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PLA2014-1062

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ATINER CONFERENCE PAPER SERIES No: PLA2014-1062

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This paper should be cited as follows:
Silva Lizcano, A. & Silva Lizcano, L., (2014) **"Location-Based Social Media and Urban Analysis. Using Foursquare Data to Map City Emotions",** Athens: ATINER'S Conference Paper Series, No: **PLA2014-1062.**

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URL: www.atiner.gr
URL Conference Papers Series: www.atiner.gr/papers.htm

ISSN: **2241-2891**
24/07/2014

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Abstract

Nowadays, due to the rapid development of the cities and the information society, planners are reconsidering the way in which urban planning is done. In this framework, the collection of location-based social media data is beginning to be explored as an opportunity to obtain valuable information related with the whereabouts of the people and their activities, but further work should still be done to find suitable approaches to produce meaningful interpretations of that data. Considering these facts, this paper presents a research work that started from the assumption that an analysis of the aggregate activity generated by such networks can help us to unveil the emotions its users experiment in order to create maps, useful for urban analysis, that represent the "Emotional Areas" of the city. For this purpose, the examination and analysis of Foursquare data is proposed through the creation of a suitable algorithm that help making the interpretation of the data gotten into representations of the users' emotions and perceptions. The main focus is to explore how the flow of information generated by location-based social media could be used as a tool to understand people's feelings and sentiments about different city places. The work developed and the analysis made shows, on the one hand, that the analysis of the social interactions in real-time would contribute to produce a deeper insight about the dynamic aspect of the city and how the social virtual interactions and emotions could be related with the physical landscape, while, on the other hand, it provides a better understanding of the impact and potentialities of location-based social media data in the context of urban analysis.

Keywords: Location-Based Social Media, Emotions, Urban Analysis.

Introduction

Location-based social media is not a new concept. Predecessors like Loopt[1] have been around since 2005. Initially, these services just allowed users to report their location via the GPS on their smartphones and send that data to their friends through an app, but newer companies have improved the concept and the facilities provided by these services. The concept really took off when those new start-ups started to create additional incentives for users to check-in and got local and national businesses actively involved in the system. Today, the users of these services are still able to figure out where their friends are, but can additionally find out about nearby businesses and locations in their city, discounts, and leave tips and recommendations for other users both in and out of their networks. The strategy has worked and the industry leader, Foursquare, has already surpassed 20 million users worldwide in 2012, corresponding to 2 billion check-ins[2].

But Foursquare is not the only one providing this kind of services. Major companies like Facebook and Google have adopted their own versions[3] of this located-based network, using the weight of their information databases and high user base to push them ahead in the market. Additionally, the increase popularity of location-based social media has also spawned a number of new spin-offs. For example, Hot Potato[4] allowed users to check-in at live events and gatherings; GetGlue[5] allows users to check-in to TV shows, movies, and sport events; and Hashable[6] allowed its users to track networking opportunities by checking-in with other people while tracking your meetings, lunches, calls and other events. These trends are really important to people interested in the use of the data provided by these kind of social media due to the fact that, as these services and applications progress, the information collected becomes less about the individual users and locations listed, but more about creating a specific network, or series of networks, within a given place.

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[1]Loopt is a mobile location-based service that allows users to discover the world and find and enjoy the friends, places and events around them via smartphones. http://www.loopt.com/blog/

[2]Data according with the announcement made during the third annual 4sqDay published in http://www.intomobile.com/2012/04/21/foursquare-surpasses-20-million-users-2-billion-checkins/

[3]The services provided by Facebook and Google are Places and Latitude respectively. In both platforms the user can check-in in places to let friends know where he is and can also get individual discounts, share savings with friends, earn rewards for repeat visits or secure donations for good causes. http://socialcompare.com/en/comparison/location-based-online-services-foursquare-facebook-places-latitude-gowalla-loopt

[4]Hot Potato combined the news feed aspect of Facebook with the location features in services like Foursquare. This company was acquired by Facebook in 2010. http://www.pcmag.com/article2/0,2817,2368078,00.asp

[5]Information about GetGlue available in http://getglue.com/about

[6]Hashable shutted down its service on July 25th 2012. http://techcrunch.com/2012/07/11/hashable-the-app-that-aimed-to-replace-business-cards-to-shut-down-on-july-25/

In light of the aforesaid characteristics of the location-based social media and the information that can be gathered by them, the main assumption of this research is that a spatial analysis of the aggregate activity generated by such networks can show us how social activity in a city is distributed, revealing spatial patterns evident in the social life of cities that could be useful for urban analysis since the information and multiple levels of data collected by such networks could give, for example, terrific insight about over and under-utilized districts and businesses. In this regard, for instance, by analysing check-in[1] patterns across these services, planners could have the ability to see which businesses and locals are more popular among locals or tourists, and which areas of the city see high or low volumes of flows of people depending on their activities and on the time of day. Additionally, since the content is completely generated by the users and it is constantly changing the data can be uploaded and refreshed in real time to reflect the most recent patterns and needs. Taking into account these facts, this research is aimed at analysing, if planners could get their hands on this evolving data, if it can move beyond the realm of creating personal networks and start being used to implement social change and improve urban form.

Background. New Information Technologies, Biosensors and Urban Planning

Much of our understanding of urban systems comes from traditional data collection methods such as surveys by person or phone. These approaches can provide detailed information about urban behaviours, but they are hard to update and might limit the results to certain periods of time (Silva Lizcano, 2013). Considering that the widespread deployment of mobile communications, supported by personal handheld electronics, is having a significant impact on urban life (Ratti, 2006) and that it is changing people's social habits, planners should be aware that the urban dynamics are becoming more complex as the activities that once required a fixed location and connection can now be achieved with higher flexibility. As a consequence, the urban planning field should develop new analysis techniques. In this regard the data collected through location-based online platforms or from mobile cell phone networks is becoming one of the most exciting new sources of information for urban analysis (Ratti, 2006).

Following this trend, in the past few years, some innovative approaches have sought to use mobile devices to collect spatiotemporal data (Celino, 2011; Cranshaw, 2012; Noulas, 2011). But little research has been done to analyse and develop the much larger samples of existing data generated daily by mobile networks. The most common explanation for this is that the challenge

[1]Check-in is a term used in some location-based social media, like Foursquare, to identify when a member has physically visited a venue (a business, physical location or residence). The check-in patterns in this case would refer to the characteristics or traits revealed by the location-based posts done in a social media.

of data-sharing with the telecommunications industry has hampered data access. However, for example, in early 2006, the collaboration between Telecom Italia and MIT's SENSEable City Lab allowed unprecedented access to aggregate mobile phone data from Rome to allow the researchers to use data for an entire metropolitan region to analyse its urban dynamics (Ratti, 2006).

But the efforts have not been only made in relation to the study of internet, the located-based services and the information they provide have been relevant issues of study too (Evans-Cowley, 2012; Lewis, 2010; Phithakkitnukoon, 2011; Scellato, 2011). Locational data are information provided by services accessible with mobile devices through the mobile network and utilizing the ability to make use of the location of the mobile device (Steiniger, 2005). Examples of the location-based services providing locational data include systems generating information about one's surroundings, distributed chat lines aimed at allowing people with similar profiles to encounter each other in space, and "digital tapestries" that attach different types of information to physical spaces (Ratti, 2006). The use of the data provided by these services is very important, as it has been proven in cases like the New York City Waterfalls[1] participative art experiment, because while network analysis focuses our attention on the symbolic relationships between actors, location-based media permit us to also evolve and root our discussion in the physical and tangible relationships (Townsend, 2008).

Furthermore, revolutionary methodologies and tools for visualising people's reactions to the external world have been also developed in the last years (Van Schaick, 2011). In this regard, one of the most notorious examples is the project called "Bio Mapping" that investigated the implications of creating technologies that record, visualise and share with each other our intimate body-states (Nold, 2009). The Bio Mapping tool proposed by Nold allows the wearer to record their Galvanic Skin Response, which is a simple indicator of emotional arousal in conjunction with their geographical location. This can be used to plot a map that highlights points of high and low arousal. By sharing this data we can construct maps that visualise, for instance, where we as a community feel stressed and excited.

[1]The Waterfalls public art exhibition in New York City provides a lens on the explosion of participation in public art through locative media. Designed by Danish artist Olafur Eliasson, and exhibited at four locations along the East River waterfront from 23 June through 13 October 2008, the Waterfalls evoked a frenzy of user-generated digital media. The Waterfalls generated an outpouring of social media products on the web including 6,000 photographs on Flickr, 1,200 blog posts, and over 200 videos totaling 3 hours in length on YouTube. (Townsend, 2008)

The Biochemistry of Emotions

For years now, the chemistry and medical field have developed research works aimed at finding how emotions might impact our biochemistry. Back in the 1980s, a group of research scientists, including molecular biologist Candace Pert and neuroanatomist Miles Herkenham at the National Institute of Health and neuroscientist of the Massachusetts Institute of Technology, began to radically change the scientific community's ideas of the way the human body works as they identified the means by which emotions cause the body wide release of all sorts of information-carrying molecules, often in areas with no electrical neurons. These chemicals, known as ligands, most of which fall into the giant class of chemical messengers called peptides, perform a vast range of functions. They travel through our extra-cellular fluids and hook up with specific, highly selective receptors located on cells throughout the body. Once attached, they impart molecular messages that can dramatically impact our physiological functioning at the cellular and systemic levels (Pert, 1999)

Moreover, thanks to new imaging technologies, research scientists have now been able to demonstrate how thoughts and emotions cause distinct neuron-firing patterns within various parts of the brain. They can also observe how these patterns coincide with chemical releases and reactions throughout the body. The science behind all this is fascinating, and the conclusions are staggering. It turns out that biochemical reactions to mental and emotional stimuli occur not just in the brain but also, often simultaneously, in virtually every system of your body (Kveraga, 2007).

We also now know that the brain and nerves, and the immune, endocrine and digestive systems are in fact capable of releasing and receiving many of the same peptides. Thus, all these systems are inextricably linked in a sort of secondary, chemically based nervous system, one that is intimately connected with the electrically based central nervous system with which most people are more familiar.

Such understandings are radically changing perceptions, not only in the chemistry and medical field, but also in other fields of study like arts, geography and urban planning. This fact has allow to develop research projects that increase our perception and make visible to the society, but ourselves in the first place, the emotional states that certain spaces and situations generate on us. The results are often in fact tangible in the visualization of real personal cartographies that, shared with other users, enrich the mapping of the territory around us and open the sight to an unexpected and new way to look at it. Cases like the "Bio Mapping" project mentioned before, create examples in which the invisible interaction of the anonymous mass breaks the lonely simultaneous proceeding, and emerges in coloured paths, re-interpreting the digital passage where space and technology become, this time, canvas and brushes (Nold, 2009).

Due to the aforementioned facts, at the beginning of this research work, we envisioned a system with which, through the use of different devices measuring for instance the heart rate and other chemistry reactions of the human body, we

could measure the level of excitement of people while moving in the city. This approach was very similar to other ones that have been used in projects developed by artists, psychogeographers, designers, cultural researchers, futurologists and neuroscientists aimed at exploring the political, social and cultural implications of visualising people's intimate biometric data using technology.

Nonetheless, as noted when doing research about these issues, a description of a city produced by biometric sensors might not be as accurate as we would like it to be as, for instance, an increase in the heart rate of the people in a specific area of the city could mean either that there is something beautiful or breath-taking in that place or that it is a dangerous area for some reason.

Considering these reflections, and taking into account the initial goals of this research, we decided that the use of biometric sensors or the analysis of chemistry reactions might not be as useful as we initially thought for the aims of this research so we decided to test an alternative path by trying to unveil people's emotions about the city not looking into their biometric parameters, which could be a little bit ambiguous, but by focusing only on making a semantic analysis of their virtual interactions and behaviour in the location-based social media networks to then characterise the different parts of the city according to the sentiments experimented by its users and create maps of what we have called "Emotional Areas" in order to be able to determine which kind of feelings each area produce.

The Study. Using Foursquare Data to Map City Emotions

From the literature review made for this research and from the analysis of the state of the art, it has been possible to recognise that the introduction of new technologies is already changing the nature of urban research (Dörk, 2011). Taking into account the potentialities and limitations of the projects developed by other scholars using biosensors and new information technologies for urban analysis and mapping, we have directed the research focusing on the latter technologies so the study presented in this paper started from the assumption that a spatial analysis of the aggregate activity generated by location-based social media networks can show us how social activity in a city is distributed, revealing spatial patterns evident in the social life of cities that could be useful for urban analysis.

Consequently, the examination of data from one such network was proposed in order to produce an urban analysis of the spatial patterns, related to people's emotions, of one specific area of a given city. To then, develop an evaluation of the information gathered and of the analysis made to ascertain the potentialities of such information for urban planning.

The main focus is to explore how the flow of information generated by location-based social media could be used as a tool for this field of studies and try to contribute to generate a better understanding of the impact of these

networks in the context of urban analysis. This is made, in particular, by attempting to explore the relation between the analysis of people's emotions, the actual space where those emotions take place and urban planning.

Architects and urban planners know that much of our understanding of urban systems comes from traditional data collection methods, such as census and surveys by person or phone. These approaches can provide detailed information about urban behaviours and have been really useful to get, for example, socioeconomic and demographic information; but they are hard to update, have high costs, might limit the results to certain periods of time and present some difficulties while trying to describe city dynamics and time dependent variations in intensity of urban spaces usages by temporary populations at different scales.

Considering these facts and the widespread deployment of mobile communications in recent years, some scholars have already started to propose that the urban planning field should develop new analysis techniques (Schroeter, 2011; Talvitie, 2004) that would allow the integration of traditional datasets with other sources of information that are easily expandable, that are able to describe the relationship in time and space of urban behaviours, that allow us to quantify practices and not simply flows and that let us identify variations in the use of space in time (Manfredini, 2013).

In this regard, the data collected through location-based online platforms, mobile cell phone networks and devices such as GPS, is becoming one of the most exciting sources of information for urban analysis, as noticed during the initial bibliographical research done for this research project.

So, following this trend, we have decided to try to get a deeper insight about the potentialities of this approach and the ways in which urban planners can effectively include these tools into their daily practice. In this regard, among the research questions that could be arisen, some queries that have driven the research have been the following:

- Could location-based social media be the next step in helping planners better understand their cities?
- How can we use the data generated by the location-based social media for urban analysis?
- Is the information provided by location-based social media a useful tool to characterise the spatial distributions of groups and activities in a city?
- Which are the specific services and the applications that could be useful for urban analysis?

Our curiosity on the aforementioned issues led us to propose the collection and analysis of data records from one such network in order to try to give possible answers to the said questions based on some kind of experimentation with that sort of data.

The proposal includes the examination of data from Foursquare, due to the fact that this location-based social network allows to get specific georeferenced

data about different kinds of city venues and comments from the users about them.

The experiment has been projected in order to try to explore the relationship between the analysis of people's emotions and urban planning by making a study of their virtual interactions and behaviour in such network to then characterise the different parts of the city, according to the sentiments experimented by its users, and create maps of what we have called "Emotional Areas", assuming that the methodology proposed, the maps produced and the information obtained could be useful tools for urban planning.

For the proposed test, the arrangement of the datasets consists of geolocated venues, at which check-ins take place, as well as data regarding users' types and actions, and their virtual interactions represented by comments, tips and suggestions.

In this regard, there are two data collection methods that have been used until now for this research. The first one is a specific process to perform the data collection from Foursquare that has been developed by Sarah Williams[1] from the MIT. In this method, a grid is set up over the area that will be analysed through x and y locations and a request of the Foursquare API data is made for each point every two hours by creating a code in the computer using a programming language.

Here it is important to highlight that the extraction of this information is a challenging task that requires skills not possessed by many engaged in urban planning (Silva Lizcano, 2013), which has been in part our case, even if we have previously learnt some programming languages. In light of this, it would be essential to create a relation and cooperate with other research centres and stakeholders involved in the development of the technology and the applications needed in order to perform the analysis of the data from the location-based social media chosen.

The second method includes a little bit more straightforward data collection process that has been performed by using the Twitter Archiving Google Spreadsheet developed by Martin Hawksey[2], which is freely available in his personal blog.

This tool allows to automatically pull results from a Twitter search into a Google spreadsheet and, among other features, it allows to set the period analysed, up to the last seven days; and the number of tweets it collects, up to 18000 per week. The information obtained includes:

- User ID
- Text string: which is the actual text of the each tweet

[1]Sarah Williams is currently an Assistant Professor of Urban Planning and the Director of the Civic Data Design Lab at Massachusetts Institute of Technology's (MIT) School of Architecture and Planning School. The Civic Data Design Lab works with data, maps, and mobile technologies to develop interactive design and communication strategies that bring urban policy issues to broader audiences. Source: http://dusp.mit.edu/faculty/sarah-williams

[2]Martin Hawksey is a Google Developer expert interested in tools/techniques for analysing and visualising data. Source: http://mashe.hawksey.info/

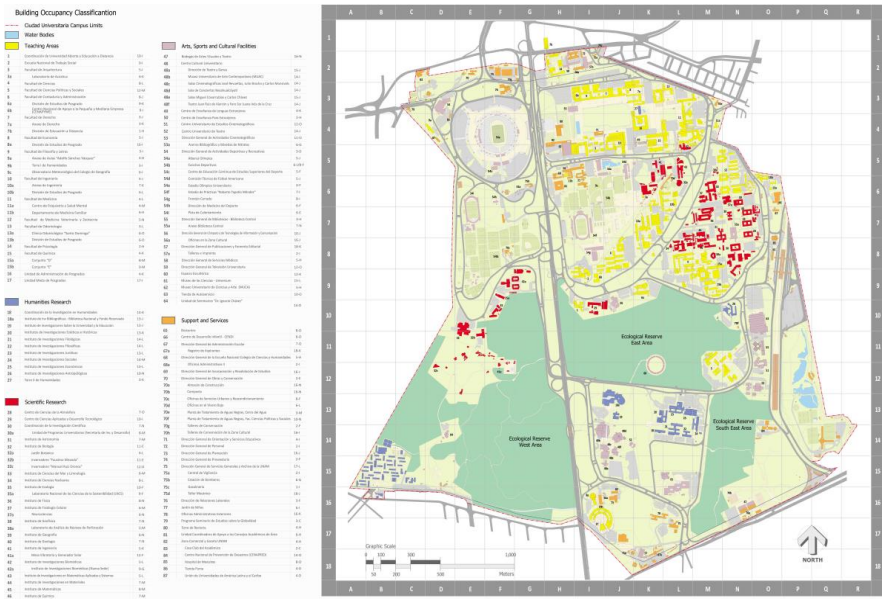
- Date and time of creation
- Coordinates: only available in some cases
- User language
- User followers count
- User friends count
- Shared links: including, for instance, Instagram, Foursquare and different websites links.

Unfortunately, this tool only allows to search terms and it does not allow to limit the search to a certain geographical area.

In order to apply the aforementioned methods for the experimental phase of the research in a real situation, and based on previous research works using geolocalized data for urban analysis, some considerations have been taken into account for the selection of a specific case study.

In this regard, the Ciudad Universitaria of the Universidad Nacional Autónoma de México, in Mexico City, has been selected in order to test the approach proposed in a relatively small area in order to have a better control of the experimentations done. Furthermore, its define boundaries and quite homogeneous population would facilitate the study. The following image (see Figure 1) shows the case study area from which a "traditional" urban analysis have been already made for this research.

Figure 1. *Map of the Ciudad Universitaria Campus of the Universidad Nacional Autónoma de México*



Source: Own elaboration with the information and maps provided by Arch. Javier Ortiz from the Dirección General de Obras of the Universidad Nacional Autónoma de México

Therefore, when applying the data collection methods to the specific case study selected, and due to the limitation previously explained of the Twitter

Archiving Google Spreadsheet, when running a search through this tool for this specific area, we looked for terms related with the Ciudad Universitaria itself in order to try to get only tweets geolocated in this precise zone.

The result of such trials was, for instance, that when looking for the term "unam", which is the acronym for Universidad Nacional Autónoma de México, we got thousands of tweets but a great number of them was not geolocated in the case study area or did not even had coordinates. However, in spite of this limitation, a good point is the availability of the actual text of the tweets. This fact has allowed us to perform a sentiment analysis in order to evaluate each text string and classify them according to a specific criteria previously settled. In this case, the emotions' characterisation criteria for this research takes into account three main areas:

- Safety or safeness
- Attractiveness: related to:
  - Spatial Quality
    - Monuments
    - Landscape
    - Urbanity
  - Functions
  - Social Encounter
- Accessibility

This kind of emotions' characterisation criteria has consented us to know, for example, if people perceive a certain place as not accessible even if we know that is well served by public transport systems when looking into official documents or results of traditional urban analysis methods.

A further step, also proposed in this research, was to find suitable representation techniques in order to translate the results of the analysis made into visual representations of the "Emotional Areas" of the city. In this regard, the maps that have been developed show the interested area with the results of the sentiment analysis performed using the emotions' characterisation criteria out of the Foursquare data obtained. The fact of keeping a proper visualization of the site of the case study has allow, at the same time, to preserve and make evident the relationship between the actual physical space and the immaterial world of the users' interactions in the location-based social media.

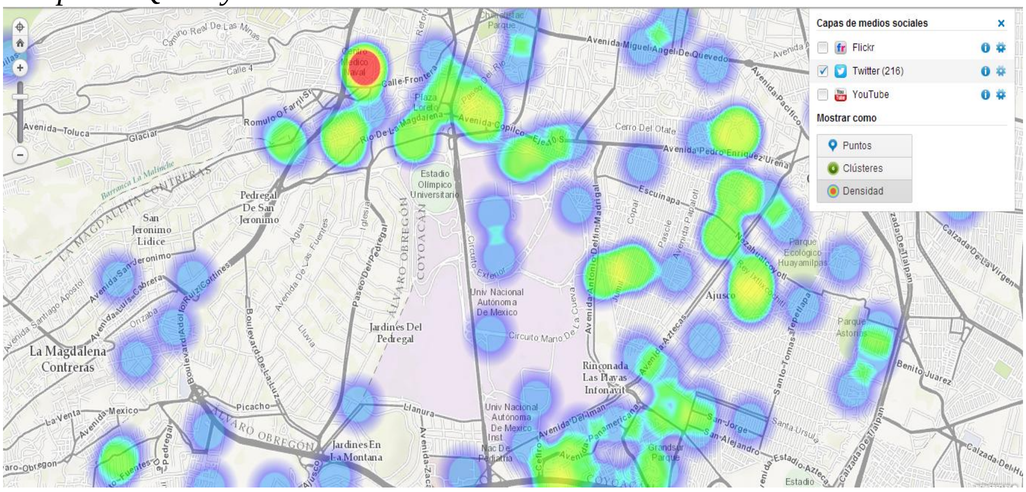
Consequently, we have produced maps showing the emotional areas of the Ciudad Universitaria Campus regarding, for instance, a positive perception of its spatial quality (See Figure 2). The analysis of the map obtained in this case provided us added-value insights about people's perception of the investigated area since it exposed positive emotions in areas we would already expected, but also in certain specific places we would consider as neutral or negative emotions' producers by relying just on the traditional urban analysis methods.

Figure 2. *Screenshot of the Web Mapping Application showing the Emotional Areas of the Ciudad Universitaria Campus regarding a Positive Perception of its Spatial Quality*

Source: Own elaboration

Furthermore, in order to have a counterpart vision of the previous map, a record regarding a negative perception of the spatial quality of the area have also been produced for the same day and time (See Figure 3). The results have shown that, while positive emotions were experienced in areas with particularly high spatial quality, adverse emotions were expressed in less neatly arranged spaces like public transport system exchange nodes.

Figure 3. *Screenshot of the Web Mapping Application showing the Emotional Areas of the Ciudad Universitaria Campus regarding a Negative Perception of its Spatial Quality*

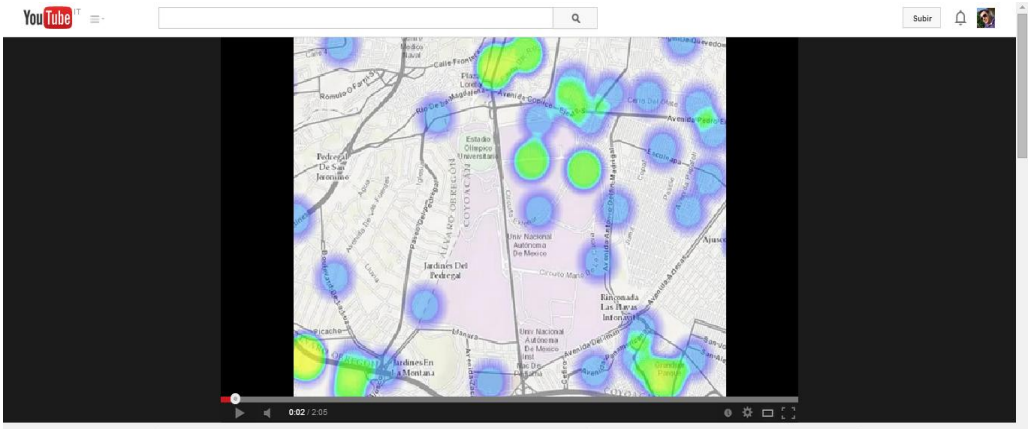


Source: Own Elaboration

In addition, one of the main potentialities of the approach proposed in this research is the possibility to relate the records obtained to specific and precise periods of time. The latest feature is an important characteristic of the kind of datasets we have worked with as it also allows to create geo-temporal animated

maps of the interested area (See Figure 4) in order to produce temporal visualisations of the phenomena and emotional areas analysed. In this regard, animated maps of the Ciudad Universitaria Campus have also been created in order to appreciate how its emotional areas evolve during the day.

Figure 4. *Screenshot of the Geo-temporal Animated Map Entitled "Happiest Places throughout the Morning" produced for this Research. The Video is available Online on Abel Silva Lizcano's YouTube Channel*



Source: Own Elaboration

Findings and outputs, like the ones mentioned before out of the "Emotional Areas" animated and static maps produced, are valuable because when applied to an urban system the kind of analysis proposed would not only deepen our understanding of man's behaviour within the urban environment but also give a broader emotional perspective of spatial behaviour. Such understanding is necessary for making useful suggestions as to how man's innumerable problems in the city might be solved.

Preliminary Results and Conclusions

At the current stage of the research, the investigation performed until now and the work done for its experimental phase show, on the one hand, that the data obtained from location-based social media may enhance the urban analysis process and a knowledge-based urban development if we have in mind the limitations of the data that could be obtained from such networks and their demographic specificity when interpreting the aggregate data.

It is also worth saying that, at least from our point of view, this kind of approach is not intended to substitute the traditional analysis methods but to serve as a complement for the information we can get from them. Another potentiality of this approach is the amount of data that could be obtained from the location-based social media networks and the unpreceded opportunity to rely on big datasets of information showing peoples comments and feelings about specific city areas and features.

While, on the other hand, the work that has been done exposes that, if urban planners are willing to use this kind of information, a cooperation between experts from the computational engineering and design field is an important agreement that should be reached.

In this regard, an interesting direction for further work would be to join this investigation with research centres specialized in computational issues. This fact might also contribute to a better understanding of the ways in which both fields could complement each other and of the mechanisms needed to ensure an effective and productive cooperation among them.

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