Mobile Recommendation System with Crowdsourcing and Geospatial Data

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Abstract. *Geospatial services have been used in several application areas. In this work, we create a mobile crowdsourcing tool aiming to assist people to publish, finding and recommend nearby services from small business. Our model is based on the concepts of Computer Supported Cooperative Work. The use of crowdsourcing for voluntary production of information is stimulated with a gamification system, which improves the data quality and keep users engaged. A recommendation engine is integrated in order to display personalized information and to keep the user interested inside the application. We show how we developed this framework and show a case study in a small business segment.*

1. Introduction

Applications that exploits, collects and disseminates geographic information, such as Google Maps, OpenStretMap and Wikimapia have attracted, for many years, as users as developers. Therefore, can be used for various purposes, such as education, entertainment, traffic and many other areas. The success of these applications relies in the crowdsourcing component. Crowdsourcing is a term that can be seen as an overlay of the terms ”wisdom of crowd” and ”outsourcing” [Muhammadi and Rabiee 2013]. According to [Howe 2006] crowdsourcing refers to a group of people that can converge to the solution of an individual problem, in which a specialist may not be able to solve.

Research conducted by the Sebrae (Brazilian service of assistance to micro and small enterprises)[1] in 2015, show that 95% of the companies in Brazil are represented by small businesses, which 44% are in commerce and 35% are in the service sector, and generates about 17 million jobs with a formal contract and reach 27% of the Gross Domestic Product, thus, we can see how important is the small businesses inside country. Nowadays, new types of smartphones and laptops have gained space in the market through the advancement of technology, powerful processors, high-resolution display, high-speed network connectivity with navigation features GPS and thus, there was a growth adoption of geospatial applications.

The lack of a tool that provides to users and small establishments individualized recommendations is a point that worth to be analyzed and the use of technology makes possible to further increase the participation of companies in the domestic market. Thus,

[1]https://www.sebrae.com.br/sites/PortalSebrae

this paper proposes the development of a generic model to create an information system that uses spatial data and posses recommendation and crowdsourcing mechanisms in order to establish data reliability to its users and suppliers, providing a template application for mobile recommendation system, which receives voluntary contributions of geographic and textual data and reviews of the quality of service from an establishment as well.

The remaining parts of this paper is organized in the following way: Section 2 discusses related work, focusing on collaborative development for mobile devices. Section 3 introduces our proposed model for creating the system. In Section 4 we apply and validate our model with a small business case of study and we finish with section 5 bringing a summary and an outlook on future work.

2. Related Work

In the early 70s, there is an increase in the fields of software and Office Automation Engineering. The purpose of these areas was to give computer support to large groups involved in projects. In 1988, Paul and Irene Greif Cashman, came up with the term Computer Supported Cooperative Work (CSCW) partly as a shorthand way of referring to a set of concerns about the support of multiple individuals working in conjunction with computer systems [Bannon and Schmidt 1989].

The crowdsourcing model for geospatial data has already been used in several real problems around the world and according to [Heipke 2010], this approach has shown that generation of content by a large number of users, for example, one of the reference projects of crowdsourcing geospatial data is OpenStreetMap[Haklay and Weber 2008], founded in 2004 by Steve Coast, with the objective of providing free access to geographic information updated worldwide. Through the data released by the own website in April 2015, it is estimated about 2.2 million registered users, 500.000 taxpayers, among these 25.000 are active. According to this paper, the quality of OpenStreetMap data obtained 80% coverage and a geometric prediction of 6 meters to the main roads in the London area in relation to the Ordnance Survey[Haklay 2010].

Another example is Wikimapia[Koriakine and Saveliev 2008], that uses Google Maps technology and allows users to delimit areas of interest and link them to descriptions and comments, allowing users to create and integrate descriptions with Wikipedia links. Another mechanism to highlight is the access policy to curb acts of vandalism, which in turn is associated with gamefication elements aiming to encourage users through scoring and ranking. According to that ranking you can have access to functions ranging from the option of adding photos to permissions for administrative privileges on the site. Another recent real example of use of geospatial data and crowdsourcing information can be seen at [Ferreira et al. 2017], which users can send their complaints and ratings about the public transport. Their locations, complaints and rankings are sent to transport supervision agencies and are stored inside a public database, which are accessible by population and researchers through an open API.

3. Framework for Web System

[Alarcon et al. 2012] presents an orientation tool to strengthen mobile collaboration and system development activities and we had its work as a basis for the development of

software to create eight categories divided into three phases: Design, analysis and architectural design. We were be able to identify a set of non-functional relevant requirements and design constraints in order to obtain a contextual application. This model is able to collect geographic data on a voluntary basis in which to assess the reliability of the contributions, providing different filtering mechanisms aimed to receive voluntary contributions of geographic data and reviews of the quality of service of an establishment. The modelling and physical schema of the database system contains the metadata that guarantee the operation of the application. Figure 1 shows schematically the operating motion to the tool with these characteristics.

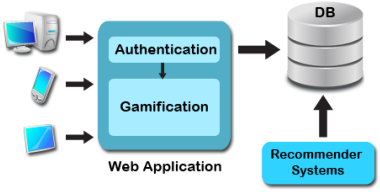


Figure 1. System Model.

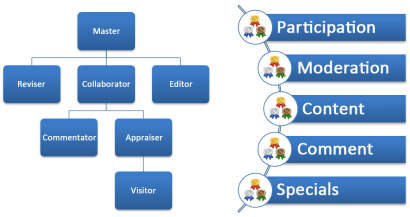
According to the model it is possible that the developer create your web and mobile system using the concepts of crowdsourcing with the data quality mechanism integrating a recommendation system. Created the structure, the developer shall be free to allow access for others to contribute. The objective is to allow access through mobile phone and computers and also streamline the application development process and systems. Besides, following the example of successful applications like Foursquare[2] and Stack Overflow[3], the idea of motivating users via game elements is generating applications in many areas, among them, finance[Deterding et al. 2011a] and academia[Huotari and Hamari 2011].

3.1. Gamification

By definition, gamification is used to represent the use of game elements to enhance the experience and user engagement in any service or application other than the context of games [Deterding et al. 2011b]. The rewards are defined as follows: Register in the app, evaluate an establishment, share, add content, moderate requests, comment and adding content, where the user can add +20, +20, +5, +2, +5, +1/-1 and +1/-1 points respectively. Figure 2(a) shows the dynamic progression of gamification system and Figure 2(b) provides the possibility to get the medals, which are divided into categories: gold, silver and bronze. Through the votes carried by users in content and comments added by a particular user can create a quality control for these data collected, thus, inhibit a member use the system inappropriately.

We use two approaches as alternatives to ensure data quality: Crowdsourcing and social approach, which aims to employ gamification to enhance this filtering data. We performed social approach based on a hierarchy of trusted individuals that act as moderators. Many studies have shown that the voluntary contributions of individuals follows a frequency distribution with a long tail with some individuals making a large number of contributions and a large number of individuals making only one or few contributions.

[2]https://foursquare.com/
[3]https://stackoverflow.com/



(a) Progression Dynamics. (b) Distribution Awards.

Figure 2. Gamification elements.

3.2. Recommender Systems

According to [Adomavicius and Tuzhilin 2005], Recommender Systems are techniques and tools used to suggest personalized items based on the interests of users. In a common system, usually the users provide the recommendations, this captured information is used by the system to present them to the groups of individuals considered potential interested for this type of recommendation. Recommender systems are designed to filter information according to the profile of interests of the users and thus, recommend items that meet the expectations and needs of users and are generally used in one of the following three aforementioned information filtering techniques: Content-based filtering, collaborative filtering, also known as social filtering and hybrid filtering.

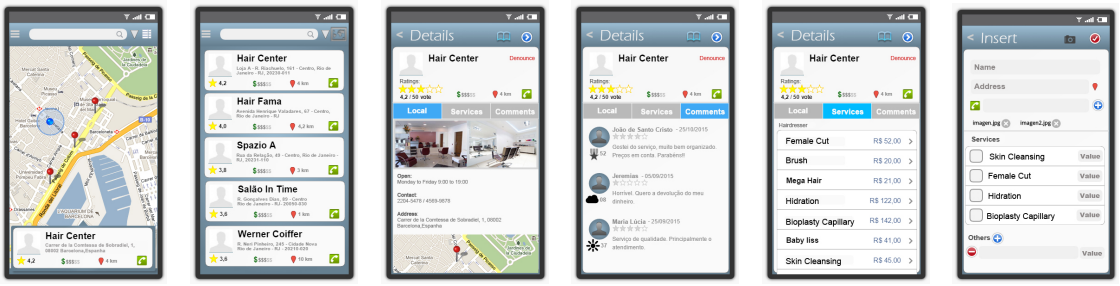
For this work we chose the collaborative-filtering approach because this method analyze large amounts of information about users' preferences and predict the preferences of similar users to recommend items. Thus, it is possible to make an accurate prediction of a user's preferences and deliver items recommendations without any need for a detailed analysis of item characteristics. The technique relies on analysis of common preference in a group of people. The essence of this technique is the exchange of experiences among people who have common interests and have similar choices for items. Besides, this technique constitutes one of the most popular recommendation techniques being used in many existing systems on the Internet [Schafer et al. 2001]. In collaborative systems, the essence is the exchange of experiences among people who have common interests. In these systems, the items are filtered based on evaluations by users.

4. Experiments

In this section we present an example using this model in the area of aesthetics and beauty. A need in this area was realized due to a number of existing establishments that do not use so much publicity and that most of the disclosure of the establishment is carried out by word of mouth, so we use the halls and aesthetic houses as inputs to this model. Below we present the key interfaces in the system, using the data mentioned above and showing how would be the implementation of the model for the mobile environment. Figure 3(a) shows how the pursuit of establishments are presented across the map. In that case, are made a new query through the point of displacement on the map, since the figure 3(b) shows the search result by a list. Both ways have filters to refine the results and address bar to perform a search.

As seen in the previous figures, the result of searches screens also feature qualifying, the distance in relation to the user and the average price of the establishments. An-

other feature of this screen is that is possible to receive establishments recommendations and make connections with the same categories establishments. The system interface is responsible for detailing the establishment. It shows the photo, the location, the score, the services offered, comments, and average prices. Figure 3(c) shows the information about the location of the property while Figure 3(d) shows the user feedback with their respective ratings already Figure 3(e) shows the services and their values and finally Figure 3(f) allows the employee to add values and services Of the establishment.



(a) Results Map. (b) Result List. (c) Local Tab. (d) Comments Tab. (e) Details Tab. (f) Insert Tab.

Figure 3. Interface of the establishment of the information.

To evaluating the model, the system carry out the evaluations of the establishments were chosen five subjects that best represents the nature of a rating, varying from 1 to 5 (higher is better) to identify better the differences between properties: Attendance; Location; Hygiene; Cost-benefit; Product quality. The calculation of the final grade given to the user establishment is the result of the average grade of the subjects. However, the rating of the establishment is developed in the frequency histogram of the ratings of the users. The ratings of the establishments along with the users of the profile is used as input to the recommendation system model. Which in turn hold their predictions thus, individualized information is passed to each user of the system, being added to the results obtained by the search or the news tab and promotions.

5. Conclusions

In this paper, we introduced the importance of this system to assist people in small business activities and through the use of the concepts of crowdsourcing applied to geospatial data. It was possible to develop effective supporting tool for group work within a system. The concepts derived from the theoretical framework and related work obtained an important role in the creation and design of the proposed model, so it was possible to meet the requirements encountered during the development and study of this model.

Therefore, another feature was the ability to keep users engaged in the project using gamification. Using the recommendation system in our model facilitated the view of information from users perspective and further incremented the loyalty of the user inside the system. Thus, this model can be applied to various business niches, such as in the area of automotive, education and food branch. Its generalization capability facilitates the development and adaptation of this system to suit according to the selected market segment. With the increasing technological advancement especially in mobile computing, the trend is to further intensify the use of systems based on crowdsourcing. However, we see the

need to determine best approaches and algorithms to be applied in the recommendation system. These in-depth analyzes with comparison of these techniques are to be performed in future work.

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