Understanding the City to Make It Smart

Roberta De Michele and Marco Furini[✉]

Communication and Economics Department,
University of Modena and Reggio Emilia, 42121 Reggio Emilia, Italy
`marco.furini@unimore.it`

Abstract. Understanding the sentiment of people is a process that may be useful when transforming a city into a smart city. A recent trend is to exploit social media data to infer people sentiments. While many studies focused on textual data, few considered the visual contents. In this paper we investigate whether the images available in the Instagram platform can be useful to understand people sentiments. Through an experimental assessment and two different validation methods, we observed that although the use of images in sentiment analysis can be useful to have insights about people sentiments, the use of Instagram images may be slightly misleading.

Keywords: Smart city · Visual sentiment analysis · Plutchink model

1 Introduction

A Smart city uses digital technology to better manage infrastructure and resources, to improve the services offered to citizens and to address challenges of development and sustainability more efficiently. To truly develop a smart city, citizen should be involved in the process [1], but most of the approaches to build a smart city does not consider the citizens while designing and implementing strategies to transform a city into its smart version [2,3].

A recent approach towards citizens involvement is to exploit the large amount of data available in social media platforms to understand their feelings. Indeed, the idea is to use these information to make more informed decisions that will end in better use of resources, better organization, better citizen lifestyle, better human relations and, eventually, better society.

In literature, many researches on sentiment analysis focused on textual contents (e.g., blogs, forum, tweets) and only recently, researches are trying to exploit the large amount of multimedia contents available in social media platforms to measure people feelings (e.g., [4,5]). The reasons behind this approach is that multimedia contents are more and more produced and shared in social media platforms (e.g., more than one billion of images are shared daily on Facebook, Instagram, Flickr and Whatsapp) and, moreover, these contents are usually produced with a mobile application that couples the pure multimedia content with additional information (e.g., GPS data, users information, etc.) that may be very useful in understanding people feelings.

In this paper we focus on the Instagram application and we want to investigate whether images shared by people in the Instagram social platform can be useful in the decision making processes that aim at transforming a city into a smart city. Instagram is an online mobile photo-sharing application that enables users to take and share pictures in social platforms. The application is becoming more and more popular among mobile customers (as of December 2014 the platform had over 300 millions of users) and therefore it is possible to publicly access to a huge amount of data.

We perform this investigation in two steps: first we define an area of interest and we access to the Instagram images taken in that area; then we use a psychological model to associate colors to emotions and we compute a low-level color analysis to determine whether the image represents a "positive" or "negative" emotion. By repeating the process for all the images located in the interested area, we can understand what is the people sentiment and how these emotions are distributed in the area. To validate our approach we perform two different validations: ground-truth and users' tag. Results obtained showed that images can be useful in understanding the sentiment of people living in an area of interest, but also showed that Instagram images are slightly affected by the massive usage of filters that modify the original picture.

The paper is organized as follows: in Sect. 2 we present related works in the area of image sentiment analysis; in Sect. 3 we present our study, whereas its evaluation is presented in Sect. 4. Conclusions are drawn in Sect. 5.

2   Background and Related Work

The social web is characterized by an abundance of multimedia resources coupled with many additional information (i.e., metadata) [6]. For instance, an Instagram image is coupled with information about the user, about his/her friends, about its description, tags and location [7,8]. Researchers are trying to exploit these information for many different reasons and one of these is to identify people sentiment. While there are several studies that focused on textual contents (e.g., the ones available in the Twitter platform), the visual sentiment analysis is in its early stage. Examples are the video/image classification and smile detection (e.g., [5,9,10]).

When dealing with emotions, it is necessary to have a psychological model that classifies them. In this paper we focus on the widely used Plutchik model [11]. This model identifies eight basic bipolar emotions (joy, trust, fear, surprise, sadness, disgust, anger, anticipation) that may be extended to 24 emotions by varying the intensity of every basic emotion (e.g., ecstasy → joy → serenity) and associates a color to each of the 24 emotions as shown in Fig. 1. Therefore, the model connects a color to its emotion (e.g., yellow → joy). Looking at the model, we observe that light colors represent positive emotions, whereas dark colors represent negative emotions.
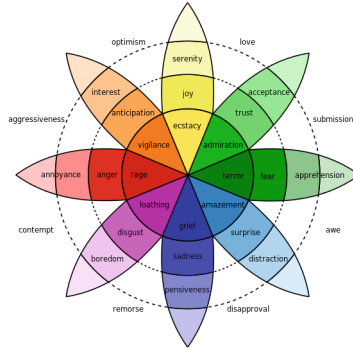
Fig. 1. The Plutchik model: emotions are associated to specific colors. (Color figure online)

3   Our Study

Understanding the sentiments of people living in a city is becoming an important aspect in decision making process and, recently, attention is given to the large amount of multimedia contents available in social media platforms. The motivation behind our study is to investigate whether the huge amount of Instagram images can be useful to understand people sentiments. In particular, our study is composed of three steps: (i) access to Instagram images located in the area one wants to investigate, (ii) mapping the retrieved images into emotions, and (iii) validate the obtained results. By repeating the process for all the images located in the interested area, one can understand the people sentiments and how these emotions are distributed in the area. This should provide useful insights to city administrator, politics, urban designer, etc.

Accessing Instagram Images. To access to Instagram images we develop a Python application that interacts with Instagram API. The application requires to specify a geographical location (latitude and longitude) and gets all the Instagram images located nearby that location (i.e., the distance from the point may vary from the default value of one km to five km). In addition to the image, the application retrieves many other information like comments and tags.

Mapping Images into Emotions. According to the Plutchik model, dark colors correspond to "negative" emotions, whereas light colors correspond to "positive" emotions. To identify whether an image is dark or light, we consider images with 24-bits RGB colors where the lightest color (i.e., white) is defined by the triplet (255, 255, 255) and the darkest color (i.e., black) is defined by the triplet (0, 0, 0).

To determine whether an image is light or dark, we measure the color distance that separates each pixel from the white and black points. The distance is measured through the Euclidean distance (see Eq. 1). Therefore, for each pixel (x, y, z) we know whether it is closer to the white or to the black point. When all the image pixels are analyzed we can call the image as "dark" or "light".

$$\sqrt{(x - bin_r)^2 + (y - bin_g)^2 + (z - bin_b)^2} \qquad (1)$$

Validation. One of the most difficult tasks in understanding the insights obtained from the analysis of the data available in social media platforms is the validation process. In this study, we consider two different validation methods: ground-truth (a methodology that requires a group of human beings to say whether an image represents positive or negative emotion) and users' tag (a methodology that analyzes the textual description attached to the image to understand what people think about the picture).

4   Experimental Assessment

To investigate whether Instagram images can be used to determine people sentiments, we set up an experimental scenario where we focus on three towns in the area of our department: Reggio Emilia (where our department is), Modena (30 km east of Reggio Emilia) and Parma (30 km west of Reggio Emilia). And we use the developed python application to build an image dataset for each town. In total, we dataset is composed of around 2,000 images.

Looking at the collected images, we observed a first possible problem in using Instagram images: many images contain textual contents (e.g., logos, flyers or quotes) and/or colored borders (Instagram only handles square images and hence images with different formats are converted using colored borders). Examples of these images are reported in Fig. 2. These images may negatively affect the sentiment results: the color of the borders and the presence of textual contents (which outweigh the colors) may affect the validity of the model. For these reasons, we manually filtered the dataset and we obtained a new dataset composed of 260 images (with no borders or textual contents) for each town.
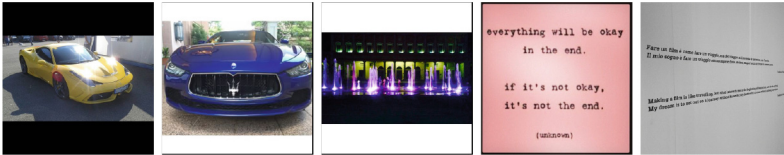

Fig. 2. Example of images excluded from the dataset: color borders (left) and textual content (right).

We applied the color analysis (defined in the previous section) to get the sentiment of the analyzed images. Results show a predominance of images with a negative connotation for the town of Modena (63 % vs. 37 %), a slight predominance of images with a negative connotation for the town of Parma (56 % vs. 44 %) and an equal distribution between positive and negative images for the

Fig. 3. Ground-truth evaluation: "positive" (left) "negative" (right) images.
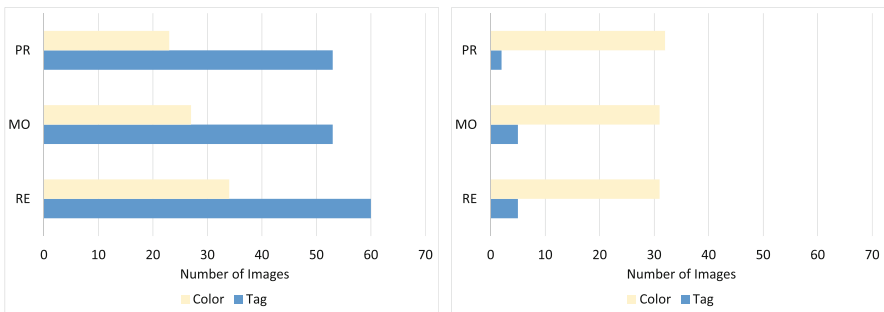

Fig. 4. Users' tags evaluation: images called as "positive" (left) and "negative" (right).

town of Reggio Emilia. By plotting the results on the city map, we can identify areas of the city where people post positive or negative images.

Groud-thruth Evaluation. We asked a group of five people to call either positive or negative every image of the dataset (260 images for each town). In particular, we considered as positive (negative) an image that receives at least three positive (negative) calls. Figure 3 shows that the ground-truth evaluation labeled as "positive" more images than the one labeled by the color analysis method. Needless to say, the color analysis method labeled as "negative" more images than the one labeled by the ground truth evaluation. The results show that the color-based analysis produce more "negative" calls.

Users' Tag. We defined a list of positive tags (e.g., "happy", "beautiful") and a list of negative tags (e.g., "sad", "ugly") and then we filtered the dataset to get only images tagged as "positive" or "negative". The resulting dataset are composed of 65 images for Reggio Emilia (60 positive and 5 negative), 58 for Modena (53 positive and 5 negative) and 55 for Parma (53 positive and 2 negative). Finally, we applied the color-based algorithm. Results presented in Fig. 4 show that the tags evaluation labeled as "positive" more images than

the one labeled by the color analysis method. Also in this case, the color-based analysis produces more "negative" calls.

In general, results showed that Instagram images should be used with caution when investigating people sentiments. We found three different main reasons: (i) the square format may introduce colored borders, thus affecting the appearance and the colors of the picture; (ii) textual contents represent the emotions better than colors and therefore their presence nullifies color analysis results; (iii) Instagram users make a large use of filters that change the original image.

5   Conclusions and Future Work

In this paper we investigated whether the Instagram images may be useful to identify people sentiments. Through an experimental assessment and two different validation methods (ground-truth and users' tags) we found that Instagram images may have characteristics that may affect the emotions analysis (e.g., colored borders, textual contents, dark filters). As a future work, we plan to investigate whether it is possible to correlate the used filter with emotions.

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