

## APP R-ALERGO. ALLERGY-HEALTHY ROUTES IN VALENCIA

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### Abstract

On the urban areas there are sources of information about the exposition to environmental allergens and others potential factors of allergies, such as: weather conditions, vegetation, urban morphology, etc. For the last two years we have been developing, together with the “La Fe” Hospital of Valencia, the Cartography Institute of Valencia (*Instituto Cartografico Valenciano*), and the Polytechnic University of Valencia (UPV), a mobile phone App to help citizens to avoid high environmental allergens exposure areas while they are walking around the city. The App uses modified grid calculations where impedances have been calculated based on the variables that affect allergens exposure: temperature, humidity and wind direction, pollution level, trees, pollination, season period, pet areas, fountains and water surfaces. People’s allergy information and the factors that have effects on the allergens exposure were agreed by a group of specialized doctors. The design follows the recommendations of the Agency of Health Quality of Andalucia (*Agencia de Calidad Sanitaria de Andalucia*). R-ALERGO

is the first App to avoid the exposure to air allergens in Spain. The App works following 4 steps: 1<sup>st</sup> Patient profile; 2<sup>nd</sup> Definition of the origin-destination of the route; 3<sup>rd</sup> Calculation of the route with the lower exposure to allergens; 4<sup>th</sup> Specific recommendations for users. The App R-ALERGO is developed following the concept of other applications dedicated to improve life quality of citizens and recovering, by using the idea of Smart Cities, the link between medicine and health, with the purpose of achieving more responsible cities towards their citizens.

## Project Background

According to estimates by the World Health Organization, the world's population in 2050 will reach nine million six hundred thousand inhabitants (Gonzalo et al, 2013). Most of this population will live in cities especially developed countries of North America and Europe, and a significant percentage, in other growing countries. Meanwhile, experts say that in the coming years 50 percent of the population will suffer from some type of allergy and this will be enhanced by both genetic factors and by environmental factors. In urban environments, these data are likely to be higher as quoted by the Spanish Society of Allergology and Clinical Immunology (SEAIC), city dwellers suffer more allergies than rural residents (Zubeldia et al. 2012). Increased exposure to allergenic species, pollution and global warming accelerates the pollination of plants and trees, makes cities are particularly conducive to the development and enhancement of these diseases environment.

As we see, the influence and importance of the physical, economic and social environments that make up our urban environments is enormous in relation to the welfare and health. Not just is a factor that directly affects the health of the people, but also presents an opportunity to develop habits or lifestyles. In that sense, the model city or urban policies that each municipality carried out, are crucial in the development of this pattern of healthful behaviour.

Without going back too far back in history, the works of Friedrich Engels (1844) "The conditions of the working-class in England", works for Barcelona of Ildefonso Cerdá (1856) in his "Statistical Monograph of the working class", the Madrid studies of Dr. Felipe Hauser and Kobler (1902) "Madrid from medically-social view" or the work of Dr. Vicente Guillen y Marcos (1889) "Valencia as winter season. study of medical topography and climatotherapy" they are precedents for these concerns hygienists contribute to consolidate during the nineteenth century a current of thought very attentive to improving living conditions and health of people in urban environments. Not in vain we can say that the revolution that gave birth to the modern movement in the twentieth century and spread throughout the world, had as its a fulcrum the struggle to reduce infections and epidemics favoured by the precarious conditions living in highly industrialized cities in Europe.

Two centuries later, the interest in improving living conditions in urban environments is still a major concern. According to the Report of the Commission on Social Determinants of Health of the World Health Organization (2008), public health research carried out for more than three decades show without doubt as the state of health of a given population is because, especially to employment and working conditions, housing, the environment, and many other social factors. Living in a poor neighborhood polluted or not have adequate environmental conditions

determines both the poor health of these people and the emergence of inequality in the population. Health inequalities, generically, has an important geographical component.

In this line, the use of mobile technologies and Big Data in dealing with health problems has opened a field of research and development known as Health Apps that in recent years has grown exponentially (Constantine, 2015) and can transform the way in which health services are provided in the world. Some of these applications have tried to incorporate the spatial component, ie the geographical position of the user as variables that clearly affects health conditions. User positioning allows you to set both temporal correlations with other components (season, time of day, ...) and physical (temperature, humidity, ...) opening the opportunity to performing calculations where the profile of the combined user and the environmental conditions that is found in.

Against a backdrop of budgetary pressures and chronicity higher, the Health Apps opens opportunities for new and more efficient ways of working (Mediavilla, 2016). However, the explosion of health-related apps to those that we referred above also have some risks if not dealt with with proper rigor. The privacy policy of sensitive data used and the scientific verification of the effectiveness of the application are presented with some of the weaknesses that this industry currently offers mobile applications.

With this background, the objective of "RALERGO" project is defined in a very simple way: create a mobile application that allows the user to calculate the most healthful from the point of allergenic view route, avoiding potential exposure to factors that worsen their status health, to moving within the city. This project is a collaboration between a research group in the Department of Urban Planning at the Polytechnic University of Valencia and Research Group Allergology (GIA) University Hospital and Polyclinic La Fe, and has been made possible by a grant acquired in a public call for the realization of "New project preparatory activities coordinated between researchers from the UPV and researchers from Hospital Universitari i Politècnic / IIS La Fe".

### *Aim of the project*

The objective of this project is to develop an application for mobile devices that allow citizens to help her get around the city is compatible with your situation regarding allergies. For this application must first obtain a series of data related to the physical conditions of the user (sex, age, body mass ratio, allergies, intolerances, regular medication ...). These data will be complemented with the origin-destination user relying on the geolocation of the mobile device. It will be understood as the most favourable route, less likely to reproduce that allergic episodes attending to personal, environmental and urban conditions. Thus it is intended that the patient falls a therapeutic step in the allergic condition being treated, thereby improving the quality of life of citizens.

### *Determination of the working environment and involved variables*

As it has been stated in (Temes et al, 2016) the urban environment that was chosen for the development of this project was the municipality of Valencia for three basic reasons: for being

the largest and most densely populated city on the Region of Valencia; by having a variety of urban environments (coastal, contact the garden, interior, ...) in which to experience the effectiveness of the application; and for having the platform "Valencia OpenData" computerized management repository that facilitates urban bigdata publicly a significant amount of information that makes possible the development of a work of these characteristics. From the selection of the urban environment, one of the key issues was the decision on the main variables to be taken into account for synthesizing the urban environment and assess the greater or lesser allergic potential of the different routes as possible to the city. To define these variables specific work made by the medical equipment Service Allergies Faith that was later contrasted with the team from the Polytechnic University of Valencia, to analyze the real possibilities for measuring such variables in urban locations with held update intervals up to 6 hours. The consensus of those requirements reflected variables were determined in the Table1.

**Table 1. Types of allergic conditions and geographical and environmental criteria adopted for the design of the application**

<b>Allergy</b>	<b>Geographical condition adopted for the type of allergy</b>	<b>Type of condition on street segment</b>
<b>Epithelia</b>	Avoid travel on streets where there is proximity or tangency with solar or areas where dust and debris suspended (solar, clearings). It is recommended not walk through parks, orchards and gardens frequented by animals. Avoid areas of animal hoarding: kennels, zoo, veterinary clinics, stables, dog hair salons and dog off-leash-area	For each section of street it has taken account of its tangency, coincidence perimeter or inclusion of any of the points or foci of possible concentration of epithelia exposed in the previous column. Has been considered a spreading factor that models the effect of the prevailing wind every 6 hours along the length of the street.
<b>Insects</b>	Avoid travel on streets where there are trees or tangents to parks, gardens, orchards. Avoid wet areas where there is a permanent accumulation of water. the season flowering periods of trees areas by the potential increase o insect near them	It is taken into account for each street segment for the presence of potential sources of insect concentration, thereby increasing the impedance transit. These variables are in turn conditioned by the season, which modifies the intensity of said impedance. Several factors dispersion (radius of influence, effect of wind...) are considered to focus for modelling dynamic presence of insects around the focus points "

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## Mushrooms

Avoid traffic on streets where there are trees in general or tangents to green areas, orchards. especially damp, shady areas where there is constant water as water bodies, ditches, orchards is also avoided. The humidity increases the risk of allergy to fungi.

In this case we have identified all sections of the streets of Valencia that are favorable or foci are tangent to the appearance of fungus, as described in the previous column. Also, every 6 hours are considered the average humidity of the city and wind direction data according AEMET. Regarding the winds, they will take into account the “*Levante*” and “*Poniente*” his greatest influence regarding humidity

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## Pollens

Avoid traffic on streets where there are trees of a particular species according to the allergic profile of the person. Humidity and “*Levante*” wind reduce the presence of pollen in the air, and the west wind increases. the season will be considered regarding the flowering season of the species that it affects the individual.

To model the presence of pollen in the streets has made a survey of all tree species in the city, including its geographical position, family, pollination period based on data from the pollen calendar of Valencia and studies in the Department of Botany of the Faculty of Sciences of the University of Valencia. The total species have been taken into account for the calculation, the following families: Cupressaceae and laurel of India, olive, pine, plane tree, bitter orange, bottle tree, white acacia, cinnamon, tree of love, hackberry, negundo maple, grasses, parietaria, urtica, plant, llantago, red and plum palmae. All these species represents more than 80% of those in the city. To model the dynamic range effect of pollen on the streets depending on the wind has considered the confinement factor of each section (height-width ratio of the street) in combination with the prevailing wind every 6 hours.

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## Methodology and system used

The way to approach this objective is based on the use of spatial analysis technology supported networks. In this case, it is the problem of a transportation network analysis but with modifications. If the calculation is based only on the road network and its characteristics (speed, direction, stops ...) in this case for a transport network, they have to take more variables that model the network and represent the individual movements.

### *The network of the city streets*

To answer the question of what is the healthiest way from the point of view of allergenicity, according to the profile of each user, the network computing technology is used. This technology is able to model two types of networks. On the one hand the geometric network that is a rigid policies in terms of movement, but flexible structure in design and connectivity between nodes is concerned. On the other Transport Network effectively representing the main features of the flow through a given area. In our case the network used to simulate traffic through the city has been offered by the cartography "CARTOCIUDAD" developed by the Valencian Cartographic Institute in the area of the city of Valencia and coordinated with the rest of the territory by the National Geographic Institute. Such mapping has been complemented by the pedestrian sections of the database Open Street Map and an additional delineation on the last orthophotograph city. Together we have developed a network dataset with over 15,000 sections.

### *The modified impedance*

In studies of the urban traffic (road and pedestrian), usually road networks in the city can be considered, in a simplified form, as a set of nodes connected by arcs (streets). When a flow passes (pedestrian or vehicle) through these arcs between node and node, there is an opposition to displacement named impedance. Impedance is defined as the cost representing a displacement along an arc and is usually measured in terms of invested time or distance. Impedance factors usually considered are: the slope of the street, average daily traffic of vehicles, pavement quality, road width, .... In our case it uses modified impedance factors specifically designed for assess the allergic potential of the sections of the streets. Thus increasing allergic potential factors in each section of street to increase or modify its impedance making them less favourable for transit by the user. For example, if a street that has an olive grove and the user confirms allergy to the species, the length of the street will be incrementally modified by a certain percentage to inhibit the passage through the arc.

### *Data used as a basis*

The initially agreed definition of variables, determine the selection of a data set whose objective was to model the operation, from the point of view of allergy urban environments. To do this, the main data were implemented in the process: woodland, environmental data, pollution, vacant lots, parks, water bodies and concentration of animals.

To model the trees in the city cartography of the City of Valencia, available via the portal "Valencia Open Data" (2016) was used, where it is possible to have the position of all the trees in the city divided by species. This source, after was enriched with attributes of periods of major pollen explosion in the city of Valencia, based on data collected from the sensor of the municipality of Burjassot (Valencia), during the years 1998 to 2003 and conducted by the Department of Botany of the Faculty of Sciences of the University of Valencia.

The meteorological prediction data necessary for the application were obtained through the State Agency of Meteorology (AEMET, 2016). The Meteorological prediction informs us the

temperature data, wind direction and relative humidity necessary for modeling impedances associated with the sections. Unfortunately in the city of Valencia there is a sufficiently extensive network of collectors of meteorological information to allow us to specify the information by sectors or neighborhoods so it has had to resort to a generic media information value for the entire city. This aspect is a clear limitation on the application that we hope can be overtaken when a regular update available meteorological data in a smaller scale within the urban environment.

Data on green areas as well as solar and edges with the orchard were obtained from the mapping of the Valencian Cartographic Institute, in its CV05 series and complementarily mapping of the General Directorate of Land Registry (2016). Regarding apposition "*pipi can*" and the sheets of water available information on "Valencia open data" (2016) was used. The position of dog hair salons was obtained from georeferencing postal address once located.

Meanwhile, pollution data come from the statistical data of daily mean intensities (IME) of the City of Valencia (2016). These data have been further processed depending on the relationship of confinement (height / width) of each street.

In Table 2 the formulas used in the calculation of impedances, where the value "L" refers to the length of the segment in meters. To this value we add different impedances depending on the allergic profile of each case. also the possibility of combination between them will be considered:

**Table 2. Formulas for calculating the impedance of each section**

Allergic.	Impedance formula
Epithelia	$L + L(\text{solar}) + L(\text{Parks}) + L(\text{pipican}) + \text{pollution}$
Insects	$L + L(\text{tree}) * (\text{Insect Factor}) + L(\text{water}) * (\text{Insect Factor}) + L(\text{Parks}) * (\text{Insect Factor}) + \text{pollution}$
Mushrooms	$L + L(\text{tree}) * (\text{Moisture Factor}) * (\text{Factor Levante}) + L(\text{parks}) * (\text{Moisture Factor}) * (\text{Factor lift}) + L(\text{water}) * (\text{humidity factor}) * (\text{Factor Levante}) + \text{pollution}$
Pollens	$L + L(\text{tree}) * (\text{Factor pollen}) * (\text{Factor species}) * (\text{Factor Poniente}) + \text{pollution}$
Ácaruses	$L + L(\text{solar}) * (\text{Factor Levante}) * (\text{Moisture Factor}) + \text{pollution}$
Pollution	$L * (\text{form-factor intensity})$

Where:

L(tree) = length section affected by the cup of the species

L (Parks) = length affected by orchard street, parks and gardens.

L (water) = Tranche affected by mass of water with 15-meter buffer.

L (pipican) = Stretches affected by buffer 30 meters from pipican.

L (solar)) = length of road affected by a lot.

Factor station: 1 (autumn, winter), 1.5 (spring, summer).

Bug Factor: 1 (autumn, winter), 2 (spring, summer).

form-intensity factor (Factor IMD) / (length / section).

up factor 0.9 if predominantly easterly wind blows.

Factor setting 1.1 if predominantemene west wind blows.

Moisture Factor: 1 (<65%), 1.1 (65-75%), 1.2 (> 75%) relative humidity in%

Pollen Factor: 1 (<65%), 0.9 (65-75%), 0.8 (> 75%) relative humidity in%.

Factor species: 1 without flowering, 1.5 to bloom. (According to the calendar of flowering)

IMD factor: 1.1 (low), 1.2 (medium), 1.3 (high).

Pollution: pollution impedance for that segment.

### *Arcgis Server (Network Analyst)*

To calculate the optimal paths are available the support of the infrastructure of the Valencian Cartographic Institute. On their servers, the institute hosting the map data and processes the requests. The application has been implemented on Arcgis Server 10.3.1 and the Network Analyst extension. The calculation of the impedances is programmed so that every 6 hours the information is updated as it is the time interval in which AEMET provides meteorological data. After that update, new values for each stretch of road depending on weather forecasting data received from the AEMET, service form we are obtained the information. In this way we can obtain a geometric pattern intentionally distorted depending on the impedances taken into account for the assessment of each route. The data requests are made via URL using the HTTP protocol and REST services to a NAServer (service network analysis ArcGIS for Server) service, returning that server the result, later, the client application draws on the screen of the user terminal the route. This REST service receives the request starting point and output as well as allergens user profiles (the parameters are embedded in the URL using the POST method) and triggers a server-geoprocess that resolves the path, returning the same in the standard JSON.

### *App Development*

The application is programmed with SENCHA ExtJs that provides the necessary components to build the application, under these components the mapping api (OpenLayers) embeds all within HTML to get the advantage of being multiplatform. Later the open development framework Apache Cordova is used to generate the necessary packaged app stores for iOS and Android. From the application, once grubbed up the services of geolocation assets, is responsible for managing user profiles and launch requests to the server. This development contains a custom interface using components SENCHA, from which it all the functions are performed. The main functions are to store the user profile allergenic and ask the points of origin and destination for the calculation. All this information is embedded in a URL using the POST method and sent to the server. This receives the profile and the points of origin and destination of the route to calculate impedance and processes a final result of adding all impedances by those affected. Once each section has an assigned path impedance as "that lower cost", ie the sum of all the



impedances of the sections is the smallest possible, between the source and destination is calculated.

### *Distinctive quality and clinical evaluation*

The growth of mobile applications for health in recent years has been very important. According to reports from the Institute for Healthcare Informatic (Constantine, 2015) there are more than 165,000 health-related applications available and at least 500 million people worldwide who uses it today. In turn one of 10 applications of this nature has the characteristic of emitting a bio-feedback of some parameter of the patient. However, despite this important development, the vast majority of them are not subject to regulatory processes. In a recent study environment related to diabetes (Blenner, et al. 2016) applications has been observed that 81% of applications had no privacy policy. The rest, which itself had not protect user privacy so that 80% was collecting personal information and 50% shared them with others.

We understand it is essential to ensure the safety of consumers by providing information on its limitations and safeguard the information that is required to generate a user profile. To this end, the app RALERGO is being subjected to an audit carried out by the Health Quality Agency of Andalusia responsible for the only Spanish mark (Distinctive "AppSaludable") in terms of quality, the mobile applications related to health. The audit valued aspects of design, quality and information security, confidentiality and privacy, and service delivery.

Another aspect that contrasts with the proliferation of these applications is the absence of clinical evidence that is demonstrative of the efficiency of the project. According to a study based on applications available to address mental health problems, only 2 of 3000 had proven effective in clinical trials (Marzano et al., 2015), in our case the project is in the design phase of a process clinical validation in order to test the usefulness of the application. To this porpoise, it poses a clinical study with allergic to dust mites, pollens, epithelia or fungi, which use the application to choose their movements for several days at different times of year people. After the use of the application will be passed satisfaction questionnaires, as well as information about symptoms, medication requirements, school / work performance and quality of sleep. Although the application is designed to choose the path less allergen exposure, it could also be applied in reverse to identify the routes with allergen exposure. This modification could be used in clinical research by providing a model of allergen exposure in real life and not in camera as usual.

### **Conclusions**

The project is now operational in their first versions, both available in the Google Play and App Store. Right now we try to improve the quality of data related to weather conditions and make more useful the recommendations in a complementary way that the app gives, once you've defined your allergic profile. Meanwhile, we have obtained a first assessment by the audit, and verified 32 points have pointed out weaknesses in 3. These reference points:

- Some inconsistencies of running the app, due to internal programming problems have been solved

- Need to make it compatible with versions of operating systems Android and iOS prior to the last, (iOS 9.2 and Android 3.4 SDK 25)
- Requiring the user may promptly informed of the changes made as a result of a malfunction of the application.

The use of mobile technologies in addressing health problems can transform the way in which health services are provided in the world. Health applications represent a technological tool to help inform and support citizens in self-management of their health and wellbeing, providing information and recommendations. GIS, in this case are presented as a fundamental tool to spatial dimension to the set of variables that are shown as priority for allergic conditions. It has shaped a line of work that has opened the door to further technology-based collaborations between the two research groups, based on improving the quality of life of people inside the city.

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