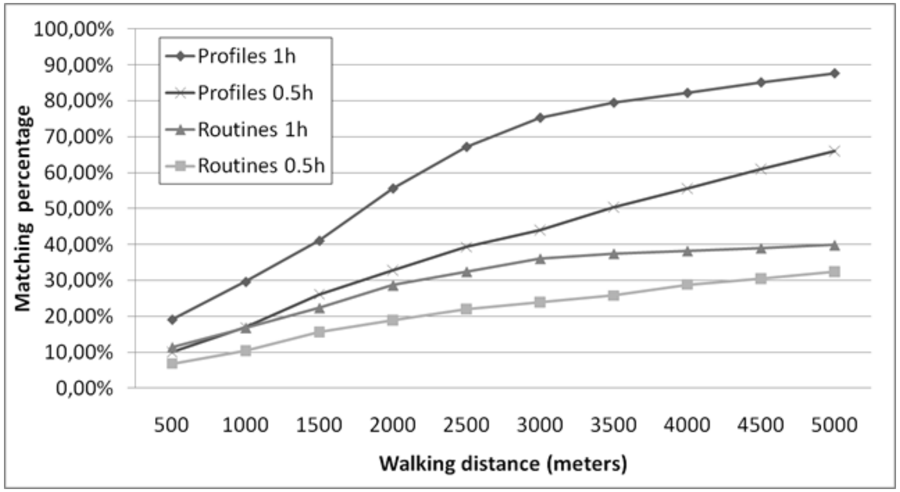
$$profileShare(\tilde{T}_1, \tilde{T}_2, th^{walking}_{distance}, th^{wasting}_{time}) = \frac{\left| \left\{ p \in \tilde{T}_1 \mid \exists q \in \tilde{T}_2 . Share(p, q, th^{walking}_{distance}, th^{wasting}_{time}) \right\} \right|}{\mid \tilde{T}_1 \mid}$$



	1	2	3	4	5	6
1	-	-	F	F	F	F
2	-	-	F	F	F	**T**
3	**T**	F	-	-	-	F
4	F	F	-	-	-	F
5	F	F	-	-	-	F
6	F	**T**	F	F	F	-

	-	0	1/2
	1/3	-	0
	1	0	-

Evaluating the impact of an hypotetical car pooling service



This is an upper bound for a car pooling application.

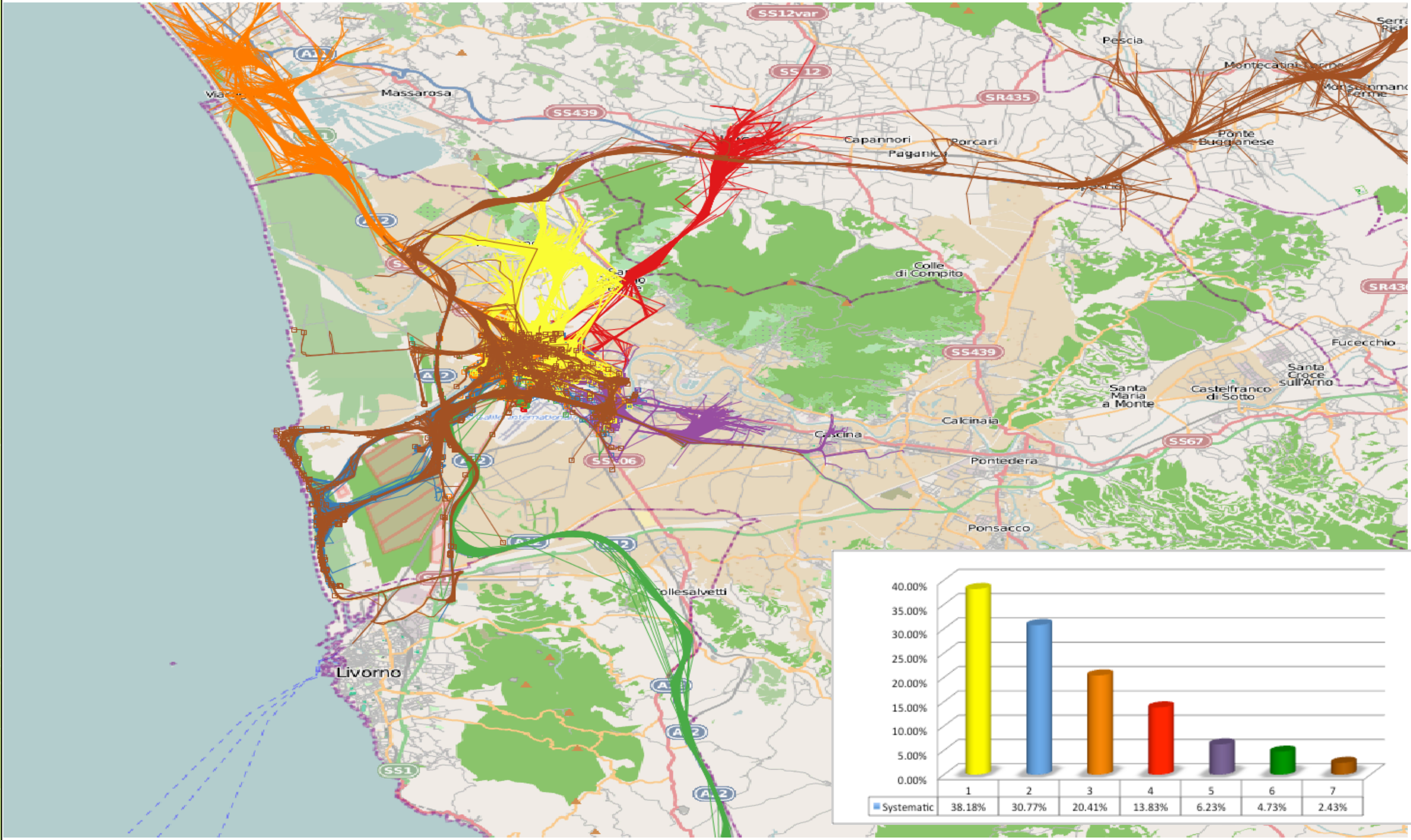
Considering a hypothetical car pooling service built on top of the proposed method, using a walking distance of 2.5 km and a wasting time of 1 hour, we obtain that the 32.4% of participants, receive at least one indication of a possible host for one of their routines.

Mobility profiles as starting point….

From this work different direction are explored:

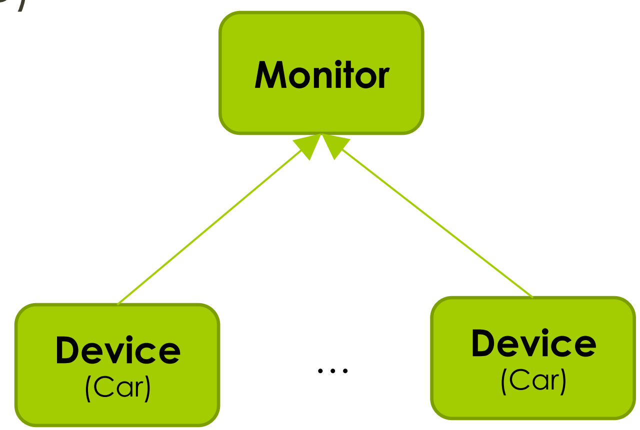
- City accesses analysis
- Profiles as predictive models
- Matching network analysis

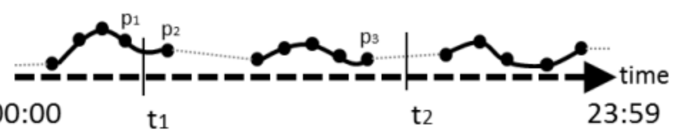
Using the profiles to classify the incoming flows of a city

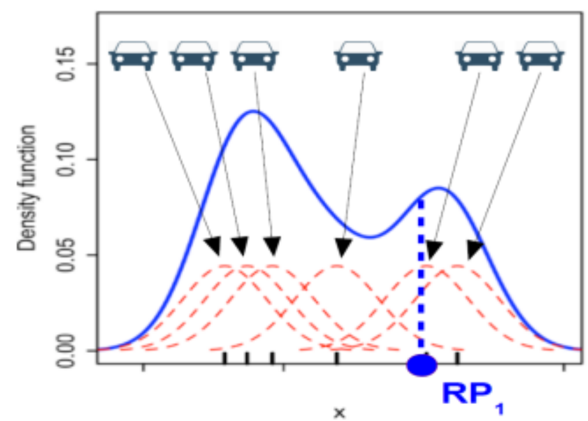


Using Profiles as predictive models

LIFT Project
Accepted UrbComp (KDD 2012 Workshop)



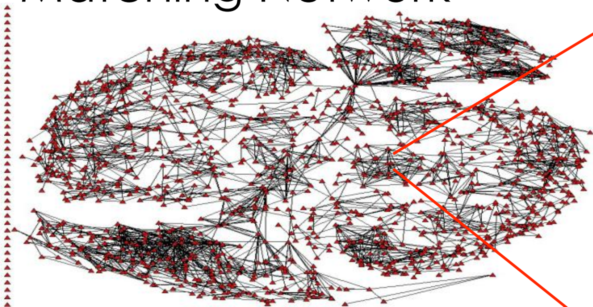




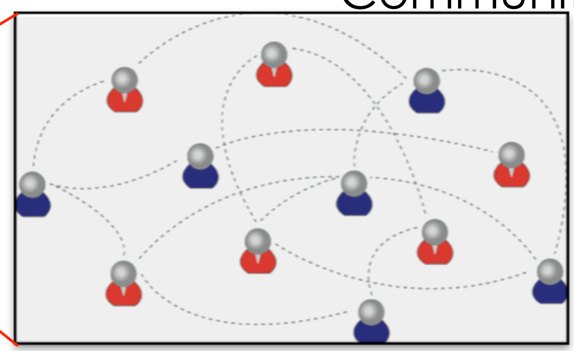
Result: 85% communications saved

Better understanding of car pooling application and impact

Matching Network



Community



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Suggestion

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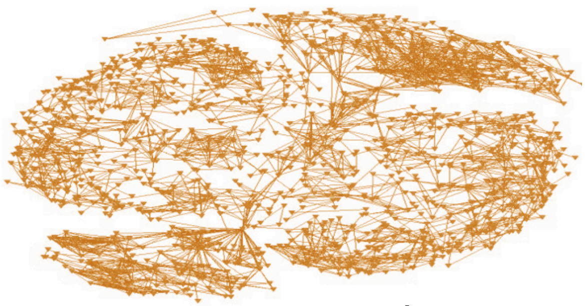

Actual Network

Questions?

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