U-Tool: A Urban-Toolkit for enhancing city maps through citizens' activity

E. del Val, J. Palanca, and M. Rebollo

Universitat Politècnica de València, Valencia, Spain
{edelval, jpalanca, mrebollo}@dsic.upv.es

1 Introduction

The study of the dynamics of cities has become a topic of particular relevance when planning the development of cities or analyzing their influence on citizen activities and how citizens interact with the cities. The availability of updated data in real time about what is happening in a city is of vital importance for the development of what is known as smart cities.

The main problem is the availability of information for decision-making in real-time. However, the use of social networks through mobile devices turns citizens into mobile sensors to trace their movements and habits.

Currently, there are several tools to analyze user activity on different social networks. We will focus on Twitter. Twitter is one of the on-line social networks that has been extensively studied due to the accessibility of the information that is posted by its users. It has millions of users around the world and they can have a public profile where their messages can be seen by anyone or they can have a private profile where only selected followers can see the messages. Most users usually have a public profile which allows other users to follow them and see their messages in their time line.

Twitter, through the application Twitter Analytics, provides users with statistics of their activity and the impact it has on their *friendship circles*. However, this tool is private and only allows to study the activity of the user that can be useful to determine the impact of specific campaigns. Other tools provide the ability to follow the impact of hashtags (i.e., *SocialBro*, *Tweetbinder*, or *Sprout Social Topsy*). However, for urban analysis is also necessary to analyze geopositioned information. *Geofeedia*, *WeLink* and *HootSuite*, allow to determine an area of study and analyze the activity of this area.

There is still a pending issue: the analysis is performed off-line, once the information has been collected. The main problem is detected is the ability to do real-time analysis, incrementally, incorporating new information as it is received and integrating it into the existing results. In this sense, *Flocker* (of Outliers Collective), allows to follow a label and perform online tracking, building real-time a network reflecting the discussions taking place in real-time about the selected label. However, it is a tool in development and the final analyzed data provided is quite limited and does not include spatial information (geopositioned) of tweets.

2 Main purpose

The objective of this web application is the generation of a tool that allows users to explore, in an intuitive and visual way, different analysis of activity in the city to assist them in making decision process. This tool will be useful both on a professional level, as is the analysis to urban planning, and users, citizens or tourists that move around town and want to explore the activity of certain areas in real time.

U-Tool is able to perform a real-time analysis on the activity of a city. This tool can be applied to: detect where an event is happening, mobility patterns (detect where the population is moving to or pedestrian flows), detect which areas and of the city receive greater attendance of visitors, prediction of activity in a particular point of interest in the city, locate the optimum location for a new urban facility, measure the spatial accessibility between different parts of the city and detect alternative routes. In general, this type of urban analysis will help us to understand the social and economic consequences of the planning of cities.

3 Demonstration

Data. The data used are tweets and photos that are geotagged in a city. Access to information is done through the public API for developers of Twitter and Instagram. Moreover, there are local governments that provides information about the infrastructure of the city through open data initiatives. By knowing the infrastructure of the city, we can estimate the area of influence of each point of interest (PoI) through a set of proposed metrics.

Currently, the web application considers: (i) density of activity/users associated to each PoI of the city; (ii) metrics associated to the network structure generated using Delaunay's triangulation; (iii) "hot"/"cold" spots in the city that have an unusual activity compared to the expected values in a usual day; (iv) estimation of the attraction of each PoI in the city; (v) mobility patterns.

Metrics. Density of activity/users of PoIs. Based on the POI (Points of Interest) identified in the city, a Voronoi map is generated. The map is colored in response to the density and the number of messages generated in each area (see Figure 1). There are two ways of understanding the data. If we consider unique authors, (i.e., considering only a tweet/photo per user), it can be estimated how many people are near a PoI. Considering the general activity, (i.e., total of number of messages generated by users located in the PoI) you can determine in which part of the city is an important activity going on.

Structural metrics. Based on the Voronoi diagram generated from the POI (Points of Interest), a network is created using a Delaunay triangulation (see Figure 2). Nodes of this network represent PoIs and links represent relations with other neighbour PoIs. Once the network is available, we consider structural measures such as diameter, degree of clustering, or index centrality measures (i.e., closeness, betweenness, and eigenvector).

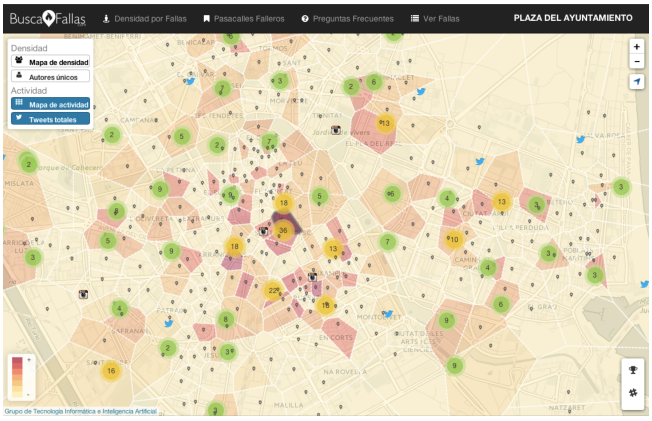

Fig. 1. Buscafallas.com

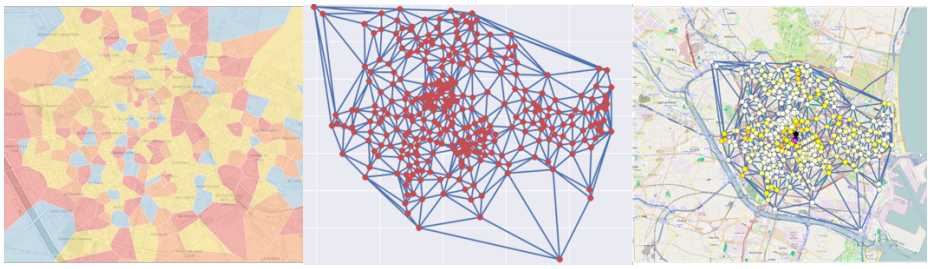

Fig. 2. Voronoi map and Delaunay triangulation

Unusual activity. We have applied the Local Moran Index. This index detects, given a set of weighted entities (PoIs), statistically significant spatial outliers. This index makes possible to determine "hot" or "cold" spots in the city that have an unusual activity compared to their expected values.

Attraction of PoIs. Using a model of gravitational potential (see Figure 3), we estimate the attractiveness of different PoIs for people.

Mobility Patterns. We create a network that captures the mobility of users individually. This allows us to detect patterns of urban mobility by using information from social networks.,

Web Application Buscafallas?

4 Conclusions

Acknowledgements

References

1. Clarke, F., Ekeland, I.: Nonlinear oscillations and boundary-value problems for Hamiltonian systems. Arch. Rat. Mech. Anal. 78, 315–333 (1982)
2. Clarke, F., Ekeland, I.: Solutions périodiques, du période donnée, des équations hamiltoniennes. Note CRAS Paris 287, 1013–1015 (1978)
3. Michalek, R., Tarantello, G.: Subharmonic solutions with prescribed minimal period for nonautonomous Hamiltonian systems. J. Diff. Eq. 72, 28–55 (1988)
4. Tarantello, G.: Subharmonic solutions for Hamiltonian systems via a $\mathbb{Z}_p$ pseudoindex theory. Annali di Matematica Pura (to appear)
5. Rabinowitz, P.: On subharmonic solutions of a Hamiltonian system. Comm. Pure Appl. Math. 33, 609–633 (1980)

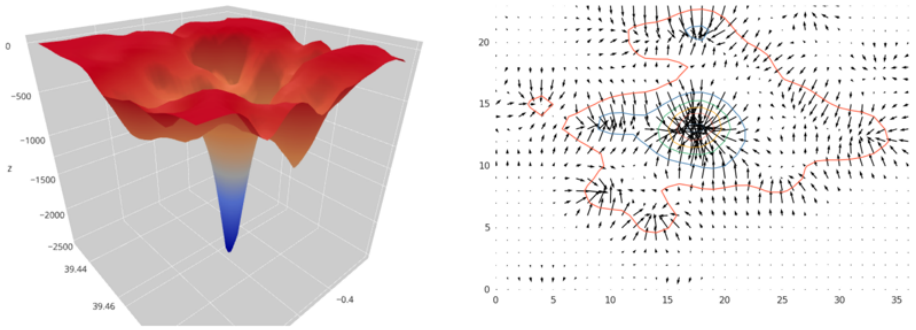

Fig. 3. Gravitational potential maps