University of Murcia

Faculty of Computer Science
Deparment of Communications and Information Engineering

Human Mobility Analysis based on Social Media and Fuzzy CLustering

Geneva, Switzerland, 6-9 June 2017 GIoTS

Jesús Cuenca Jara
Dr. Fernando Terroso-Saenz
Dr. Mercedes Valdes-Vela
Dr. Aurora Gonzalez-Vidal
Dr. Antonio F. Skarmeta-Gómez

Horizon 2020

Agenda

1)Introduction

2)Proposed system

3)Evaluation

4)Conclusions

Introduction (1/4)

- **IoT** not limited to static sensors, but **moving** ones capable to deliver measurements at different points within an area.
- At the same time, **social networking** has become a very popular activity in most developed and developing societies allowing people remain socially connected
- The mmobility pattern is a key element to identify possible actions for energy efficiency

Introduction (2/4)

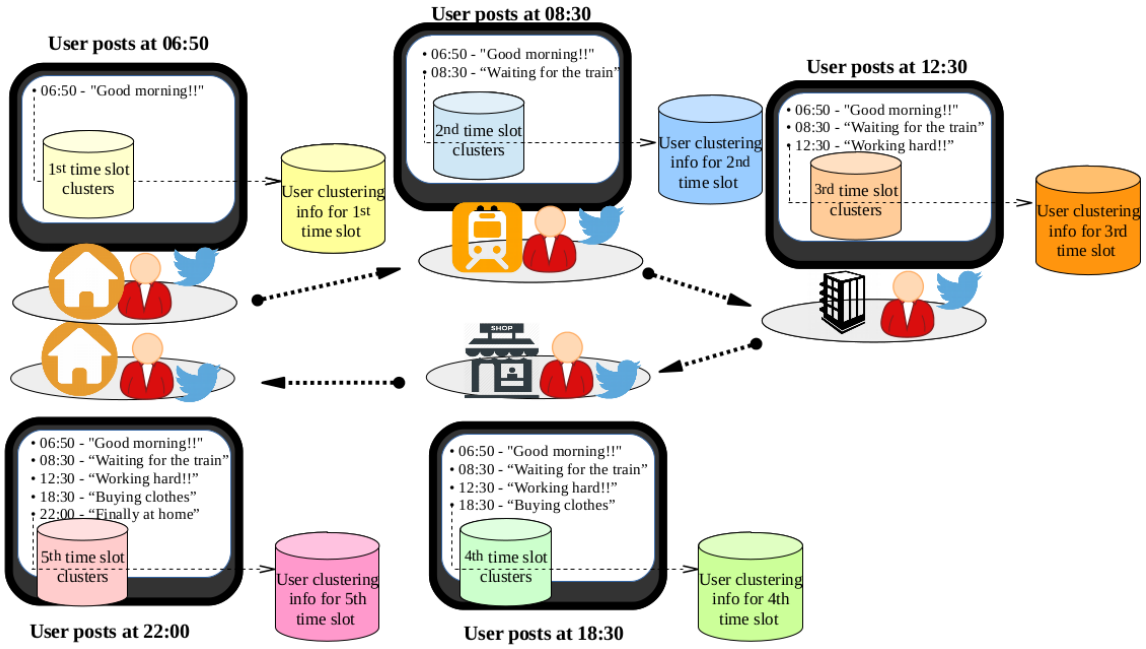
- Many social-network sites, such as Twitter, Facebook or Foursquare, have included **location-based capabilities** into their apps.
- This geo-tagging of most of the documents has enabled the advent of *soft sensors* combining social-media and location data.
- The use of this kind of data has become crucial to the **prediction of the mobility** of a population.
- Knowing in advance the next movement of citizen can be used for preparing in advance actions in locations related to energy management

Introduction (3/4)

- **Several solutions** to give insight into these new social-media data have been proposed, coming up with novel human-mobility models and patterns. Nonetheless, previous studies frequently suffer from some of the following **drawbacks**:
  - They focus on extracting general mobility information **without distinguishing the time of the day** in which the information was generated (time slots)
  - Most of the employed algorithms do not consider the **fuzzy and noisy** nature of the kind of data generated by humans.
  - Most works do not take into account the **activity level** of the users within each detected region.

Introduction (4/4)

The **present work** puts forward a novel approach for **personal mobility mining** based on social-media content that fully considers the three challenges listed above.



Agenda

1)Introduction

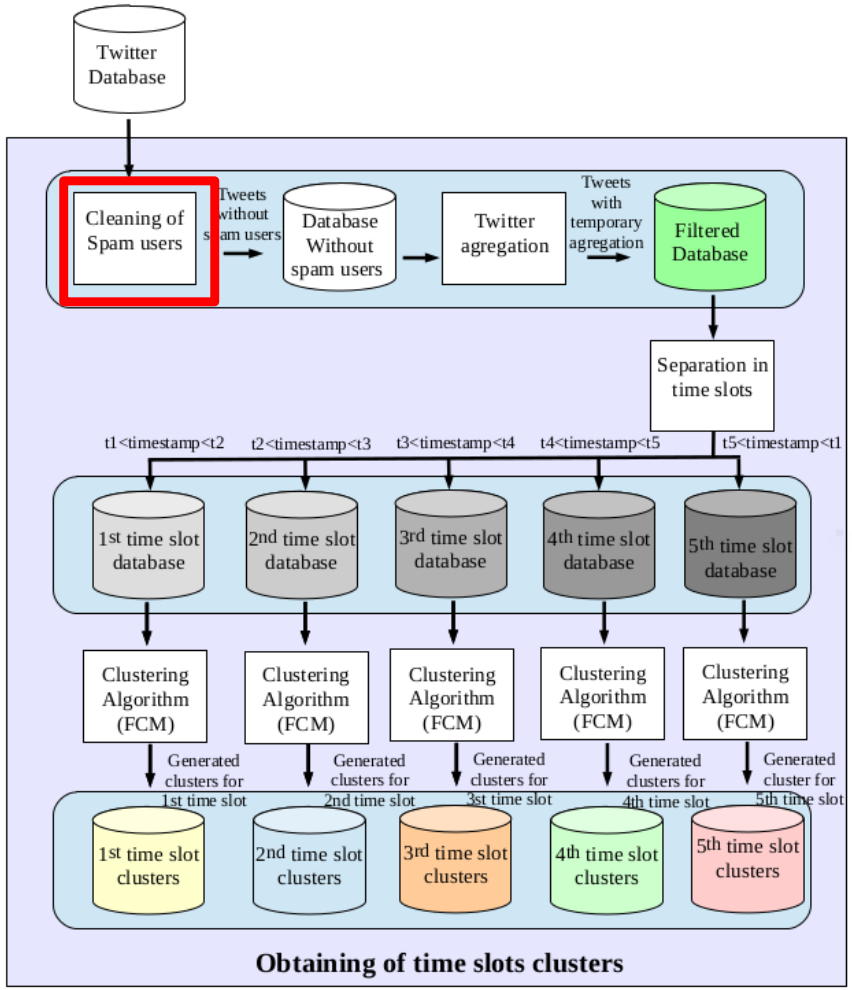
2)Proposed system

3)Evaluation

4)Conclusions

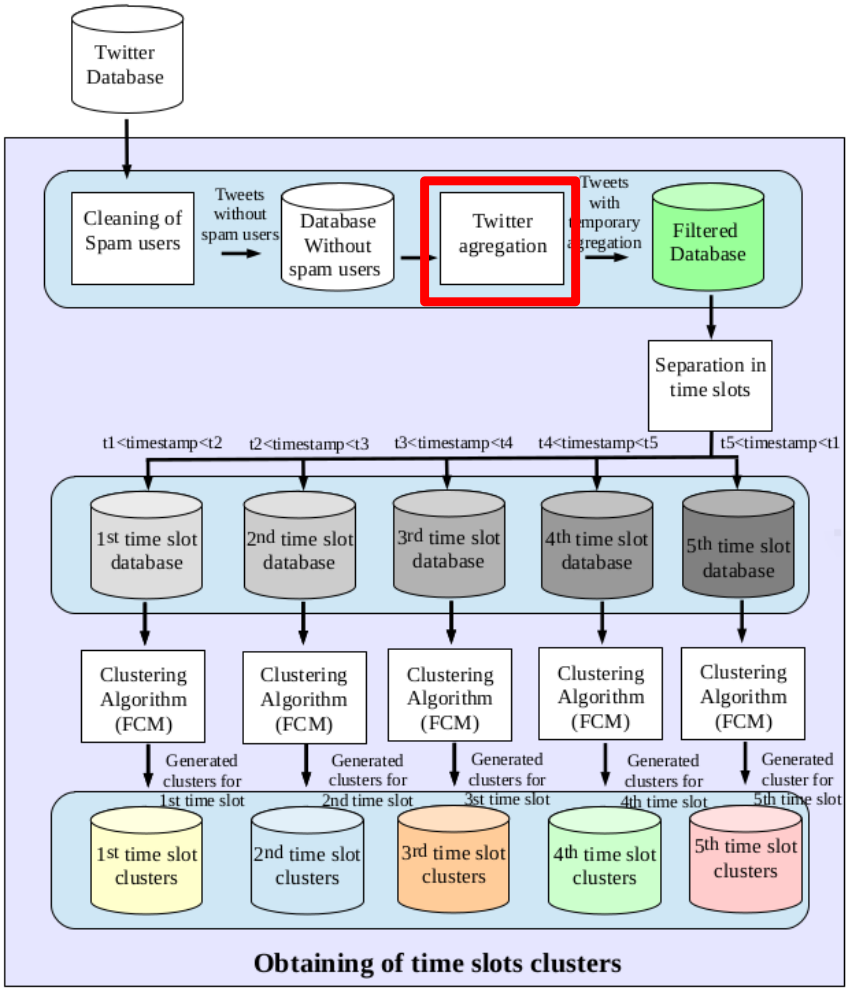
Proposed System(1/7)

- *Cleaning of spam users*: spam users do not represent real users and might disturb the obtained results.



Proposed System(2/7)

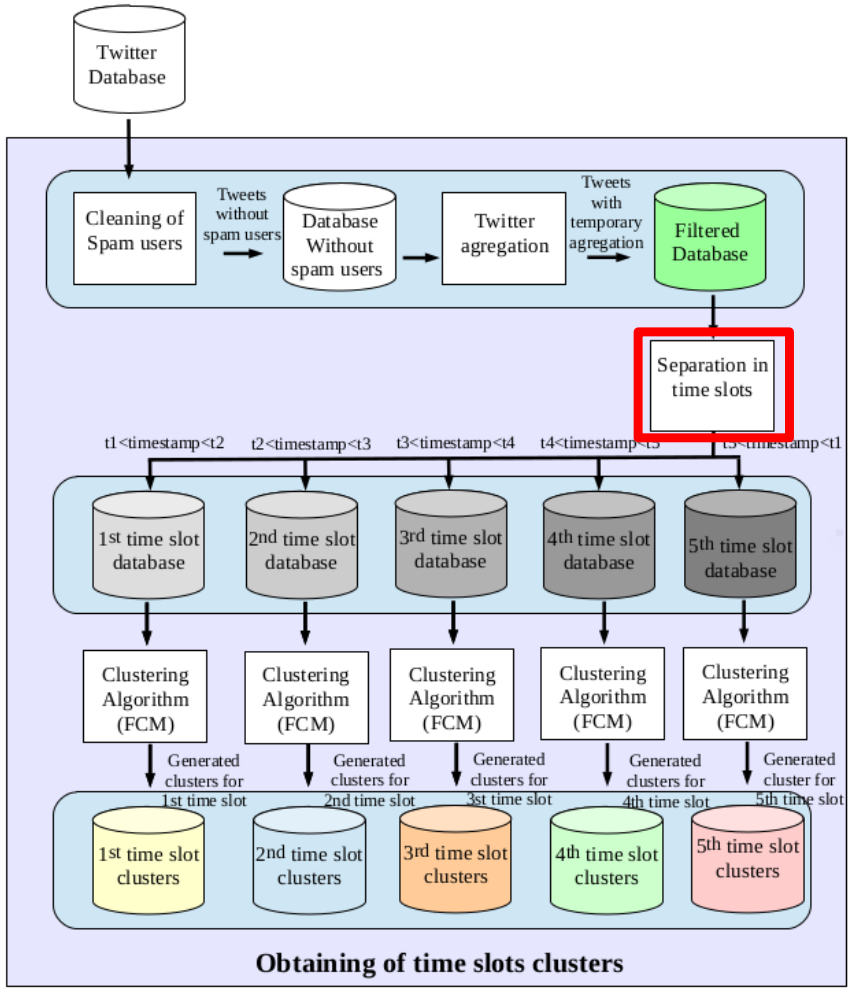
- *Twitter agregation:* the next step is to aggregate tweets that have been posted in similar locations and time.
- Avoiding the disturbance of the real prediction with tweets posted by the same user which do not represent a real movement in space-time dimension.



Proposed System(3/7)

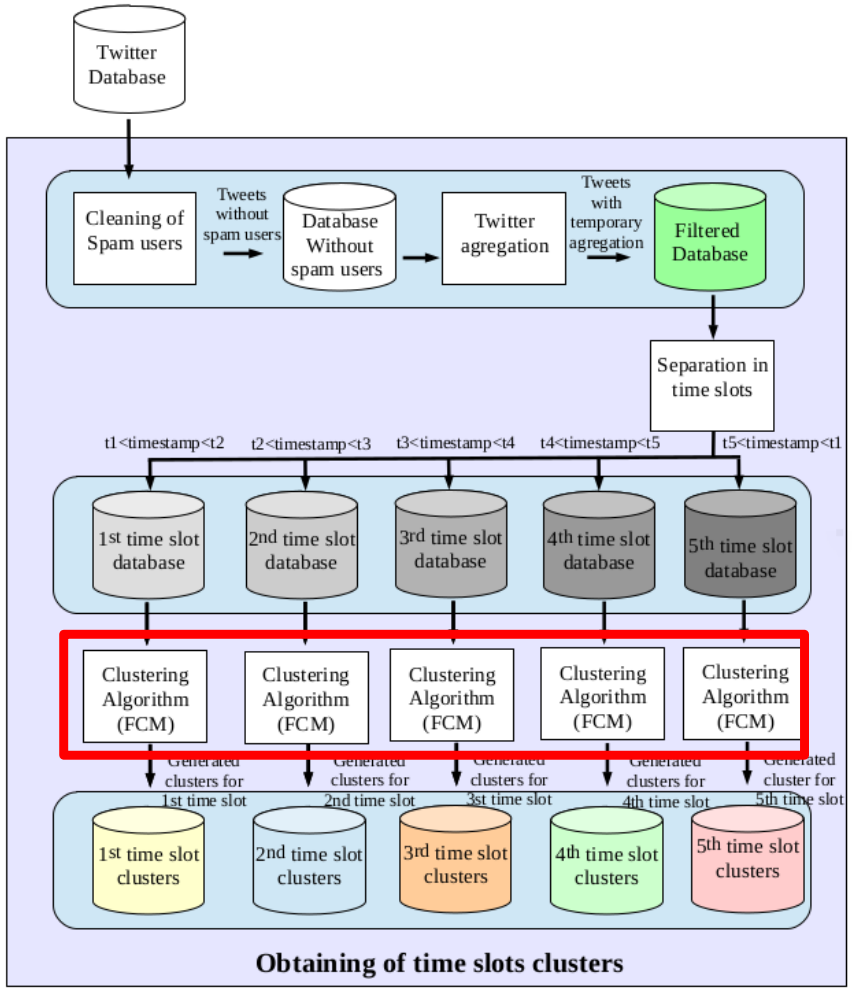
- *Separation in time slots*: database is split into five datasets, according to the time the tweets were posted.

Daytime Slot	Time range
Early morning	00:00 - 08:00
Morning	08:00 - 12:00
Evening	12:00 - 16:00
Late	16:00 - 21:00
Nigth	21:00 - 00:00



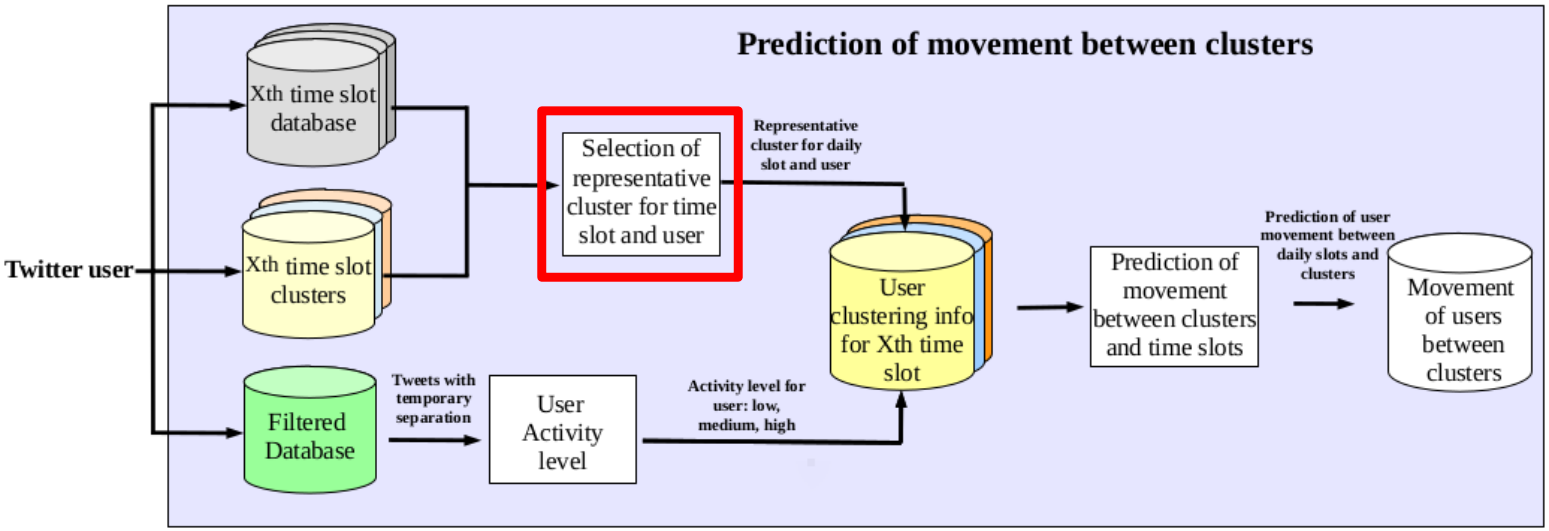
Proposed System(4/7)

- *Clustering algorithm FCM*: The FCM clustering algorithm is applied to each of the five datasets.
- **Result:** a membership matrix between all tweets and all clusters for each time slot.



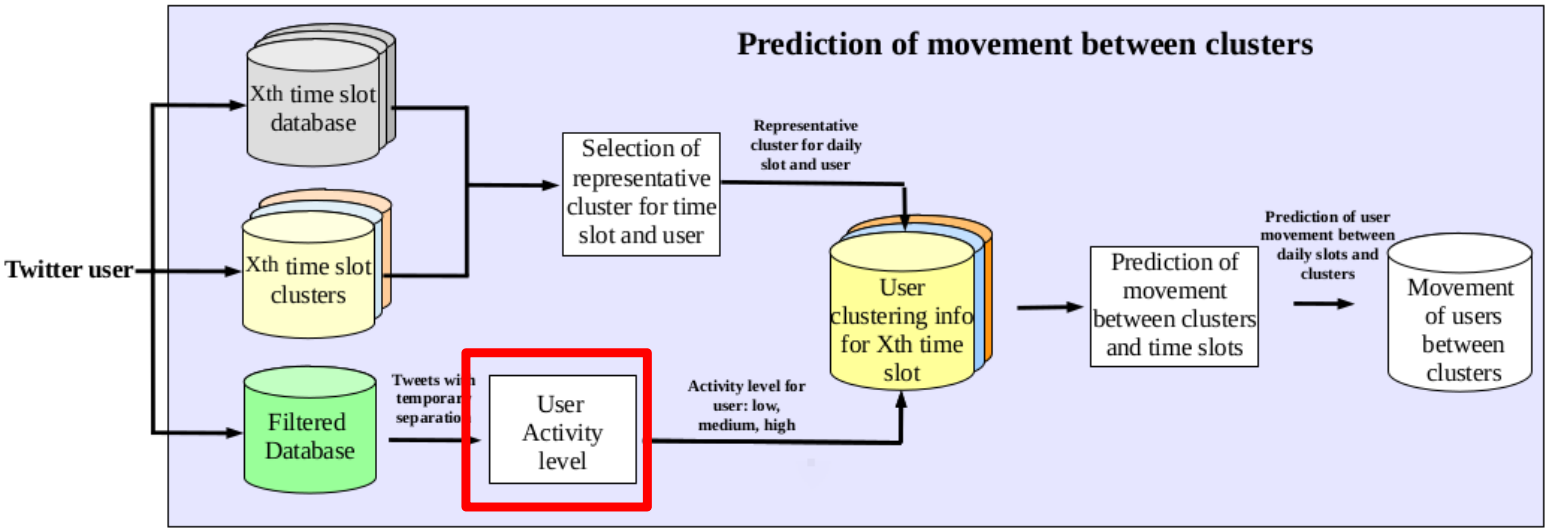
Proposed System(5/7)

- *Selection of representative cluster for time slot and user: f*or each time-slot, the cluster for each user with highest membership is selected to be the representative one for the user in that timeslot.
-
- **Result:** five pairs of **centroid-time slots** by user, which represent the usual movement of the user during the day across the time slots.



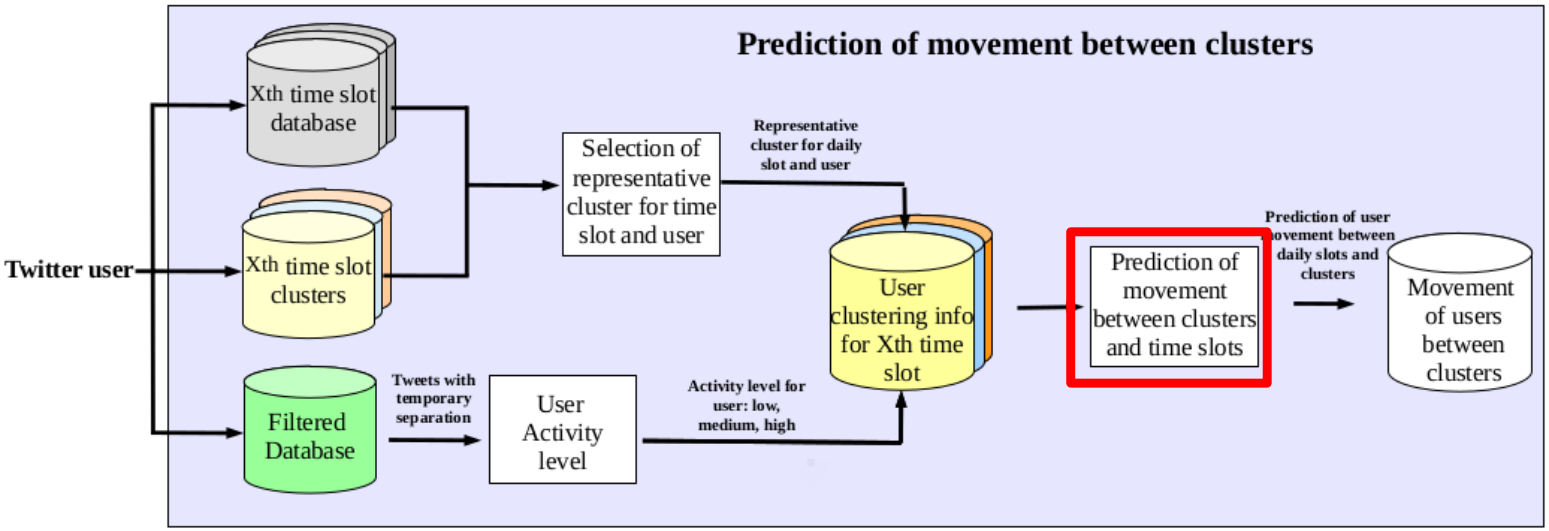
Proposed System(6/7)

- *User activity level:* the activity level (low, medium, high) of each cluster is measured in order to discover the kind of users in each cluster.
- Determined by combining the degree of membership and activity level for each tweet.
- **Result:** percentage of users of each of the levels of activity associated to each cluster.



Proposed System(7/7)

- *Prediction of movement between clusters and time slots*.
- **Result:** The percentage of users in each time slot (calculated using the representative cluster for each time slot and user) and the percentage of users that flow from one cluster to another (in the following time slot).

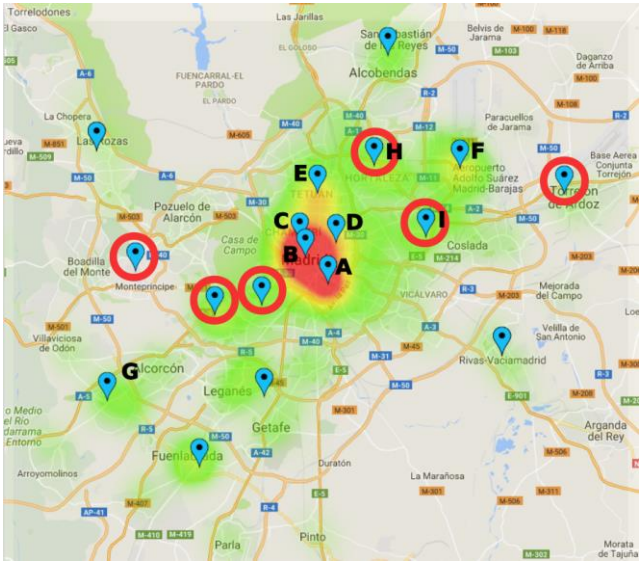


Agenda

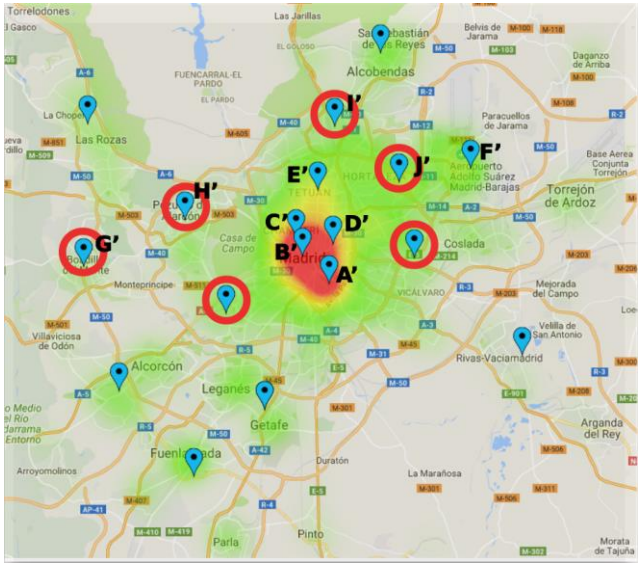
1)Introduction
2)Proposed system
3)Evaluation
4)Conclusions

Experimental Results(1/3)

- Heat maps of resulting digital traces of the datasets and generated clusters in the early morning and morning time slots.
  - **Early morning slot**: the clusters are generated mainly in residential areas.
  - **Morning slot**: activity is perceived in areas related to work and study.
  - Although some generated clusters are practically identical in both time slots the percentage of users in them and their movements are different.



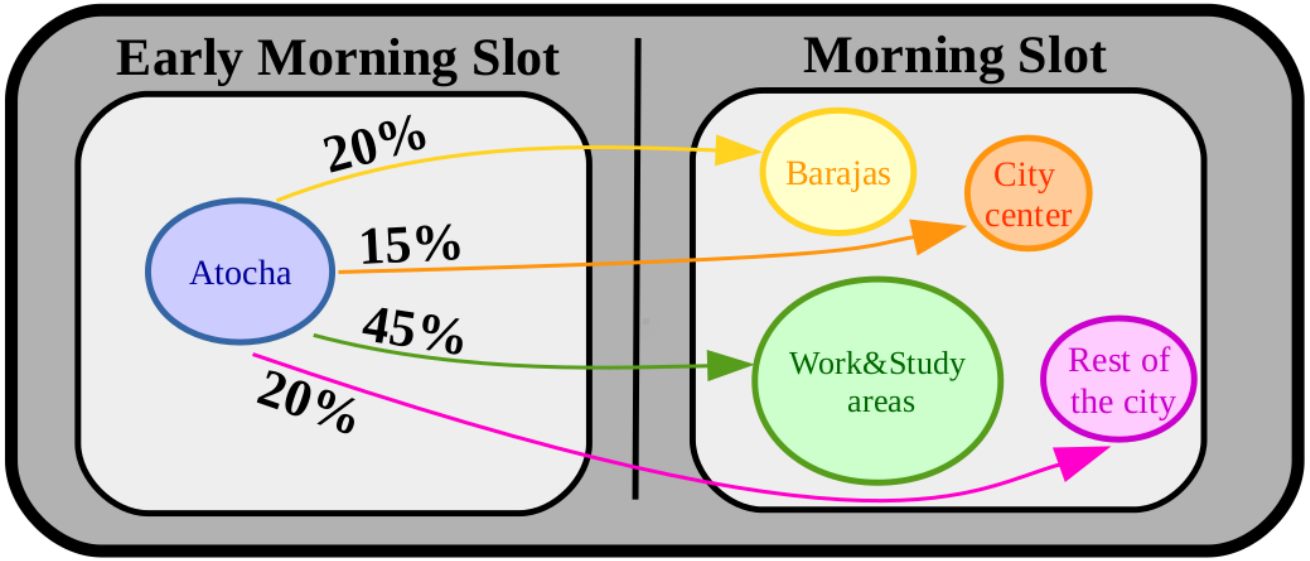
Early morning slot



Morning slot

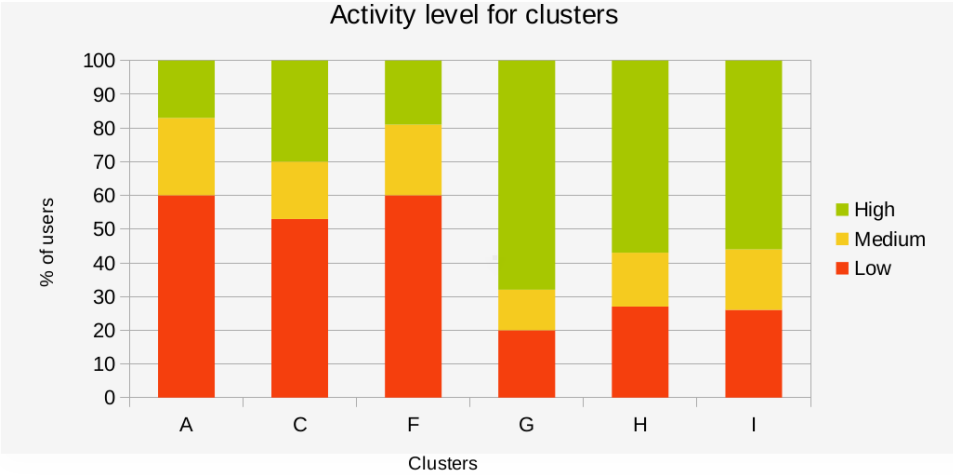
Experimental Results(2/3)

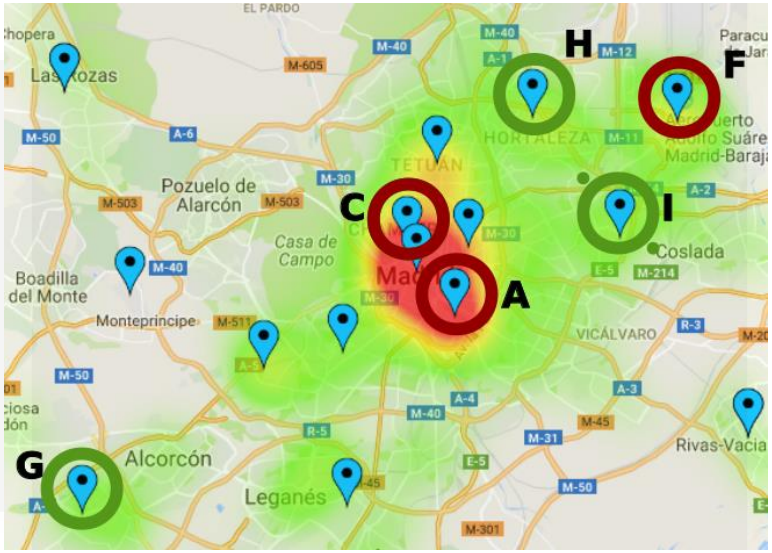
- Regarding the **prediction mechanism** the percentage of people who move from one cluster to other is extracted for each time slot.



Experimental Results(3/3)

- Concerning the **activity level** of users in each cluster, the results show that:
  - The most crowded areas (Madrid center and airport) have high levels of users with low activity.
  - Less crowded areas have more users with higher activity level.
  - Lower levels of information are compensated with more active users and vice versa.





Agenda

1)Introduction
2)Proposed system
3)Evaluation
4)Conclusions

Conclusion

- At the dawn of the **IoT** era, the advent of *soft sensors* provides a huge amount of novel semantically-rich location data.
- The **prediction of movement** that can be obtained with such a data allows urban areas to adapt its **transport and energy efforts** to the real needs of its population. In turn, this will aid the development of economically, socially and **environmentally sustainable** means of transport.
- The present work has taken full advantage of new forms of data through the **fuzzy c-means** algorithm, in order to understand the movement of cities.
- Future work will be twofold.
    - We will fuzzyfy certain crisp parameters of the proposal like the time slots and the users' activity level
    - We will work on the enrichment of the obtained results with the use of semantic and textual information included in social-media documents.

Partially funded by:

ENTROPY

Horizon 2020

http://entropy-project.eu/

EDISON

Unión Europea
Fondo Europeo de Desarrollo Regional
"Una manera de hacer Europa"