

Scientific Report

Reference	CyberParks ECOST-STSM- TU1306-110115-052037			
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Home institution	SiTI - Higher Institute on Territorial Systems for Innovation			
STSM Topic	Capturing movements and opinions in urban open spaces through the analysis of user generated data			
Period	from	January 12, 2015	to	January 23, 2015
Host institution	Universitat Autònoma de Barcelona. Department of Geography			

1. Abstract

Focus of the author's STSM in Barcelona is the analysis of possible improvements in the design of open urban spaces by means of user generated data coming from social network platforms and apps. To carrying on the study, two sets of data have been used: the first one is given by the gathering of Tweets sent within the metropolitan area of Barcelona during the period January 7-19, 2015. The second set is the collection of records generated by the CYBERPARKS App during its pilot test in Barcelona in the afternoon of November 27, 2014.

The experimental study within the STSM has been organised in different steps. First step concerned the analysis of the status of the art regarding the application of user generated content data within spatial studies. Second step consisted in setting the methodology to deal with the objectives of the STSM and its application to the two case studies in Barcelona. The final step has provided the conclusions derived from the direct experience of STSM with a particular reasoning of possible future developments for the integration of new methodologies within spatial planning processes.

The analysis status of the art highlighted a diffuse and a worldwide interest in the use of both Open and Big data, especially in their possible applications for the improvement of quality of life in cities. The analysis of data coming from the two platforms and their comparison provided outcomes on the possible use of such data within the planning and design of public open spaces. This study pointed out also some guideline on possible applications of user generated content (UGC) data to collect information that could be useful and effective in the design processes. In particular, the research produced a number of possible maps which can be obtained by the analysis and elaboration of Twitter data. The first map generated by tweets data shows the density of message sent per walkable cell. A second map connects the tweets sent by each single user according to their temporal sequence. The same visualisation was realised considering only the users who tweeted from almost one of the two case study areas. A further map was generated using the subsequent Tweets location overlaid on the road network downloaded from the Open Street Map (OSM) portal (Open Street Map Community, 2004). Using the shortest-path algorithm and the actual road system, the width of road line express the density of Tweets on roads. Splitting the Tweets according their time attribute, other maps show variations in the use of urban space during the week days and along the 24 daily hours. Finally, mapping the users' paths according to the language setting in users' profile allows to generate maps on the use of the city made by local or tourist people.

To conclude, an overview of pros and cons in the use of UGC data provides considerations on possible effective uses, while a list for future developments is illustrated to show how the research can evolve in the next months.

2. Purpose of the STSM

Recent development in Information and Communication Technologies (ICT) brought new important changes in the daily life of people. The possibility to communicate worldwide through common smartphones opened new perspectives to individuals, who very quickly responded with a massive use of social network platforms and applications. Since smartphones include Global Positioning System (GPS), the data outgoing from each device can be geo-referenced. Thus, the large amount of data coming from smartphone can be geo-located with a time reference. The consequence is the constant production of “Big Data” which can be overlaid on maps and analysed not only by mathematical or semantic techniques, but also by means of spatial analysis methods.

The goal of the STSM is to deepen the study on data generated by users for exploring new methodologies that could support and improve the understanding and design of open public spaces in urban areas. In particular, the current study should analyse two different urban areas within the city of Barcelona, considering their different characteristics and needs. The method proposed consists on the use of data generated by users coming from two different platforms.

The first platform is Twitter, the web social network currently used by 284 million of monthly active users (Twitter Inc., 2015). The messages sent by the use of this platform are public and, according to users' setting, geo-referenced. Thus, each message can be downloaded and stored on a personal database through free API available on the Web. The Twitter data used for the experimental research in the STSM have been collected by SiTI– Higher Institute on Territorial Systems for Innovation, the home institution of the author of this report, during the period January 7-19, 2015 for the entire area covering the city of Barcelona. The total amount of records is 126,288 Tweets, of which only 103,404 are georeferenced. Among these, only 4,781 records are from users who passed across one or both of the two case study areas.

The second platform is WAY, the CYBERPARKS App developed by DeustoTech Mobility within the COST Action TU1306 – CYBERPARKS (Deusto Tech Mobility, 2014). This GPS-based platform focuses on the use of ICT for understanding and collecting data on the use of public open spaces in order to improve the production of public spaces and their relevance to sustainable urban development. Available data are only those gathered during the pilot test organised in November 27, 2014 with a selected group of users moving between the two case study areas in Barcelona. Of course, in this moment there is only a small number of users. As a consequence, also the variety of users is very low.

Therefore, the main objective that motivates the here described STSM in Barcelona concerns the analysis and design of urban spaces by means of user generated data coming from social network platforms and apps.

3. Description of the work carried out during the STSM

(3.1) State of the art

The availability of big and open data is nowadays offering new opportunities for re-thinking the human behavior and impact on Earth. Since these data are often geo-referenced, their overlaying on maps is a simple procedure that can easily provide information on particular organization and structure of spatial systems. Therefore, many disciplines can benefit from their use such as urban planning, urban design, transport planning, social sciences or human geography.

Although a large number of applications and experiments constellates the landscape of research, the academic research has not yet found a specific own identity within these huge opportunities. Meanwhile, geographers do not have the knowledge of computer scientists or mathematicians, nor architects know how to handle this intangible material. However, a lot of public and private bodies have begun to use these data for their own development. A brief overview on the state of the art on the use of User Generated Contents (UGC) in spatial planning can show latest applications and uses. The following list resumes the examples analysed:

- *Chicago: City of Big Data*: the new exhibition launched by the Chicago Architecture Foundation (CAF), partnering with IBM and others (CAF, 2014; IBM, 2014; Snodgrass, 2014; Kokalitcheva, 2014).
- *Twitter Data – Seeking Spatial Pattern*: The Center for Advanced Spatial Analysis at University College London monitored several cities' Twitter use over a one week period to determine patterns in temporal activities of cities overall and learn about networks within the cities (Neuhaus, 2011).
- *Geek Cities - How Smarter Use of Data and Evidence Can Improve Lives*: Bridgespan and the education organization America Achieves have released a big report (Lanzerotti, Bradach, Sud, & Barmeier, 2013) packed with case studies that illuminate how data-driven decision making can lead to the most effective use of a city's limited financial resources” (Kamenetz, 2013).
- *Smart Cities*. The examples on how the biggest technological companies such as IBM, Cisco or Siemens are promoting the concept of smart cities as a vision for planning the future of new and existing urban areas.
- *Urban Design With Emotions*: universities in Heidelberg and Kaiserslautern are testing the possibilities of the “People as Sensors” concept, which automatically measures emotions and stress levels. They are also analysing publicly available data from social networks like Twitter, Facebook, Flickr and Instagram (Resch, Summa, Sagl, Zeile, & Exner, 2014).
- *Big bang data – Barcelona, May 9- November 16, 2014*: Putting data culture at the centre of decision-making and of our way of interpreting the world opens up many possibilities, but also involves numerous risks (<http://bigbangdata.cccb.org>)
- *The Democratization of Big Data*: Some suggestion on how conceiving the use of Big Data as support to spatial planning From Robert Goospeed, Assistant Professor of Urban Planning at the University of Michigan Taubman College of Architecture and Planning (Goodspeed, 2011; 2012).
- *Eric Fisher’s maps*. The use of Twitter’s API to collect tens of thousands of geotagged tweets and map them onto the streets of several cities around the world (Fisher, 2012).
- *Tweet Bursts - The Senseable City Lab*, in partnership with Ericsson, has explored how we express excitement online, and how this could improve our understanding of human behaviour (Szell, Grauwin, & Ratti, 2014).
- *Sensing the Urban*: using location-based social network data in urban analysis. Large-scale data from Foursquare is analysed across three cities in order to produce an inter-urban analysis (Bawa-Cavia, 2010).
- *FlowSampler: Visual Analysis of Urban Flows in Geolocated Social Media Data*. An interactive visual interface designed for spatial planners to gather, extract and analyse human flows in geolocated social media data (Chua, Marcheggiani, Serrvillo, & Vande Moere, 2014).

(3.2) Methodology

Assumptions of this STSM were the use of UGC data to understand how their use could improve the design of public spaces. In particular, two different kinds of data have been analysed: Twitter data and CYBERPARKS App data.

The first set of data comes from Twitter, the web social network platform which counts hundreds millions of users worldwide. The particularity of this kind of data is that they are open and can provide very large amount of records and information, including attributes on time and location of each single tweet. In fact, according to users’ personal setting, the position tracking of devices can be enabled so that messages are geo-referenced. Furthermore, free APIs available on the Web allow people to download tweets and store them on personal databases. Furthermore, for each tweet is possible to freely obtain various information: the text of the message, the nick-name of the user who sends the message, the eventual name of the user receiver of the message, the date and hour in which the message was sent, the latitude and longitude from where the tweet was launched. At the same time, it

is possible to obtain information also on single Twitter users, such as the user's screen name, the user's full name, his/her location, the user's self-description, the number of his/her follower, the date in which the user first joined Twitter, the user's time zone, main language, current status with date, the user's numeral ID, the ID of this user's followers, his/her profile pictures.

The second set of data comes from the CYBERPARKS App, developed by DeustoTech Mobility within the COST Action TU1306. This app is GPS-based platform that, differently from Twitter data, registers the users' movements twice a second. The result is a point database which allows to build up the a timeline with the full path travelled by users, with continuity and precision (fig. 1). The app is conceived as a Volunteered Geographic Information (VGI) platform where users collaborate for producing information. In particular, it collects data for better understanding the use of public open spaces in order to improve their production and their relevance to sustainable urban development. To achieve this task, it collects also data on the user such as age, sex, education, job, the distance from home and from working place, and the reason of being in a public space, such as walking, running, reading, kids or pets.



Figure 1 Data collected by the CYBERPARKS App.
Image source: Elena Masala.

Once data have been collected the subsequent steps are as it follows:

- Import data from Cyberparks App in Arcmap: converting the *.json file into a file readable from ESRI ArcMap.
- Elaboration of Twitter data in Excel.
- Import Twitter data in ESRI Arc Map.
- Use of information about time and coordinates of data from Cyberparks App to trace plausible paths of single users (or group of users).
- Use of time and coordinates of tweets to trace plausible paths of single users (or group of users) within specific areas.
- Use of time and coordinates of tweets to trace plausible paths of single users (or group of users) who pass through specific areas.
- Use of tweets information about languages, presence of tweets for large period, keywords, to identify different kinds of densities within specific areas. This can also be useful to differentiate local users from tourists.

(3.3) Case study

The research developed in Barcelona focused on two particular areas: the "Carrer d'Enric Granados" and the "Fòrum de Les Cultures" (Fig. 2). Carrer d'Enric Granados is a street within the consolidated historical city which connects Avinguda Diagonal with the old University building on the Gran Via de les Corts Catalanes. Differently from the near "Rambla de Catalunya" and "Passeig de Gracia", Carrer d'Enric Granados is not highly touristic, but hosts several various activities mostly for local people.

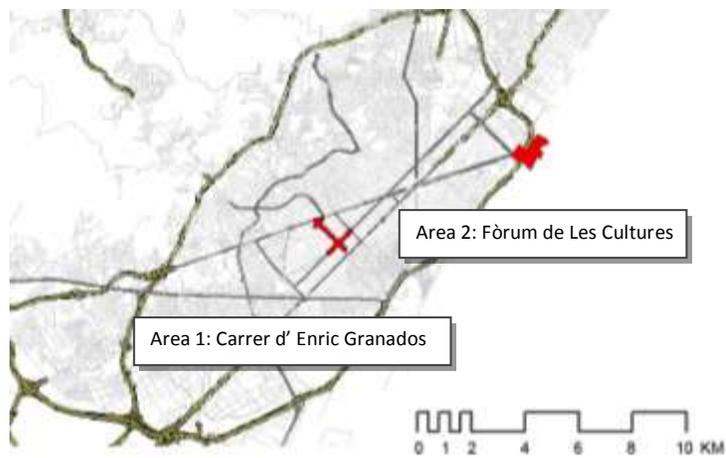
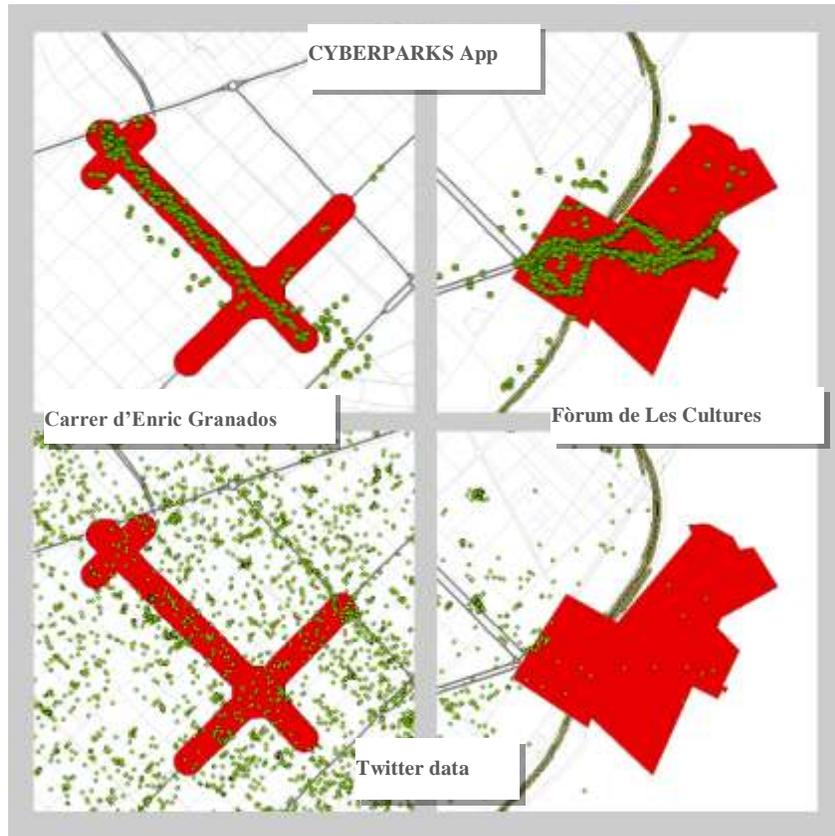


Figure 2 Location of the 2 case study areas within the city of Barcelona. Image source: Elena Masala.

The second area, the Fòrum de Les Cultures, rises on the old industrial pole of Poblenou, an urban district which has been renewed during the end of the XX century and got ready for hosting in 2004 the Universal Forum of Cultures. This area is a key-point of the city layout, in fact, it is where the Avinguda Diagonal meets the sea. The area is pointed by a number of new architectures, with buildings, skyscrapers and open spaces designed by very famous architects, providing a new character to the area. Actually, the area could be very more attractive. Nevertheless, the connections between these interventions are lacking. The large paved esplanade provide a sense of incompleteness. In fact, the size of the place and buildings, together with a general lack of facilities and attractions, make this area outsized for pedestrians. A first comparison between the two areas provides different elements to consider (fig. 3). First, data from the CYBERPARKS App are very dense and provide continuity, so that users' paths can be easily identified, while Tweets are diffuse in both space and time dimensions. Second,



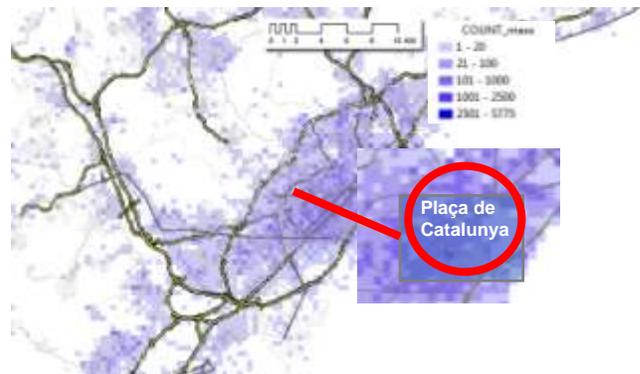
CYBERPARKS App data are mostly located in the two areas, whereas Tweets cover the whole city / region /country / continent /globe. As a consequence, while the GPS app provides very detailed information on a place and on single users movements, Tweets can provide more general information on how a place can be hierarchized on the basis of different spatial and non-spatial elements. Third, CYBERPARKS users are aware that their data will be used for spatial analysis, while Twitter users' do not generally consider this possibility.

(3.4) Maps and visualisations

The data from the CYBERPARKS app that have been used during this STSM provided a number of information which can be very interesting for analysing the small design scale. Nevertheless, users are currently very limited and the outcomes are not reliable. Thus, the STSM focused on the use of Twitter data for identifying possible applications on the design of public spaces. The scale comprehends the whole city for understanding how the two case study areas relates to the rest of the urban space.

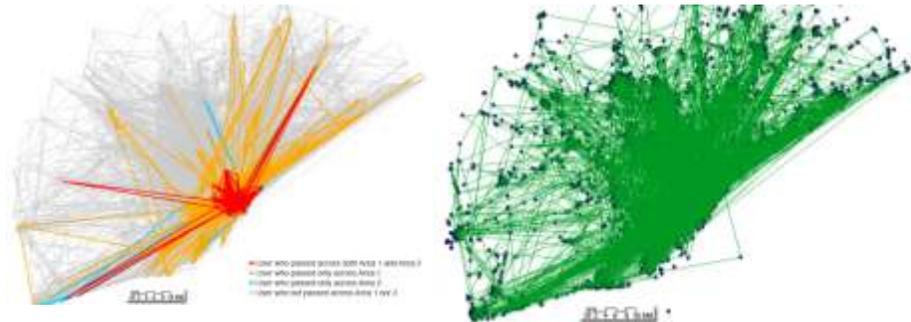
Tweet density

Density of message sent per walkable cell, that is a cell 400m x 400m as defined by O'Sullivan & Morral (1996). This kind of map can be very useful in highlighting the presence of particular place, such as touristic attractions, transport mode exchange hubs, or public spaces such as universities or shopping malls. Looking at the cells with highest densities, it appears evident the high concentration of tweets in the area of Plaça de Catalunya, which is the key-point for the public transport within, towards and outwards the city of Barcelona.



Users' movements

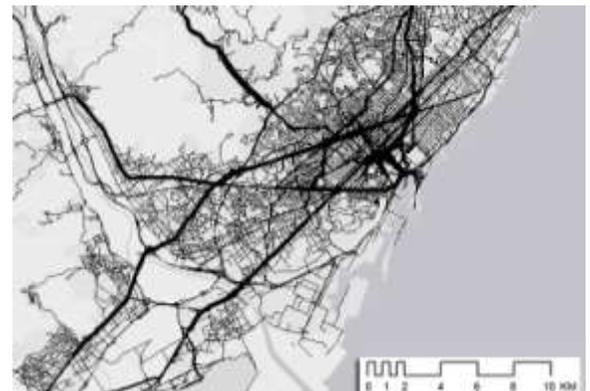
The map below connects the tweets sent by each single user according to the temporal sequence. This map does not show the actual paths of users, but it connects all the places where each user has been. Although lines are not paths, it is evident the centrality of the city centre and the direction of main axes outside the city.



Links between each subsequent tweets for each user who tweeted from the whole area of Barcelona (on the left) and from one or both of the two case study areas (on the right) in the period January 7-19, 2015.

Road congestion according to Tweets

Using the shortest-path algorithm, the lines connecting subsequent Tweets is superimposed to the actual road system, whose map has been downloaded from the Open Street Map (OSM) portal (Open Street Map Community, 2004). The higher the density of Tweets on the road, the larger will be the width of road line. Of course, this map will not be useful for planning a transport system, neither on mobility because railways and tramway tracks were not considered, but it can provide other information on social behaviour.



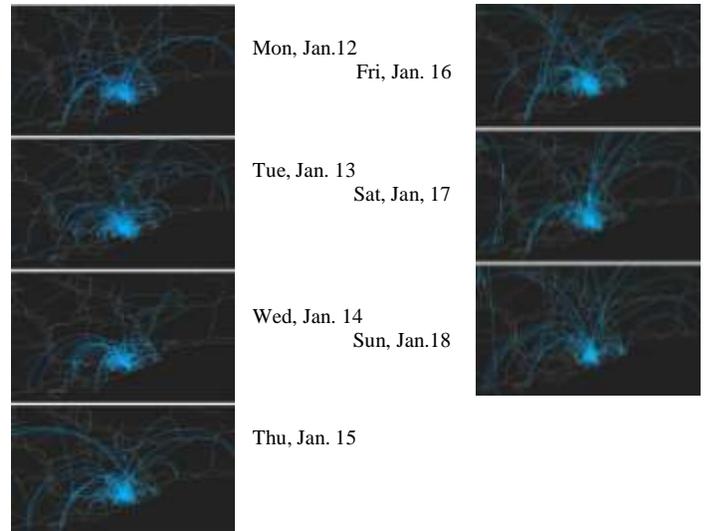
Week days visualisation

Splitting the Tweets according their time attribute, other maps show variations in the use of urban space during the week days.

This set of maps has been realised considering both the spatial and temporal information of subsequent tweets, which are connected by semi-circular arches, whose radius is proportional to the spatial distance which separate each couple of tweets.

Thus, it is possible to see that displacements during Wednesday 14 have been shorter than other days, or that during Sunday 18, the activity around Plaça de Catalunya is significantly decreased in comparison to the rest of the week. The visualisations considers only the Twitter users who have been tweeting from one of the two case study areas.

Using 3D arches instead of line laying on maps allows to connect distant points without providing suggestions on users' paths and preventing wrong information.

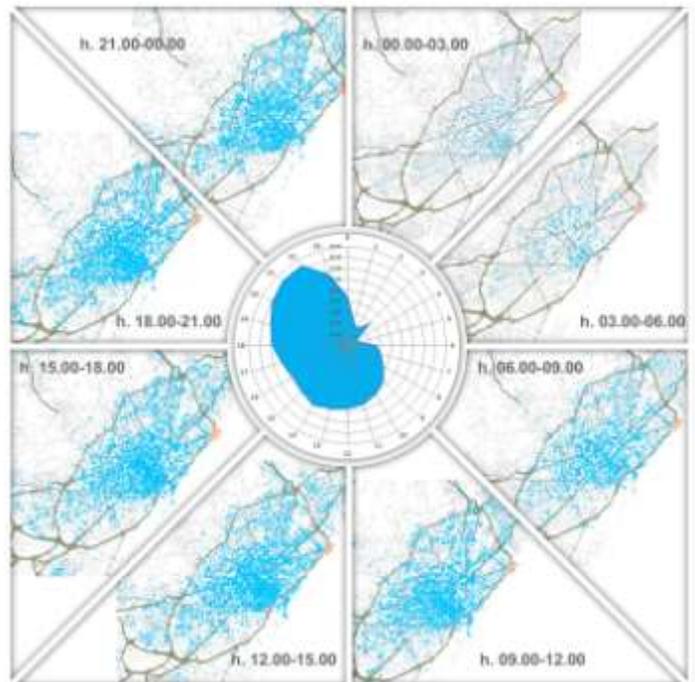


Daily hours visualisation

Splitting the Tweets according their time attribute, other maps show variations in the use of urban space along the 24 daily hours making possible to better understand the city life. In fact, the number of tweets increases during the evening, reaching a peak at 9.00-10.00 pm, as resumed by the radial diagram.

It is particularly interesting to see how the city centre and some specific axes remain active also during the night time, while other areas are practically abandoned.

Other possible visualisations concerning the daily hours have been realised using a three-dimensional visualisation similar to that about the week days, but with dynamic and interactive features. In fact, a sliding cursor allows the viewer to explore data and choose the range of hours to visualise or to view the sequence of tweets hour by hour.

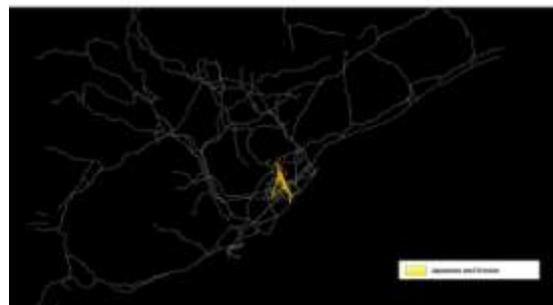
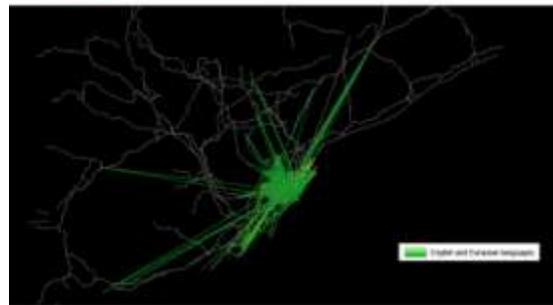
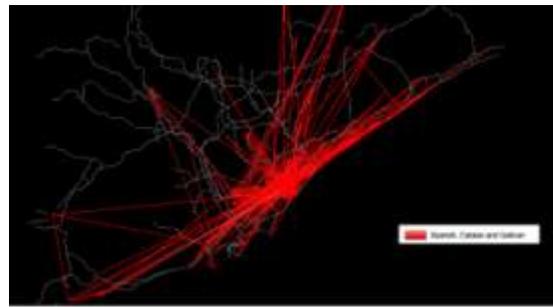


Use of urban space according to Twitter users' chosen language

The first log-in in Twitter makes users to choose a language. This setting can be known through Twitter free API. Therefore, maps concerning the language of users can be generated.

Using only the Tweets of users who passed by almost one of the two case study areas, these maps have been generated differentiating users by the chosen language of their accounts. The result is very particular, because it highlights the use of tourists from local people, outlining also some attitudes of tourists: higher is the distance they come from, smaller and more oriented towards famous arts and architectures is the area they visit.

Map of users' paths according to the language setting in users' profile



4. Description of the main results obtained

The use of Twitter data showed to be very effective from the point of view of use of public space within the urban area. The illustrated maps show its possible use in different fields such as human geography, spatial planning, transport planning or social issues. Nevertheless, a number of issues has to be considered before using these data. First of all, Twitter users are a small part of the entire population, while geo-referenced data are a portion of the total amount of useful Twitter messages. This outlines that only a small part of the entire demographics is represented by usable Twitter data. Secondly, Twitter messages contents are about everything, then, in order to be used, they need to be hardly filtered. Thirdly, it is essential to consider that while local people have access to local tariffs for Web connections and can use smartphone anywhere, tourists from abroad generally use free Wi-Fi hot spots for the use of web-related apps. Thus, in order to study tourist paths, maybe an integration with maps of Wi-Fi hot spots is necessary. Furthermore, information on users languages, and presence of their tweets for a long period in the same area can provide information on users, making deductible if they are local or tourists. This opens to new opportunities in the use of Twitter data. In addition, it is particularly important to consider that Twitter users are not conscious that their messages are tracked, or more simply, they are not interested on the way their data will be used. Finally, the location of a tweet should be approximated considering that a tweet take some time to be written and sent, and beside this, the user can move during sending a tweet. Thus, according to the mode of mobility, in the meantime the user may have traveled a substantial spatial distance.

Nevertheless, the main limit of CYBERPARKS data is given by the fact that who generates the data, namely the user, is conscious that he/she is producing data for some specific analysis task. Therefore, it is necessary to consider that this awareness can alter the veracity of the data.

5. Follow-ups - future collaboration with host institution and foreseen publications or papers for conferences/congresses resulting or to result from the STSM (if applicable)

The success of the experiment in using UGC data for the improvement of spatial planning has provided the opportunity for enlarging the network of both TU1306 Action's members and the author of this report.

First future collaboration has been proposed with the Deusto Tech team, the group of researchers who are working at the CYBERPARKS App. In fact, one important element will be the comparison of information coming from Twitter data with CYBERPARKS App GPS data. Their merging will provide complementary information which could be used to improve the efficiency of the use of UGC data within the spatial planning and design.

Second collaboration has been planned with Ernesto Marcheggiani (University of Leuven - KUL, Belgium / University of Marche - Univpm, Italy) and the group in Leuven including Alvin Chua for preparing a paper on the comparison between our methods. This will be essential for identifying a strong methodology in the use of Twitter data in the support of planning processes.

Last but not least, prof. Montserrat Pallarès Barberà from the Host Institution proposed to me the co-authoring of a paper on the topic of my STSM.

Until now, from a technical point of view, the analysis has not considered the message within the twitter data. However, a method for obtaining the most used words, tags and receiver has been determined. In fact, the computation of the text can provide further data on public space. For example, the filtering of tweets can be processed on the base of keywords related to public spaces (i.e. parks, architecture, fountain, dirty, clean, tree,...); this can provide information on the specific places, but it can also provide suggestions in looking for efficient keywords and/or opinions from users. The implementation of such study, will certainly contribute to deepen the connections with other TU1306 Action's members.

6. Personnel Benefit and mutual benefits for the Home and Host institutions

The experience carried out during this STSM provided very fruitful outcomes for this report's author, for the Home and for the Host institutions. At the personal level, the author grew her professionalism on the use of UGC data. Home institution showed particular interest in the work carried out during the STSM, so that a general presentation of the research has been done to a consistent group of researchers. At the same time, the work is now contributing to identifying new lines of research of the Home institutions within national and international research project. Finally, the host institution declared satisfied from the research so that it wants to carry on the collaboration between the parties.

7. Other comments (if any)

The brief overview on the state of the art shows how spatial planning is now facing a transition to a new undefined status. The recent trend led by the "smart city" concept has opened the spatial planning to a logic of numbers and data. City-sensors as well as UGC systems constantly provide huge amounts of data which can be used to supply to citizens' demands. In this context, two main branches are developing. The first branch is a data-oriented and technology-driven approach, which makes use of quantities for assessing and justifying decisions. Eye-catching visualisations are the most evident outputs of such an approach, where analysts and statistics prevail on the human experience of professionals and experts.

The second branch uses these new technologies to improve the human abilities and it is mostly used to support the decision and policy-making processes. Particular efforts are spent in understanding how data can support and be complementary to the traditional approach, providing new insights on spatial issues. The debate on the use of big data is nowadays shifting from a technology-driven vision towards a more human dimension, introducing the concepts of people friendliness and a human-to-human approach (Melis, Masala, & Tabasso, 2014). In this concept, as in a new renaissance, the man is the

central focus of the whole system. To achieve this social vision, the collaboration between different experts such as urban planners and data analysts and designers appears essential in order to guide them towards relevant questions and policy issues (Goodspeed, 2011). Then, the communication at different levels become one of the most important element in structuring the planning processes.

In this context, the author of this report believes that the exchange of opinion between researchers and the possibility to collaborate at different levels are really important opportunities not only for personal growth, but for the production of a common idea which could organize the basis of future cities.

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