5th INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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PLACES AND TECHNOLOGIES 2018

THE 5TH INTERNATIONAL ACADEMIC CONFERENCE ON PLACES AND TECHNOLOGIES

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ANALYSES OF PUBLIC SPACES IN BELGRADE USING GEO-REFERENCED TWITTER DATA

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ABSTRACT

The ICT supported methodology for properly determine attractiveness of public spaces has been an important tool in fields like urban planning, transport, marketing, business, migration and tourism. The use of Twitter data is very interesting to make analysis of how people use urban open spaces and what is the geographical pattern of their communications. Since the Twitter is a massive platform for online communication within extremely diverse social groups, with data generated by users of this network it is possible to research the spatiotemporal dynamics of location and different aspects of users' behaviour.

The paper concerns the study of user-generated twitter data that could support and improve the understanding of spatial patterns for urban planning and (re)design of public spaces. The data generated by Twitter social network are analysed, regarding temporal and spatial distribution, content classification, language determination and sentiment analyses. The data based on geo-referenced tweets collected in Belgrade, has been pre-processed, filtered and classified by given criteria, by using "Twitter search engine" (TSE) web application based on Twitter REST API.

Keywords: Geo-referenced data, Social Networks, Twitter, Belgrade, Public Space

Introduction

The cities and their open public spaces are reflections of users experience and changing needs in terms of urban culture with digital streams. The information and communication technologies (ICT) provide the overlapping of real and virtual spaces and allow creative participation of users. The future of urban space depends on the role of ICT and importance of their networks should be reconsidered since they have become indispensable ingredients of urban life [1]. The explosive growth of social media on the Web allows increasingly using the content in these media for decision making by individuals and organizations. In that context, research about people opinions and sentiments in social media is very actual.

Twitter with more than 310 million monthly active users is one the most popular data sources for research [2] because of its open network allowing access to information published through the platform. This paper will present and analyse the connections which are established and intensified between users and open public spaces via Twitter. The methodology used in this analysis is the method of mapping users on the social maps (via social networks), based on a software application TSE [3]. The aim was tracking and measuring the intensity of users in the monitored territory, testing the latest behavioural patterns of them as well as tracing the "positive routes". The obtained results have enabled the determination of the image of the open public spaces perceived by the users, as well as the potential of the analysed area for the formation of transverse and longitudinal pedestrian flows that could help improving networking of open public spaces.

This paper is focused on sentiment analysis, also called opinion mining, as a part of Natural language processing (NLP) -field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages. NLP researchers aim to gather knowledge on how human beings understand and use language so that appropriate tools and techniques can be developed to make computer systems understand and manipulate natural languages to perform desired tasks.

The research inlinguistics and natural language processing have a long history. Sentiment analysis and opinion mining mainly focuses on opinions, which express or imply positive or negative sentiments. In paper [4], Hu and Liu proposed a lexicon-based algorithm for aspect level sentiment classification, but the method can determine the sentiment orientation of a sentence as well. It was based on a sentiment lexicon generated using a bootstrapping strategy with some given positive and negative sentiment word seeds and the synonyms and antonyms relations in WordNet. The sentiment orientation of a sentence was determined by summing up the orientation scores of all sentiment words in the sentence. In [5] the relationships between the NFL betting line and public opinions in blogs and Twitter were studied. In [6] Twitter sentiment was linked with public opinion polls. In [7] Twitter sentiment was also applied to predict election results. In [8] twitter data, movie reviews and blogs were used to predict box-office revenues for movies. In [9] Twitter moods were used to predict the stock market. In [10] they tracked opinions about movies on Twitter and predicted box-office revenues with very accurate results. They simply used their opinion parser system to analyse positive and negative opinions about each movie with no additional algorithms.

Classification and analyses of data using TSE application

Twitter search engine [3] application (TSE) allows gathering, mining and storing of geospatial data produced on Twitter social network. Here, new features of web application TSE is illustrated in terms of its ability to process and analyse data from Twitter social network. In order to illustrate new functionality of this application, the paper shows results of spatial and temporal analysis of geo-referenced data collected from tweets for Vračar region in Belgrade, Serbia.In addition to the collection and storage of data, TSE offers visualization and analysis, but also it can execute complex queries over stored data. This queries use special geospatial functions that are built within MySQL database. These functions represent correlation between two objects that are defined by geospatial points. The application offers users to draw polygons on Google map, in order to define boundaries of their analysis. Polygon drawing is done by using Google Maps JavaScript API, this API is also used for generating user routes based on position of user tweets. The newest analytics feature of TSE is visualization of user routes. Application searches through all tweets within given region, and tries to find consecutive tweets posted by same user on different locations in timespan that is less than specified. Given timespan defines maximal time between two consecutive tweets. Routes are represented by the shortest distance between the locations where the user posted tweets. These locations are ordered by

posting time and illustrated on map with numeratedmarkers. Web application TSE also has the ability to detect the language and perform sentiment analysis of text in different languages.

The most important indicators of sentiments are sentiment words, also called opinion words. These words are commonly used to express positive or negative sentiments. For example, good, wonderful, and amazing are positive sentiment words, and bad, poor, and terrible are negative sentiment words. Sentiment words and phrases are instrumental to sentiment analysis for obvious reasons. A list of such words and phrases is called a sentiment lexicon (or opinion lexicon).Although sentiment words and phrases are important for sentiment analysis, only using them is far from sufficient. The problem is much more complex. In other words, we can say that sentiment lexicon is necessary but not sufficient for sentiment analysis of complex texts. Since, tweets are generally short and informal, and use many Internet slangs and emoticons, they are easier to analyse due to the length limit because the authors are usually straight forward, and immediately get right to the point. Thus, it is often easier to achieve high sentiment analysis accuracy. Reviews are also easier because they are highly focused with little irrelevant information. Because of that for sentiment analysis, this paper uses lexicon-based algorithm to determine the sentiment orientation of a sentence [4].

Since in many languages (including Serbian) is common to use words from English, so in order to execute proper semantic analysis it is necessary to have dictionary that contains both words from English and ones from local country. In our case, this means having words from Serbian language.Tweets can be classified as a positive or negative depending on which group of words they contain. Since the area of Serbia belongs to the world top by multilingualism, it is necessary to classify tweets based on language. For language detection TSE uses web service “Language detection API” [12], that hasability to detect 160 different languages. Before language detection, first step is separate useful text in tweet removing URLs from content. Language with top priority is always the local language of the country where analysed region is located.

Data processing and analysis

The analysis of geospatial data requires data to be in the specified format so that geospatial queries can be executed. However, since all information obtained from the Twitter REST API is in JSON format, before any analysis it is necessary to perform transformation of geo-information to specific format. This process of transformation of the original data to geospatial data types represents the pre-processing, and this is the first step in this analysis.

In order to illustrate possibilities of TSE application, tweets collected over a period of four months (December 2017 - March 2018) for region Vračar in Belgrade, were analysed and results of this analysis are shown in this paper. This space is defined by the corresponding polygon on the map, as shown in Fig 1, where the geospatial tweets classified and grouped by their latitude and longitude are shown. Tweets are displayed on the map with markers in different colours depending on the u density of tweets: red (one tweet), blue (between one and ten tweets) and orange (between ten and hundred tweets).NThe execution of geospatial queries for the given polygon was obtained the cumulative data presented in Table 1.

Table 1: Cumulative data for region Vračar

Type of analysis	Value
Number of tweets	505
Number of users	174
Number of followers	1511895
Number of friends	999347

Number of retweets	23
Number of likes	243
Number of applications	6
Number of languages	41

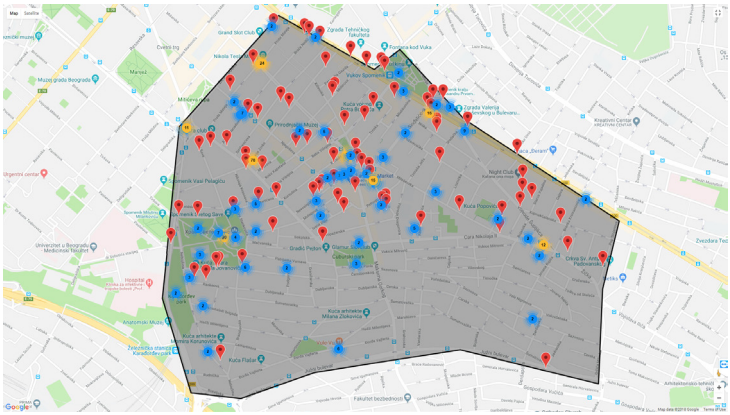

Figure 1: Geospatial tweets for region Vračar

In addition to the cumulative analysis, TSE allows filtering data based on the analysis in specified time intervals, in other words this means classification by months of the year, days of the week, hours of day or otherwise defined time intervals. Fig 2. shows the distribution of tweets by days, which are shared in the studied area.Based on them, we can conclude that the users were most active on Saturdays.

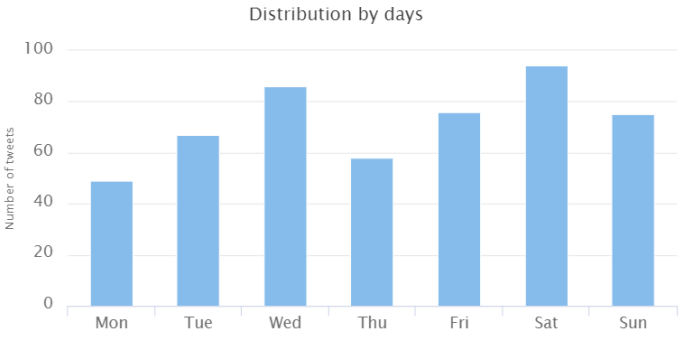

Figure 2: Tweet count by months for region Vračar

The results of data classification by time intervals of three hour are shown in Fig 3. Based on them, we can conclude that the users were most active in the morninghours, from six to twelve oclock.

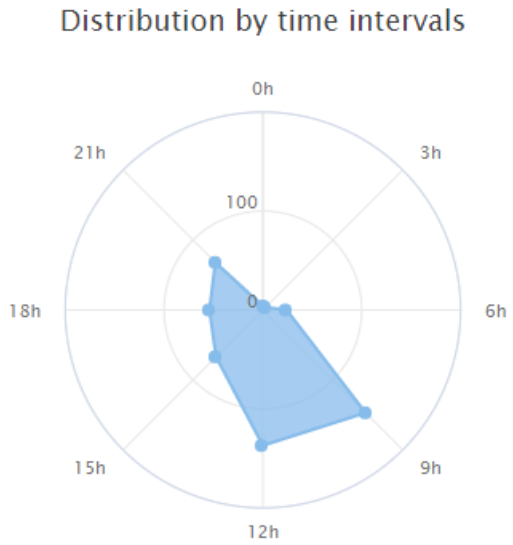

Figure 3: Tweet distributions by time intervals of three hours for region Vračar

In addition to analysis of data for a given time, the type of content of tweet itself could classify the collected tweets. Fig 4.represents the percentage representation of application of analysed tweets.

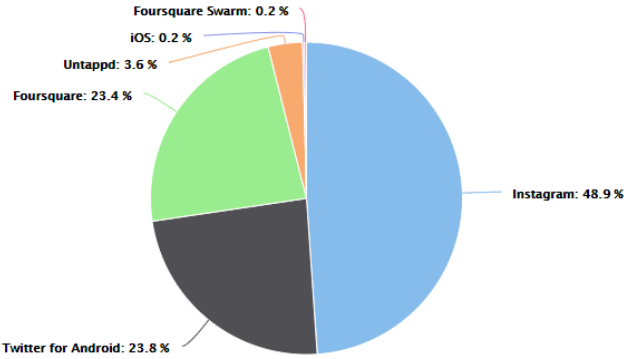

Figure 4: Tweet distributions by applications for region Vračar

Based on the distribution of tweets per application used to post it, it can be concluded, which content type has a tweet, without the need for a deeper analysis. For example, all tweets, which are sent by Instagram, must contain a picture. From the analysis results, it can be concluded that each Twitter user from community of Vračar on average posted 2.9 tweets, the users were most active on Saturday, the largest number of tweets has been posted in the morning hours and the most popular application is Instagram with 48.9%, following Twitter for Android with

23.8%, which indicates high attractiveness of the area.

Analysis of all tweets detected 13 different languages: English, Serbian, Turkish, Italian, Slovak, Danish, Japanese, Thai, Russian, Bulgarian, Spanish, Ukrainian and Greek, of which the most common are English with 53.5% and Serbian with 25.3%.

Based on sentiment analysis of content posted in region Vračar, tweets were divided into four groups, tweets which contain positive words, negative words, which contain both positive and negative (complex type) and tweets that don't contain neither positive or negative words (neutral type). The results of sentiment analysis of tweets are shown in Table 2.Sentiment analysis can be executed only on tweets that contain text. Since some portion of text tweets were posted from Foursquare, which do in fact contain text but that text in most cases is only showing user current location (so called check-in), that further leads to conclusion that sentiment analyses of this tweets in most cases will give neutral type. This is confirmed in Table 2. Application TSE detected 118 tweets posted from Foursquare application, and 89.9% of this tweets belong to neutral type. On the other hand, if we remove this tweets from the pool, we come to the conclusion that 39% of them are positive, and 12.1% of those are negative.

Table 2: Sentiment analysis of tweets

Orientation	Count (with Foursquare)	Count (without Foursquare)
Positive	151	160
Negative	47	57
Complex	21	21
Neutral	168	267
∑	387	505

The newest analytics feature of TSE, searching and visualizing user routes in some timespan, detected fifteen different routes, from five users, where posting time between two consecutive tweets was less than two hours. Figure 5.shows the longest user route in Vračar, detected on 7th of March between 10am and 1pm.

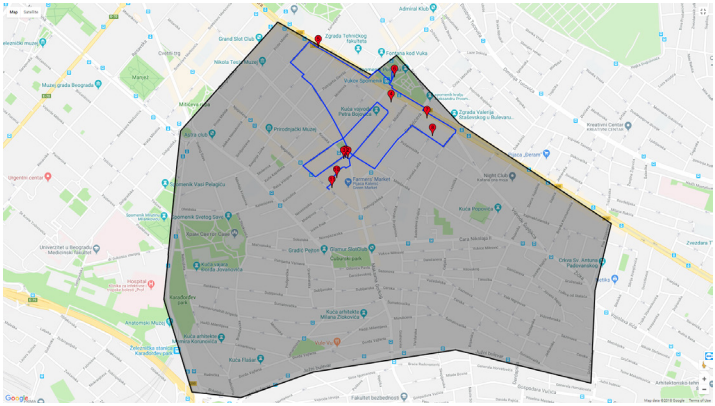

Figure 5: The longest user route for region Vračar

Conclusion

Generally, Twitter social network turned out to be a great basis for analysis of public space popularity. Its API provides a lot of publicly available information about tweets, but also about the users, which is the most important thing for every successful research. New feature of TSE application for language detection confirms the fact that Serbia belongs to the world top by multilingualism, which indicates that Vračar is very popular for foreign tourists. Combined sentimental analysis for English and Serbian language also shows that attraction sites of this region leave a positive impression on tourists who come to visit them.Also, new feature for detecting user routes in some timespan can be used for creating the most popular tourist routes in open public spaces.All these analyses represent only a portion of possibilities that TSE application can offer and all of them can be used for creating better urban plans, in terms of (re)design of public spaces. These analyses can be used to quantify popularity of locations of interest and public spaces in general, as well as to determine correlations between locations.

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