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Pollen Allergies Prediction Through Historical Data in Mobile Devices

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ABSTRACT

The mobile devices have become an essential item for many people in developed countries. Thanks to small software called apps, we can use these devices for a lot of tasks. This article proposes to use these mobile devices in combination with large databases of pollen in a region to track the health status of the patient and relate the detected levels of pollen to obtain possible relationships that result in the diagnosis of the user.

Keywords: allergy, fisher's test, prediction.

Mathematics Subject Classification: 46N30

Computing Classification System:D.1.7

1. INTRODUCTION

Pollen allergy is a disease that affects 15% of the Spanish population (Subiza, 2014), reaching as much as 30% of the young population (Caillaud, *et al.*, 2013). Currently, there are few applications for mobile terminals that can obtain data about the level of pollen in a given environment and predict allergies. However, it is possible to find similar and more well-known services, such as those providing information about the weather. Given the proliferate growth in the use of mobile devices, it would be of great interest to create an application that facilitates access to information about pollen levels and then use this information to predict allergies. An application of this kind can combine the information available in web repositories with the contextual information obtained from a mobile device. Information about the pollen (historical and captured in-situ information) can be used in conjunction with the user's location and health status to detect and determine potential types of pollen allergy.

As mentioned above, there are some applications in Spain that provide information about pollen levels. These applications use the data provided by the Spanish Society of Allergology and Clinical Immunology. Some of these applications are Polen Control, or AlertaPolen AlergoAlarm, each of

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which provides information on the pollen although they do not detect a user's allergies. This work shows an application developed in Android that provides access to information about pollen levels from mobile devices in a quick and easy way. Furthermore, we present an automatic process for detecting allergies, which makes use of the information indicated by the user about his or her health status and combines it with the location and historical data of pollen in order to predict allergies based on statistical tests (De benito, *et al.*, 2004). The execution of the algorithm is performed on a remote server to reduce the computational load on the mobile terminal. The system used the information of historical levels of pollen available in the open data portal of the Government of Castile and León.

The paper is organized as follows: section 2 includes a revision of related work, Section 3 describes our proposal, and finally sections 4 and 5 provide the preliminary results and conclusions obtained after testing the proposed approach.

2. BACKGROUND

The field of medicine provides different tools to predict disease in certain areas (De Paz, *et al.*, 2009), such as detection of asthma presented in, in which the authors use data from the health history of children aged 1-3 years to predict asthma (Pescarote, *et al.*, 2014). In the same line, there is an API used for predicting infant and adult asthma (Balemans, *et al.*, 2006) using data collected from patients between 2-21 years of age. Numerous studies (Lewis and Leonard, 2013) on the detection of pollen allergies indicate the incidence of the different grasses in the state of health of patients with an even greater level of detail than just a few years ago (Leonardi, *et al.*, 2011).

Today there are applications for mobile devices that visualize the levels of pollen by using measurement information centers. For example Figure 1 shows the Pollen Alert app, which reports pollen levels in the Spanish towns where the measuring centers are located. The data are measured periodically and are provided by a network of centers including the Aerobiology Committee of the Spanish Society of Allergology. The Clinical Immunology (SEAIC) also supports this application.

The Pollen Alert app provides measurement data from different station across Spain. Users may filter this information according to several criteria such as type of pollen (grasses, olive, Salsola, etc.) city or cities etc. Additionally, the application allows setting alarms to alert the users when the amount of pollen in the air from a certain type of grass exceeds a pre-established level of contamination.

Other applications such as Alergo Alarm were developed by SEAIC (Spanish Society of Allergology and Clinical Immunology) and Almirall (Spanish pharmaceutical company). These applications are more for primary care physicians. They provide daily information of levels in Spain and predict possible levels to assess the risks of allergies.

As with the previous application, Allergo triggers alarms based on predefined levels. The application filter information by type of grass and location. The filtering process reduces the information for display on the mobile.

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In addition to Alarm Alergo, the Spanish Society of Allergology and Clinical Immunology and Almirall have other applications such as Pollen Control, which is used to monitor and diagnose allergies related to environmental pollen, especially in patients with hay fever. Pollen Control tracks the user symptomatic progression, thus allowing the user's allergist to obtain information about the relationship between the pollen levels and their evolution. In addition, this application also provides information on daily pollen levels, and predicts their expected evolution.

3. PROPOSED REASONING SYSTEM

The developed application uses the information provided by the Junta de Castille and (Corchado and Fyfe, 1999) León about present and past levels of pollen. The current pollen levels are shown on a map (the Google maps application is used for this purpose). This representation facilitates the selection of the nearest station to the user in an easy and intuitive way. Figure 1a shows a screenshot with information about pollen levels. The red circles represent the different types of pollen that are present with a medium or high level in the areas specifically requested by the user. In this way, the user can quickly and easily view the number of relevant levels in the measurement centers close to the area of observation (Corchado, 2000). The proposed system obtains information from the measurement centers by selecting one of the markers in the map. The detailed information about this center is shown in a dialog box, which presents personalized information about the pollen in a more specific area, representing medium or high levels (Corchado, *et al.*, 2009). In Figure 1b, the yellow and red circles represent medium and high levels of pollen respectively (Bajo and Corchado, 2005). The arrow on the right represents a prediction about the level of pollen (increases, reduces or remains stable). Fuzzy logic can be used as well (David, *et al.*, 2012; Jafarian, 2014).

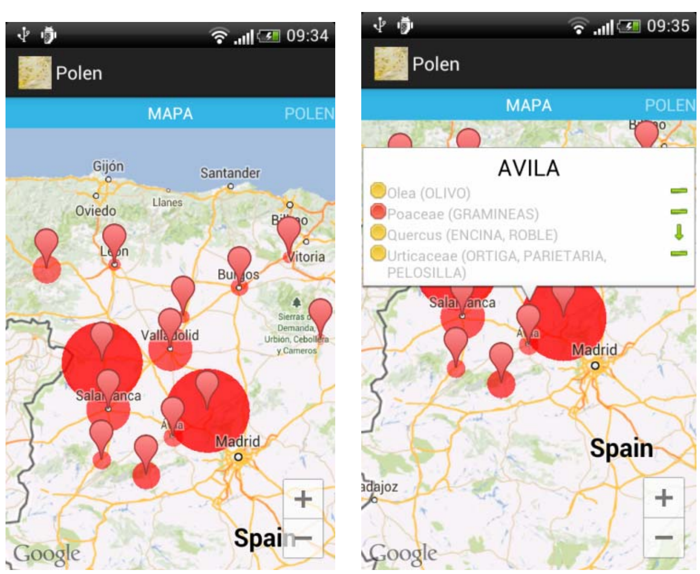

Figure 1. a) Google maps with pollen levels in different seasons. b) Levels of pollen for the selected station.

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Scrolling down the screen to the left displays the second screen. Figure 2 displays the different pollens that are available for filtering. By checking or unchecking the boxes pollens will appear or disappear on the Google maps shown previously.

Figure 2. Selectable pollens.

The third screen contains three tabs, although the last one only displays help in-formation that it is not relevant in the development of our study (Fdez-Riverola and Corchado, 2003). The first tab is used to add information about the health status of the user (Fraile, *et al.*, 2011). The user has to indicate the date, the health status and the location associated to a measurement (once a week because it is the data update period). Figure 3a displays a screenshot of this information. In Figure 3b, the second tab contains the prediction for allergies, which is calculated using a Fisher's test (Requena, *et al.*, 2006) according to the health status of the user and the historical values of pollen. Pollens are arranged according to allergy for each type of grass. The health status of the user and the level of the grass are displayed, making it easy to verify and validate the results. The information is processed on a remote server through a REST request. This way the mobile terminal does not execute the algorithm and the level of traffic is reduced because the weight of the historical data file is 1.5 MB. The current level file only takes around 25KB so the traffic is very small.

Figure 3. a)User state. b)Predictions.

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4. RESULTS

In this section we present a demonstration about the prediction system. The user indicates the date the measurements are taken, his or her health status and location; according to this information the system then provides a prediction of the types of grasses the user may be allergic to.

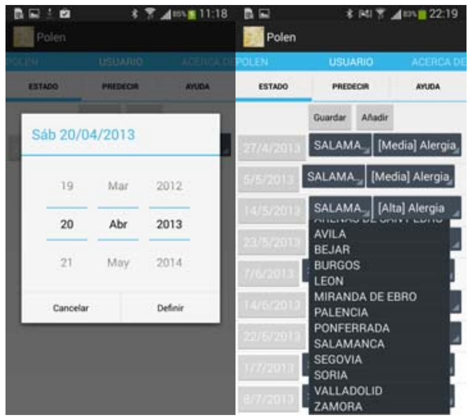

Figure 4. a) Selecting a measurement date. b) Site selection of measurement.

As seen in Figure 4.a the user introduces the data about his or her health status, location and date. The values for location and date are not established automatically (Tapia, *et al.*, 2010) because the user can introduce previous values. The place is introduced according to the Figure 4.b.

Figure 5.a indicates the health status of the user for that date. There are three levels of intensity with these possible values: no allergy, medium allergy or high allergy. The first option removes the measurements. After entering this data, the user selects the "Predict" button and sends the data to the server, which in turn calculates the allergy and returns the results to the user.

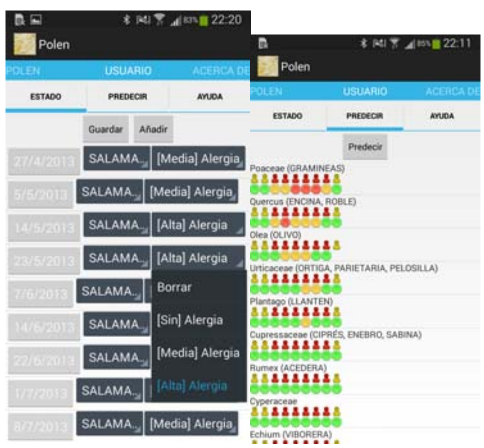

Figure 5. a) Introduction level of allergy.b) Calculated results.

The user can then view the results in the mobile. The types of grass are sorted ac-cording to their relevance (Corchado and Lees, 2001), as represented in Figure 5.b. In this figure we can see the different types of grass. For each one we have a history of the user's health status (green for a zero level of allergy, orange for average, and red for a high level) and a history of the grass represented as circles. According to the information, the user is probably allergic to Poaceae and possibly Quercus as well.

5. CONCLUSIONS

The presented system provides fast and easy access from mobile devices to the in-formation of the level of pollen. A view based on Google maps makes it possible to monitor the level of all zones globally, allowing the user to obtain detailed information about a specific region. Furthermore, the user may detect possible allergies using the historical data.

The application has two different parts: a mobile and a server. The mobile application was developed for Android. The server was also developed using java web services REST (Representational State Transfer) and JSON (JavaScript Object Notation) for sending the information. The software is available in the play store of Android, and the app is free and has no advertising. It may be downloaded by searching the name "APCYL: Alergia al polen CyL".

As a final conclusion, we have developed a mobile application that provides real-time information about pollen levels in the region of Castille and León in Spain. Over this information and after applying statistical filters about health data provided by users, we can infer the types of pollen allergy that has the user.

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